TSI Lab and Health Care Solutions

UNDERSTANDING,
ACCELERATED

Jacco & Associates

Who is Jacco

- Established 1968
  - Hudson, Ohio
  - Columbus, Ohio
  - Toledo, Ohio
- Focused on the Engineered Environment
- Systems Knowledgeable
  - HVAC Systems
  - Service & Maintenance
  - Parts

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Who is Jacco

- Operations
  - –Brenda Homjak
  - –Mike Spangler
  - –Chad Russell
  - –Mike Mueller
  - –Hana Lee
- Contractor Owning Experience
  - –Dan Duignan
  - –Rick Baker
- Engineering Owning Experience
  - –Greg Drensky
  - –Jerry Cohen
- Owning Experience
  - –Beth Plazak
  - –Jeff Watson

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Who is Jacco

Purpose:

To provide an unparalleled owning experience.

- 30 Minute Pledge
  - Design
  - Questions
  - Problems
  - Answers

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Who is TSI

- Founded in 1961
- HQ in Minneapolis, MN
- Technology Driven Company

NIST – National Institute of Standards and Technology

NIST Uses TSI Sensors As Their Standard For Calibration!

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TSI

- Largest Markets are in Health Care
- Labs/Pharmacies/OR
- Products
  - Pressure Monitors/Controllers
  - Flow Monitoring (Ebtron)
  - Sensors
  - Actuators
  - Particle Counters
  - More

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PresSura Room Pressure Monitor/Control

Applications

- Isolation Rooms
- Operating Rooms
- Compounding Pharmacies
- Intensive Care Units
- Laboratories

- Avita Pharmacies, Aultman Hospital

- Monitor up to 3 rooms

- Monitor or Control
  - Temperature
  - Relative Humidity
  - Airflow with ACH Calculations
  - Door Switch
  - Occupancy Sensor

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PresSura Room Pressure Monitor/Control

Features and Benefits

- Accurate Room Pressure Differential Measurement
  - Thermistor or Pressure Transducer
- 4.3 in. Flush-Mounted Color Touchscreen
- Integration to BMS via BACnet MS/TP, LonWorks and Modbus Communications
- Digital Interface Module has Audible and Visual Alarms

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Nurses Station

Features & Benefits

- 8 rooms at a time
- Compatible with all TSI Room Pressure
- Audible and Visual Alarms
- Modbus/BACnet/LON

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Thermistor vs Pressure Transducer

- Thermistor (Through the wall)
  - Accurate (+/- 10% of Reading)
  - 2 Hour UL Fire Listing
  - No Drift
  - Not good for applications that require wash down or allow air transfer

- Pressure Transducer
  - No issues with lint, dust, or dirt
  - Needs UL Listed Box for fire rating
  - Require Recalibration
  - +/- 15% Accuracy of Reading

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Pressure Transducer vs Thermistor

Accuracy over time (including stability)	Typical Pressure Transducer	TSI Through-the-wall Thermal Sensor
At Calibration	+/- 0.0019”* (±15.8% of actual reading)	+/- 0.0012” (±10% of actual reading)
End of Year 1	+/- 0.0029”* (±24.1% of actual reading)	+/- 0.0012” (±10% of actual reading)
End of Year 2	+/- 0.0039”* (±32.4% of actual reading)	+/- 0.0012” (±10% of actual reading)
End of Year 3	+/- 0.0049”* (±40.8% of actual reading)	+/- 0.0012” (±10% of actual reading)

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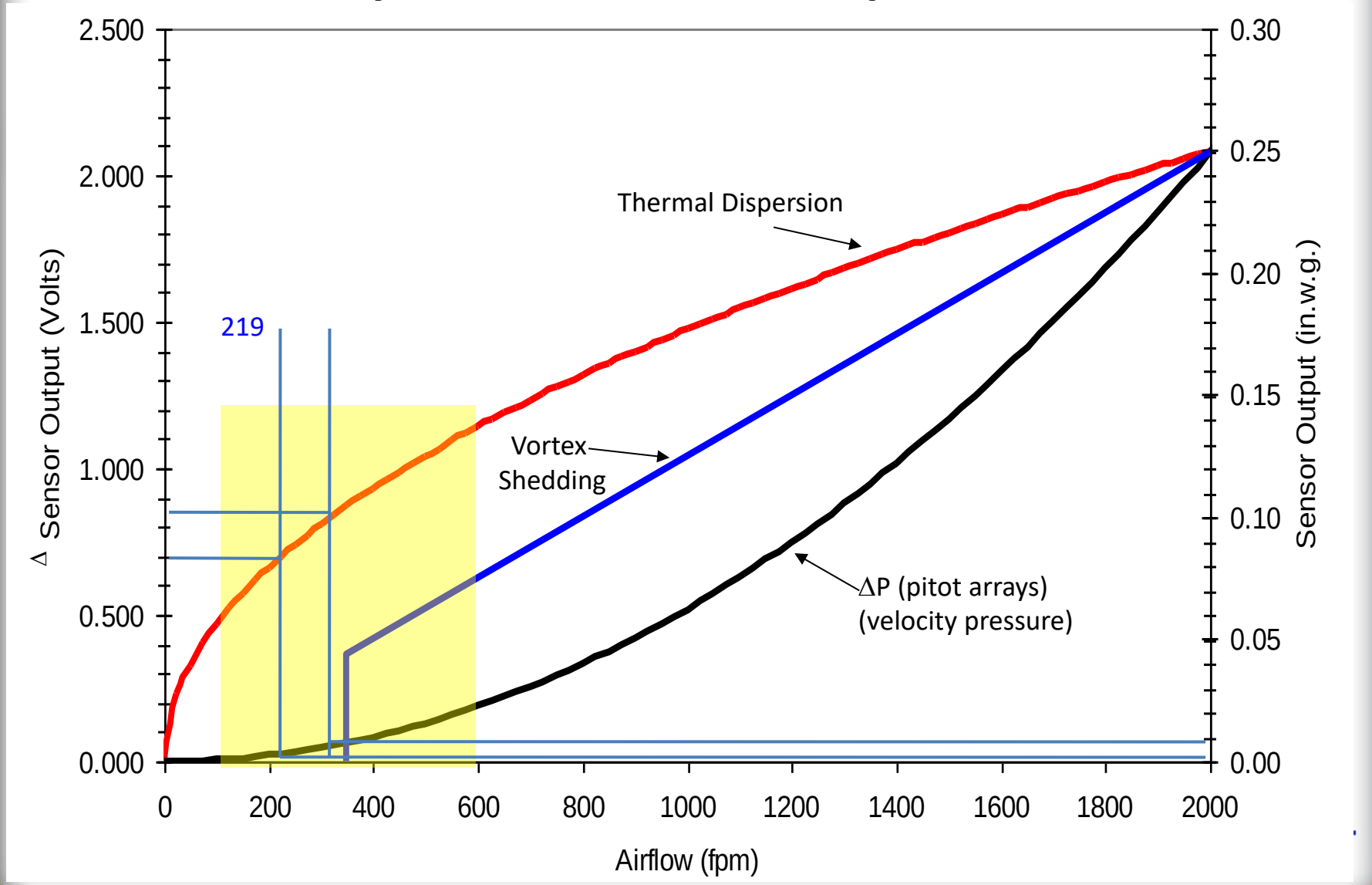
Flow Monitoring

Ebtron Air Flow Monitoring Station

- ±3% Accuracy
- Temperature Measurement ±0.15°F Accuracy
- Thermal Dispersion Technology
- Calibrated Range 0-5000 FPM
- Humidity Sensor Coming Soon!
- BACnet MSTP, Modbus RTU, 4-20 mA, 0-5 / 0-10 VDC

Why Thermal Dispersion



Ebtron How it works

Power

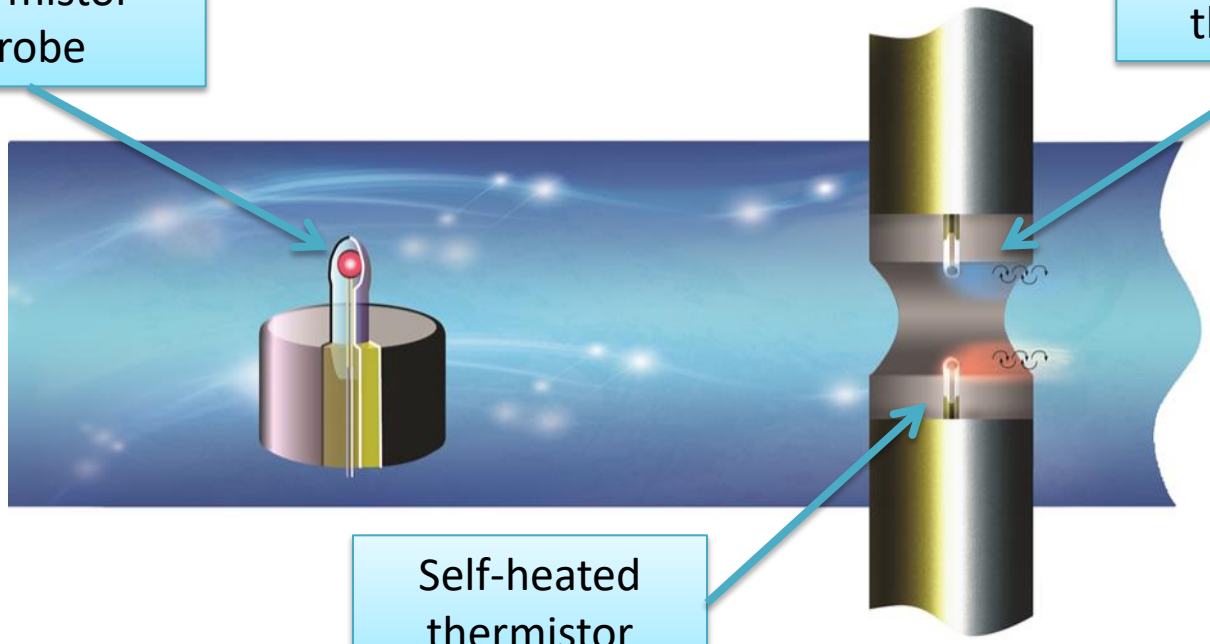
Velocity

ΔT

$$Q = \frac{\kappa A}{d}\left[B + C\left(\frac{\rho v d}{\mu}\right)^{m}\right](T_H - T_A)$$

Bead-in-glass thermistor probe

Zero-power thermistor



Self-heated thermistor

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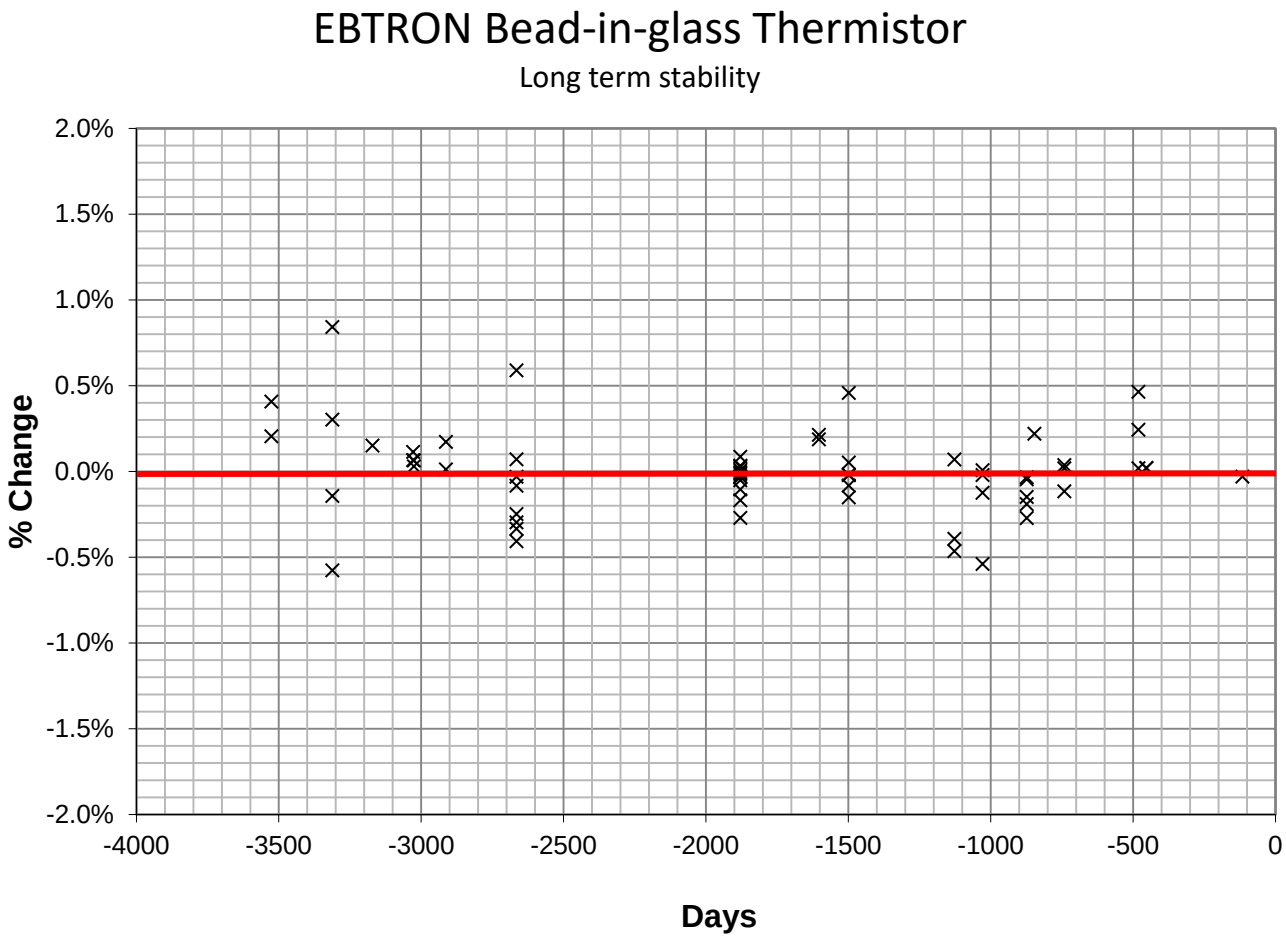
Long Term Stability



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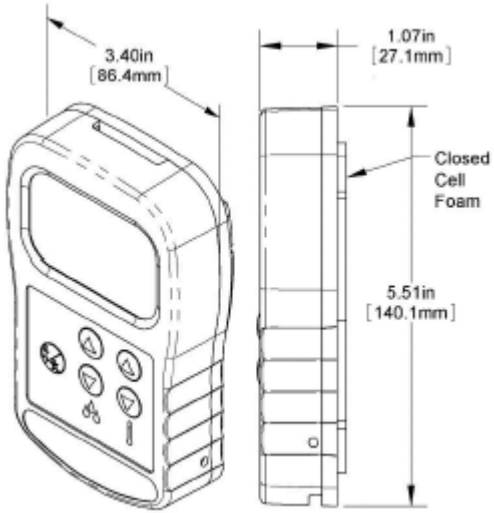
Temperature and Humidity Sensor

- -/+ 5% Temperature Range
- 0-10VDC Temperature Set point Signal

- 0-100% RH Range
- +/-2% Humidity Sensor Accuracy

- UL Enclosure



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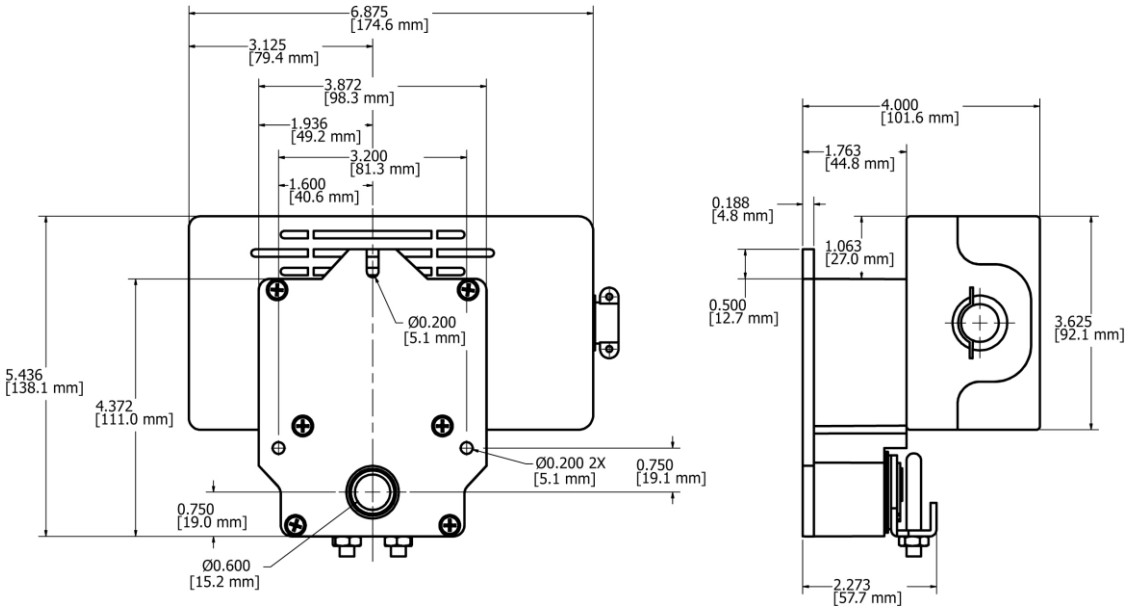
Magnetic Actuator

- Fast Reacting, Slow Control
- 1,000 Points of Resolution
- Magnetic - No Drift



Particle Counter

Applications

- Air Monitoring in Critical Infrastructures
- Monitor USP 797-800 Clean Spaces

Features and Benefits

- 0.3 to 50 Microns Size Range
- 0.1 CFM Flow Rate
- Internal Pump and Filtered Exhaust
- Modbus TCP over Ethernet Output
- 3000 Sample Record Storage for Data Redundancy

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Fume Hood Controller

Applications

- Research Laboratories
- Life Science and Pharmaceutical
- Universities and Academic
- Healthcare Facilities

Fume Hood Control

- **Using Side Wall Velocity Sensors**
- Utilizing Sash Sensors

Flow Control

- Controls Damper or Valves with Fast Acting Actuator
- Linear Venturi Valves
- Measure Airflow With Ebtron

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Fume Hood Controller

Features and Benefits

- Controls Fume Hood Face Velocity to Provide Containment and Safety to Occupants
- Reduces Laboratory Air Flow Usage
- Integration to BMS via BACnet, LonWorks or Modbus
- Visual, Audible and Remote Alarms
- Easy Configuration using Keypad or Configuration Software
- Large Configurable Display Provides Detailed Fume Hood Information

Velocity Sensors

- Surface or Flush Mount Options Available

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Laboratory Room Controller (LRC)

Features and Benefits

- Up to 32 Inputs and 10 Outputs
- Configurable Inputs and Outputs
- Serves up to 20 Fume Hoods
- BACnet IP, MS/TP, LonWorks, Modbus, N2

- Graphical Interface
- Create Interface using the Envysion Software
  - Easy Duplication of Configuration
- Zoning Features

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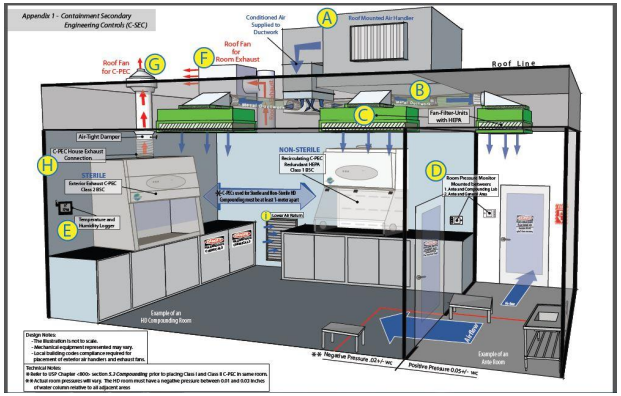
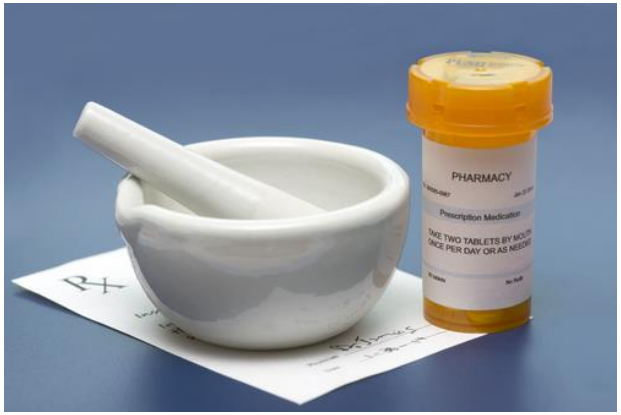
Compounding Pharmacies and USP-800





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USP Compounding Standards

- USP 797

Sterile, Non-Hazardous

- **ENFORCED TODAY**
- Temperature <68 F
- Humidity <60%
- Pressure +0.02”WC
- Air Changes 15-30
- Particles measured 6-12” in front of compounding

- USP 800

Hazardous

- **ENFORCED 12-1-19**
- Pressure -0.01” to -0.03”WC
- Air Changes 30
- Particles measured 6-12” in front of compounding

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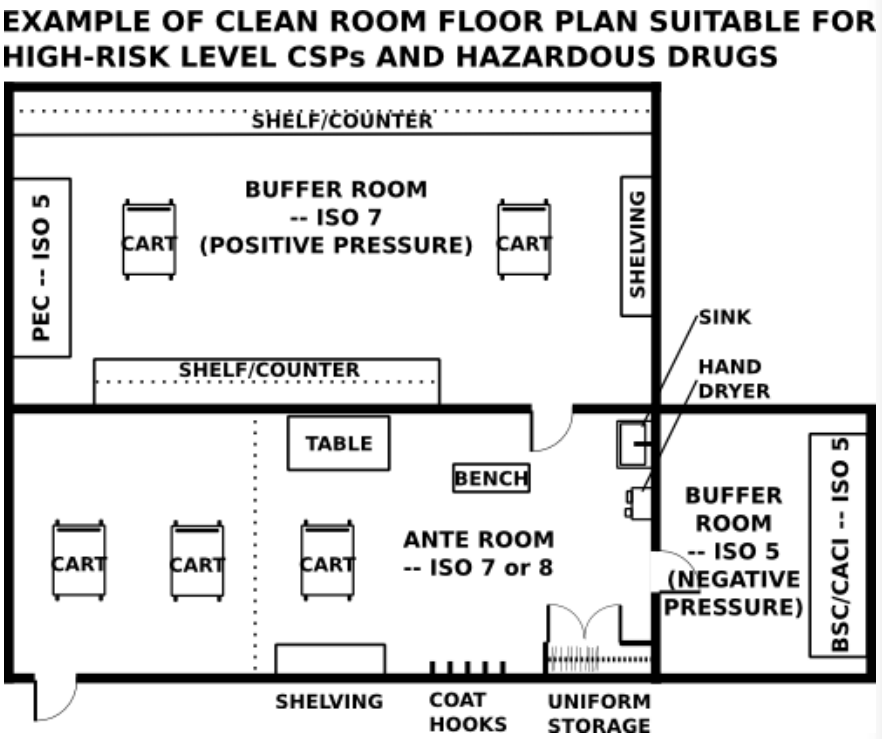
What is USP-800

- Applies to ***ALL HAZARDOUS*** compounding
  - All Hospitals
  - Outpatient Chemo Clinics
  - Diagnostic Facilities
  - Compounding Facilities
- Dictates HVAC Requirements
- Dictates Particle Contamination
- Enforceable by both FDA and States



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USP 800 HVAC Requirements

- 30 Air Changes/ hour
- Externally Vented Exhaust
- Negative Pressure
  - -0.01” to -0.03” W.C. to Adjacent Room
- ISO Class 7 Cleanroom
  - ISO Class - Determines Maximum Concentration Limits For Particles
  - Class 7 Requires Particle Count Test Every 6 Months

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Pharmacy Layout

- Three Main Areas
  - Anteroom
  - Sterile Compounding
  - Hazardous Compounding

  USP 800 only requires these to be monitored, but how are these controlled?

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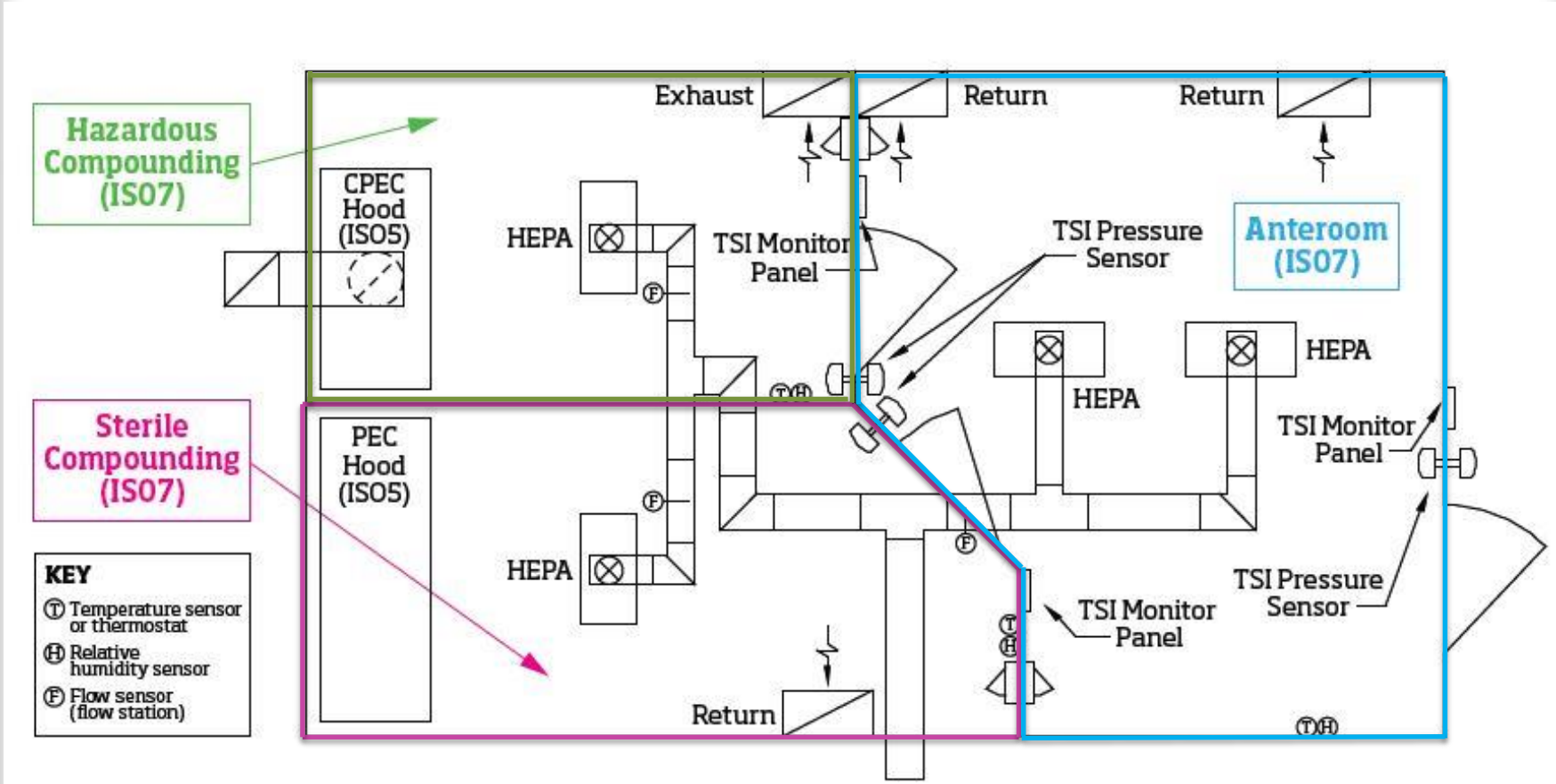
Hazardous Compounding (ISO7)
Sterile Compounding (ISO7)
KEY
Ⓣ Temperature sensor or thermostat
Ⓗ Relative humidity sensor
Ⓕ Flow sensor (flow station)
CPEC Hood (ISO5)
PEC Hood (ISO5)
Exhaust
Return
Return
HEPA
TSI Monitor Panel
TSI Pressure Sensor
Anteroom (ISO7)
HEPA
HEPA
TSI Monitor Panel
HEPA
TSI Pressure Sensor
TSI Monitor Panel
Return

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Monitoring Anteroom

- **Requirements:** Measure and Alarm
  - Room Pressure
  - Ventilation (ACH)
  - Room Temperature
  - Room Humidity

- **Sequence:**
  - Constant Volume Supply And Exhaust
  - +0.02” W.C. With Respect To Corridor
  - Alarm On Room Pressure Differential, Supply Flow (ACH), Temperature, and Relative Humidity

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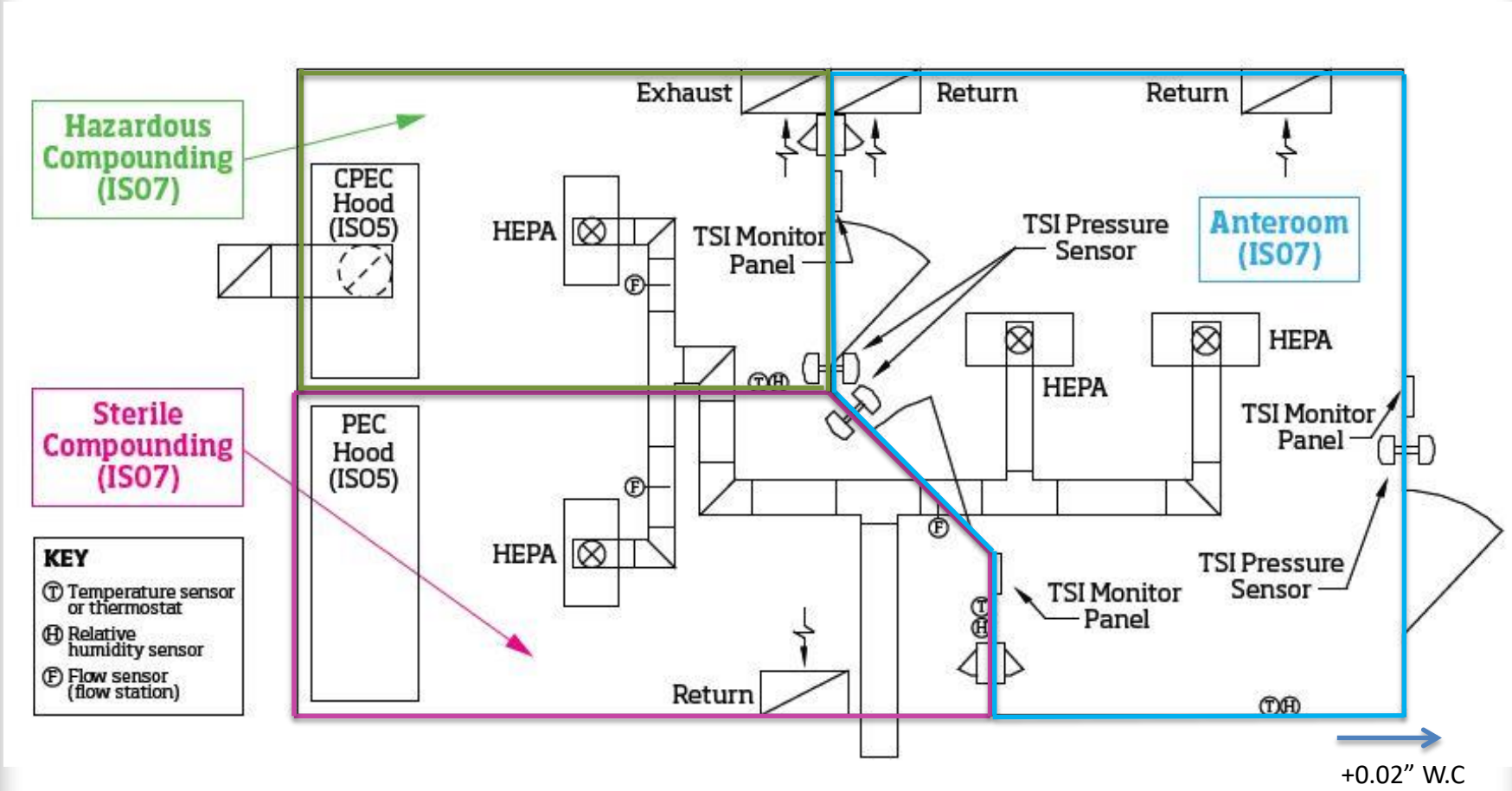
Controlling Anteroom

- **Control:**
  - Ventilation (ACH)/Supply Flow
  - Room Pressure Differential by adjusting exhaust flow
  - Room Temperature
  - Room Humidity

- **Sequence:**
  - Room Temperature and Humidity Controlled By RTU
  - Room Controller Modulates Supply To Maintain Flow
  - Exhaust Modulates to Maintain Room Pressure
  - +0.02” W.C. With Respect To Corridor
  - Measures And Alarms On Room Pressure Differential, Supply Flow, Temperature And Relative Humidity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HEPA
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TSI Monitor Panel
Return
+0.02" W.C

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Monitoring Sterile Compound

- **Requirements:** Measure and Alarm
  - Room Pressure
  - Ventilation (ACH)
  - Room Temperature
  - Room Humidity

- **Sequence:**
  - Constant Volume Supply And Exhaust
  - +0.02” W.C. With Respect To Anteroom
  - Alarm On Room Pressure Differential, Supply Flow (ACH), Temperature, and Relative Humidity

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Controlling Sterile Compounds

- **Control:**
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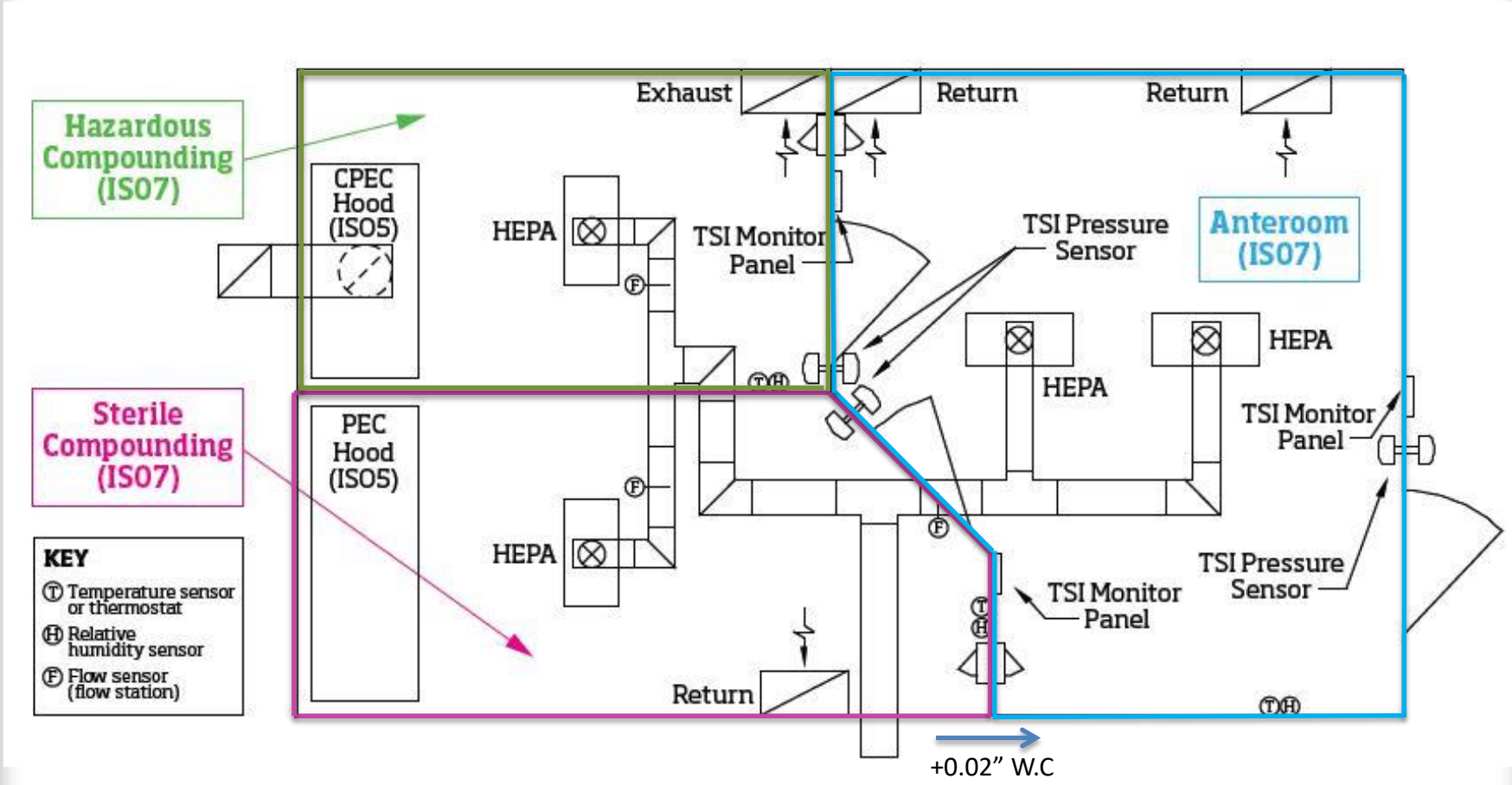
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Anteroom (ISO7)
HEPA
HEPA
TSI Monitor Panel
HEPA
TSI Pressure Sensor
TSI Monitor Panel
Return
+0.02” W.C

Monitoring Hazardous Compounding

- **Requirements:** Measure and Alarm
  - Room Pressure
  - Ventilation (ACH)
  - Room Temperature
  - Room Humidity

- **Sequence:**
  - Constant Volume Supply And Exhaust
  - -0.03” W.C. With Respect To Anteroom
  - Alarm On Room Pressure Differential, Supply Flow (ACH), Temperature, and Relative Humidity

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Hazardous Compounding Room Control

- **Control:**
  - Ventilation (ACH)/Supply Flow
  - Room Pressure Differential by adjusting exhaust flow
  - Room Temperature
  - Room Humidity

- **Sequence:**
  - Room Temperature and Humidity Controlled By RTU
  - Room Controller Modulates Supply To Maintain Flow
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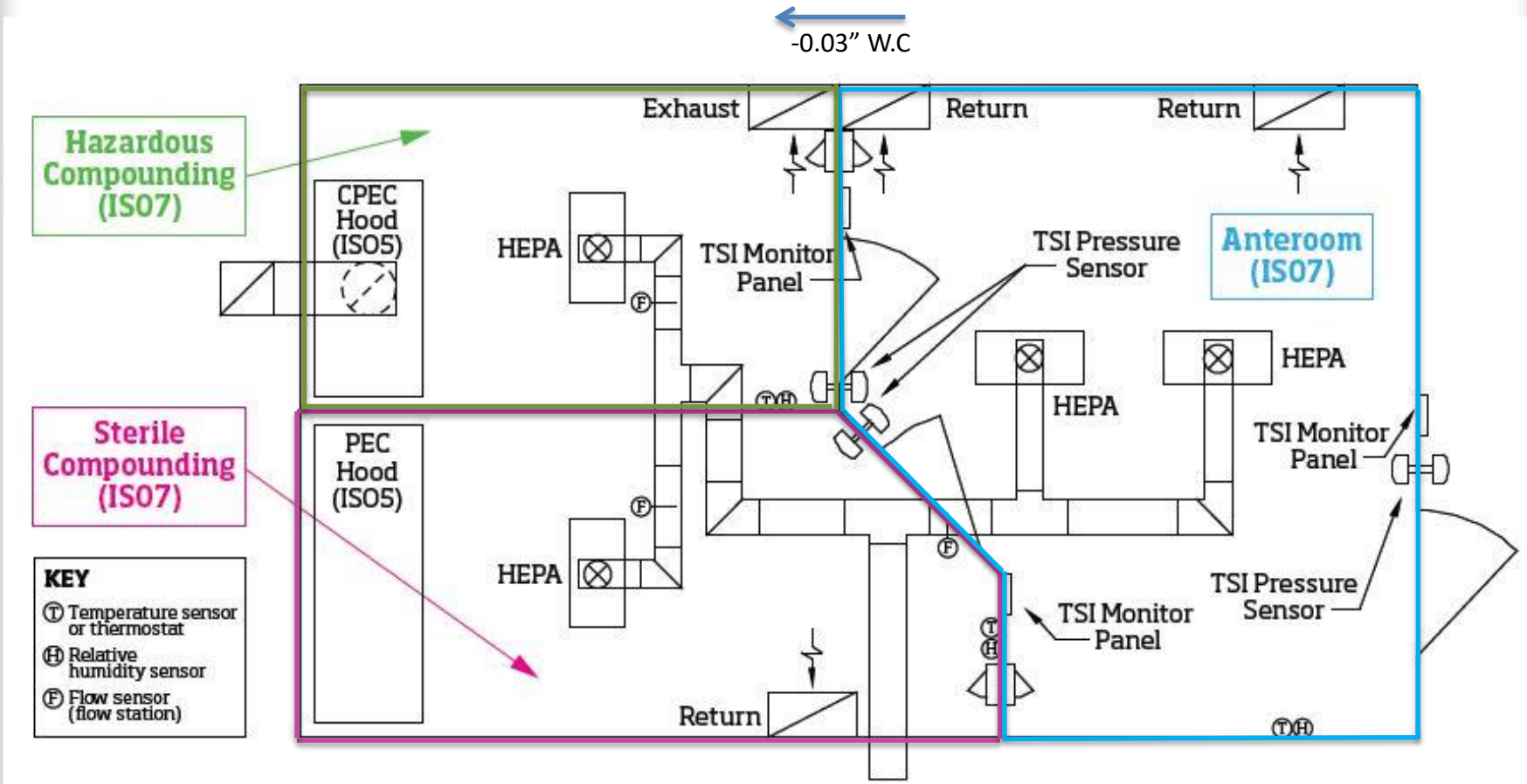
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Return
KEY
Ⓣ Temperature sensor or thermostat
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Ⓕ Flow sensor (flow station)

Equipment you will need

Monitoring

- PresSura Room Pressure Monitor
- Temperature and Humidity Sensor
- Airflow Station

Control

- PresSura Room Pressure Controller
- Temperature and Humidity Sensor
- Airflow Station
- High-Speed Magnetic Actuators/Dampers

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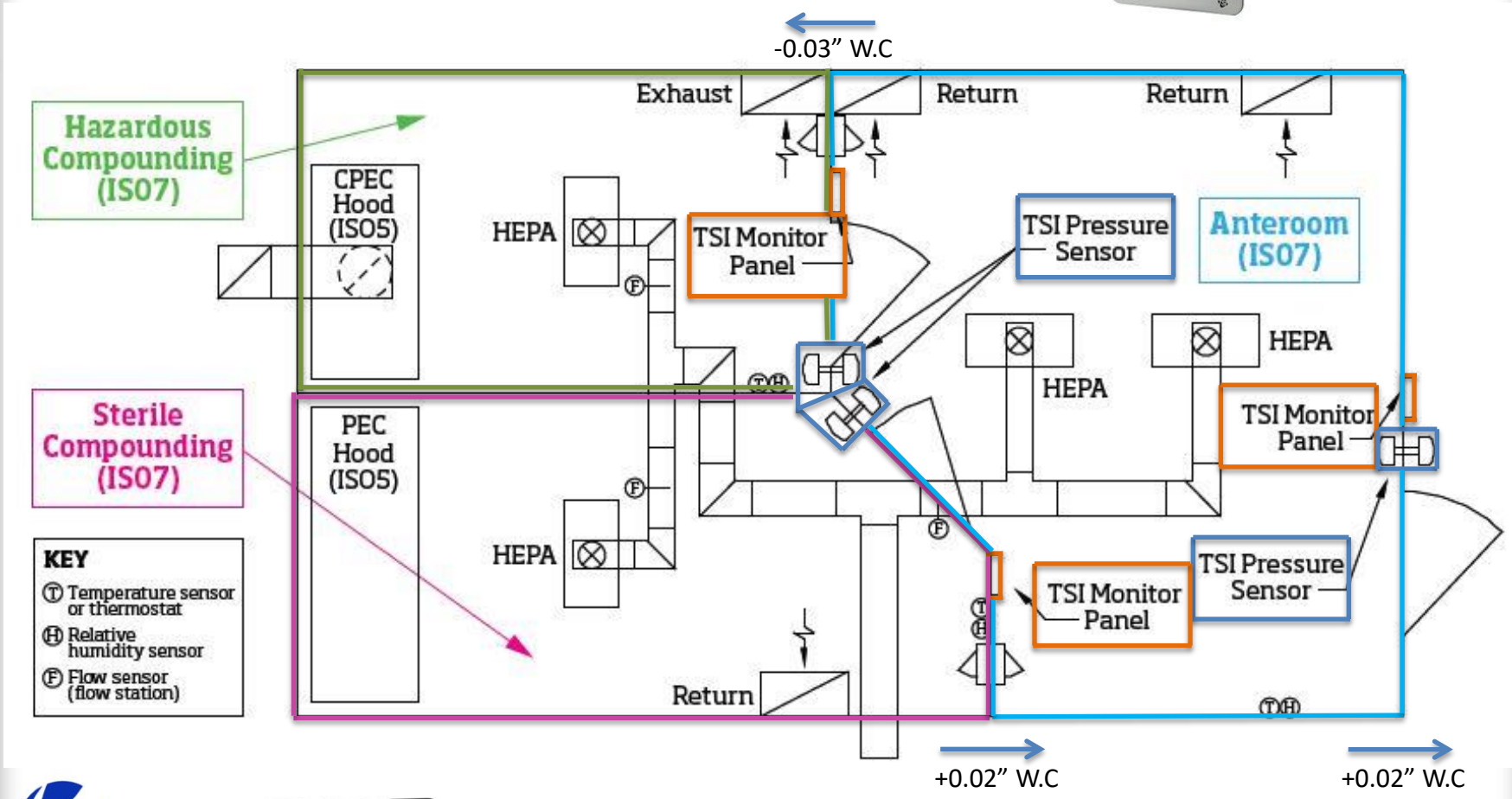
Pressure Room Pressure Monitor



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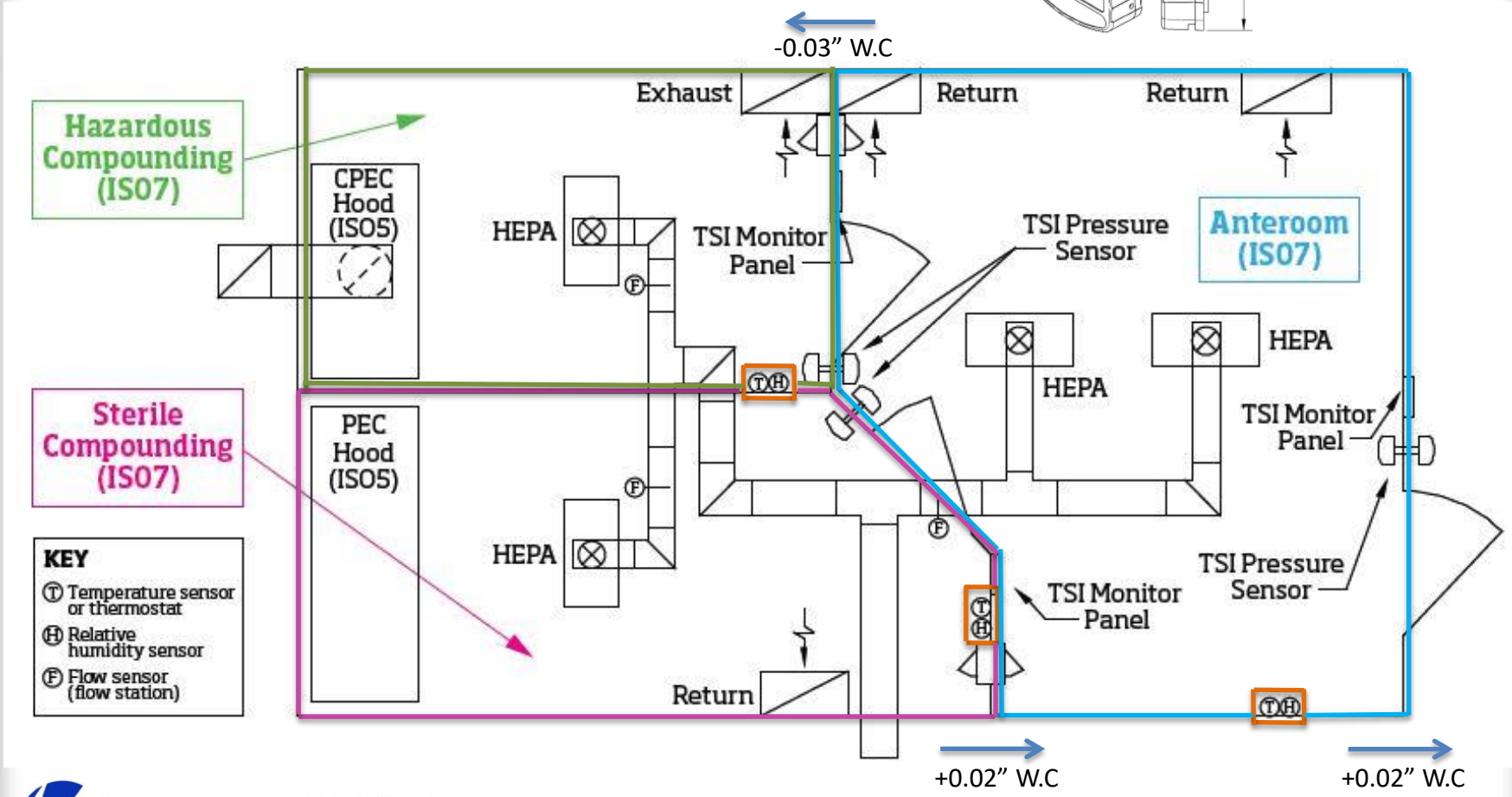
Temperature & Humidity Sensor



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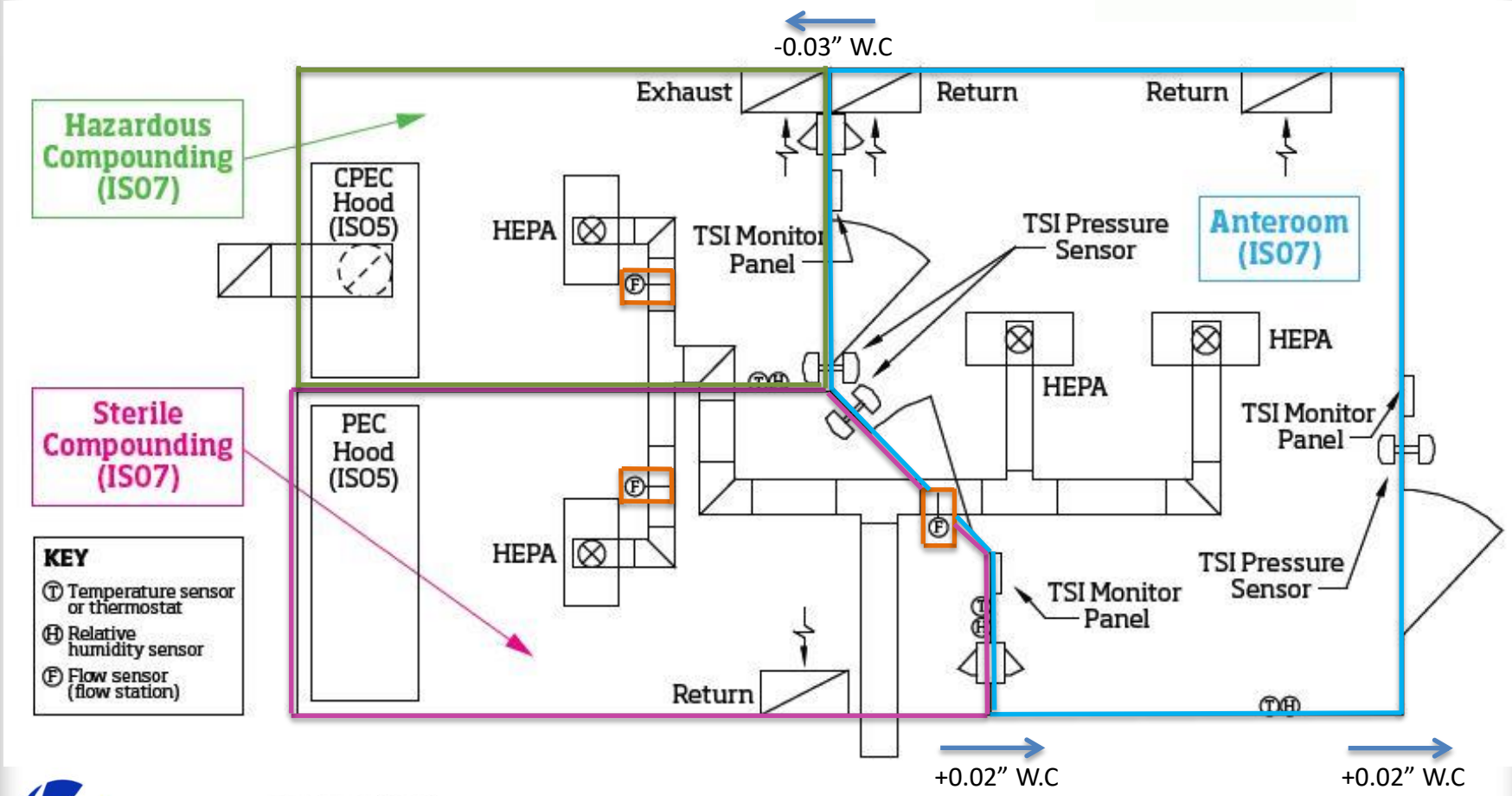
Air Flow Monitoring

EBTRON®
Thermal Dispersion Airflow Measurement



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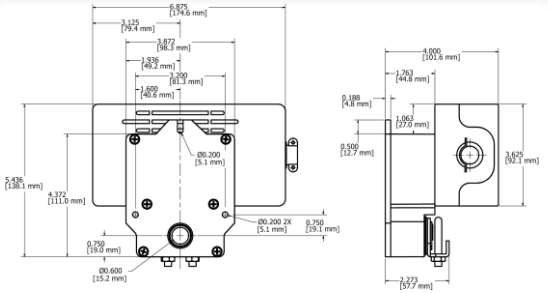
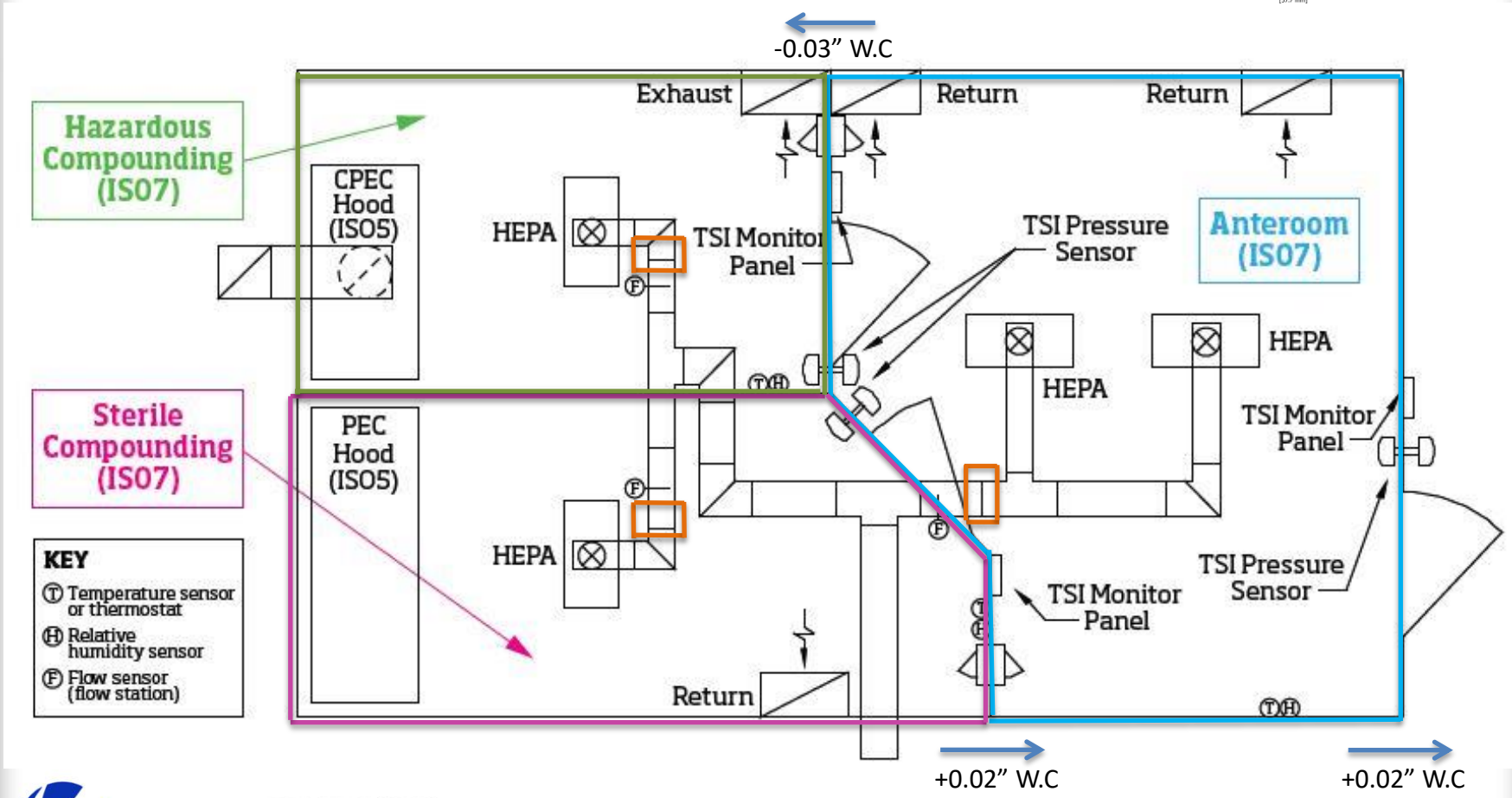
Magnetic Actuator For Control





What About The Air Changes?

- USP-800 Requires 30 Air Changes Per Hour

- ACH = CFM * 60/Room Volume
  - 1,000 sq.ft Hazardous Compounding Pharmacy
  - 10,000 cu.ft
  - CFM=ACH*Room Volume/60
  - CFM = 30*10,000/60
  - CFM= 5,000

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Aaon For Air Changes

- Capable Of High Outside Air Loads
- Precise Temperature/Humidity Control
  - Can Accurately Control To +/-1° F and +/- 5% RH
  - Modulating Hot Gas Reheat
  - Modulating Compressors
  - Modulating Condenser Fans
  - Modulating Heat (Gas/Electric)
- Maintain Room Pressure
  - VFD Supply/Exhaust Fans
  - Tie In Room Pressure Directly

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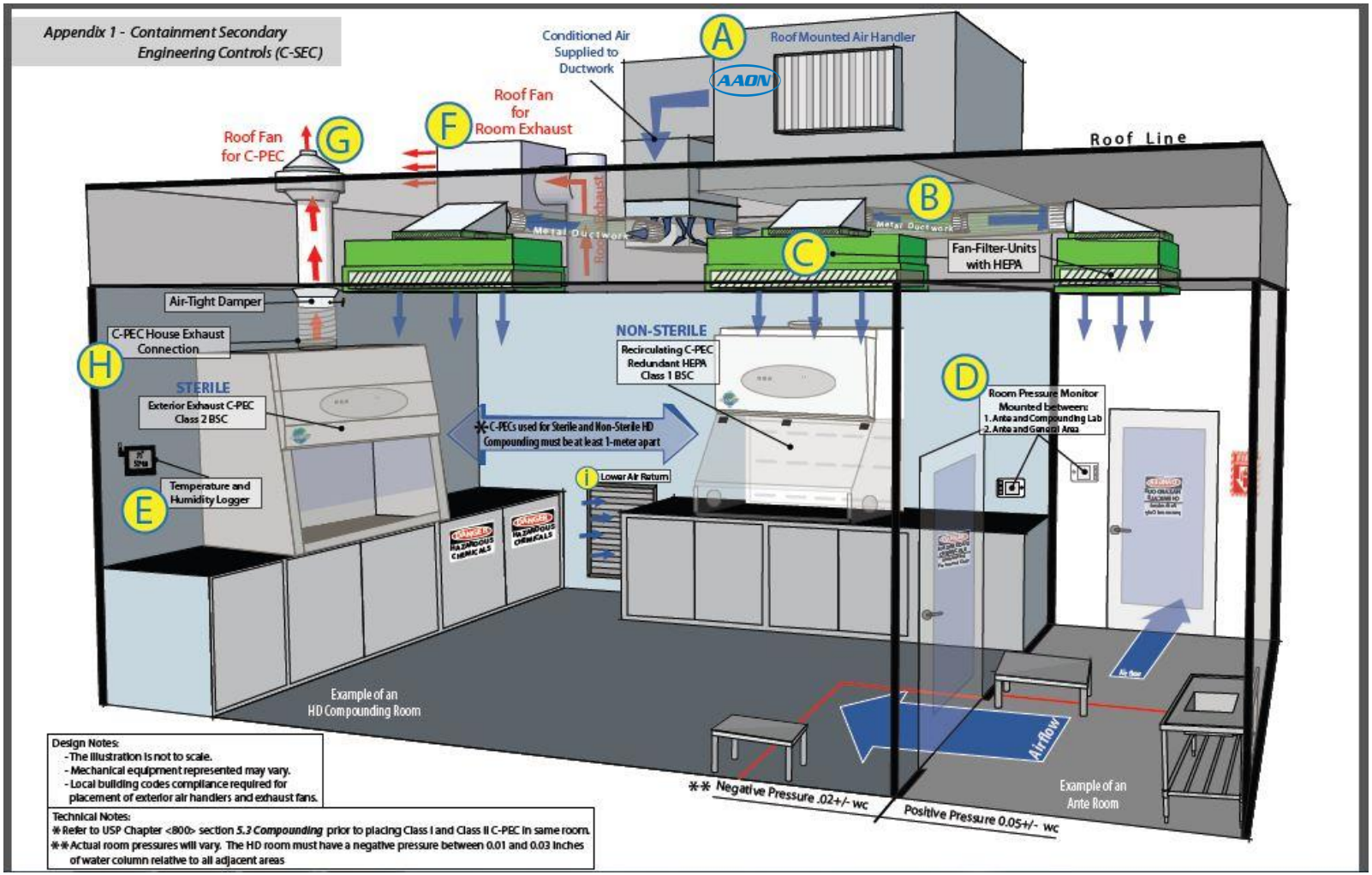
Pull It All Together



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USP-800 Questions?

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Lab and Fume Hoods

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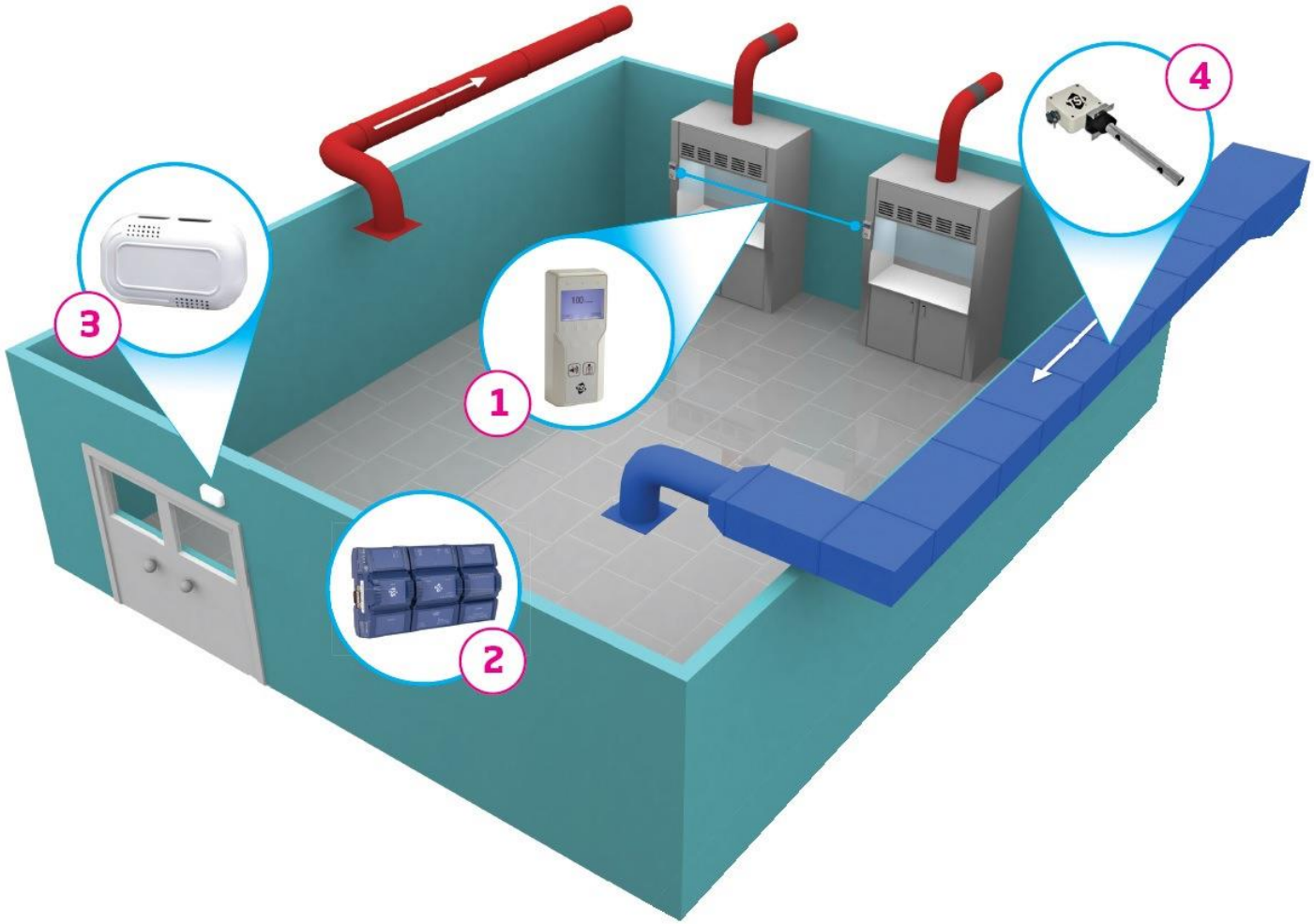
What's in a Lab Project



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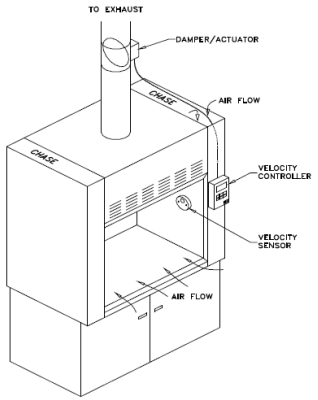
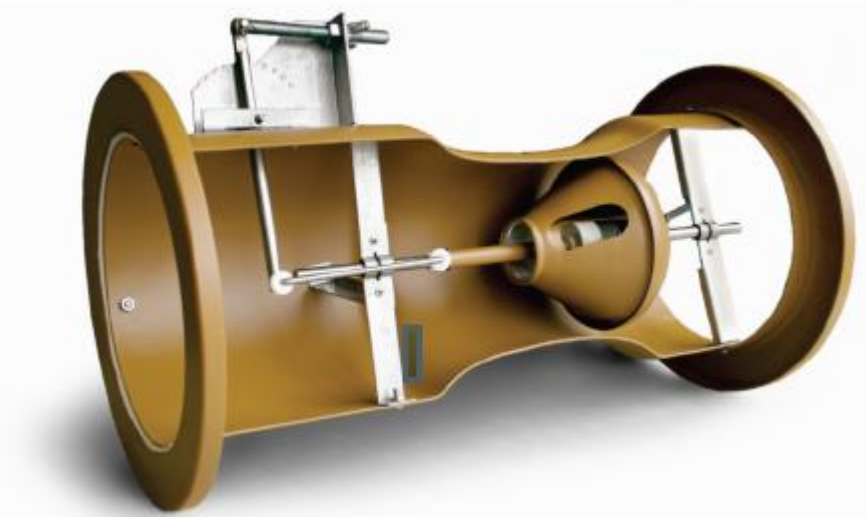
Sash Sensing With Venturi Valve

- Calculates Venturi valve position to change airflow based on sash position.

- Valve Per Hood
- Valve For General Exhaust





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Velocity Sensing

- The Velocity Sensor Measures the velocity thought the hood, airflow monitoring and damper insure proper airflow
- Velocity Sensor Per Hood
- Air Flow Monitor – Hoods/Ex/Supply

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Sash Sensing vs Velocity Sensing

	Venturi Valve	Damper and Thermal Flow Station
Pressure Drop	1"-3"	0.01" -0.1"
Sound	NC upper 30s	NC lower 20s
Cost	High	Low
Pressure Independence	Yes, via an internal spring	Yes, via a flow measurement
Measurement Accuracy	No flow measurement	±3%
Metering Accuracy	±5%	±3%
Device Length	24"-30"	24"-30" includes straight run
Turn down ratio	16:1	6:1

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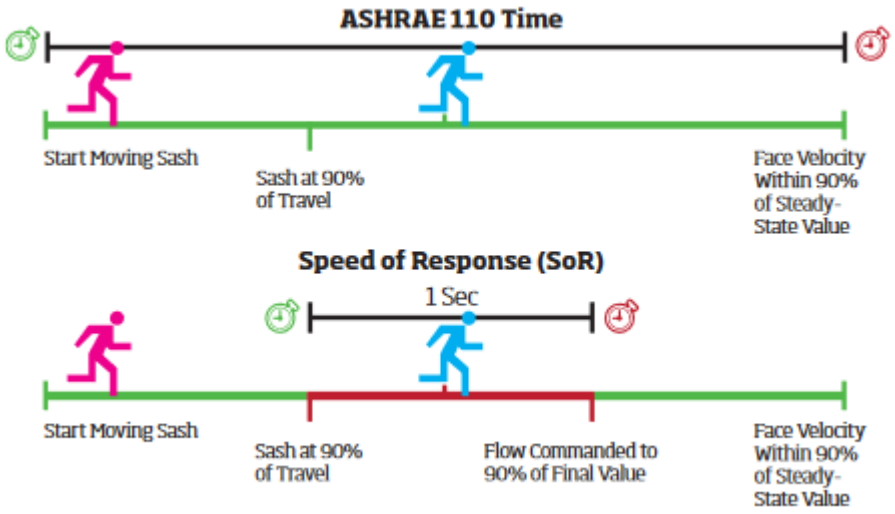
Speed of Response

ANSI / ASHRAE 110

Start Time – When the sash starts moving

- Stop Time – When face velocity is within 90% of steady state (90-100fpm
- Response Time – less than 3 seconds



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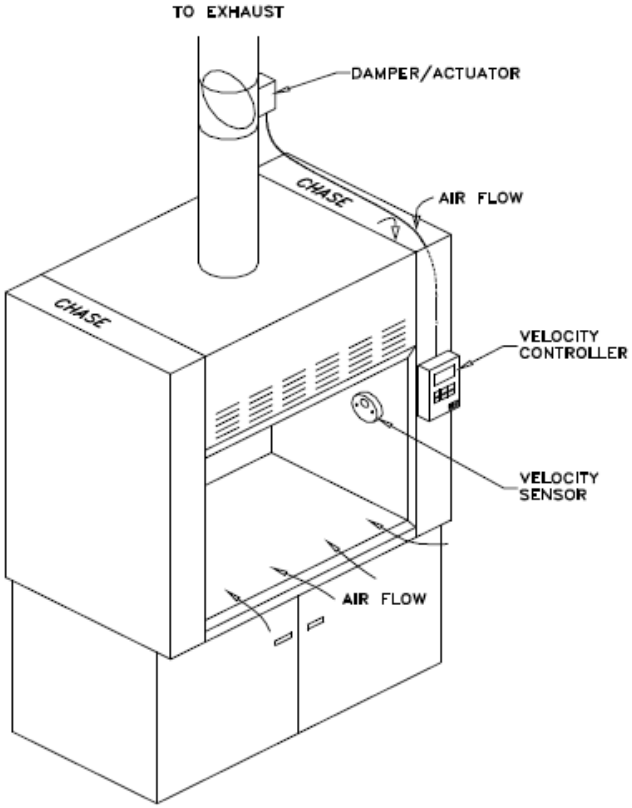
Sash Sensing vs Velocity



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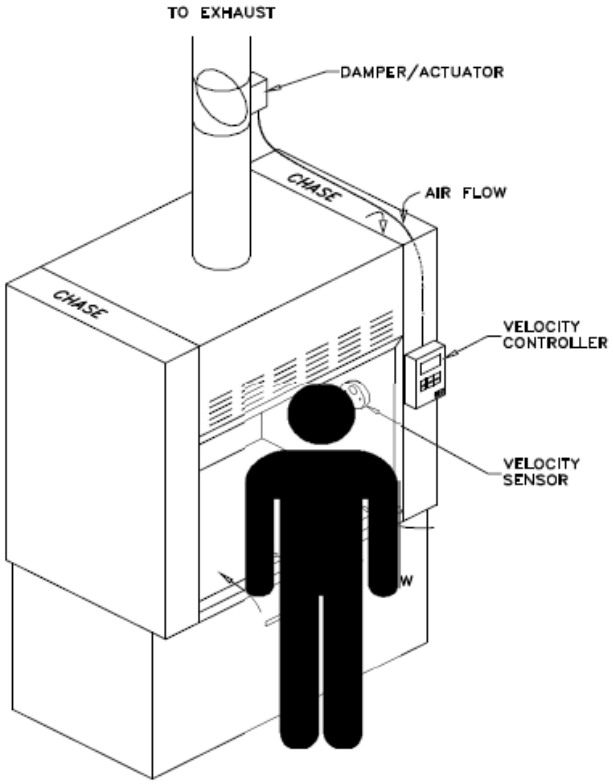

What happens if you are standing in front of the hood?

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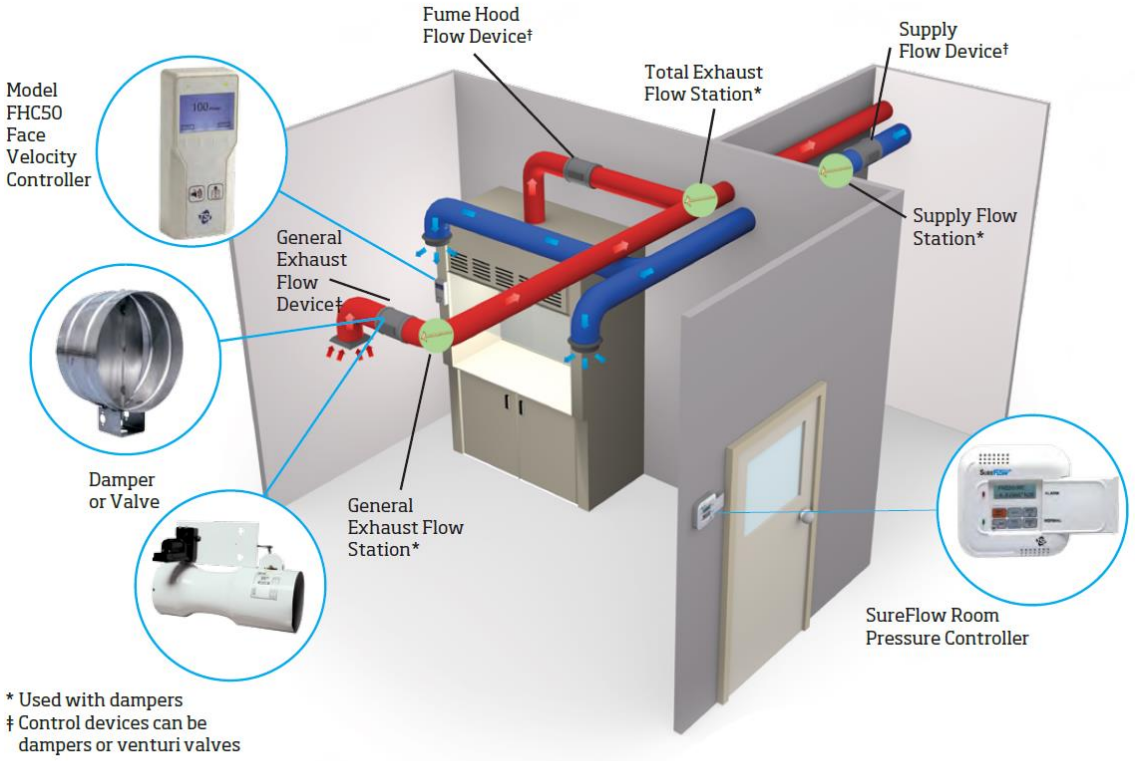
The TSI Solution



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Phoenix Controls	Siemens	Accutrol
Venturi Valves	Venturi Valves or Dampers	Dampers
Sash Position	Sash Position, Some Sidewall	Sash Position
NO Flow Measurement	100% Orifice Ring Flow Measurement	Vortex Shedding Flow Measurement

Triatek	CRC	Price - Antec
Venturi Valves	Dampers	Venturi Valves or Dampers
Sash Position, Sidewall, or Both	Sash Position or Sidewall	Sash Position, Sidewall or Both
No Flow Measurement	Venturi Flow Measurement / Damper Control	No Flow Measurement (Venturi), VAV box flow measurement, Venturi flow measurement

What Does It Cost?

Sash Sensing

Equipment – $3,450

Install/Balance – $675

Total- $4,125

Velocity Sensing

Equipment – 3,330

Install/Balance – $340

Total- $3,670

Laboratory Room Controller (LRC)

Features and Benefits

- Up to 32 Inputs and 10 Outputs
- Configurable Inputs and Outputs
- Serves up to 20 Fume Hoods
- BACnet IP, MS/TP, LonWorks, Modbus, N2

- Graphical Interface
- Create Interface using the Envysion Software
  - Easy Duplication of Configuration
- Zoning Features

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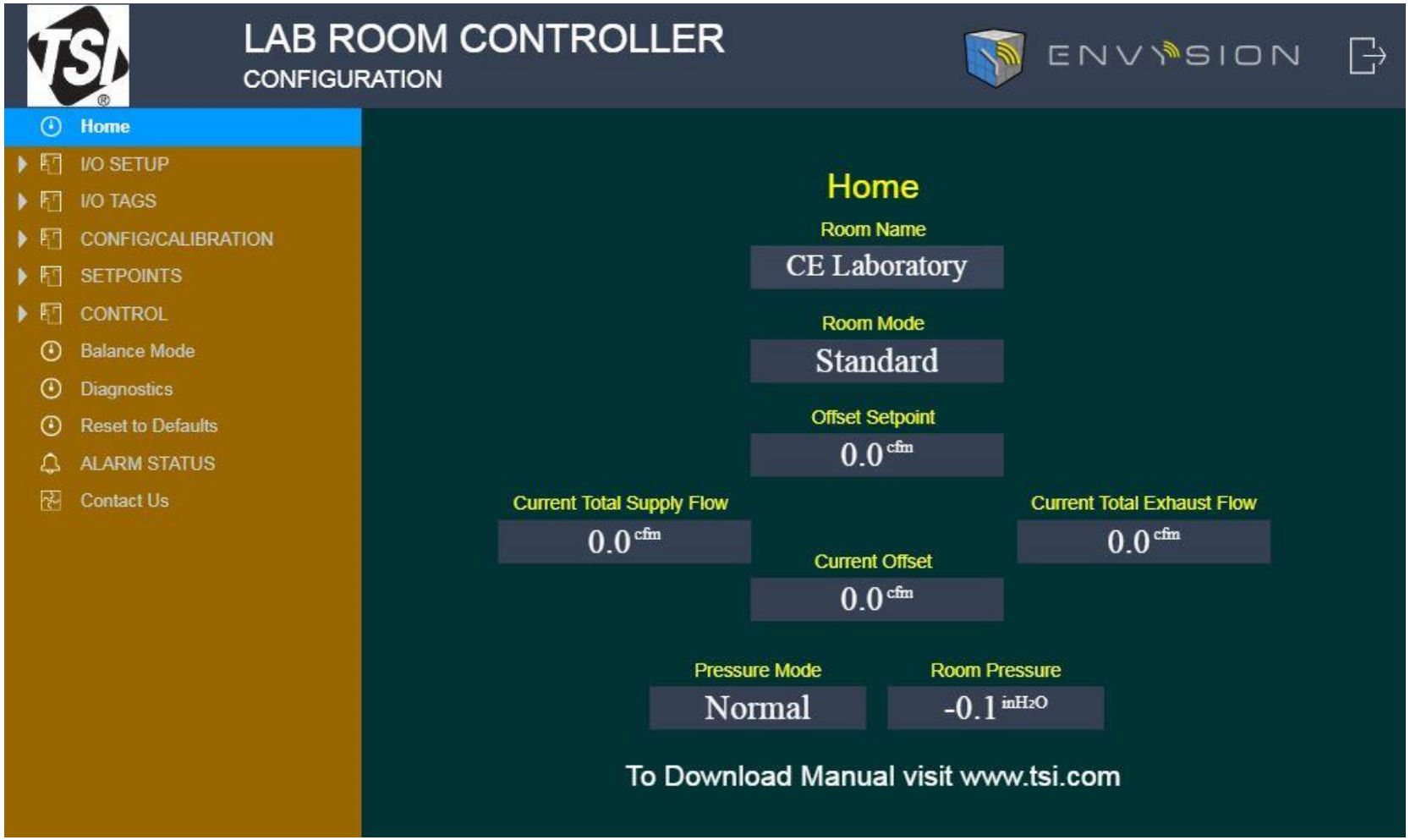
LAB ROOM CONTROLLER
CONFIGURATION
ENVISION
Home
I/O SETUP
I/O TAGS
CONFIG/CALIBRATION
SETPOINTS
CONTROL
Balance Mode
Diagnostics
Reset to Defaults
ALARM STATUS
Contact Us
Home
Room Name
CE Laboratory
Room Mode
Standard
Offset Setpoint
0.0 cfm
Current Total Supply Flow
0.0 cfm
Current Total Exhaust Flow
0.0 cfm
Current Offset
0.0 cfm
Pressure Mode
Normal
Room Pressure
-0.1 inH2O
To Download Manual visit www.tsi.com

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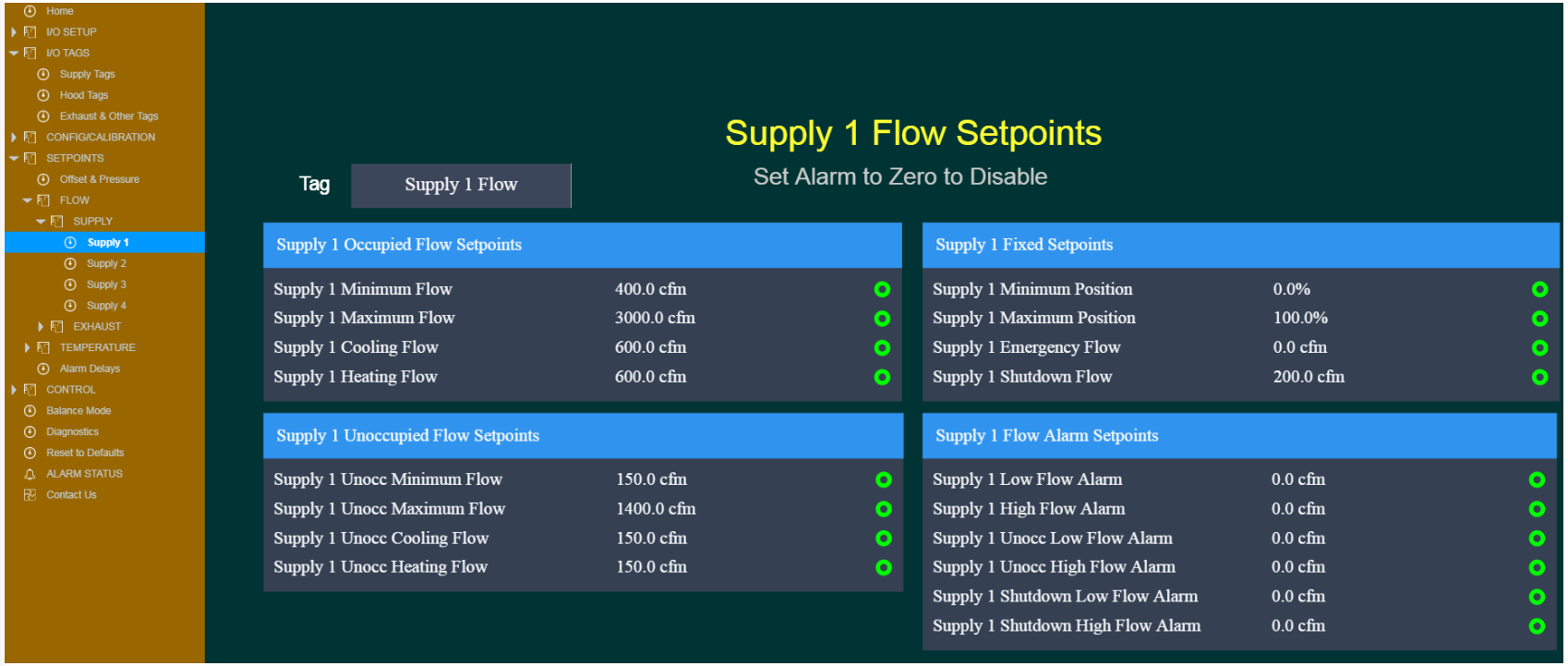
Home
I/O SETUP
I/O TAGS
Supply Tags
Hood Tags
Exhaust & Other Tags
CONFIG/CALIBRATION
SETPOINTS
Offset & Pressure
FLOW
SUPPLY
Supply 1
Supply 2
Supply 3
Supply 4
EXHAUST
TEMPERATURE
Alarm Delays
CONTROL
Balance Mode
Diagnostics
Reset to Defaults
ALARM STATUS
Contact Us
Supply 1 Flow Setpoints
Set Alarm to Zero to Disable
Tag
Supply 1 Flow
Supply 1 Occupied Flow Setpoints
Supply 1 Minimum Flow 400.0 cfm
Supply 1 Maximum Flow 3000.0 cfm
Supply 1 Cooling Flow 600.0 cfm
Supply 1 Heating Flow 600.0 cfm
Supply 1 Unoccupied Flow Setpoints
Supply 1 Unocc Minimum Flow 150.0 cfm
Supply 1 Unocc Maximum Flow 1400.0 cfm
Supply 1 Unocc Cooling Flow 150.0 cfm
Supply 1 Unocc Heating Flow 150.0 cfm
Supply 1 Fixed Setpoints
Supply 1 Minimum Position 0.0%
Supply 1 Maximum Position 100.0%
Supply 1 Emergency Flow 0.0 cfm
Supply 1 Shutdown Flow 200.0 cfm
Supply 1 Flow Alarm Setpoints
Supply 1 Low Flow Alarm 0.0 cfm
Supply 1 High Flow Alarm 0.0 cfm
Supply 1 Unocc Low Flow Alarm 0.0 cfm
Supply 1 Unocc High Flow Alarm 0.0 cfm
Supply 1 Shutdown Low Flow Alarm 0.0 cfm
Supply 1 Shutdown High Flow Alarm 0.0 cfm

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LAB ROOM CONTROLLER
CONFIGURATION
ENVYSION
Home
I/O SETUP
I/O TAGS
CONFIG/CALIBRATION
SETPOINTS
CONTROL
Balance Mode
Diagnostics
Reset to Defaults
ALARM STATUS
Contact Us
DIAGNOSTICS
Room Pressure
-0.1 inH2O
Rel Humidity
0.0 %
Occupancy
Status
Supply 1 Occupancy
OCCUPIED
Supply 2 Occupancy
UNOCCUPIED
Supply 3 Occupancy
OCCUPIED
Supply 4 Occupancy
OCCUPIED
Switch Status
Door Mode
OPEN
Emergency Mode
NORMAL
Shutdown Mode
NORMAL
Supply DAT
Temp
Supply 1 DAT
50.0°F
Supply 2 DAT
0.0°F
Supply 3 DAT
0.0°F
Supply 4 DAT
0.0°F
Temp Adjustment
Adjustments
Supply 1 Temp Adj
0.0°F
Supply 2 Temp Adj
0.0°F
Supply 3 Temp Adj
0.0°F
Supply 4 Temp Adj
0.0°F
Envysion version 1.0
Gfx version- 1.5
Controller Mode
Standard
Offset Setp
null
Current Offset
0.0 cfm
Total Supply
0.0 cfm
Total Exhaust
0.0 cfm
Temp Zone
Temp
Heat Set
Cool Set
% Open
Mode
Manual Pos
Supply 1 Room Temp
0.0°F
68.0°F
72.0°F
0.0%
AUTO
50.0 %
Supply 2 Room Temp
0.0°F
62.0°F
78.0°F
0.0%
AUTO
50.0 %
Supply 3 Room Temp
0.0°F
68.0°F
72.0°F
0.0%
AUTO
50.0 %
Supply 4 Room Temp
0.0°F
68.0°F
72.0°F
0.0%
AUTO
50.0 %
Flow Device
Flows
Volt
Setpoint
% Open
Mode
Manual Pos
Supply 1 Flow
0.0 cfm
0.0 V
0.0 cfm
59.2%
AUTO
50.0 %
Supply 2 Flow
0.0 cfm
0.0 V
0.0 cfm
0.0%
AUTO
50.0 %
Supply 3 Flow
0.0 cfm
0.0 V
0.0 cfm
0.0%
AUTO
50.0 %
Supply 4 Flow
0.0 cfm
0.0 V
0.0 cfm
0.0%
AUTO
50.0 %
General EXH 1
0.0 cfm
0.0 V
0.0 cfm
59.2%
AUTO
50.0 %
Exhaust 2 Flow
0.0 cfm
0.0 V
0.0 cfm
0.0%
AUTO
50.0 %
Hood Flow
Flows
Volt
Hood 1 Flow
0.0 cfm
0.0 V
Hood 2 Flow
0.0 cfm
0.0 V
Hood 3 Flow
0.0 cfm
0.0 V
Hood 4 Flow
0.0 cfm
0.0 V
Hood 5 Flow
0.0 cfm
0.0 V
Hood 6 Flow
0.0 cfm
0.0 V
Hood 7 Flow
0.0 cfm
0.0 V
Hood 8 Flow
0.0 cfm
0.0 V
Hood 9 Flow
0.0 cfm
0.0 V
Hood 10 Flow
0.0 cfm
0.0 V
Hood Flow
Flows
Volt
Hood 11 Flow
0.0 cfm
0.0 V
Hood 12 Flow
0.0 cfm
0.0 V
Hood 13 Flow
0.0 cfm
0.0 V
Hood 14 Flow
0.0 cfm
0.0 V
Hood 15 Flow
0.0 cfm
0.0 V
Hood 16 FLow
0.0 cfm
0.0 V
Hood 17 Flow
0.0 cfm
0.0 V
Hood 18 Flow
0.0 cfm
0.0 V
Hood 19 Flow
0.0 cfm
0.0 V
Hood 20 Flow
0.0 cfm
0.0 V

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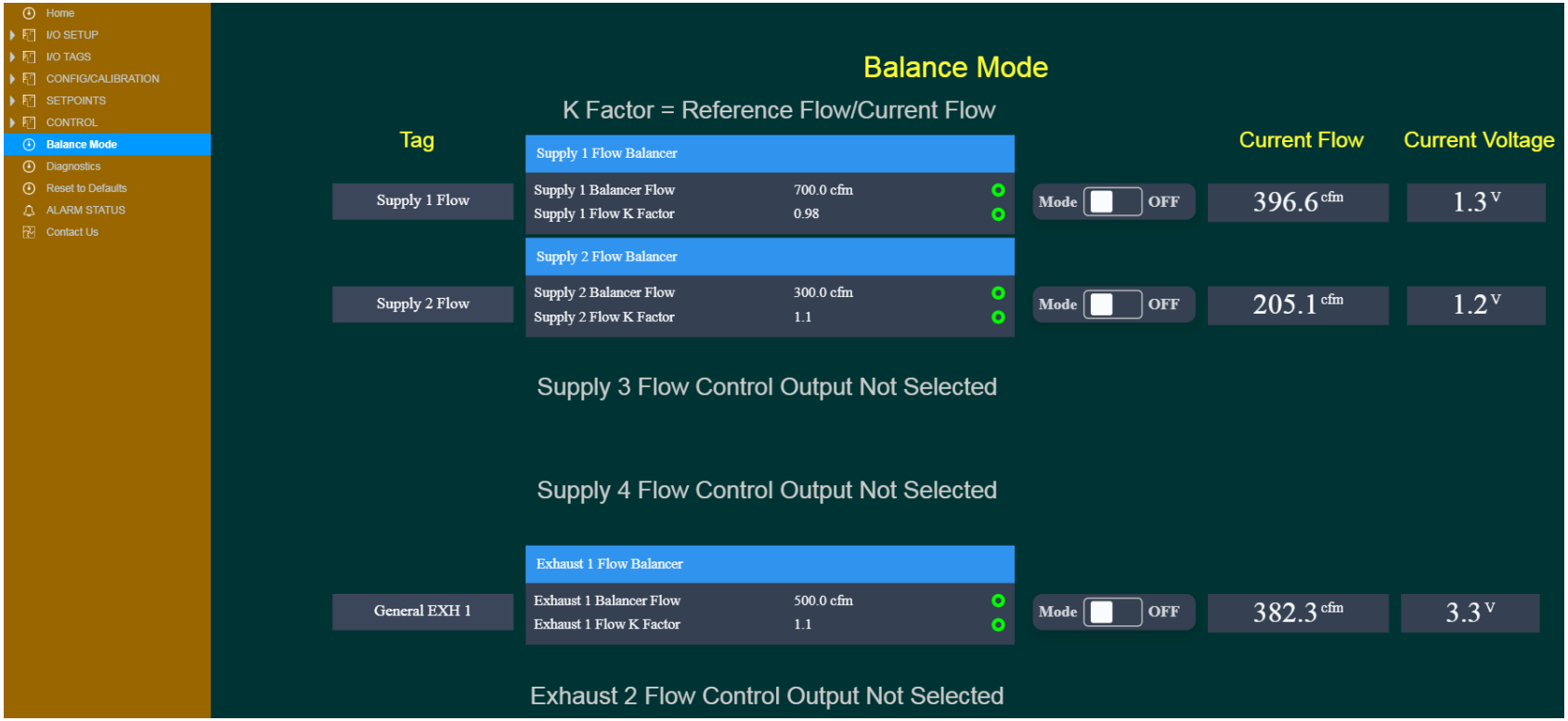
Home
I/O SETUP
I/O TAGS
CONFIG/CALIBRATION
SETPOINTS
CONTROL
Balance Mode
Diagnostics
Reset to Defaults
ALARM STATUS
Contact Us
Balance Mode
K Factor = Reference Flow/Current Flow
Tag
Current Flow
Current Voltage
Supply 1 Flow Balancer
Supply 1 Flow
Supply 1 Balancer Flow 700.0 cfm
Supply 1 Flow K Factor 0.98
Mode OFF
396.6 cfm
1.3 V
Supply 2 Flow Balancer
Supply 2 Flow
Supply 2 Balancer Flow 300.0 cfm
Supply 2 Flow K Factor 1.1
Mode OFF
205.1 cfm
1.2 V
Supply 3 Flow Control Output Not Selected
Supply 4 Flow Control Output Not Selected
Exhaust 1 Flow Balancer
General EXH 1
Exhaust 1 Balancer Flow 500.0 cfm
Exhaust 1 Flow K Factor 1.1
Mode OFF
382.3 cfm
3.3 V
Exhaust 2 Flow Control Output Not Selected

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Lab Control Strategies

- Offset
- Offset with Pressure Monitoring
- Adaptive Offset

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Offset Sequence

General Sequence of Operation

- The room controller simultaneously controls room supply and exhaust to maintain room balance, ventilation and temperature in the laboratory.

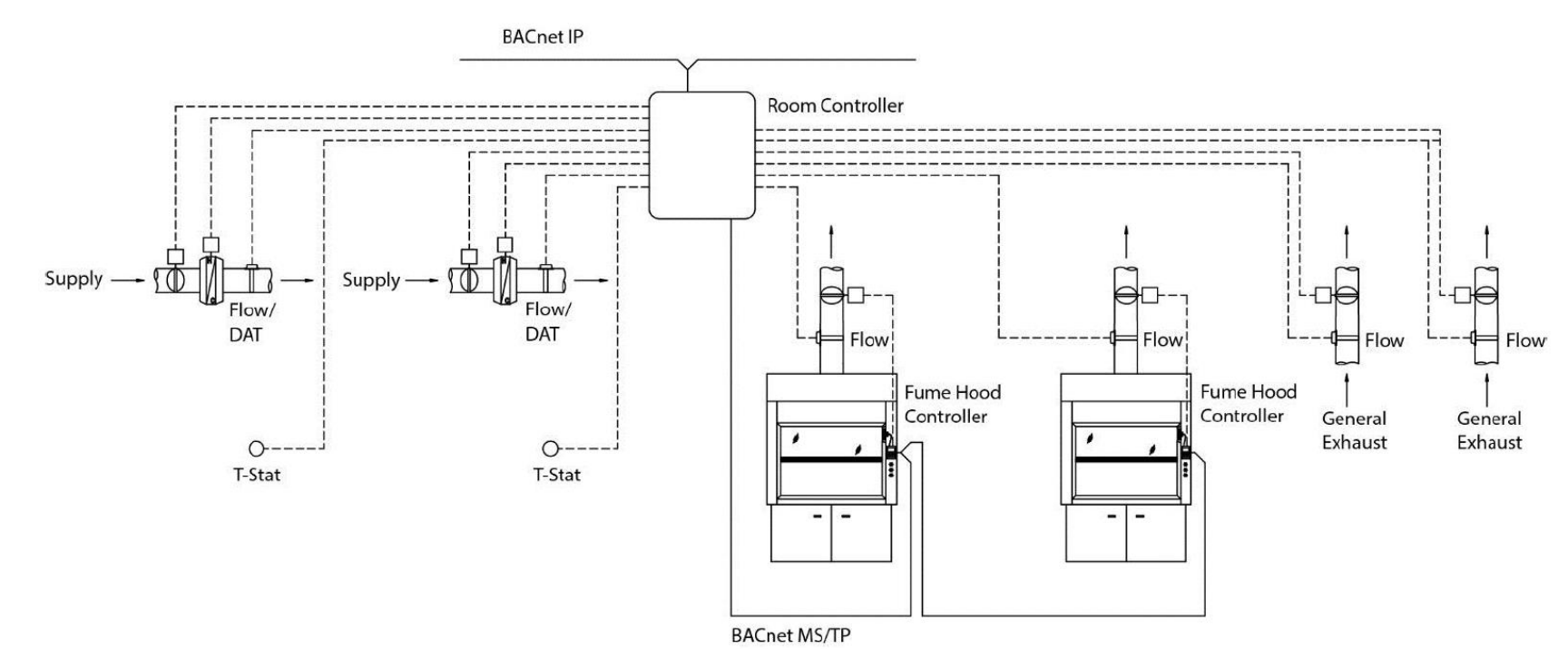
Room Balance Sequence of Operation

- The room controller continuously measures supply and exhaust flows in order to maintain room balance.
- If the offset becomes too large, indicating that the room balance is too negative, the room controller proportionally closes each general exhaust. If the offset is still too large, the room controller will then proportionally open each supply to its maximum setpoint.
- If the offset becomes too small, indicating that the room balance is not negative enough or positive, the room controller proportionally closes each supply to its minimum ventilation or cooling flow setpoint. If the offset is still too small, the room controller will then proportionally open each general exhaust.

Ventilation (ACH) Control Sequence of Operation

- The room controller continuously measures and maintains each zone supply at or above its minimum setpoint

Offset


BACnet IP
Room Controller
Supply
Flow/
DAT
Supply
Flow/
DAT
T-Stat
T-Stat
Flow
Fume Hood
Controller
Flow
Fume Hood
Controller
Flow
General
Exhaust
Flow
General
Exhaust
BACnet MS/TP

Offset with Pressure Monitoring Sequence

General Sequence of Operation

- The room controller simultaneously controls room supply and exhaust to maintain room balance, ventilation and temperature in the laboratory.

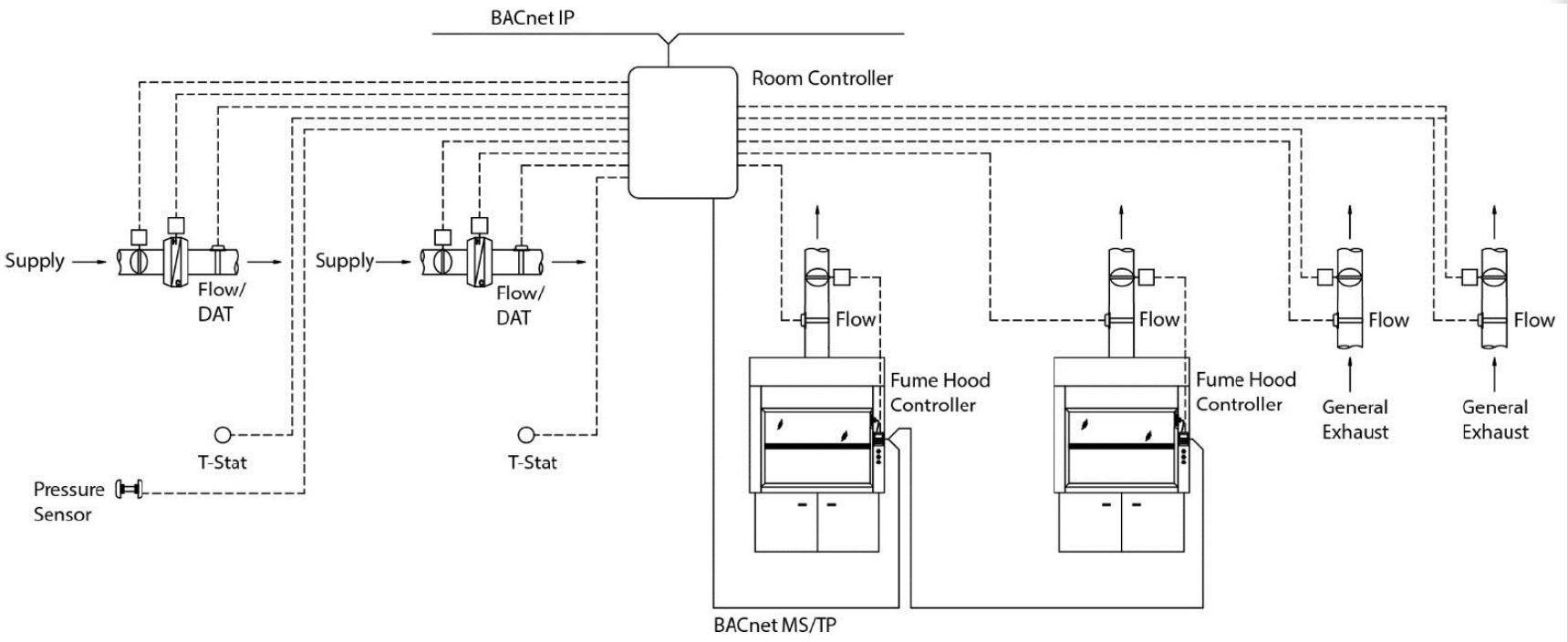
Room Balance Sequence of Operation

- The room controller continuously measures supply and exhaust flows in order to maintain the room balance.
- If the offset becomes too large, indicating that the room balance is too negative, the room controller proportionally closes each general exhaust. If the offset is still too large, the room controller will then proportionally open each supply to its maximum setpoint.
- If the offset becomes too small, indicating that the room balance is not negative enough or positive, the room controller proportionally closes each supply to its minimum ventilation or cooling flow setpoint. If the offset is still too small, the room controller will then proportionally open each general exhaust.
- The room controller continuously measures room pressure differential. If room pressure differential is too negative or too positive, the room controller will alarm.

Ventilation (ACH) Control Sequence of Operation

- The room controller continuously measures and maintains each zone supply at or above its minimum setpoint.

Offset with Pressure Monitoring



Adaptive Offset

General Sequence of Operation

- The room controller simultaneously controls room supply and exhaust to maintain room balance, ventilation and temperature in the laboratory.

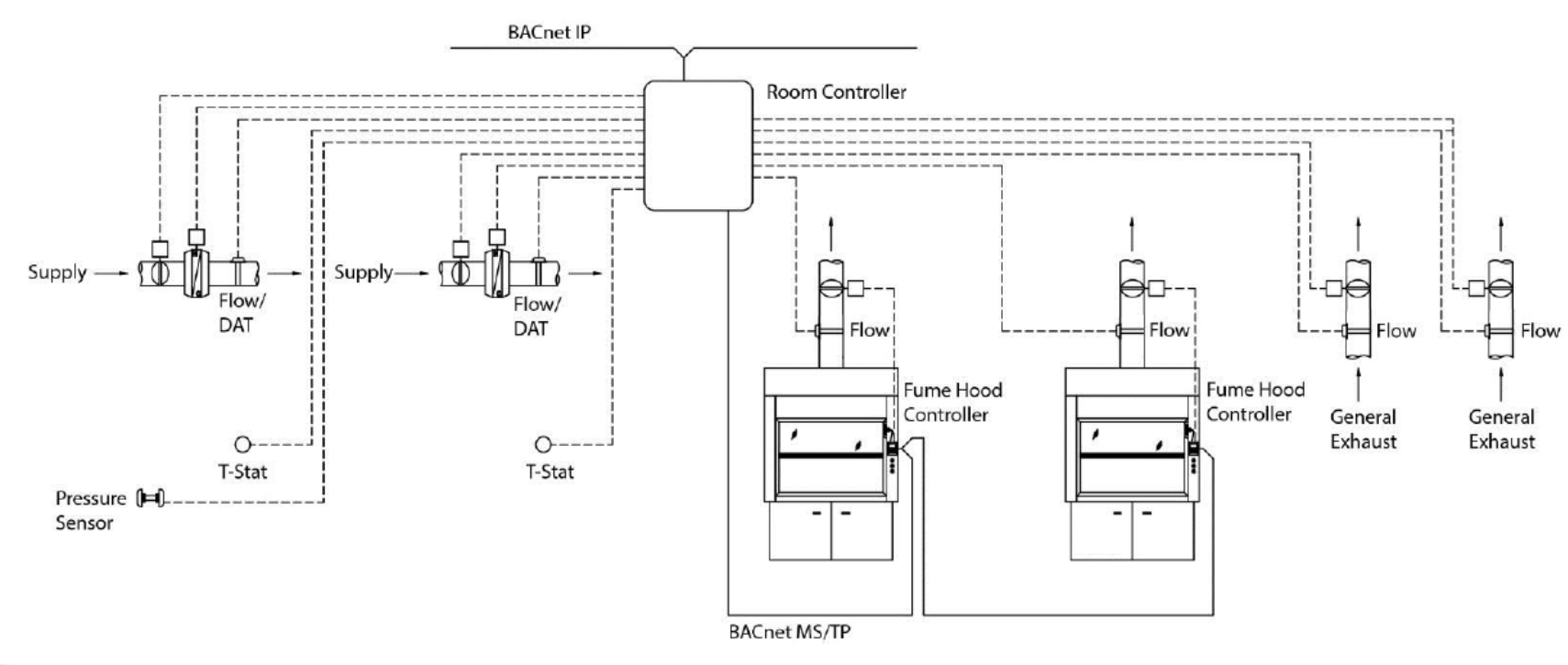
Room Balance Sequence of Operation

- The room controller continuously measures supply and exhaust flows in order to maintain the flow offset.
- If the offset becomes too large, indicating that the room balance is too negative, the room controller proportionally closes each general exhaust. If the offset is still too large, the room controller will then proportionally open each supply to its maximum setpoint.
- If the offset becomes too small, indicating that the room balance is not negative enough or positive, the room controller proportionally closes each supply to its minimum ventilation or cooling flow setpoint. If the offset is still too small, the room controller will then proportionally open each general exhaust.
- The room controller continuously measures room pressure differential. If the room pressure differential is too negative, the room controller will slowly increase the flow offset within field-configurable limits. If the room pressure differential is too positive, the room controller will slowly decrease the flow offset within field configurable limits.

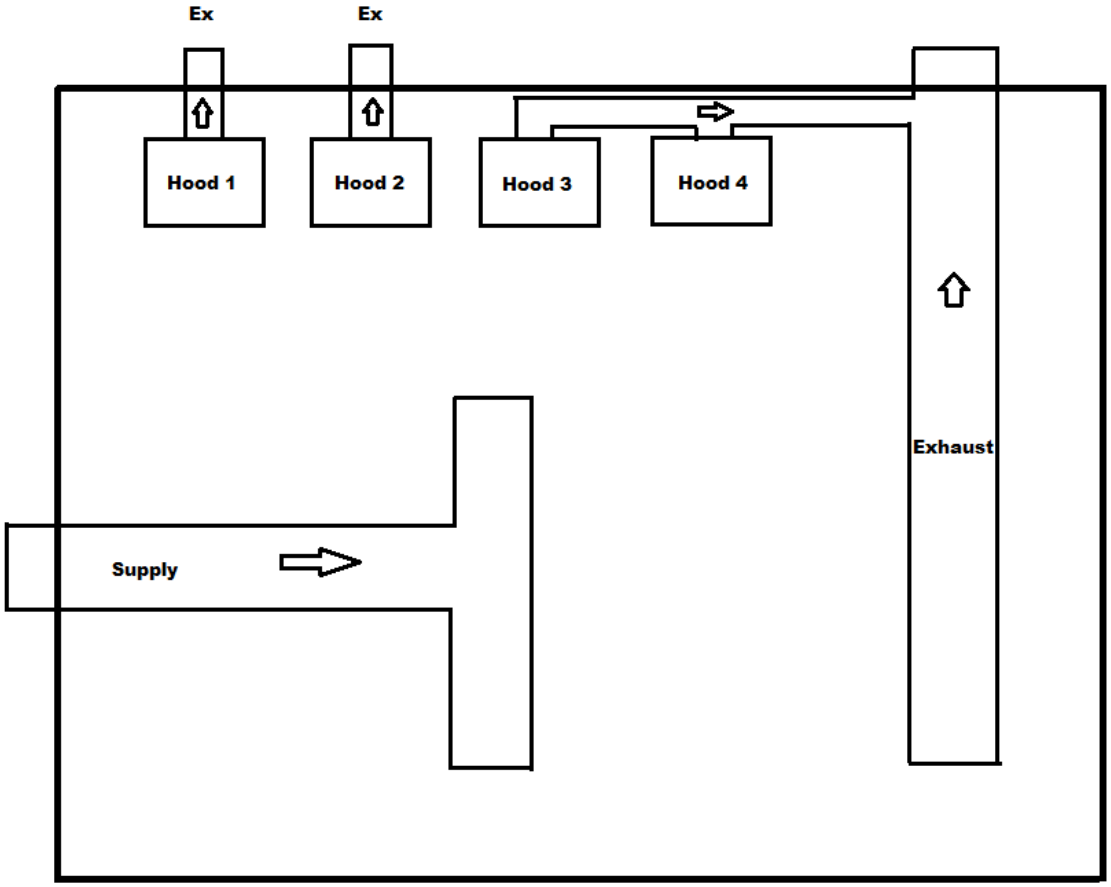
Ventilation (ACH) Control Sequence of Operation

- The room controller continuously measures and maintains each zone supply at or above its minimum setpoint.

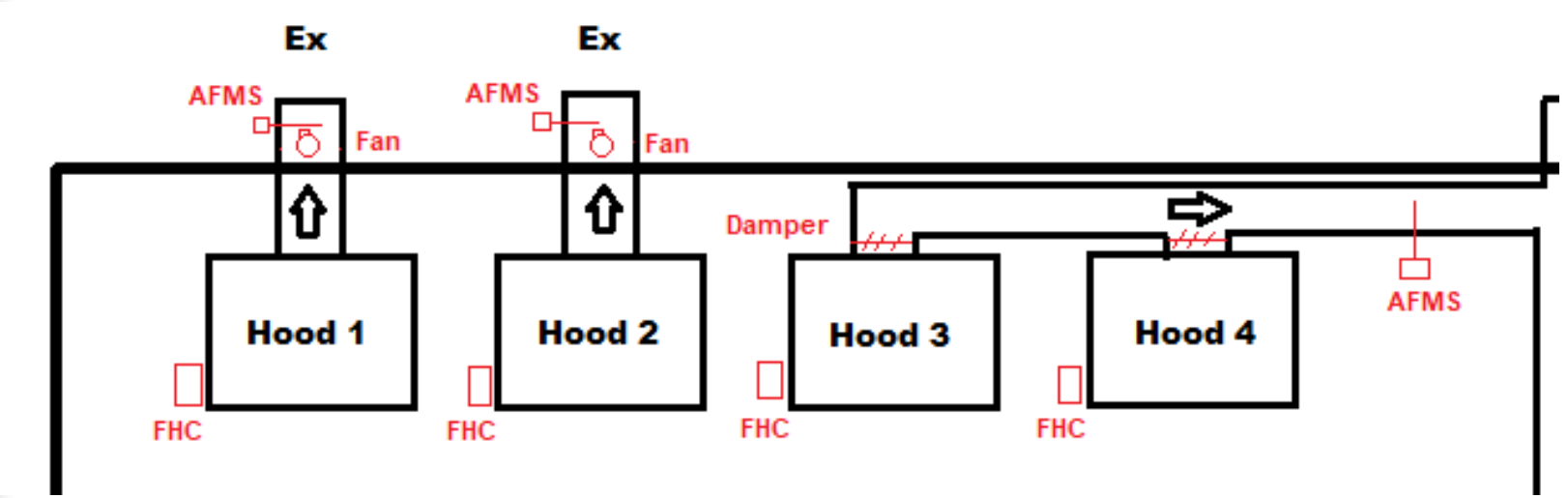
Adaptive Offset



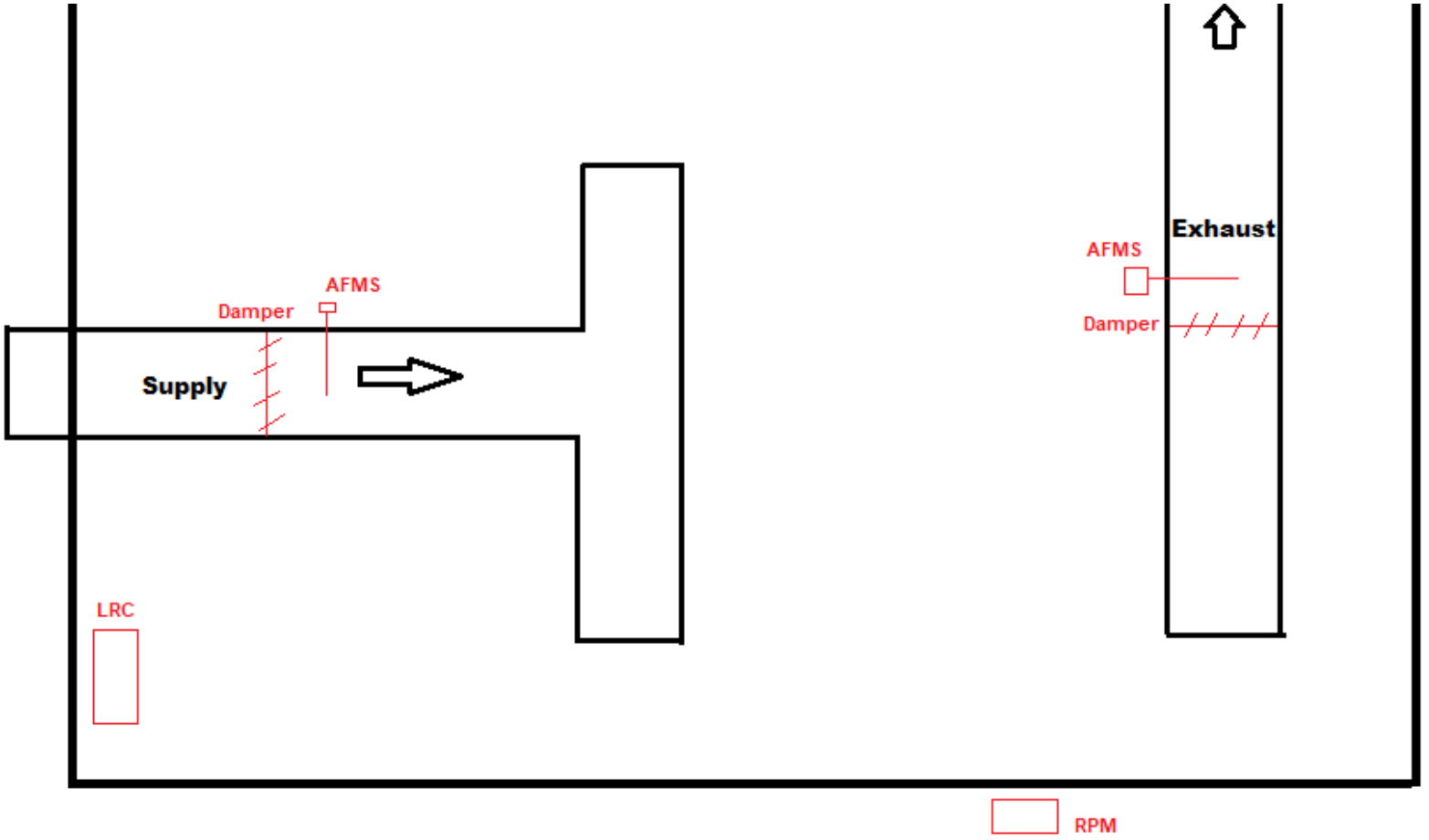
Lab Design Example



Lab Design Example



Lab Design Example



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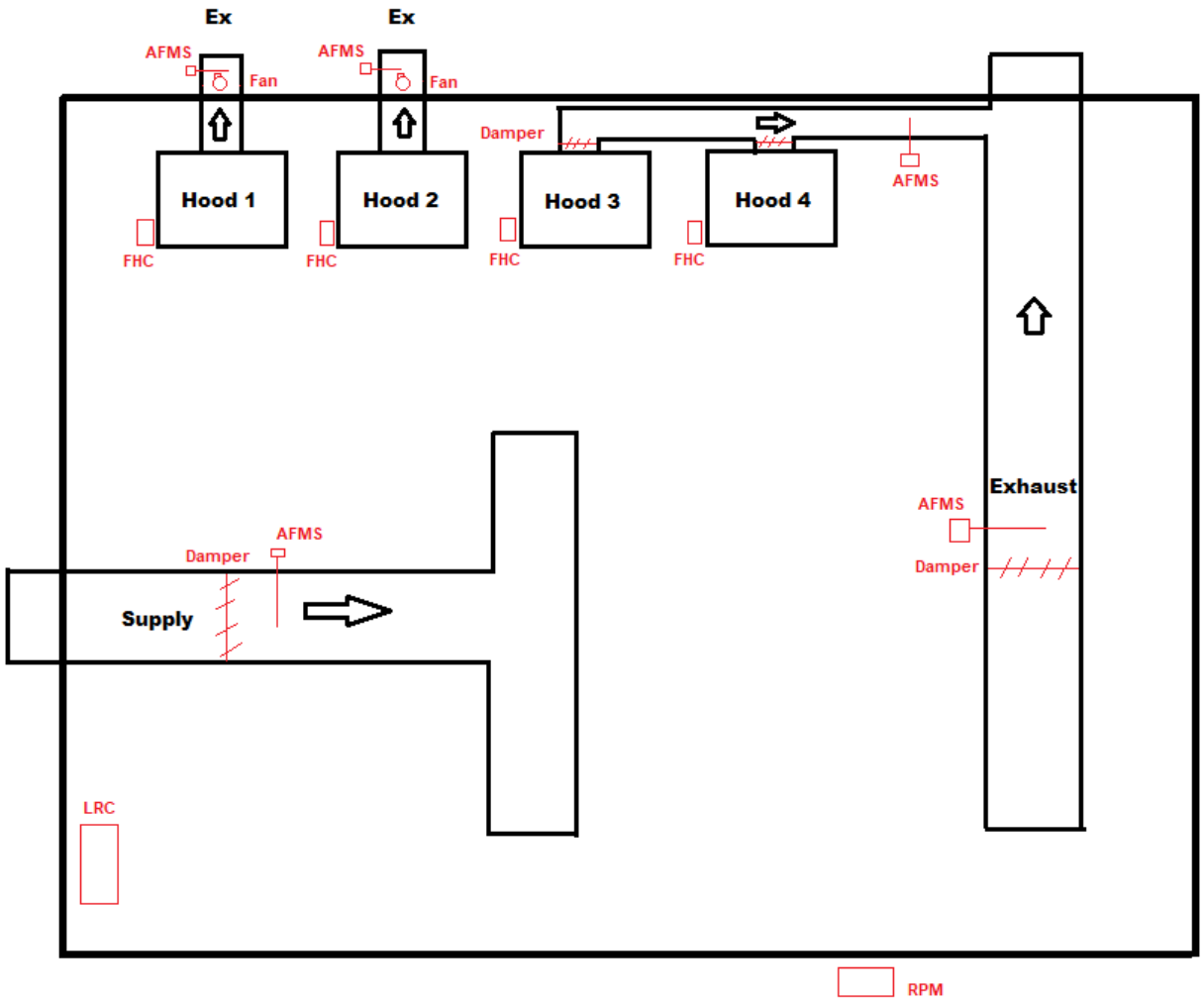
Lab Design Example



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Questions?

Jacco & Associates