SECTION 15960 - LABORATORY AIRFLOW CONTROL SYSTEM
[Add6-12]

PART 1 - GENERAL

1.01 REFERENCE

A. Section 17200 – Building Management System

B. Section 15010 – General Provisions

C. Section 15855 – Air Handling Units

D. Section 15890 – Sheet Metal Work & Accessories

E. Section 15996 – Testing, Adjusting, Balancing

1.02 SCOPE

A. Provide and install a laboratory airflow control system (LACS) to maintain laboratory airflow, pressurization, temperature and fume hood average face velocity. Room pressurization control shall utilize airflow tracking to vary the volume of supply air into the room and general exhaust air from the room to maintain both minimum ventilation and airflow balance. The room pressurization control system shall also maintain laboratory temperature. Also, humidity and differential pressure monitoring (where applicable). The exhaust air volume of laboratory fume hoods shall be controlled by a stand-alone fume hood controller that is, seamlessly, incorporated into the room pressurization control system.

B. The system shall include room controllers, fume hood controllers, supply and exhaust air flow control devices, reheat coils and valves, all associated low voltage wiring, and all necessary accessories to implement an integrated system as specified herein. System verification and documentation as specified under the commissioning section) shall also be included.

C. All laboratory air valves and associated controls shall be furnished by Division 17. [Add7-24

1.03 QUALITY ASSURANCE

A. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of LACS systems and shall be the manufacturer's latest standard design that complies with the specification requirements.

B. Warranty shall start on the date of owner acceptance for a period of 1 year. Any materials or system performance problems shall be corrected by the manufacturer at no cost to the owner.

C. Supplier shall have an in-place support facility within 150 miles of the site with technical staff, spare parts inventory, and all necessary test and diagnostic equipment.

D. Installation as well as the startup, checkout and commissioning of the LACS shall be by full time employees of the control system manufacturer and shall be fully trained by the system manufacturer.

1.04 SUBMITTALS

A. Submit 5 complete sets of documentation prior to start of installation. The submittal shall include:
   1. Manufacturer's product data including all equipment components such as fume hood monitors, controllers, terminal devices, etc.
   2. Shop drawings shall include system wiring diagrams with sequences of operation, schedule of air terminal devices, and a system configuration diagram showing all controller types and locations.

PART 2 - PRODUCTS

2.01 LABORATORY SUPPLY AND EXHAUST AIR TERMINALS

A. Laboratory terminal units shall be venturi type units with varying orifice functionality. Laboratory terminal units shall provide turndown ratios of 8 to 1 for fume hood exhaust terminals and adequate turndown for room supply and general exhaust terminals. Adequate turndown to assure that the airflows specified can be maintained. All terminals shall be controlled to be pressure independent and include actual airflow measurement feedback as an integral part of their control process. Minimum airflow measurement accuracy shall be +/- 5% of actual reading over the entire rated airflow range of each device. Airflow measurement device accuracy shall be certified by AMCA (Air Movement and Control Association). Proof of AMCA accuracy certification shall accompany the submittal. Overall room control performance shall substantiated by a third party test report. Minimum to maximum terminal airflow (or visa versa) shall be attained in less than 1 second.

B. Exhaust airflow measurement shall be provided by airflow sensing techniques that are not likely to obstruct the exhaust duct or become inoperative due to the accumulation of chemical deposits . Pitot tube arrays are NOT acceptable for exhaust airflow measurement since they may collect tissues and other debris and their minute pressure sensing holes become plugged with deposits.

C. All terminals shall have a pressure drop of 0.3" or less at the maximum rated airflow.

D. A loss, increase and/or decrease of airflow shall be transmitted to the fume hood or room controller as appropriate.

E. Discharge and Radiated sound power level data for all terminals shall be available and provided at the owner's or engineer's request. The data shall be in accordance with the test procedure in ARI 880-89 Standard for Air Terminals and all data shall be obtained in a qualified, accredited and ARI approved testing laboratory.

F. Terminals that require factory calibration shall be calibrated to the job specific airflow's indicated on the drawings. Factory calibration shall be conducted on certified NIST traceable air stations and shall be conducted for eight airflows including a test of pressure independence at three static pressures. NIST instrument certificates shall be provided as evidence of compliance. Each terminal device shall be individually marked with its specific factory calibration data. As a minimum, include tag number, serial number, model number, eight point characterization information, and quality control inspection numbers. All information shall be available for inclusion on as-built drawings.

1. Room and fume hood airflow accuracy and performance shall be guaranteed as specified irrespective of field conditions.

2. In order to guarantee safety and compliance, LACS systems that do not measure actual airflow must provide independent airflow measuring stations. Independent airflow measuring stations shall be provided at each supply air valve, general exhaust air valve and fume hood exhaust air valve for each laboratory or pressurized space. The signals from these measurement stations shall be directly linked to the central BAS. Airflow measurement stations shall consist of an averaging airflow sensor, which shall provide an average duct velocity pressure to an airflow transmitter. Airflow transmitters shall provide an output of 4-20 mA proportional to velocity pressure. Airflow transmitters shall have an accuracy of at least +/-0.5% of the transmitter range.

G. Supply air terminals shall be provided with a 2-row heating water coil of size and performance indicated on the plans. Coils shall be copper tubes mechanically expanded into aluminum plate fins, leak tested under water to 300-psig pressures, factory installed. Air pressure drop thru coils shall not exceed 0.25" at scheduled airflows.

H. As an option, pneumatically actuated laboratory air valves may be utilized by using compressed air from laboratory air system. All additional compressed air piping, accessories and controls shall be provided as required to provide a fully functional system that is integrated into the BMS.

2.02 LABORATORY ROOM CONTROLLER

A. Each supply and associated exhaust terminal shall be controlled to maintain an actual CFM airflow differential between total room exhaust and supply air that is equal to 10% of the maximum laboratory room design airflow or 200 CFM, whichever is greater, to meet space pressurization requirements. For negatively pressurized rooms, supply airflow shall be controlled to equal the total room exhaust airflow less the required airflow differential (200 CFM setpoint). For positively pressurized rooms, total exhaust airflow shall track supply airflow less the required airflow differential. A room pressure transmitter shall be installed to monitor room pressure versus corridor pressure. The CFM offset shall be increased if room pressure becomes less negative with respect to the corridor (0.05" setpoint). An alarm condition shall be displayed at the BAS workstation if the room pressure drops below 0.04" static pressure for a user defined time period (typically 20 seconds).

Room airflow tracking shall be accomplished via actual measurement of terminal unit airflow. Controllers which track within a range of airflow's versus actual airflow setpoints, shall not be acceptable.

B. Each laboratory room controller shall be specifically designed for control of laboratory temperature, (humidity and differential pressure monitoring where applicable) and room ventilation. Each controller shall be a microprocessor-based, multi-tasking, real-time digital control processor. Control sequences shall be included as part of the factory supplied software. These sequences shall be field customized by adjusting parameters such as control loop algorithm gains, temperature setpoint, alarm limits, airflow differential setpoint, and pressurization mode. Closed loop Proportional Integral Derivative (PID) control algorithms shall be used to maintain temperature and airflow offset set points.

C. Controllers using a differential pressure switch to monitor differential pressure across control devices such as an air valve shall include provisions for manual and automatic zeroing in order to maintain stable control and ensure against drift over time.

D. Controller shall include all inputs and outputs necessary to perform all ~~the~~ specified control sequences.

E. *Each controller shall operate stand alone, performing its specified control responsibilities independently.*

F. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM memory, or a minimum of 72-hour battery backup shall be provided. All controllers shall return to full normal operation without any need for manual intervention after a power failure of unlimited duration.

G. Should a power failure or operational failure occur within the controller, the terminal unit damper shall automatically be positioned to the fully open or fully closed (failsafe) position as defined by the owner.

2.03 VARIABLE AIR VOLUME FUME HOOD CONTROLLER

A. Provide a UL 916 listed individual fume hood controller for each fume hood which shall maintain the face velocity setpoint (adjustable) in response to sash position.

B. In operation, the fume hood control process consists of calculating the fume hood exhaust flow necessary to provide the required average face velocity at any sash position based upon actual sash position and total fume hood open area. The controller shall then position the fume hood exhaust terminal damper to attain the required exhaust airflow in conjunction with constant feedback from an integral exhaust airflow sensor. The controller shall perform this exhaust airflow calculation ten times per second to ensure maximum speed of response to changes in sash position Even when no change has occurred in sash position since the previous calculation, the controller shall continue to position the exhaust terminal damper in response to its airflow

measurement feedback to ensure that the required fume hood exhaust is always maintained independently of variations in exhaust system static pressure or room conditions that could otherwise affect fume hood exhaust airflow.

1. *The fume hood controller shall initiate corrective action immediately upon sash movement and be completed when sash movement stops so as to restore the required average face velocity within 1 second after completion of sash movement. Control scenarios that are not based upon sash sensing such as those utilizing side wall airflow sensing must substantiate that fume hood face velocity will be restored within 1 second after completion of sash movement. ASHRAE 110 fume hood response time test data substantiating this performance requirement shall be submitted. All such ASHRAE 110 testing shall be conducted by a qualified, accredited and independent testing source.*
2. *Air velocity sensors utilized for side-wall sensing shall be UL 913 listed. Documentation of UL listing shall be submitted with the technical proposal and included with the submittals.*
3. *A "Sash Alert" feature shall provide periodic beeps at the Operator Display Panel when the sash remains open above the recommended safe working height (adjustable) for an adjustable period of time. This feature shall enhance fume hood safety operation and energy efficiency. This feature shall include a beep interval and be capable of being implemented on individual fume hoods as desired by authorized owner personnel.*

C. *The face velocity setpoint shall be adjustable by authorized owner personnel*

D. *Controllers shall include the ability to accept and incorporate into the control sequence a dry contact closure from auxiliary sensors. Example: Occupancy override, Emergency button, etc.*

E. *Controllers shall provide a general alarm output for use with auxiliary devices.*

F. *Momentary or extended losses of power shall not change or affect any of the control system's setpoints, calibration settings, or emergency status. After power returns the system shall continue operation exactly as before without need for any manual intervention.*

2.04 FUME HOOD OPERATOR DISPLAY

A. *An operator display panel shall be provided for each fume hood to comply with laboratory safety standards. The operator display panel shall provide the following functionality:*

1. *Indicator lights that verify normal operation (green), marginal operation (yellow), and alarm condition (red). An alarm condition shall automatically be initiated for both high and low face velocity conditions.*
2. *An audible alarm device shall also be initiated in response to an alarm condition. The audible alarm device shall be capable of being silenced by a user silence button, however the alarm device shall automatically resound upon another alarm occurrence.*
3. *A user initiated emergency purge function shall initiates a visual and audible alarm and increase the fume hood exhaust to maximum airflow. When the emergency purge button is depressed, a second time, the emergency sequence shall be terminated and fume hood control shall return to normal operation.*

2.05 SASH SENSOR

A. *Provide, sash position sensors for each fume hood to indicate the actual position of each sash. The sash sensor shall be a precision, linear device with repeatable location accuracy within one half inch.*

B. *Sash sensors material shall be corrosion resistant.*

C. *Sash sensors shall allow complete and easy removal of the sashes for cleaning and maintenance.*

D. *Operational life of each sash sensor shall be a minimum of 1,000,000 full cycles.*

E. *Sash sensor failure shall be indicated as an alarm at the fume hood operator display panel.*

PART 3 - EXECUTION

3.01 INSTALLATION

A. The laboratory ventilation system contractor shall install the sash sensors, control equipment, and operator display panels on fume hoods. This contractor shall install and terminate all low voltage control wiring between each controller and all control and sensing devices, and provide 24 VAC power where required by the controllers and control devices. This contractor shall install pneumatic control tubing from the nearest building air main for all laboratory control devices that are pneumatically operated.

B. The electrical contractor shall provide 120 volt power circuit in the laboratory ceiling space for connection to the laboratory control equipment.

C. Supply terminals with reheat coils, exhaust terminals and valves shall be installed by the mechanical contractor.

3.02 SYSTEM STARTUP

A. System startup shall be provided by factory certified and trained employees of the laboratory ventilation control system manufacturer. Start up shall include the following:
- Determine when the HVAC equipment and physical space is ready for operational testing.
- Set up fume hood face velocity controls and verify face velocity and air flow measurement accuracy
- Verify room supply system performance
- Verify room exhaust system performance
- Verify room airflow tracking performance

B. All steps of system startup shall be formally recorded when performed and provided to the owner as part of the as built documentation.

3.03 TRAINING

A. The contractor shall provide competent instructors to give complete and specific on site instruction to owner designated personnel in the adjustment, operation and maintenance of the installed system, in lieu of a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter and the installed system. All training shall be held on weekdays during the normal work hours of 8:00 a.m. to 4:30 p.m.

B. Training shall consist of not less than 16 hours for owner designated operating personnel. Training shall include:
1. Explanation of as built drawings, overall system operation and user required maintenance
2. A thorough walk-through of the job to locate control components
3. Laboratory and fume hood controller specific operation and functions
4. Explanation of adjustment, calibration and replacement procedures

C. Since the owner may desire that specific personnel have more comprehensive understanding of the system and its components, additional training shall be available from the Contractor at a future agreeable date.

3.04 BUILDING AUTOMATION SYSTEM INTERFACE

A. The following laboratory environment information shall be provided to the building automation system.
1. Fume hood exhaust airflow (cfm)
2. Laboratory room supply airflow (cfm)
3. Laboratory room general exhaust airflow (if applicable) (cfm)
4. Fume hood sash position
5. Fume hood flow alarm

6. Laboratory room airflow alarm
7. Laboratory room temperature
8. Laboratory room humidity (where specified)
9. Laboratory differential pressure (where specified)

Information may be transmitted electronically through protocol translators, seamless LAN connection, or through a direct connection (hard wire). If the direct connection approach is used, this contractor shall be responsible for all wiring and any additional building automation and LACS systems control panels required. If the electronic approach is used, this contractor shall be responsible for all network wiring and any protocol translators required by the building automation and LACS systems.

B. The LACS system shall accept control inputs (as a minimum) from the building automation system as follows.
1. Laboratory room airflow offset setpoint adjustment.
2. Laboratory room temperature setpoint adjustment.
3. Occupied state of Laboratory room controls

PART 4 - SEQUENCES OF OPERATION

4.01 LABORATORY ROOM PRESSURIZATION

A. The room pressurization controller shall maintain "negative" laboratory pressure by continuously calculating the required room supply airflow CFM necessary to maintain the predetermined airflow tracking differential. This process shall be based upon subtracting the airflow tracking differential CFM set point (adjustable) from the total room exhaust CFM. The room pressurization controller shall then modulate the supply air terminal unit to achieve the necessary room supply airflow CFM to ensure that the airflow tracking differential is always maintained.

B. The room pressurization controller shall continuously receive the fume hood exhaust CFM set point values from each fume hood controller in the room and shall measure the actual room general exhaust CFM, this includes snorkel exhaust CFM. The controller shall continuously calculate total room exhaust CFM by adding the room general exhaust CFM and all fume hood exhaust airflow's together. The controller shall then modulate the room general exhaust as necessary to ensure that the minimum total room exhaust necessary to meet the required room ventilation rate is continuously maintained as well as maintain a 200 CFM offset between exhaust and supply air CFM.

C. The room pressurization controller shall utilize a differential pressure sensor in the wall between the room and an adjacent non-lab area to continuously measure the actual differential pressure between the laboratory room and adjacent area. The controller shall utilize the differential pressure measurement to establish the airflow-tracking differential required to maintain the room differential pressure set point.

D. The room pressurization control sequence shall include a selectable maximum airflow tracking differential set point and a selectable minimum flow tracking differential set point. The minimum and maximum flow tracking differential set points shall serve as control limits for the room pressurization control scenario.
1. The maximum flow tracking differential set point shall prevent the room pressurization control scenario from decreasing the room supply airflow to an undesirable, low level. Whenever a condition (such as an open door allowing excessive airflow into the room from the adjacent area) would otherwise result in an undesirable, low level of room supply airflow, the maximum flow tracking differential set point shall limit the decrease.
2. The minimum flow tracking differential set point shall prevent the room pressurization control scenario from increasing the room supply airflow to an undesirable, high level. Whenever a condition (such as a failure of the room differential pressure sensor) might cause the room supply airflow to approach or exceed the total room exhaust, the minimum flow tracking differential set point shall limit the increase.

3. ***The room pressurization control shall also include selectable high and low room static pressure alarm limits and an adjustable alarm delay period. Whenever the room static pressure exceeds a high or low static pressure alarm limit for a period of time in excess of the alarm delay period, annunciation of the high or low alarm condition shall occur at the central workstation.***
4. ***Provide a room pressure monitor, which indicates proper pressurization levels. This monitor shall provide a local audible and visual alarm if the lab space becomes positively pressurized. In addition, this monitor shall transmit this alarm condition to the Siemens Apogee Insight server for alarm transmission to all connected workstations.***

END OF SECTION