

LABORATORY FUME HOOD CONTROL SYSTEMS ENVIROTRAK II-MZ

Sample Specification

PART 1 - GENERAL

- A. Provide a complete system for the variable air volume control of laboratory fume hood systems.
- B. System shall include, but not be limited to, control panels, supply variable air volume boxes, general room exhaust valves, fume hood exhaust valves, airflow sensing stations and fume hood sash position and/or velocity sensors.
- C. Total system shall be installed and commissioned by, or under the direct supervision of, factory trained and authorized field engineers.

1.2 Related Work

- A. Section : General Provisions
- B. Section : Variable Frequency Drives
- C. Section : Factory Assembled Air Handling Units
- D. Section : Factory Built-Up Air Handling Units
- E. Section : Centrifugal Fans
- F. Section : Axial Fans
- G. Section : Power Ventilators
- H. Section : Ductwork
- I. Section : Ductwork Accessories
- J. Section : Air Distribution Device
- K. Section : Airflow Control Systems
- L. Section : Building Control Systems
- M. Section : Building Automation Systems

N. Section : Control Sequences of Operation

O. Section : Testing, Adjusting and Balancing

1.3 Job Conditions

A. Coordinate exact sizes and locations of components with the contractor installing the ductwork, temperature controls, and Division 16 work.

1.4 Submittals

A. Furnish shop drawings on all equipment provided under this Section, including but not limited to:

1. Hardware and devices.
2. Installation control drawings.
3. Sequence of Operation.
4. Operating and maintenance manuals.

1.5 Quality Assurance

A. Supplier of this Section systems shall be regularly engaged in the production, assembly, and installation of laboratory fume hood control systems and have a proven track record of a minimum of 5 years.

B. Supplier of this Section systems shall assume single source responsibility for the complete installation, calibration, and startup of the fume hood tracking systems. Systems shall be left in a completely automated, fully functioning mode of operation.

1.6 Warranty

A. Warranty shall commence upon the date of project acceptance by the owner and extend for a period of twelve (12) months.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Base Bid: Laboratory Control Systems Inc. Envirtorak II-MZ system.

2.2 General

A. Fume hood tracking system shall use closed loop control to continually monitor and adjust the supply, general room exhaust, and fume hood exhaust volumes. Open loop control systems that merely feed back an analog signal that measures a position of a mechanical device or systems that can control by pressure only are unacceptable and will not be considered. Open loop and closed loop as defined by 1991 ASHRAE Applications Manual Chapter 41, pg.41.1.

2.3 Systems Design

A. In all cases, systems shall fail-safe to a mode which achieves the maximum safety to personnel in the spaces served by the systems.

B. Room pressurization control will be accomplished by flow synchronization (airflow tracking) or by direct space pressure control, or by a combination of both. Unless specifically identified elsewhere, all systems on this project shall utilize flow synchronization as the mode of control. Airflows from the supply air, general room exhaust, and fume hood exhaust will be measured and controlled to maintain a safe, comfortable, and energy efficient environment.

C1. Fume hood face velocity control (vertical rising sash) will be used to maintain a preset adjustable face velocity setpoint. Input to the controller shall include sash position and fume hood exhaust airflow, from which the controller will calculate the hood face velocity. A pneumatic, normally open, damper motor will modulate an exhaust valve as required to maintain the face velocity setpoint.

C2. Fume hood face velocity control (horizontal sliding or combination sash) will be used to maintain a preset adjustable face velocity setpoint. Input to the controller shall be a direct measurement of fume hood face velocity via a sidewall velocity sensor. A pneumatic, normally open, damper motor will modulate an exhaust valve as required to maintain the face velocity setpoint.

D. The volume of the supply air and exhaust air systems will be varied as required to maintain duct static pressure. Airflow volume control of these systems will be the responsibility of the fume hood control supplier (optional).

E. All actuators will be pneumatic to insure quick response time.

2.4 Equipment

A. Laboratory Room Control Panels: Equal to Laboratory Control Systems Inc. Envirotrak II-MZ laboratory control panels and shall include all control components for the system logic, input signal conditioning, output signal conditioning, power supplied and operator interface. Laboratory control panels shall be located to facilitate maintenance and troubleshooting. Panels shall be of standalone design with the ability to

operate the entire laboratory space it serves upon loss of communications from the laboratory network. Each panel shall be fully field programmable, open architecture type.

B. Central Processing Unit (CPU): Industrial quality with the following minimum performance parameters;

1. Scan Rate: The time used by the control system to read a sensor value, calculate a control response, and output a signal to the controlled element shall not exceed 1/3 second. If a communications link is used to pass control information, then the communications rate and protocol lag time must still allow the control loop to obtain the 1/3 second scan rate.

2. Input Accuracy: To maintain the accuracy of the pressurization control, the input section of the electronics (A/D converter) shall be at least 10 bits (0.02%).

C. Control Modes: The control system shall incorporate proportional, integral and derivative modes of control. Each mode shall be indefinitely adjustable.

D. Alarm Processing: The pressurization and fume hood control system shall provide fully field programmable alarm processing capabilities. The system shall have the capability of high and low alarms. These alarms shall be transmitted over this network to the supervisory system.

E. Controller: Equal to Laboratory Control Systems Inc. Envirotrak II-MZ microprocessor based distributed control system. Able to control a variety of fume hood and face velocity control sequences through standard configurations of interface hardware and software. Controller will accept inputs from RTD (resistance temperature detector) type space and duct temperature sensors. Analog inputs shall be capable of being software filtered to eliminate hysteresis effects and unwanted signals. Controller database (including control sequences) stored in non-volatile EEPROM memory for complete stand alone operation. Features include:

1. 2 wire RS-485 serial communications, 19.2K baud.

2. UNIVERSAL INPUTS

Quantity 8.

Thermistor Input 20 to 140°F (-6.67 to 60°C) range.

Barber-Colman TS-5700-850 series or equivalent.

Balco Input -40 to 250°F (-40 to 121°C) range.

Barber-Colman TS-8000 series or equivalent.

Copper Input -31 to 240°F (-35 to 116°C) range.

Barber-Colman TS-5600 series or equivalent.

Platinum Input -40 to 240°F (-40 to 116°C) range.

Barber-Colman TS-5800 series or equivalent.

Potentiometers 1000 to 20,000 ohms resistance.

Voltage 0-5 Vdc.
Current 4-20 mA_{dc} with 250 ohm shunt resistor.
Contact Input Dry.

MAXIMUM PULSE COUNT RATE

10 per second (50 msec. minimum On or Off time per pulse)
to 1 per 4 minutes (1 input per MZ-II).
1 per second (0.5 sec. minimum On or Off time per pulse)
to 1 per minute (up to 7 inputs per MZ-II).

3. DIGITAL OUTPUTS

Quantity 8.
Contact Ratings
30 VA at 24 Vac, pilot duty.
120 VA at 120 Vac, pilot duty.
Contact Type Form C(SPDT) isolated.
Status Indication Light emitting diode.

4. Analog Input Accuracy: 10 Bit

5. Power Requirements: 20.4 - 30 Vac, 50/60 HZ, 20 VA

6. The control unit shall generate real time signals reflecting actual airflow measurement. Systems that provide only a 0 - 10 volt analog signal must be programmable and must provide an actual airflow measurement to complete a closed loop system. Systems that merely sense a 15 - 20% reduction in airflow are not acceptable. As a minimum the following signals shall be available:

- a. Hood exhaust flow (CFM).
- b. Supply/make-up airflow (CFM).
- c. General exhaust flow (CFM).
- d. Total lab exhaust flow (CFM).
- e. Total lab supply flow (CFM).
- f. Room offset (CFM).
- g. Sash position or Face Velocity.
- h. Room temperature.

7. ANALOG OUTPUTS

Quantity 4.

Type 0-20 mA range programmable source into 500 ohm maximum load, momentary short circuit protection.

8. DIGITAL TO ANALOG CONVERSION RESOLUTION 10 bit.

F. Hood Interface Module: Equal to Laboratory Control Systems Inc.HMI-MZ (Hood Mounted Interface) to provide emergency override, high flow alarm, low flow alarm, hood status lights and programmable audible alarm (90 db at 1 meter). Module designed to fit in a 2 inch by 4 inch (single gang) electric box and mounted on the face of the fume hood. Connection using phone jack termination. All alarm setpoints shall be fully field programmable as well as the time delay interval prior to alarming. HMI-MZ shall also allow high/low sash alarms and limits. All points shall be monitored at the laboratory room control panels and supervisory work station. Alarm and mute functions shall automatically reset when the alarm condition ceases to exist. Alarm annunciation shall be as follows:

1. Normal condition - green LED lighted.
2. Alarm condition - red LED lighted, indicating either:
 - a. Low face velocity
 - b. High face velocity
 - c. Emergency override
3. Caution or control transition: green and red LED flash alternately.
4. Buzzer: energized in any alarm condition (pulsating tone).
energized in any override condition (continuous tone).
5. Push button functions:
 - a. Red - Override
Blue - Alarm Acknowledgement/Audible Mute

G. Auxiliary emergency override switch (optional): each laboratory space connected to the fume hood system control shall include a hall mounted emergency override switch, located near the exit door from the space. This switch shall be equal to the remote HMI-MZ module installed in a tamper resistant box

H. RTD Space Temperature Sensor: Equal to Laboratory Control Systems Inc.RTS in decorative housing for direct wall surface mounting. Two-wire interface with Envirotrak II-MZ controller. No bridge modules required. Features include:

1. Type: Resistance temperature detector (RTD).
2. RTD material: 10K thermistor.
3. Nominal Resistance: 10,000 ohms at 77°F.
4. Temperature range: 40°F - 140°F.
5. Stability: Better than +/- 0.045°F per year.

I. RTD Duct Temperature Sensor: Equal to Laboratory Control Systems Inc.DTS or RTD sensor for installation in air ducts. Two-wire interface with Envirotrak II-MZ controller. Features include:

1. Type: Resistance temperature detector(RTD).
2. RTD material: 10K thermistor.
3. Nominal resistance: 10,000 ohms at 77°F.
4. Temperature range: 32°F - 158°F.
5. Stability: better than +/- 0.045°F per year.

J. Pressure Transmitter: Equal to Autotran differential pressure transmitter. All transmitters shall be easily replaceable. Features include:

1. Fast response time.
2. Auto Zero feature: Unique zero tracking circuitry allowing it to virtually eliminate all output signal drift problems by correcting its zero reference pressure over time and temperature.
3. Solid state circuitry.
4. Virtually position insensitive even at very low pressure (0.01 inches).
5. Accuracy: +/-1% of range being measured (including non-linearity and hysteresis). Range shall be selected for each sensor to match the application, and shall not exceed actual measured device range by more than 25%.

6. Zero adjustment: 10% minimum.
7. Operating environment: 32 - 125°F, 20 - 90% RH (non-condensing).
8. Effect of temperature: +0.05%/C.

K. Airflow Sensors: Multipoint airflow sensors providing an amplified pneumatic signal proportional to velocity pressure in the duct will be used to measure the total room supply and exhaust airflows. Sensors installed in fume hood exhaust ducts shall be made from 316L stainless steel or appropriately coated material for corrosion resistance.

L. Supply Variable Air Volume (VAV) Boxes: Furnish VAV boxes as shown on the drawings and specified under Section, Air Distribution Devices. Controls for the VAV box shall be located in the laboratory control panel for ease of adjustment, calibration, and troubleshooting. This shall apply to all supply VAV boxes serving laboratory and collections areas. Each device must be field calibrated to accurately reflect construction and last minute design changes.

M. Supply Box Reheat Coils: Furnish reheat coils as shown on the drawings and specified under Section, Air Distribution Devices.

N. General Room Exhaust Valves: Furnish general room exhaust valves as shown on the drawings and specified under Section, Air Distribution Devices. Controls for the exhaust valves shall be located in the laboratory control panel for ease of adjustment, calibration, and troubleshooting. This shall apply to all supply VAV boxes serving laboratory and collections areas. Each device must be field calibrated to accurately reflect construction and last minute design changes.

O. Fume Hood Exhaust Valves: Furnish fume hood exhaust valves as shown on the drawings and specified under Section, Air Distribution Devices. Controls for the exhaust valves shall be located in the laboratory control panel for ease of adjustment, calibration, and troubleshooting. Each device must be field calibrated to accurately reflect construction and last minute design changes.

P. Sash Position Sensors: Sash position will be sensed using an industrial quality, digital encoding rotary position transducer connected to the counterweight system of the hood with a stainless steel cable. The sash sensor shall have an expected life of over 250,000 full height sash openings and closings.

Q. Sidewall Face Velocity Sensors: Face velocity will be sensed using a glass enclosed platinum thermal anemometer mounted in the sidewall of the fume hood.

2.5 SEQUENCE OF OPERATION

A. Fume Hood Face Velocity Control:

1. General: The control shall determine the face velocity by measuring the fume hood sash position and the fume hood exhaust flow. The fume hood exhaust damper shall then be adjusted to maintain the programmed adjustable face velocity setpoint. Response time will be 3 seconds or less.

(Alt.) 1a. Through the wall direct velocity sensing is acceptable as long as the remainder of this specification is met. Response time will be 5 seconds or less.

2. Alarms: A visual and audible alarm signal will be initiated if the fume hood face velocity falls below, or rises above, the low or high alarm setpoints respectively. The audible alarm will continue until the alarm silence button is depressed on the fume hood interface module. The visual alarm will continue until the alarm condition ceases.

3. Emergency Override: When the emergency override button on the fume hood interface module is depressed, the exhaust damper shall go to its preprogrammed position (normally, this would be the full open position), and the visual and audible alarms will be activated. Depressing the button a second time will return the system to normal operation. An optional remote override located in the hall outside the space shall function similarly.

4. Night Setback: If desired, the controller will go into the night setback mode at a preprogrammed and adjustable time, or when receiving a signal from an external source. Night setback reduces the face velocity to preprogrammed value.

5. Minimum Flow Setting: The system shall allow a preprogrammed and adjustable sash position setpoint capable of automatic night setback.

B. Airflow Tracking - Laboratories With Fume Hoods:

1. The laboratory tracking system measures all supply and exhaust flows into and out of the laboratory space. Supply air flow is varied to maintain a fixed ratio or combination of fixed and ratio (offset and ratio) air volume differential between the supply and total exhaust in a closed loop tracking arrangement. A space temperature sensor and a duct mounted temperature sensor are inputs to a master/submaster temperature control proportional/integral/derivative (PID) loop.

2. The supply and total exhaust air volumes from the laboratory space shall be controlled (varied) in such manner as to perform both air flow volume (mass) and air flow temperature (energy) calculations and adjustments.

3. Space supply air volume shall be controlled by either a space thermostat, to maintain space comfort conditions, or by the total exhaust volume from the space, to maintain the required air volume offset between the supply and exhaust air volumes.

4. When the supply air volume required for makeup exceeds the volume required for space comfort conditions, the control system shall modulate the general exhaust damper to its closed position. If additional makeup air is still required, the supply air volume will be increased as required to maintain the volume differential between the supply air and exhaust air. The temperature of the supply and exhaust air, along with their respective air volumes, will be measured and input into the controller. The controller will adjust the heating valve on the supply air reheat coil, based on those inputs as well as an input from a space temperature sensor, as required to perform an energy balance in the space. The controller program shall be adjusted and calibrated to each space it serves to perform the mass and energy calculations and adjustments without noticeable swings in space temperature.

5. As the required total exhaust from the space is reduced because of reduced fume hood usage, the supply air volume delivered to the space will be reduced to a level where the required air volume offset is being maintained. If the space thermostat requires a greater volume of supply air to condition the space than is being supplied to maintain the required supply/exhaust offset, the supply air volume shall be increased and the general exhaust volume from the space will be increased as required to maintain the offset.

6. Supply and exhaust systems shall be adjusted to provide a minimum of 4 air changes per hour when in their lowest air flow condition.

C. Airflow Tracking - Laboratories and Collection Areas Without Fume Hoods:

1. The laboratory tracking system measures all supply and exhaust flows into and out of the laboratory space. Supply air flow is varied to maintain a fixed air volume differential between the supply and room exhaust in a closed loop tracking arrangement. A space temperature sensor and a duct mounted temperature sensor are inputs to a master/submaster temperature control proportional/integral/derivative (PID) loop.

2. The supply and room exhaust air volumes from the space shall be controlled (varied) in such manner as to perform both air flow volume (mass) and air flow temperature (energy) calculations and adjustments.

3. Space supply air volume shall be controlled by either a space thermostat, to maintain space comfort conditions, or by the room exhaust volume from the space, to maintain the required air volume offset between the supply and exhaust air volumes.

4. Negative Pressure Spaces: The general exhaust damper shall be modulated to maintain either the minimum ventilation setpoint or to satisfy cooling demand, whichever is higher. The supply flow shall track the exhaust flow to maintain a fixed offset CFM between total exhaust and total supply to keep the space negative at all time. If the air quantity necessary to maintain the ventilation setpoint causes a drop in space temperature below the room setpoint, the reheat coil control valve shall be modulated to maintain setpoint.

5. Positive Pressure Spaces: The supply box shall be modulated to maintain either the minimum ventilation or cooling setpoint, whichever is higher. The general exhaust is modulated to maintain a fixed offset CFM between total supply and total exhaust to maintain the space positive at all times. If the air quantity necessary to maintain the ventilation setpoint causes the space temperature to fall, then the reheat coil control valve shall be modulated to maintain space temperature setpoint.

6. Supply and exhaust systems shall be adjusted to provide a minimum of 4 air changes per hour when in their lowest air flow condition.

D. Fan Static Pressure Control (Optional): Constant static pressure (positive or negative) shall be maintained in each of the supply and exhaust systems by varying the speed of the motor through a variable frequency drive. The tracking control system shall accept a signal from a low differential pressure transducer, the output of which is proportional to the system static pressure as measured by a system static transducer. A change in system static pressure, as recognized by the control system, is compared to the static pressure setpoint, and the output to the variable frequency drive is adjusted, through a PID control loop, to maintain the system static pressure at a constant level. Actual static pressure and control system setpoints shall be available for display at the local control panel and at the control operator's station through the communication network. Control system high and low alarm limits and actions shall be programmable for each system.

PART 3 - EXECUTION

3.1. Installation

A. The laboratory control manufacturer shall be responsible for ensuring that the control system is installed and operates properly as intended and designed. Installation of all components shall be installed by, or under the direct supervision of, factory authorized personnel.

B. The Sheet Metal Contractor shall be responsible for the installation of the supply VAV boxes, fume hood exhaust valves, general exhaust valves, airflow sensing stations and any other devices to be installed in the air streams.

C. The laboratory control manufacturer shall provide detailed control schematics and prepare field installation drawings. The Temperature Control Contractor shall provide a source of clean, dry, control grade 20 psig air as required.

D. The electrical contractor will provide 120VAC power for each laboratory control panel.

E. The laboratory control manufacturer shall send the fume hood interface modules, sash position sensors and/or sidewall velocity sensors to the successful fume hood supplier for mounting at the fume hood manufacturer's factory. Provide detailed mounting schematics.

3.2 System Start-Up

A. All point to point terminations, setpoint adjustment and calibration, system start-up, and final calibration shall be performed by, or under the direct supervision of, factory trained and authorized field engineers. The installed system must be able to be field calibrated on site without removing the box or valve. This will insure an accurately calibrated finished product that will reflect changes in the construction phase or last minute design requirements.

B. Each fume hood system shall be calibrated and tuned to provide safe, efficient, fail-safe operation. Sash position sensors shall be field calibrated for sash area, velocity sensors and flow transducers shall be field calibrated for zero and span, and control loops shall be turned for each mode of proportional, integral and derivative control. All dampers, damper operators, flow sensors, etc., shall be checked for proper operation and field calibrated where required. Alarm systems and fail-safe modes shall be checked for each and every device.

C. Each tracking system shall be calibrated and tuned to provide fail-safe, efficient operation. Flow transducers shall be calibrated for zero and span, the control loop shall be tuned for each mode of proportional, integral and derivative control. All dampers, damper operators, flow sensors, etc., shall be checked for proper operation. The flow volume control system shall be run through its entire range and calibrated as required to linearize the output. Alarm systems and fail-safe modes shall be checked for each and every device.

D. The laboratory control system supplier shall work closely with the balancing contractor to ensure proper air distribution in the HVAC system. The balancing contractor shall coordinate the work of the hood and tracking systems supplier with the hood certification testing and the HVAC balancing. It is imperative that the methods of testing air flow at the hoods are known and understood by all parties involved. Where there is a conflict as to proper methods to use for balancing, the Engineer shall have the final say.

E. The Balancing Contractor shall be responsible for providing CFM versus signal data to the laboratory fume hood control system supplier, who will then generate CFM versus signal airflow charts for each box. This data shall be provided to the Owner as a part of the Operation and Maintenance manuals.

3.4 DOCUMENTATION AND TRAINING

- A. The laboratory control supplier shall provide all the documentation and training necessary so that the Owner can be capable of operating and maintaining the control system.
- B. Provide four (4) hours of preconstruction systems overview for construction personnel.
- C. Provide three (3) days of onsite training to personnel designated by the Owner. Training is to include: systems operation, troubleshooting, instrument calibration, alarm handling and system reconfiguration.
- D. Provide five working days of training for three (3) people, of the Owner's choosing, at a factory training site. Transportation, lodging and eating expenses will be the Owner's expense. The training presented shall be the same training that the factory field engineers receive.
- E. Documentation shall consist of dimensional data for control panels, supply boxes, exhaust valves, flow measuring sensors, etc. Control schematics, equipment sizing, instrumentation data sheets and Sequences of Operation shall be included.

END OF SECTION