1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Laboratory containment and ventilation system.

1.3 DESCRIPTION

A. Laboratory Containment and Ventilation 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 the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.

B. Laboratory Containment and Ventilation System shall maintain exhaust airflow to plus or minus 5 percent of signal within one second of a change in exhaust duct static pressure regardless of the magnitude of the pressure change, airflow change, or quantity of airflow control dampers on the manifold over a range of 0.6 to 3.0 inches water column and minimum 16 to 1 turndown.

C. Laboratory Containment and Ventilation System shall measure laboratory fume hood sash position, calculate open area, and proportionally control exhaust airflow control damper in a variable air volume operating mode to maintain a constant laboratory fume hood face velocity in accordance with the requirements of the laboratory hood supplier with a control tolerance of plus or minus 15 feet per minute of set point (100 ± 15 fpm) over a range of 20 to 100 percent of sash travel. Calculations shall be performed minimum 8 times per second to ensure maximum speed of response to changes in sash position.

D. The laboratory fume hood exhaust airflow control damper shall respond to the laboratory fume hood sash position by achieving 90 percent of its commanded value within one second of the sash reaching 90 percent of its final position with less than 5 percent overshoot or undershoot. Rate of sash movement shall be from 1 to 1-1/2 feet per second.
E. Flow element airflow measurement shall be within plus or minus 2 percent of actual flow up to 2,500 feet per minute air velocity as determined by U.S.-G.S.A. type certification tests. Flow element pressure drop shall not exceed 0.1 inches water column at 2,000 feet per minute air velocity. Flow element shall not be affected by contaminated airstreams, dust, temperature, pressure, or humidity. Flow element measurement shall be linear with respect to airflow velocity and capable of sensing airflow in one direction only.

F. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.

G. Airflow control damper shall be capable of operating over a static pressure range of 0.6 to 3.0 inches water column. Control damper pressure drop shall not exceed 0.5 inches water column with an air velocity of 2,000 feet per minute. The corresponding minimum laboratory fume hood exhaust airflow turndown ratio shall be 5 to 1.

H. The sound power levels generated by the control damper shall not exceed the following at 1.5 inches of water pressure drop across the damper. If airflow control damper cannot meet the sound power level specification, a properly sized silencer or sound attenuator shall be used. All silencers shall be of packless design (constructed of minimum 18-gauge 316 L stainless steel when used with laboratory fume hood exhaust) with a maximum pressure drop at the control damper's maximum rated flow rate not to exceed 0.20 inches of water.

<table>
<thead>
<tr>
<th>Discharge Sound Power Level (dB re: 10^{-12} watts)</th>
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<tbody>
<tr>
<td>Octave Band Center Frequency (Hz)</td>
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<tr>
<td>Control Damper Application</td>
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<tr>
<td>Supply</td>
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<tr>
<td>125 70</td>
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<td>250 67</td>
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<tr>
<td>2000 44</td>
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<tr>
<td>4000 39</td>
</tr>
</tbody>
</table>

I. The laboratory fume hood exhaust airflow control damper shall be switched automatically between in-use and standby levels based on the operator's presence immediately in front of the hood based on presence or motion sensor. The airflow control damper shall achieve the required in-use commanded value in less than one second from the moment of detection with less than 5 percent overshoot or undershoot.

1.4 SUBMITTALS

A. Product Data:

1. Submit manufacturer product data for furnished materials in accordance with the requirements of Division 1.
2. Submittals shall include, but not be limited to manufacturer's name and model number of all components, materials of construction, dimensions, instrument specifications, capacities or ratings, controller description, with identification as referenced in construction documents.
3. Submit two templates for all laboratory fume hood mounted instruments including laboratory fume hood monitors, interface
boxes, and sash sensors necessary for complete installation of Laboratory Containment and Ventilation System. Laboratory fume hood manufacturer shall provide necessary cutouts with blank cover plates.

B. Shop Drawings:

1. Submit ten copies of shop drawings. Submit shop drawings and product data as a single submission, unless otherwise noted. Allow one-week review period for either partial or single submissions.
2. Shop drawings shall be in accordance with Lilly CAD Standards and compatible with current Autocad software version. Prepare submittals on minimum 11-inch by 17-inch size paper.
3. Shop drawings shall include the following information, as applicable:
   a. Project Title/Index Sheet: Project title/index sheet for furnished Laboratory Containment and Ventilation System drawings.
   b. System Architecture: Relationship of major system components for the entire Laboratory Containment and Ventilation System architecture including controllers, termination boards, network routers, operator interfaces, and other equipment.
   c. Wiring Typicals: Loop wiring typical circuits from Laboratory Containment and Ventilation System controller hardware to instruments showing fields from an associated engineering database representing enclosure number, terminal number, wire number, and other information for all instruments.
   d. Electrical Installation Details: Wiring details for installation of instrumentation such as wiring routing, connection details, etc.
   e. Mechanical Installation Details: Instrument installation details such as in-line connections, sensing tube connections, mounting supports, tube fittings, etc.
4. Provide damper and control valve information to the Building DDC System Supplier.
5. Submit sequence of operations with highlighted discrepancies from contract documents.
6. Provide Laboratory Containment and Ventilation System instrument list sorted by system name and tag name with item manufacturer name, model name, and other pertinent information.

C. Quality Assurance/Control Submittals:

1. Submit factory calibration certification for each control damper, excluding blade-type control damper, to the airflows indicated on the Drawings and Specifications using NIST traceable instruments with total accuracy of at least plus or minus one percent of signal over the entire range of measurement.
2. Submit manufacturer's product data indicating conformance to UL-916.
3. Submit manufacturer's information indicating compliance to FCC Rules, Part 15, Subpart J for Class 'A' computing device.
4. Submit published performance data and radiated sound power level performance in accordance with ARI 880 for each control damper.

D. Closeout Submittals:

1. During construction, maintain a complete and legible set of drawings at the construction site showing changes and deviations between actual construction and contract drawings.
2. Submit to the Owner for review at the completion of work a complete, accurate, and neat set of marked-up drawings showing the complete "as-built" construction.
3. Submit to the Owner a construction turnover package consisting of commissioning documentation.

1.5 QUALITY ASSURANCE

A. Qualifications: Installation and commissioning of Laboratory Containment and Ventilation System shall be completed by factory-certified personnel employed directly by a local manufacturer's representative, within 100 miles of Owner's installation location.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Products shall be packaged to minimize damage during shipping, handling, and unloading.

1.7 WARRANTY

A. Guarantee work for three years following acceptance by Owner, including both hardware and software. Perform corrective work during that period at no cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Tek-Air Systems, Inc.
2. Phoenix Controls Corporation.

2.2 SYSTEM COMPONENTS

A. The Laboratory Containment and Ventilation System shall consist of the following components:

1. Control panels.
2. Controllers and hardware.
3. Communication hardware.
4. Actuators and operators.
5. Sensors and transmitters.
6. Control dampers.
7. Accessories.

2.3 CONTROL PANELS

A. Enclosure:

1. Enclosures shall be Hoffman NEMA 1 or NEMA 12 steel construction with controller hardware and accessories internally mounted.
2. Enclosures shall be fully recessed in walls with the exception of mechanical areas.
3. Enclosures shall be fully assembled and pre-wired to terminal strips.
4. Enclosures shall contain instrument identification tags.

2.4 CONTROLLERS AND ASSOCIATED HARDWARE

A. General:

1. Each laboratory or pressurization zone shall have its own subnet able to support a minimum of 20 controllers. Laboratory or pressurization zone control functions shall be independent and not reliant on external or building-level control hardware.
2. Controllers shall utilize peer-to-peer, distributed control architecture to perform humidity, temperature, and pressurization control functions as well as implement occupancy and purge mode control schemes. Master-slave control schemes shall not be acceptable.
3. Networks shall utilize a LonTalk (1.25 Mbps) communications protocol and can support up to 100 subnets or 6000 data points.
4. Controllers shall meet FCC Part 15 Subpart J Class A and be UL-916 listed. All equipment shall have been tested and in compliance with the limits for a Class ‘A’ computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in a commercial environment.
5. Laboratory Containment and Ventilation System shall contain a fully stand-alone laboratory controller for each individual laboratory such that each laboratory operates independently without using controllers or information external to the laboratory. Laboratory controller may serve more than one laboratory support space provided all spaces served by a single laboratory controller are on the same floor level and on the same side of the floor, with the intent of maintaining adjacencies.
6. Laboratory Containment and Ventilation System shall provide capability to customize and adjust factory-supplied control parameters such as setpoints, alarm limits, and algorithm gains. Closed-loop proportional integral derivative (PID) control algorithms shall be used to maintain laboratory temperature and volumetric airflow offset.
B. Laboratory Controller:

1. Laboratory controller shall be industrial-grade, microprocessor-based, multi-tasking, real-time digital controller, able to reliably communicate on manufacturer's communication bus with a minimum of 100 laboratory controllers network-wide within the building.

2. Laboratory controller shall have the capability of providing supervisory control of a minimum 20 controllers within the laboratory or pressurization zone.

3. Laboratory controller shall be panel-mounted in an enclosure and operate on 24 volts AC power. Power transformer for the laboratory controller shall be mounted in the same enclosure or in another enclosure adjacent and accessible to the laboratory controller.

4. Laboratory controller application software and database shall be stored in non-volatile EEPROM, EPROM, and PROM or a minimum of 72-hour battery backup shall be provided. Laboratory controllers shall be able to return to full normal operation after a power failure of unlimited duration without operator intervention.

5. Laboratory controller shall have a secure port for connecting a portable computer, modem, or printer for commissioning, maintenance, and troubleshooting.

6. Laboratory controller shall provide control signal to terminal heating temperature control valve, provided by Owner, to maintain laboratory temperature.

7. The ATC Contractor shall furnish control valves with 4-20 mA actuators for the supply air valve hot water coils.

C. Laboratory Fume Hood Controller:

1. Laboratory fume hood controller shall support all laboratory fume hood sash configurations as indicated on the Drawings. Verify with laboratory fume hood manufacturer all laboratory fume hood sizes, sash configurations, and installation requirements.

2. Laboratory fume hood controller shall be industrial-grade, microprocessor-based, multi-tasking, real-time digital controller, able to reliably communicate on manufacturer's communication bus with a minimum of 20 controllers.

3. Laboratory controller shall be panel-mounted in an enclosure and operate on 24 volts AC power.

4. Laboratory fume hood controller shall store its control algorithms in non-volatile, re-writable memory. The controller shall be able to stand-alone or to be networked with other room-level digital controllers using an industry standard protocol.

5. Laboratory fume hood controller shall 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.

6. Laboratory fume hood controller set points, calibration parameters, or operation shall not be affected by momentary or extended losses of power. Laboratory fume hood controllers shall be able to return to full normal operation after a power failure of unlimited duration without operator intervention.

7. Laboratory fume hood controller, upon loss of power, shall retain normally open dampers (exhaust air) to their maximum design flow position and normally closed dampers (supply air) to their...
minimum design flow position. Under no circumstances shall loss of power command the exhaust system to full flow upon return of power.

8. Laboratory fume hood controller shall have a secure port for connecting a portable computer or hand-held instrument for commissioning, maintenance, and troubleshooting.

9. Laboratory fume hood controller shall have built-in integral input/output connections able to address laboratory fume hood control, temperature control, humidity control, occupancy control, purge control, and non-network sensors, switches, and control devices. At a minimum, the controller shall have:

   a. Three universal inputs capable of accepting 0 to 10 volts DC or 4 to 20 mA.
   b. One digital input capable of accepting a dry contact or logic level signal input.
   c. Two analog outputs capable of 0 to 10 volts DC or 4 to 20 mA linear control signal.
   d. One Form C (SPDT) relay output capable of driving up to 1 amp at 24 volts AC per volts DC.

D. Laboratory Fume Hood Monitor:

1. A laboratory fume hood monitor shall be provided for each laboratory fume hood, installed in accordance with the fume hood supplier, and complete with the following items on the faceplate:

   a. Standard operation LED.
   b. Standby operation LED.
   c. Purge exhaust LED.
   d. Caution flow alarm LED.
   e. Purge override button with LED.
   f. Annunciation mute button.

2. The laboratory fume hood monitor may also contain a LCD display for face velocity status, either displayed as NORMAL or ALARM. Calculated or measured face velocity shall not be displayed.

3. All buttons, switches, and indicators on the laboratory fume hood monitor shall be labeled according to their function.

E. Local Display Unit: (ADD#4)

1. The Laboratory Containment and Ventilation System shall have a local display unit that allows control and system variables to be displayed on a user interface terminal device. The local display unit shall communicate with the room-level network and provide access to all room-level control data.

2. The local display unit shall have provisions for flush mounting or surface mounting, either directly to a standard electrical enclosure or DIN rail. Electrical conductors shall terminate inside the local display unit housing to a plug-type terminal block. The local display unit shall operate on 24 volts AC or 24 volts DC.

3. The local display unit shall utilize an LCD display with variable contrast adjustment and backlighting to adapt the display to various lighting conditions.
4. The local display unit shall provide a means of entering and displaying a unique location descriptor that may be used to identify the location and/or function of the display unit. The descriptor shall allow up to two lines of at least 13 alphanumeric characters to be entered in the description field.

5. The local display unit shall have the ability to display up to 250 parameters, organized into display screens of up to five parameters per screen. Each screen shall have the ability to have a descriptive name of up to 16 alphanumeric characters for ease of navigation. Each parameter being displayed shall have the ability to include such information as:
   a. Descriptive tag (up to 13 alphanumeric characters).
   b. Present value, which may be read directly off the network, or conditioned with a fixed multiplier and/or offset to scale the value for the desired units of measure.
   c. Units of measure, which are configurable based on local user conventions.

6. The local display unit shall provide a means for viewing set points and editable control parameters. The user shall have the ability to enable a security pass code to prevent unauthorized changes to set points and control parameters.

2.5 COMMUNICATION HARDWARE

A. Communication Jack:

1. Laboratory Containment and Ventilation System shall include a secure communication jack in each laboratory to allow local commissioning, maintenance, and troubleshooting of any controller within the laboratory. Communication jack shall not allow access to any controller or parameter not serving the laboratory and shall not be affected by communication faults on either side of the laboratory controller.

2. Communication jack may be included as component of other system controller hardware located in the laboratory.

B. Building DDC System Interface:

1. The Laboratory Containment and Ventilation System shall digitally interface to Building DDC System. The Laboratory Containment and Ventilation System supplier shall be responsible to provide an interface device between the Laboratory Containment and Ventilation System and the Building DDC System that is acceptable to the ATC Contractor.

2. The Building DDC System Supplier shall be responsible to provide digital interface devices, drivers for interfacing with BacNet protocols, software indigenous to the Building DDC System, and graphic displays for the Laboratory Containment and Ventilation System.

3. The following laboratory parameters shall be available at all times through the interface to the Building DDC System for graphical interface, trending, archiving, alarm notification, and status reports. Laboratory Containment and Ventilation System
performance (speed, stability, and accuracy) shall be unaffected by the quantity of points being monitored, processed, or controlled. Alarm notification, when defined, shall be at the designated 24/7 response Building DDC System operator workstation:

a. Laboratory Controller Points:

1) Laboratory temperature.
2) Laboratory temperature setpoint.
3) Laboratory humidity, where specified.
4) Laboratory humidity setpoint, where specified.
5) Laboratory volumetric airflow offset.
6) Laboratory volumetric airflow offset setpoint.
7) Laboratory Exhaust Air Valve position
8) Laboratory Supply Air Valve position
9) Laboratory Supply Air Valve supply air temperature
10) Laboratory Local alarm
11) Laboratory Communication alarm

b. Laboratory Fume Hood Controller Points:

1) Laboratory fume hood airflow alarm.
2) Laboratory fume hood control damper alarm.
3) Laboratory fume hood sash position
4) Laboratory fume hood face velocity
5) Laboratory fume hood purge mode
6) Laboratory fume hood Exhaust Air Valve airflow
7) Laboratory fume hood Exhaust Air Valve position

4. The following laboratory parameters shall be available at all times through the interface to the Building DDC System for adjustment:

a. Laboratory Controller Points:

1) Laboratory temperature setpoint.
2) Laboratory humidity setpoint, where specified.
3) Laboratory Occupied / Unoccupied / Summer – Unoccupied schedule

5. SmartLab Interface shall serve as communications gateway between the Laboratory Containment and Ventilation System and the Building DDC System and shall be seamless as viewed from the Building DDC System operator workstation.

6. The SmartLab Interface shall provide a communication port into the room-level network, provide isolation between the room network and building network, and pass point data between the two systems in a bi-directional fashion.

7. Each SmartLab Interface shall require 24 volts AC, support N2 RS485 at 9600 Baud, and be capable of addressing up to 5 laboratory controllers and up to 15 laboratory fume hood controllers. Each controller on the room-level network shall be accessible from a communication port within the SmartLab Interface. Diagnostics, programming, commissioning, and troubleshooting shall be performed on-line without interfering
with other controllers. Visual indicators shall include a red LED for power, green LED for communications, and yellow LED for room-level network.

8. Points defined above as available through the interface shall be added to as required to support any additional data transfer requirements defined by the sequences of operation on the Automatic Temperature Control drawings M-8.1 through M-8.4. The laboratory air flow control system manufacturer shall be responsible for coordinating with the ATC Contractor and providing all required information without additional cost to the owner.

2.6 SENSORS AND TRANSMITTERS

A. Flow Element:

1. Flow element shall be a flow-sensing device, constructed of type 304 stainless steel for all supply and general exhaust applications and type 316L stainless steel for all laboratory fume hood, biological safety cabinet, and local exhaust applications, unless otherwise indicated on Drawings. Type of connection and/or use shall be indicated on Drawings.

2. Flow element shall be vortex-shedding type consisting of multiple velocity sensors, supported on probe bars. Supply air dampers shall be equipped with flow straighteners.

3. Flow element shall provide digital pulses in direct proportion to the velocity and airflow through the duct.

4. Flow element shall have an accuracy of plus or minus 2 percent of airflow over the entire flow range. Sensors shall provide information to controller either directly as digital pulses or as 4 to 20 milliampere analog signals linear and proportional to the airflow.

5. Flow element shall include identification label on casing listing manufacturer, model number, size, area, and specified airflow capacity.

6. Flow element shall consists of multiple sensors in accordance with the following recommendations:

   a. Flanged:

<table>
<thead>
<tr>
<th>Duct Area In Square Feet</th>
<th>Rectangular Number of Sensors</th>
<th>Circular Number of Sensors</th>
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<tbody>
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<tr>
<td>0.3 to 0.8</td>
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<td>8.0 to 15.0</td>
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<td>15.0 and larger</td>
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b. Insertion:

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<td>8</td>
</tr>
<tr>
<td>15.0 and larger</td>
<td>16</td>
<td>12</td>
</tr>
</tbody>
</table>

B. Temperature Element, Room:

1. Temperature element shall be 100 ohm, 4-wire, alpha = 0.00385, platinum RTD.
2. Temperature element accuracy shall be plus or minus 0.3 degrees F at calibration point.
3. Temperature element shall be selected so that the designed operating temperature is located mid-span of sensor range.
4. Temperature element shall be furnished with required mounting hardware and conduit connections necessary for proper installation.

C. Humidity Transmitter, Room:

1. Humidity transmitter shall be factory calibrated and shall measure relative humidity with a hygrometer capacitive sensor.
2. Humidity transmitter output signal shall be 4 to 20 milliampere DC control signal over the stated range.
3. Humidity transmitter accuracy shall be plus or minus 2 percent RH from 0 to 100 percent RH at 77 degrees F including hysteresis, linearity, and repeatability.
4. Humidity transmitter shall be selected so that the operating temperature is located mid-span of sensor range.
5. Humidity transmitter shall be furnished with required mounting hardware and conduit connections necessary for proper installation.
6. Humidity transmitter, located in rooms or areas, shall include plastic locking cover with brushed aluminum face.

D. Temperature Transmitter:

1. Temperature transmitter shall be selected to operate in conjunction with temperature element
2. Temperature transmitter shall be two-wire loop-powered type requiring 12 to 24 volts DC power.
3. Temperature transmitter output signal shall be 4 to 20 milliampere DC control signal over the stated range.
4. Temperature transmitter accuracy shall be plus or minus 0.2 percent of span, including hysteresis, linearity, and repeatability.
5. Temperature transmitter, located in rooms or areas, shall include plastic locking cover with brushed aluminum face.
E. Sash Sensor:

1. Unified sensor bar enclosed in the laboratory fume hood such that no wires are visible.
2. Sash sensor shall have a rated operational life of 250,000 cycles minimum.
3. For variable air volume (VAV) systems, a sash sensor shall be provided to measure the height of each vertically moving laboratory fume hood sash. A sash sensor shall also be provided for horizontal overlapping sashes.

E. Zone Presence and Motion Sensor: (ADD#4)

1. A presence and motion sensor shall be provided to determine an operator's presence in front of a laboratory fume hood by detecting the presence and/or motion of an operator, and to command the Laboratory Containment and Ventilation System from an in-use operating face velocity (e.g., 100 fpm) to a standby face velocity (e.g., 60 fpm) and vice versa.

2. Sensor shall define a detection zone that extends approximately 20 inches from the front of the laboratory fume hood. If the sensor does not detect presence and/or motion in its detection zone within five seconds, it shall command the system to the user-adjustable standby face velocity. When the sensor detects the presence and/or motion of an operator within the detection zone, it shall command the system to the in-use face velocity within one second.

3. Sensor shall have a control circuit that adapts to its specific surroundings and adjusts automatically for inanimate objects placed within its detection zone. It shall map the area into memory and, after a period of five minutes, nullify the image of the inanimate object and return to a standby mode. When operators enter and leave the zone, the unit shall adjust automatically between in-use and standby modes. If the inanimate object is moved or taken out of the zone, the unit shall re-map the area automatically.

2.7 CONTROL DAMPERS

A. Control Damper (ADD#4)

1. The Airflow Control Valve shall be a multichamber AccuValve or approved equal.

2. The Airflow Control Valve shall consist of a compression section, two airflow control surfaces, factory-mounted digital VorTek airflow measuring device and factory-mounted high speed actuator.

3. 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 performance.

4. Airflow control valves shall be a linear type and shall operate with a minimum turndown ratio of at least 8 to 1.

5. The airflow control valve shall respond within one second of a change in duct static pressure when provided with factory controls.

6. Accuracy of the airflow valve shall be 5% of reading in the 8 to 1 range of the damper.

7. Valves for fume hood or other corrosive service shall incorporate stainless steel materials of all components in contact with the airstream. Valves made of aluminum or steel that are coated will not be acceptable. Valves for non-corrosive service shall be made of galvanized steel.

8. Airflow control valves shall operate without linkages, springs, levers, or bearings, in the airstream due to the effect of fume hood exhaust on those materials, and shall exhibit no deadband or hysteresis. Airflow control valves shall be field selectable fail-safe to either the open or closed position depending on the application. For airflow valves with linkage, springs, levers or bearings in the airstream access doors must be provided upstream and downstream of each and every damper for inspection of those devices for maintenance purposes.

9. All critical components of the airflow control valve shall be easily accessible from one side of the valve. All linkages shall be out of the airstream to avoid possible corrosion and loss of accuracy.

10. Airflow control valves shall be of a low pressure drop design for energy efficiency. Valves shall not require greater than 0.25” pressure drop at 1500 fpm and 0.4” pressure drop at 2000 fpm. Airflow control valves that require higher pressures to operate shall not be acceptable.

11. The airflow valve shall be complete with an 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. If an airflow valve such as a venturi valve is submitted that uses mechanical means for creating pressure independence such as springs and plungers, the valve manufacturer shall provide a 5 year service contract to the owner at no additional charge. The contract shall provide recalibration of the mechanical device using NIST traceable air stations and instrumentation having a combined accuracy of at least +1% of signal over the entire range of measurement. These mechanical devices shall be further calibrated and their accuracy verified to +5% of signal at a minimum of eight different airflow across the full operation flow and static pressure range of the device. Service is provided twice annually for 5 years with complete service reports provided to the owner.

12. 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. A VorTek airflow sensor shall be provided in each chamber of the airflow control valve. Airflow measuring devices shall be capable of measuring velocity over the full range of 400 to 5000 FPM. Pitot or Thermal Airflow sensors shall not be acceptable.
13. 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 CPVC and ABS.

14. 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.

15. Velocity measurements from individual sensors shall be summed in the associated Airflow Controller via integral Airflow Measurement circuitry or an integral Airflow Transmitter. The measurement shall be input and conditioned digitally to eliminate Analog-to-Digital 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 8:1.

16. 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, 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 guidelines for up and downstream conditions.

17. The airflow sensors shall be easily accessible in the valve for inspection.

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

19. Sensing methods employing thermal devices in the airstream shall not be acceptable due to their susceptibility to dust and dirt buildup in and exhaust airstream which could cause serious errors in readings and resultant safety issues in the laboratory.

20. Airflow Control Valve shall have factory installed electric actuator which shall operate on 24VAC. Actuator shall accept either a 4-20maDC or 2-10VDC signal and shall modulate the valve over the range of CFM. The actuator shall modulate the valve between 0 to full scale CFM in under 2 seconds.

21. Warranty shall commence upon the date of shipment and extend for a period of twenty-four months whereupon any defects in materials shall be repaired by the supplier at no cost to the owner.

B. Control Damper, Venturi Valve:

1. Damper shall be formed in a venturi configuration with a sliding control ball regulating airflow by means of a calibrated spring.

2. Damper shall be constructed in accordance with the following:
   a. Class A – Non-corrosive airstreams (supply and general exhaust):
1) Damper shall be constructed of minimum 16-gauge aluminum.
2) Damper shaft and shaft support brackets shall be constructed of type 316 stainless steel.
3) Pivot arm and internal mounting linkage shall be constructed of aluminum.
4) The pressure independent springs shall be a spring-grade stainless steel.
5) The internal nuts, bolts, and rivets shall be constructed of 300 series stainless steel.
6) All shaft bearing surfaces shall be made of Teflon, polyester, or PPS (polyphenylene sulfide) composite.

b. Class B - Corrosive airstreams (laboratory fume hoods and biological safety cabinets):

1) Damper shall be constructed of minimum 16-gauge aluminum with baked-on, corrosion-resistant phenolic coating.
2) Damper shaft shall be constructed of type 316 stainless steel with Teflon coating. Damper shaft support brackets shall be constructed of type 316 stainless steel.
3) Pivot arm and internal mounting linkage shall be constructed of type 303 or 316 stainless steel.
4) The pressure independent springs shall be a spring-grade stainless steel.
5) The internal nuts, bolts, and rivets shall be constructed of 300 series stainless steel.
6) All shaft bearing surfaces shall be made of Teflon or PPS (polyphenylene sulfide) composite.

3. Damper control ball shall ride on ball bearings or Teflon. The control rod shall slide on PET, PEEK, or nylon bushings.
4. Damper control ball shall have a positive bearing surface at both the upstream and downstream ends of the ball to reduce jamming on the control rod.
5. Damper shall have factory-installed quick disconnect flanges on both ends.
6. Damper for two-position or variable air volume application shall be provided with factory-installed UL 916 listed electronic actuator. Loss of main power shall cause the damper to failsafe state. This position shall be maintained constantly without external influence, regardless of external conditions on the damper. Constant air volume applications do not require actuator.
7. All supply air applications, damper shall be factory insulated with minimum 3/8-inch flexible closed-cell polyethylene insulation having a flame spread index of 25 maximum and smoke developed index of 50 maximum in accordance with ASTM E84, NFPA 255, and UL-723. Insulation shall have a permeability of less than 0.05 perm-inch, minimum thermal conductivity (K) of 0.13 BTU-inch per hour-square foot-degree F at 75 degrees F mean temperature, and a nominal density of 2.2 pounds per cubic foot. Internal insulation or lining is prohibited.
8. Each damper shall be marked with device-specific factory calibration data. At a minimum, it should include the Owner's tag number, serial number, model number, eight-point
characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation.

9. Sound attenuating devices used in conjunction with general exhaust or supply airflow control dampers shall be constructed of minimum 24-gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.

2.8 ACCESSORIES

A. Pilot Positioner: Pilot positioner shall be positive positioning, field reversible with adjustable starting pressure and operating span, factory mounted on the actuator. Pilot positioner air consumption shall be maximum 0.035 cubic feet per minute.

B. Signal Converter: Signal converter input signal shall be 4 to 20 milliampere or 0 to 10 volts DC. Signal converter output signal shall be 1 to 13 pounds per square inch, 3 to 15 pounds per square inch, or 0 to 20 pounds per square inch. Signal airflow rate shall be minimum 4.5 standard cubic feet per minute at 20 pounds per square inch supply pressure. Signal converter shall be provided with 1/8-inch NPT or 1/4-inch barbed connections.

C. Static Air Pressure Probe, Room:

1. Static air pressure probe shall be nominally 6- to 8-inch diameter, perforated faceplate, with aluminum baffle canister to dampen pressure measurement located on unexposed side. Faceplate shall be constructed of 300 series stainless steel for cleanroom application and either aluminum or 300 series stainless steel for non-cleanroom application.

2. Static air pressure probe shall be provided with 1/4-inch brass barbed connection.

3. Static pressure probe shall be secured to ceiling or wall with stainless steel screws. Faceplate shall be secured from outside for a cleanroom application (unexposed screws) and may be secured either from within or outside for a non-cleanroom application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The ATC Contractor shall be responsible for installation of the laboratory air flow control system under the supervision of the laboratory air flow control system manufacturer. The HC shall install all air valves and control valves. The ATC Contractor shall install all transformers, controllers and associated terminal devices, control wiring and communication trunk wiring based on shop drawing submittal information prepared by the laboratory air flow control system manufacturer. The ATC Contractor shall integrate the laboratory air flow control system with the BMS such that the BMS colorgraphic displays, alarm and trending capabilities are used in conjunction with
data from the laboratory air flow control system. The HC shall install all airflow monitoring transmitters. (ADD#4)

B. Equipment Installation: Equipment shall be installed in accordance with manufacturer's instructions and/or as indicated on Drawings. Controllers, which are surface-mounted, shall be anchored in place in an upright position with top enclosure no higher than 6 feet above finished floor.

C. Instrument Installation:

1. General:
   a. Instrument locations shall be verified before installation.
   b. Instruments shall be installed in accordance with manufacturer's instructions.
   c. Instruments, dials, scales, etc. shall be covered during construction for protection.
   d. Instruments shall be furnished with identification tags attached, bearing the Owner's identification number, in the format "Tag Prefix-Tag Suffix" as indicated on Drawings.
   e. Instruments located in mechanical areas, shall be installed with centerline 4'-6" above finished floor or platform. Instruments located in non-mechanical areas, shall be installed no greater than 4'-0" above finished floor or platform. Minimum height for mounting instruments shall be 2'-0" above finished floor or platform to the bottom of the instrument. Owner or Owner's designated representative must approve exceptions to this requirement.
   f. Instruments, their process connections, and piping configuration shall be oriented so to not obstruct operation and maintenance areas.
   g. Instruments mounted on insulated surfaces shall have insulation between it and the surface to prevent condensation or heat transfer.
   h. Instruments shall be supported independent of pipe, duct, and equipment. Pipe, duct, and equipment shall not be used for attaching structural supports.
   i. Instruments shall be installed with mounting brackets.

2. Sensors and Transmitters:
   a. Instruments to be located on duct (temperature, humidity, high limits, and static pressure probes) shall be installed such that they are readily accessible for servicing and maintenance. Duct-mounting access doors shall be installed adjacent to instruments for maintenance and calibration.
   b. Flow elements shall be installed in a straight section of duct with strict adherence to the manufacturer's installation instructions (usually ten duct diameters upstream or five duct diameters downstream).
   c. Temperature elements mounted on an exterior wall shall be provided with an insulated back plate.
   d. Sash sensors mounted on the laboratory fume hood sashes shall extend to a maximum of 1/8-inch of the sash trim edges.
3.2 COMMISSIONING

A. The system supplier shall be responsible for commissioning of all equipment, instruments, and systems under this section. Commissioning, as defined by the Owner, is a planned, documented, and managed engineering approach to the startup and turnover of facilities, systems, and equipment to the end-user that results in a safe and functional environment that meets established design requirements and stakeholder expectations. Commissioning shall include, but not be limited to, the following activities:

1. Receipt verification shall be performed on all AF&ID and P&ID tagged components, under the responsibility of this Contractor, verifying
   a. model number
   b. tag number (tag prefix and tag suffix)
   c. component is not damaged
   d. all required manufacturer's documentation (e.g., IOM manuals, catalog cut sheets) is available, and
   e. key aspects are satisfied.
   f. In addition, component-specific information (e.g., Owner's property tag number, component serial number) shall be recorded.

2. Maintenance package development shall consist of identifying and documenting maintenance requirements (i.e., PMs, spare parts, CMMS data) for all new equipment and instruments installed under this Contract. Maintenance package development shall be by Owner.

3. Installation Verification
   a. Component installation verification shall be performed on all AF&ID and P&ID tagged components, under the responsibility of this Contractor, verifying
      1) receipt verification has been executed and documentation has been completed and approved
      2) component has been installed per Owner and manufacturer's specifications
      3) tag number (tag prefix and tag suffix) matches number on AF&ID or P&ID
      4) component is not damaged
      5) component has been piped or wired as required, and
      6) safety devices are installed.
   b. System installation verification shall be performed verifying
      1) surface finishes, where applicable
      2) location and tag of major equipment
      3) major components of the system and their interconnections
      4) location of instrumentation and control devices, and
      5) major components of control system.
4. Instrument loop checks shall be performed to verify wiring continuity from field device to remote controller input/output after installation, to confirm proper scaling and indication on remote monitors, and to confirm correct fail position upon loss of power or air. Loop checks shall be performed using pre-approved forms unless prior Owner approval is obtained. If there is an instrument database available, the procedures and forms may be electronically generated.

5. Initial calibration checks shall be performed to ensure that newly installed devices produce accurate test results prior to functional testing or operational qualification testing. Initial calibration checks shall be performed after field installation and instrument loop checks.

6. Upon satisfactory installation, each system shall be formally started-up to ensure that the equipment or system is compliant with requirements and can be safely set into motion and stabilized prior to functional testing. System start-up activities may include Owner's Health, Safety, & Environmental reviews, start-up sequence training, verification of default parameters and set points, preliminary functional testing, troubleshooting and problem resolution.

7. Functional testing shall be performed on all systems after system start-up to verify components of the system operate safely within required operating range and meet design criteria.

8. Commissioning Package shall be compiled which includes or references all commissioning documentation listed as well as a summary of the commissioning results. Where a commissioning plan was developed, a summary report shall be developed and approved to indicate that all of the requirements of the plan were met.

9. All system qualification and validation activities shall be by Owner.

3.3 MAINTENANCE

A. The system supplier shall provide, at no additional cost to the Owner, during and after the warranty period, ten years of required preventive maintenance on all flow elements and flow transducers provided under this section. Flow elements shall be removed, inspected, and cleaned annually during the five-year period to prevent inaccuracies due to long-term buildup from corrosion, lab tissues, wet or sticky particles, or other materials that foul the sensor. If impractical to remove the airflow sensors, the Contractor shall include in the proposal the cost of supplying and installing one duct-mounted access door for each sensor. The transducer shall be checked and recalibrated annually to ensure long-term accuracy.

3.4 DEMONSTRATION

A. Training:

1. The Laboratory Containment and Ventilation System supplier shall furnish a minimum of 32 hours of Owner training by factory trained and certified personnel. The training shall provide an overview of the job specific airflow control components,
verification of initial laboratory fume hood monitor calibration, general procedures for verifying airflows of control dampers, and general troubleshooting procedures.

2. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

3.5 SEQUENCE OF OPERATIONS

A. Laboratory Fume Hood Monitor:

1. The laboratory fume hood monitor shall provide visual alarm indication and audible alarm annunciation upon low face velocity condition, after a 10 second delay, preferably adjustable. There shall be no alarm indication for high face velocity condition. The visual alarm indication (flashing light) shall always continue during an alarm condition and never be deactivated. The audible alarm annunciation may be silenced by the mute button; however, it must reactivate after 10 minutes if alarm condition still exists.

2. The laboratory fume hood monitor shall provide continuous visual alarm indication and audible alarm annunciation while purge mode is activated, initiated by pressing of the purge override button. Visual alarm indication may only be deactivated and audible alarm annunciation silenced when purge mode is deactivated, initiated by pressing of the purge override button again.

3. The laboratory fume hood monitor audible alarm annunciation mute function shall be automatically reset when an alarm condition ceases or when a new alarm is detected.

4. The laboratory fume hood monitor shall not have any means to interrupt or modify laboratory fume hood exhaust airflow.

5. The laboratory fume hood monitor shall provide the following additional interface capabilities:

   a. Accept command inputs to regulate the flow accordingly and make this command value available to the Building DDC System.
   b. Accept a sash position signal and make this value available to the Building DDC System.
   c. Accept a Usage Based Control signal to indicate user presence and make this signal available to the Building DDC System.
   d. Provide a flow feedback signal to the fume hood monitor, which may be used for calculating face velocity or to confirm the airflow device has achieved the proper flow rate and make this value available to the Building DDC System.

B. Pressurization Control:

1. The Laboratory Containment and Ventilation System shall control supply and auxiliary 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. This offset shall be field adjustable and represents the volume of air, which will enter (or exit) the room from the corridor or adjacent spaces.
2. The pressurization 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. The offset shall be adjustable by an authorized user with the appropriate access level.

3. The pressurization control algorithm shall consider both networked devices, as well as up to three non-networked devices providing a linear analog flow signal and any number of constant volume devices where total of supply devices and the total of exhaust devices may be factored into the pressurization control algorithm.

4. Volumetric offset shall be the only acceptable means of controlling room pressurization. Systems that rely on differential pressure as a means of control shall provide documentation to demonstrate that space pressurization can be maintained if laboratory fume hood sashes are changed at the same time a door to the space is opened.

5. The pressurization control algorithm shall support the ability to regulate the distribution of total supply flow across multiple supply airflow control devices in order to optimize air distribution in the space.

C. Purge Mode Control:

1. The Laboratory Containment and Ventilation System shall provide a means of overriding temperature and pressurization control in response to a purge command, 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 Building DDC System command.

2. Once a purge mode is invoked, pressurization and temperature control are overridden for the period that the mode is active. Purge modes shall have a priority scheme allowing a more critical mode to override a previously set condition.

D. Temperature Control:

1. The Laboratory Containment and Ventilation System shall regulate the space temperature through a combination of volumetric thermal override and control of reheat coils and/or auxiliary temperature control devices. The Laboratory Containment and Ventilation System shall support up to four separate temperature zones for each pressurization zone. Each zone shall have provisions for monitoring up to five temperature inputs and calculating a straight-line average to be used for control purposes. Separate cooling and heating set points shall be writable from the Building DDC System, with the option of a local offset adjustment.

2. Temperature control shall be implemented through the use of independent primary cooling and heating control functions, as well as an auxiliary temperature control function, which may be used for either supplemental cooling or heating. Cooling shall be provided as a function of thermal override of conditioned air with both supply and exhaust airflow devices responding simultaneously so as to maintain the desired offset. Heating
shall be provided through modulating control of a properly sized reheat coil.

3. The Laboratory Containment and Ventilation System shall also provide the built-in capability for being configured for hot deck/cold deck temperature control.

4. The auxiliary temperature control function shall offer the option of either heating or cooling mode and to operate as either a standalone temperature control loop, or staged to supplement the corresponding primary temperature control loop.

E. Humidity Control:

1. The Laboratory Containment and Ventilation System shall have an embedded humidity control function, which allows the monitoring and control of the relative humidity level in the pressurized zone. Using peer-to-peer control, the airflow devices shall have the ability to monitor the relative humidity level of the space and, based on a Building DDC System writable set point, develop a control signal to drive one or the other humidification or dehumidification control circuits.

2. The humidity control loops shall share a common set point, with a configurable deadband adjustment to prevent the humidification and dehumidification control functions to operate at the same time.

F. Occupancy Control:

1. The Laboratory Containment and Ventilation System shall have the ability to change the minimum ventilation and/or temperature control set points, based on the occupied state, in order to reduce energy consumption when the space is not occupied. The occupancy state may be set by either the Building DDC System as a scheduled event or through the use of a local occupancy sensor or switch.

2. The Laboratory Containment and Ventilation System shall support a local occupancy override button that allows a user to override the occupancy mode and set the space to occupied for a predetermined interval. The override interval shall be configurable from 1 to 1440 minutes. The local occupancy sensor/switch or bypass button shall be given priority over a Building DDC System command.

G. Local Alarm Control: Laboratory Containment and Ventilation System shall provide the means of summing selective alarm activity at the room-level network and generating a local alarm signal. The local alarm signal may be directed to any available output, as well as to the Building DDC System. The alarm mask may be configured differently for each room-level system.

H. Diversity Alarm: The Laboratory Containment and Ventilation System shall have the ability of monitoring the airflow values for the pressurized space and generating an alarm signal in the event the total exhaust flow exceeds a predetermined threshold. The diversity alarm is intended to allow the user to take diversity in the design and generate an alarm condition in the event the diversity threshold
is compromised. This function must be available in either an integrated or standalone system.

I. Two-Position Exhaust Airflow Control Damper: Controller shall maintain a factory-calibrated fixed maximum and minimum flow set point based on a switched 0 to 20 pounds per square inch pneumatic signal. Two-position devices requiring feedback shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow. All two-position devices shall be either networked or hard-wired into the room-level network so as to be considered under airflow control.

J. Laboratory Office Airflow Control Damper: Controller shall maintain a temperature set point by controlling the airflow and the reheat coil temperature control valve (if required) in response to a room temperature sensor. An additional output shall be provided for supplementary cooling or heating of the office space. If the controller is not required for make-up airflow control for the laboratory fume hoods, then the one-second speed of response and fail-safe conditions required of the Laboratory Containment and Ventilation System shall not apply.

K. Constant Volume Airflow Control Damper: Controller shall maintain a constant airflow set point. It shall be factory calibrated and set for the desired airflow. It shall also be capable of field adjustment for future changes in desired airflow.

END OF SECTION 23 38 16