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Introduction to Airflow Control in Critical Environments



Wisconsin Healthcare
Engineering Association

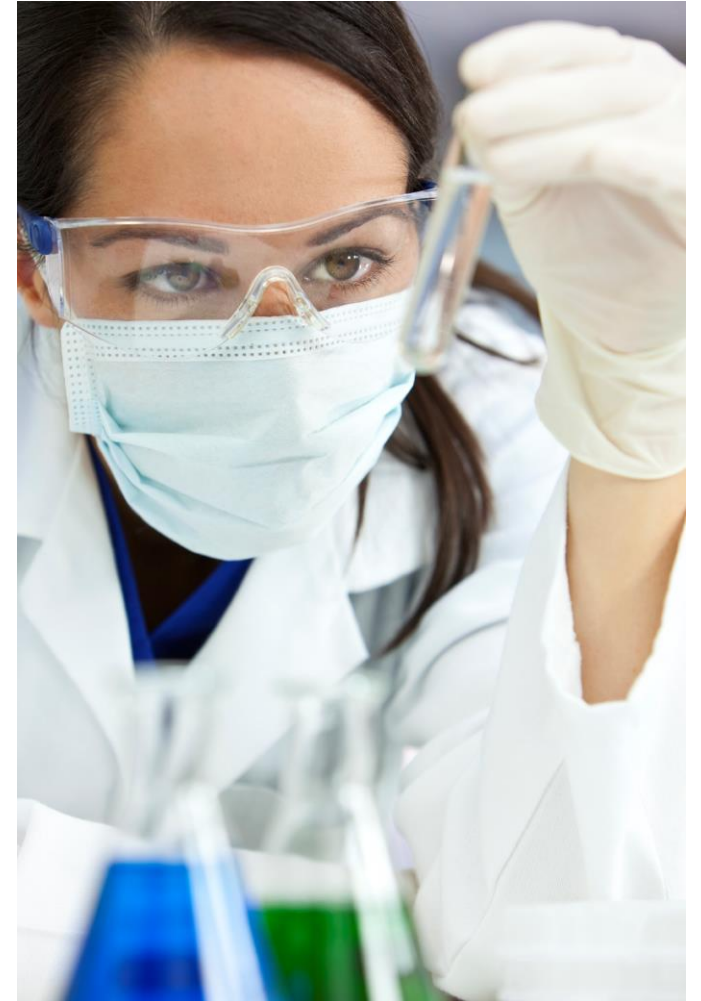
Joe Pustai, PE, LEED-AP

Project Development Engineer - Critical Environment Controls



Agenda

- Introduction
- Presentation Goals
- What is a Critical Environment?
- Airflow Control Methodologies
- Current Codes and Standards
- Putting It Together
- Q&A



What is a Critical Environment?



Operating Suites

Ante Rooms / Isolation Rooms

Clean Rooms

Pharmaceutical Manufacturing

Emergency Rooms

Oncology Suites

Government Facilities

K-12 and University Labs

Burn Units

Biocontainment Facilities

Corporate Labs

Mortuary Labs

Vivariums

Biocontainment Facilities

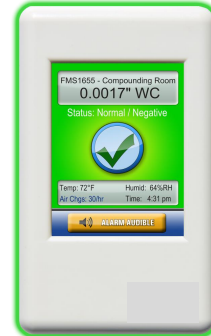
Teaching Labs

Wet Chemistry Labs

Food Research Labs

Crime Labs

What is a Critical Environment: Commonly Used Products



- Venturi air valves
- Venturi valve conversion kits
- Ultra-low pressure valves
- Actuators

- Fume hood controllers
- Room pressure controllers
- Central monitoring stations
- Remote monitors
- Motion sensors
- Temperature sensors

- Fume hoods
- Fume hood conversion kits
- Humidity sensors
- Air flow sensors
- Sash position sensors
- Face velocity sensors

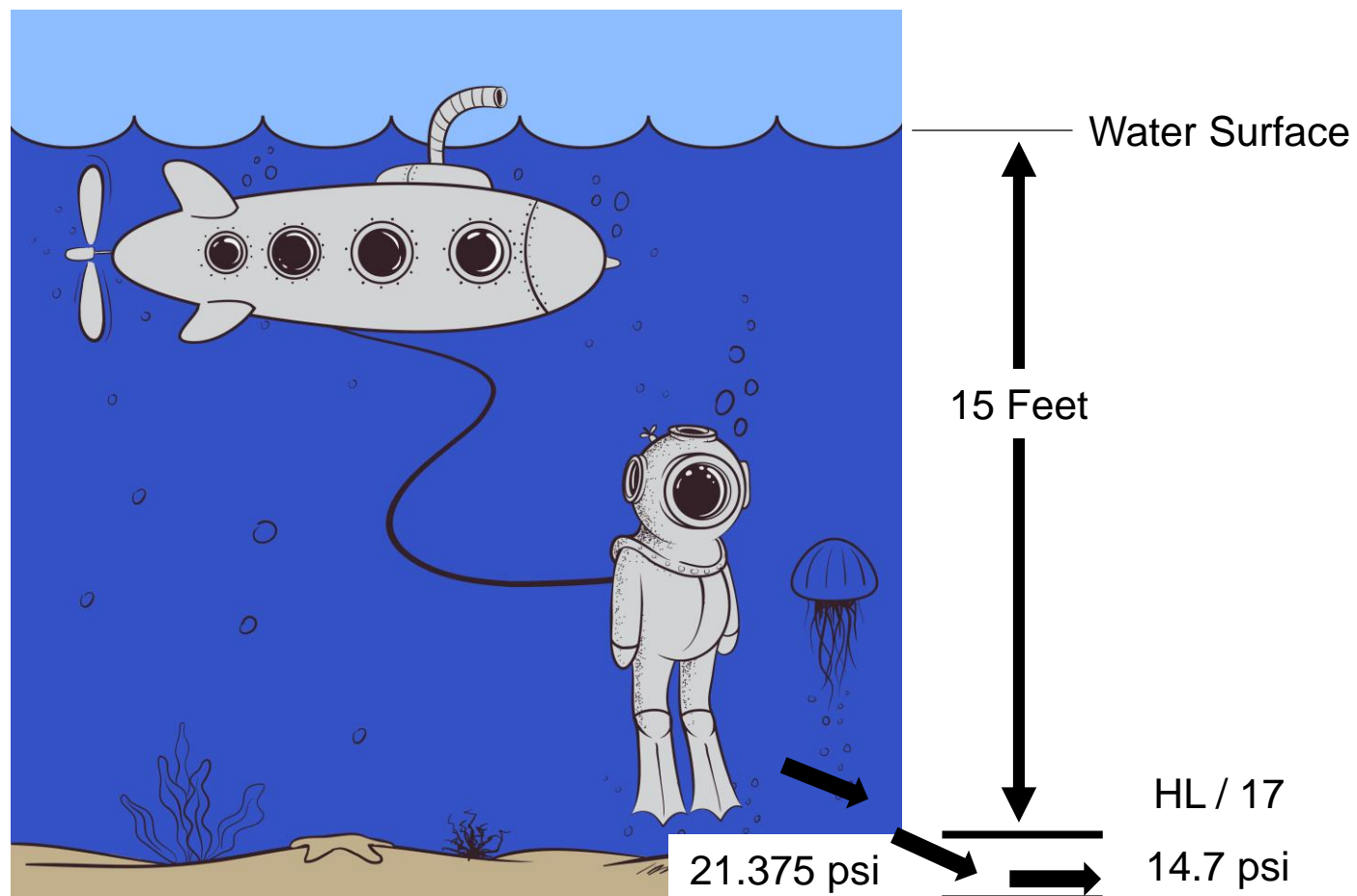
What is a Critical Environment?

Protecting People



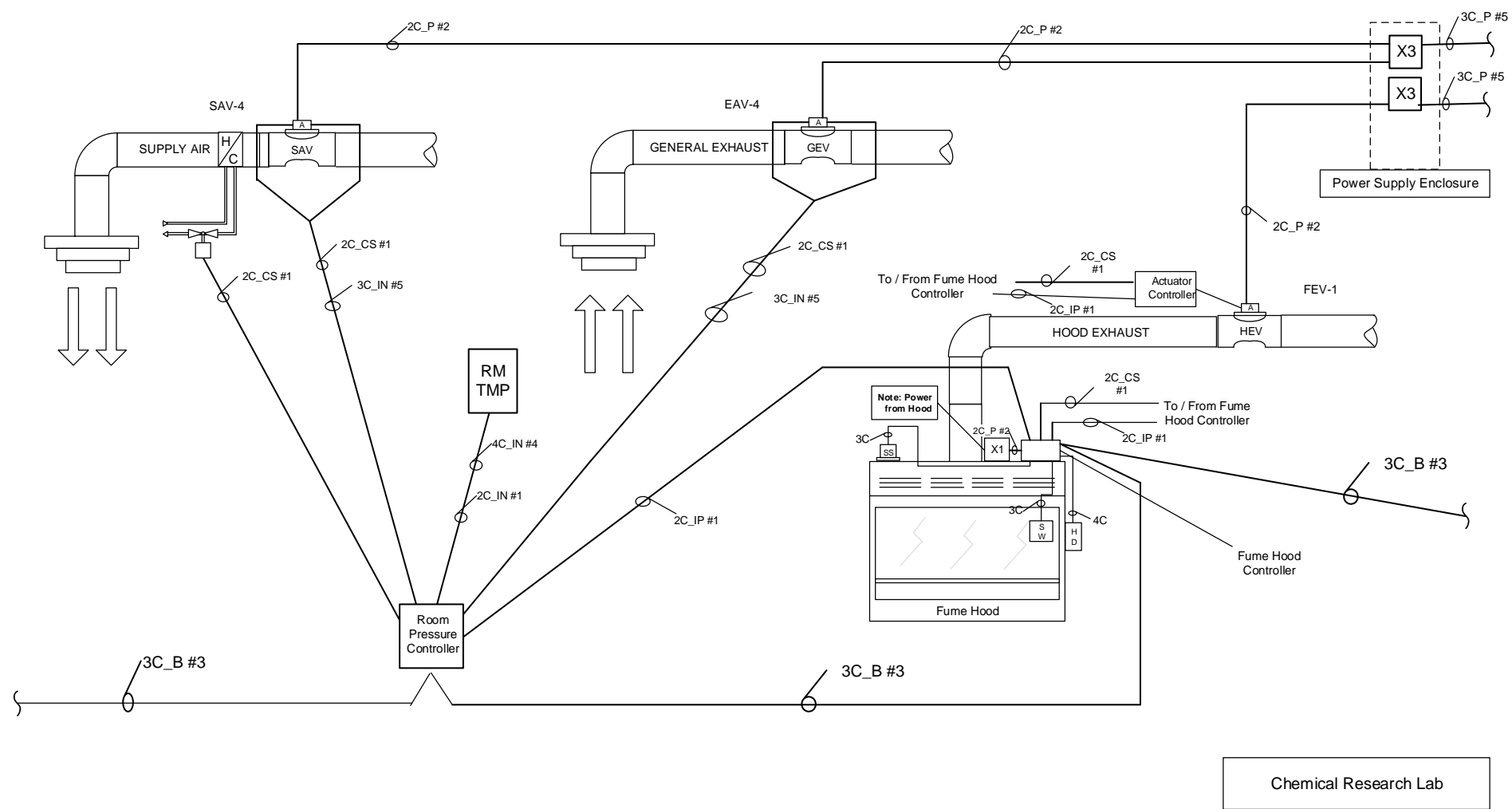
What is a Critical Environment?

Why pressure control?



What is a Critical Environment?

Offset Tracking Control



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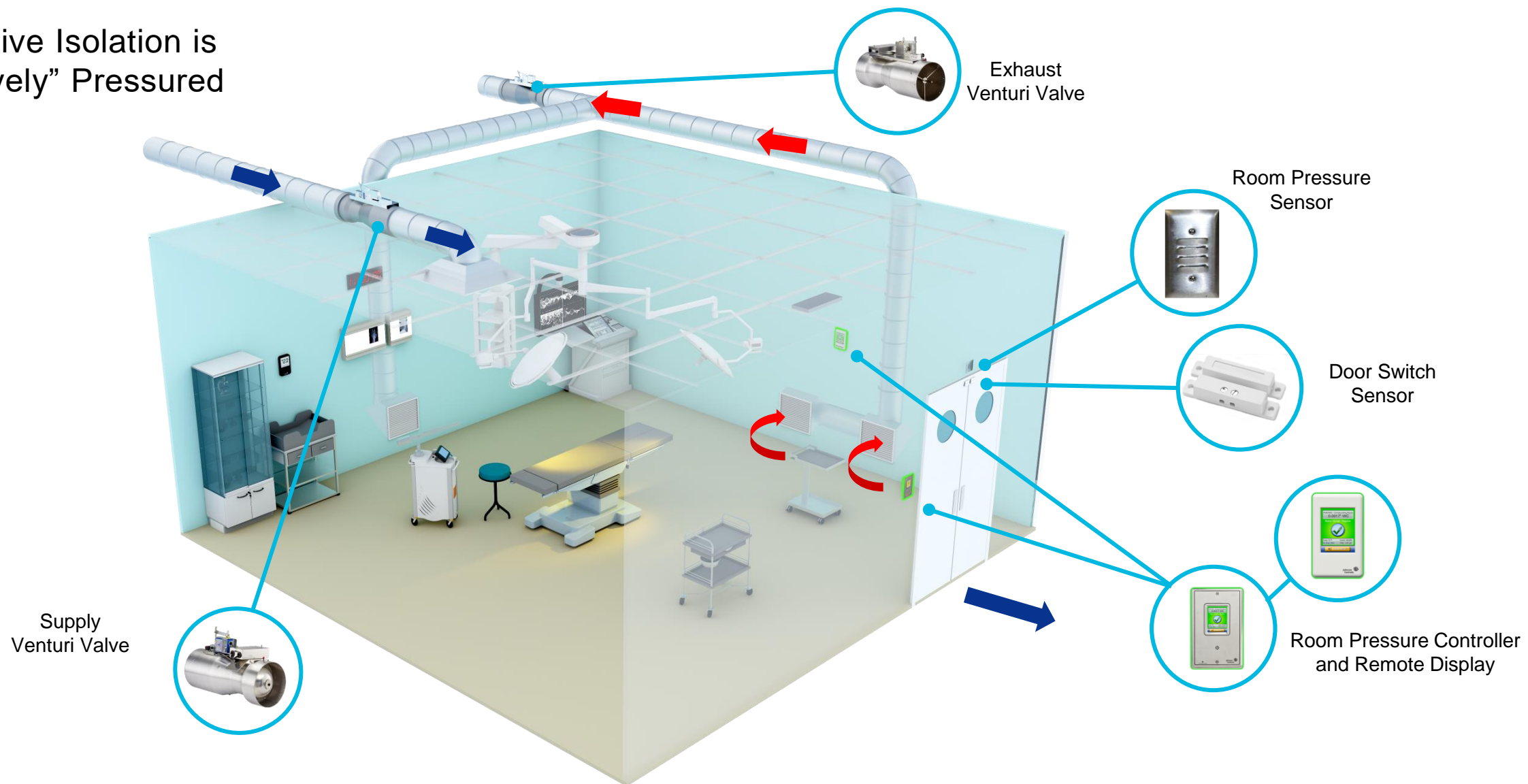
Wet Chemistry Labs

Food Research Labs

Crime Labs

What is a Critical Environment?

Protective Isolation is
“Positively” Pressured



What is a Critical Environment?

Protecting Patients



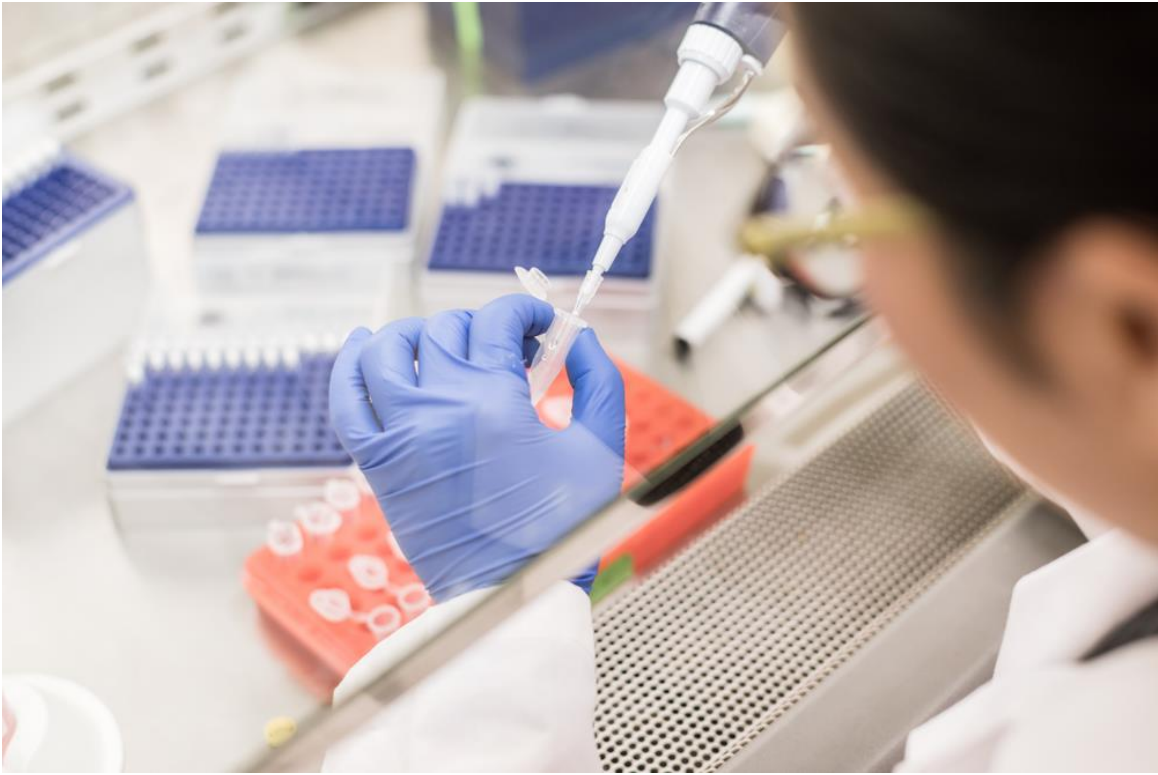
What is a Critical Environment?

Protecting Research



What is a Critical Environment?

Protecting Medications



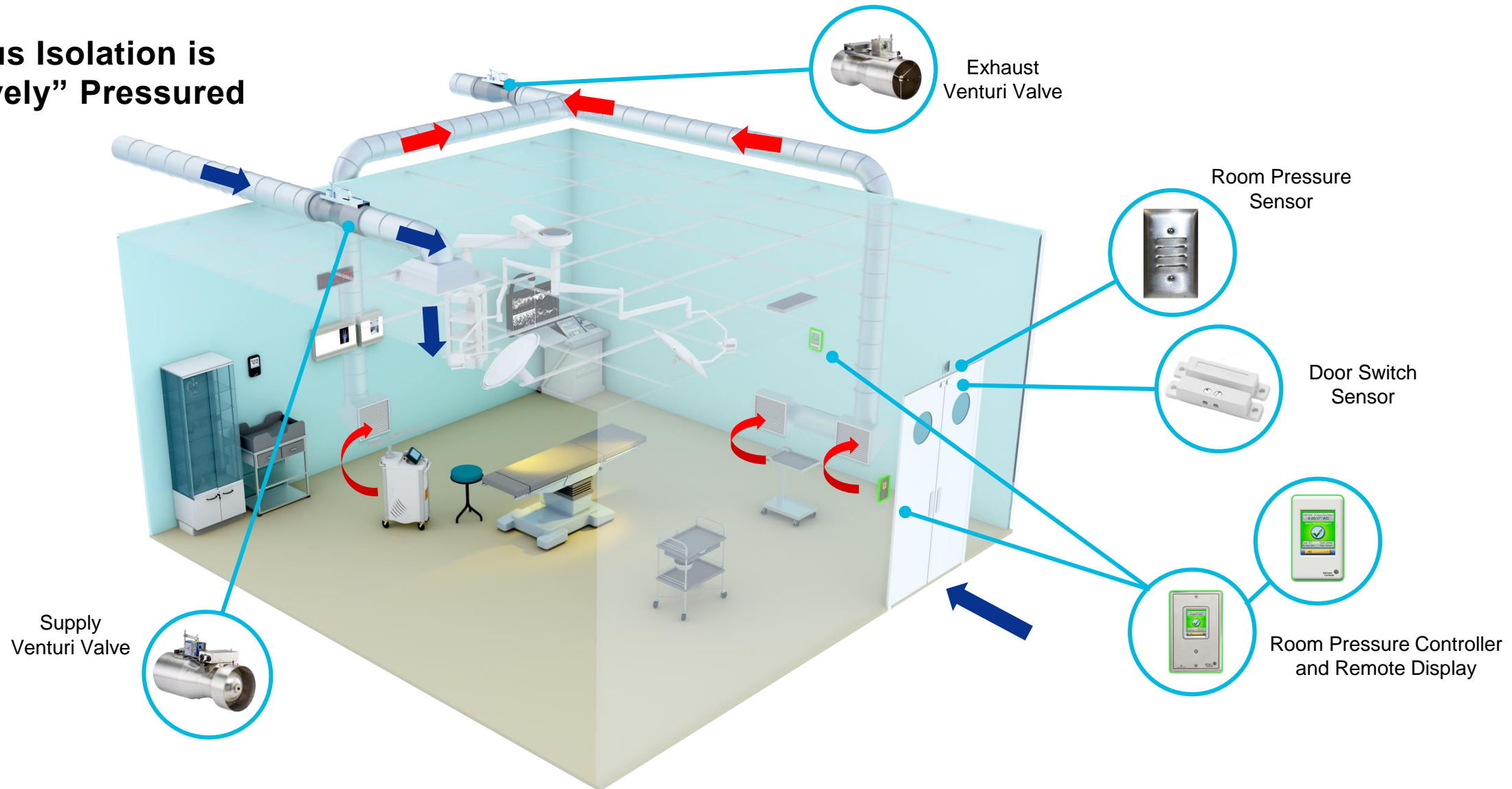
What is a Critical Environment?

Protecting People

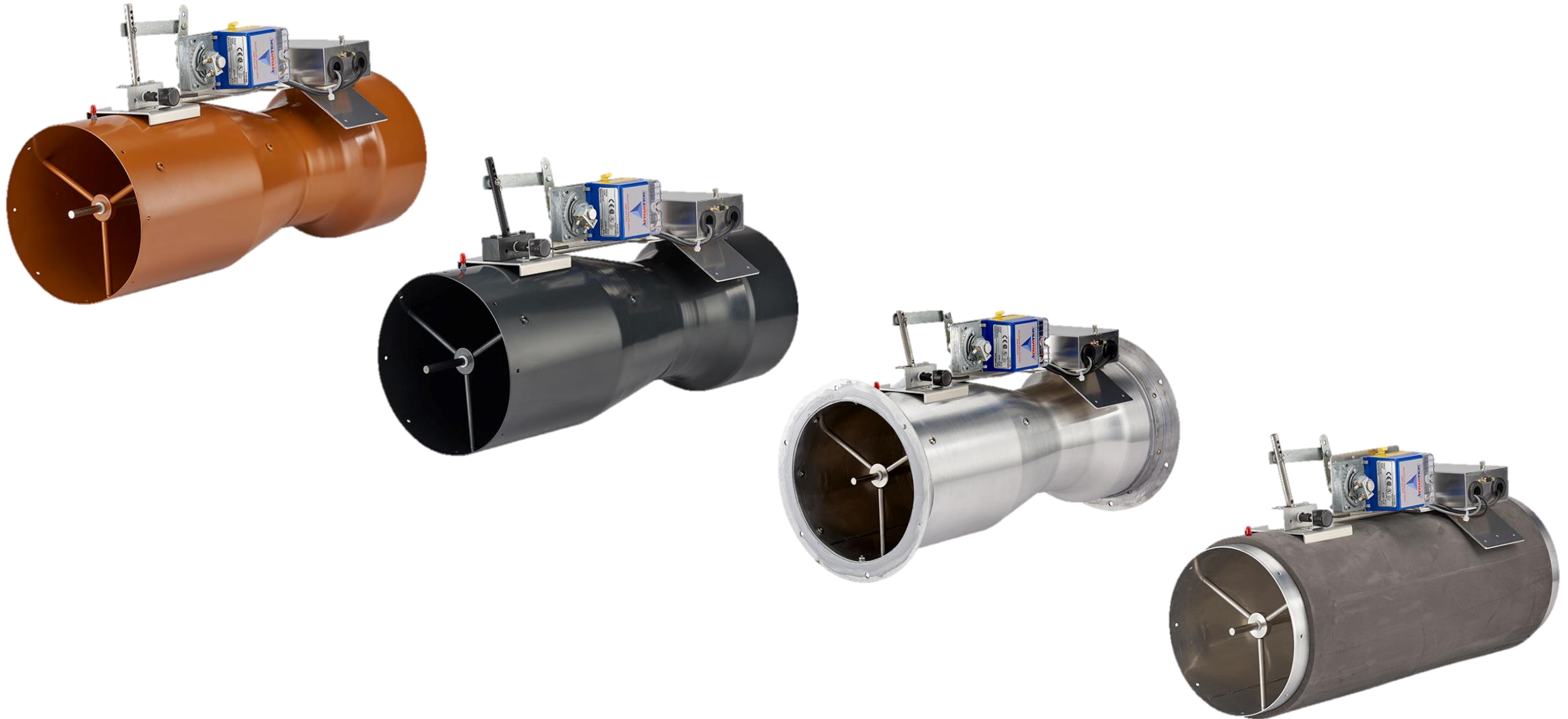


What is a Critical Environment?

Infectious Isolation is “Negatively” Pressured



Airflow Control Methodologies: Air Valves



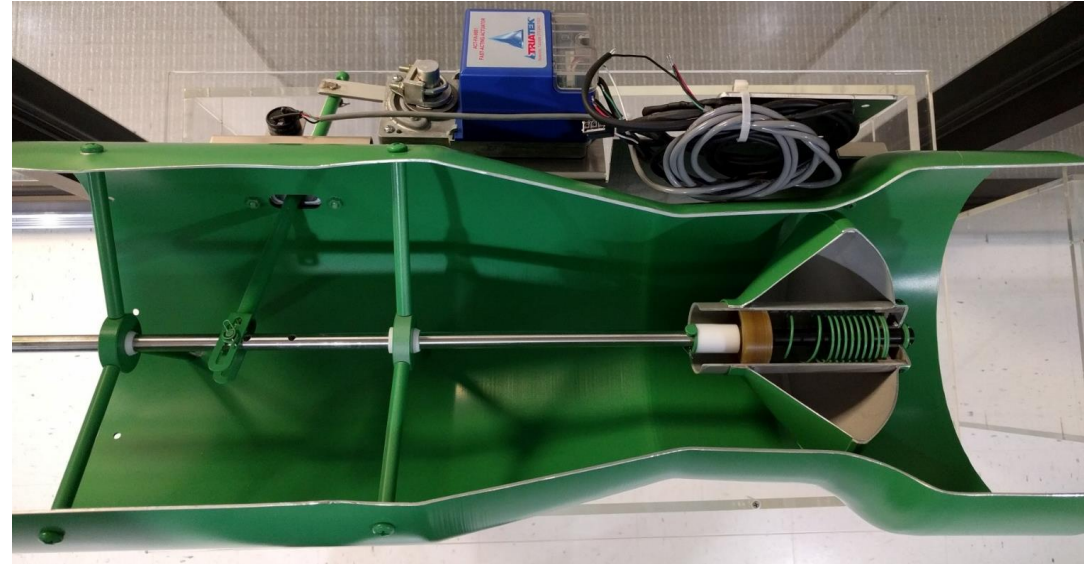
VAV Box vs. Venturi Air Valve

VAV Box



- The flow sensor has multiple tiny holes that are easily blocked with lint and dust requiring regular cleaning
- When the sensor is blocked, the controls will open the damper to compensate, increasing the flow unnecessarily

Venturi Air Valve



- When a flow change is required the actuator moves the linkage that is connected to the cone assembly
- The cone assembly responds independently to changing duct pressure – the actuator does not move

Venturi Air Valve Overview

- Highly accurate flow metering device utilizing a dynamic cone assembly
- Accurately controls airflow even at very low velocity pressure
- High turndown ratios up to 20:1
- Designed to provide accurate and repeatable flow and pressure control specifically for life safety spaces

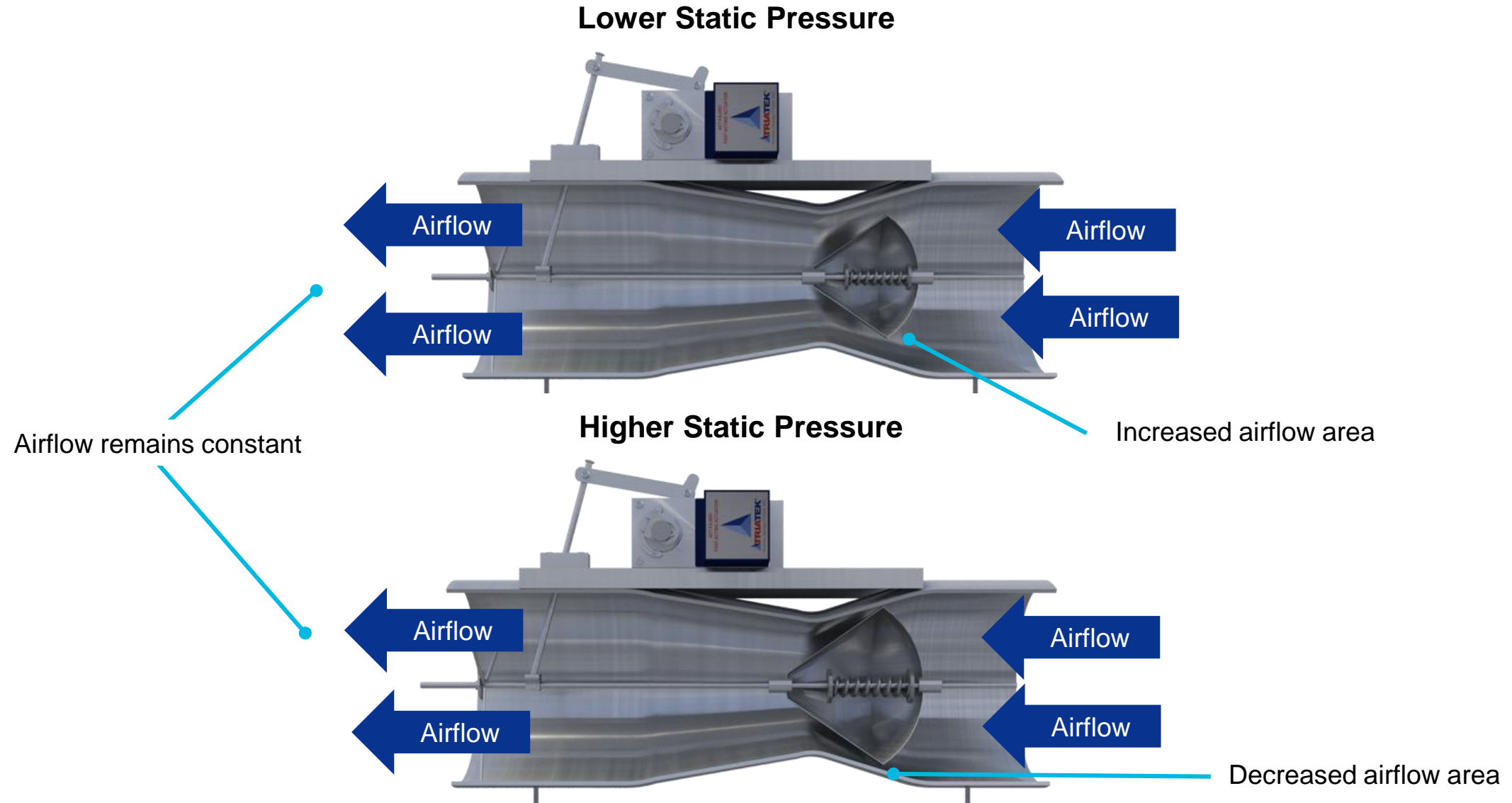


Why Venturi Valves are Used for Critical Environments



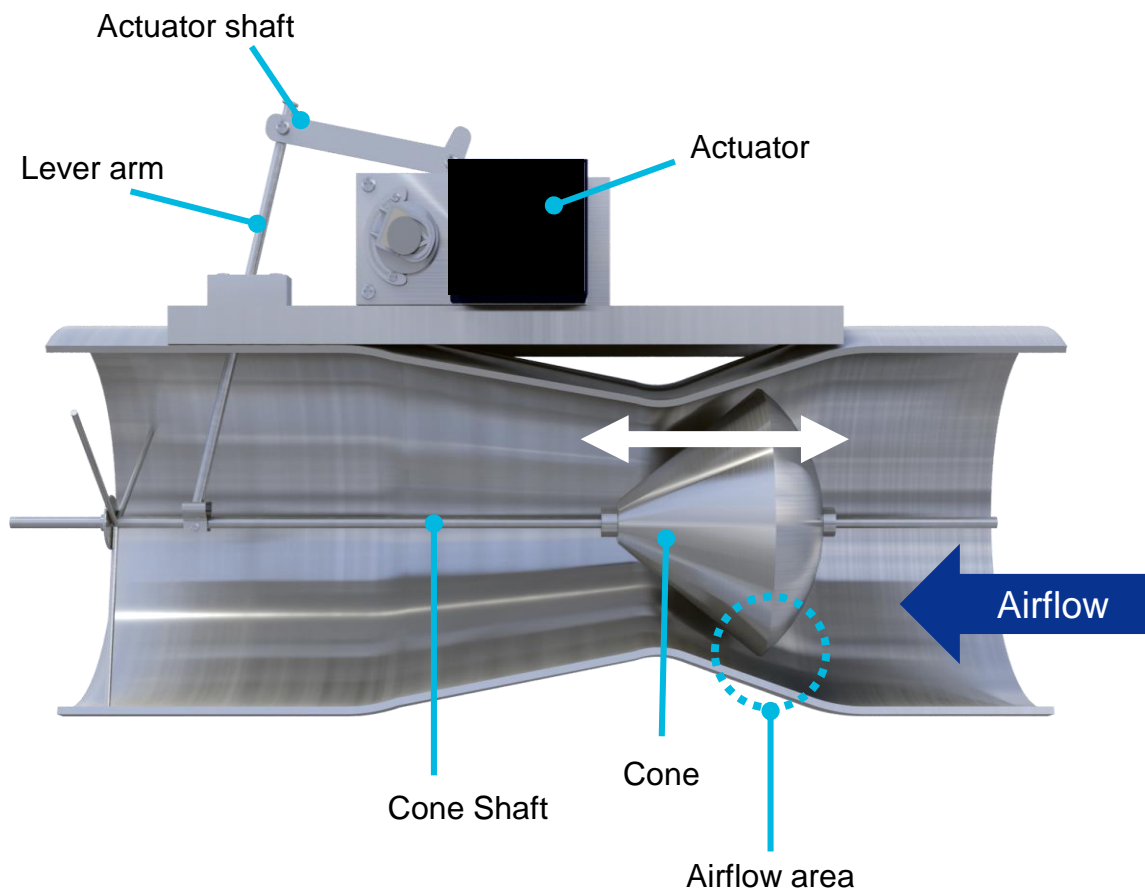
- **More accurate and stable** >5% of signal
- **NIST-traceable**
- **More options** for critical environments like thermal insulation, coatings for chemical resistance, and sizes
- **High turndown ratios** - 16:1 - 20:1; enabling occupied or unoccupied mode = energy savings
- **Inlet insensitive** - not affected by elbows or duct transitions either upstream or downstream
- **Pressure independent** - open loop pressure control
- **Maintenance-free** - no flow crosses to clean
- **Speed of response** <1 second to duct pressure
- **Simplified start-up and commissioning**
- **Multiple valves work better together** than multiple VAV boxes

Venturi Valve Pressure Independence

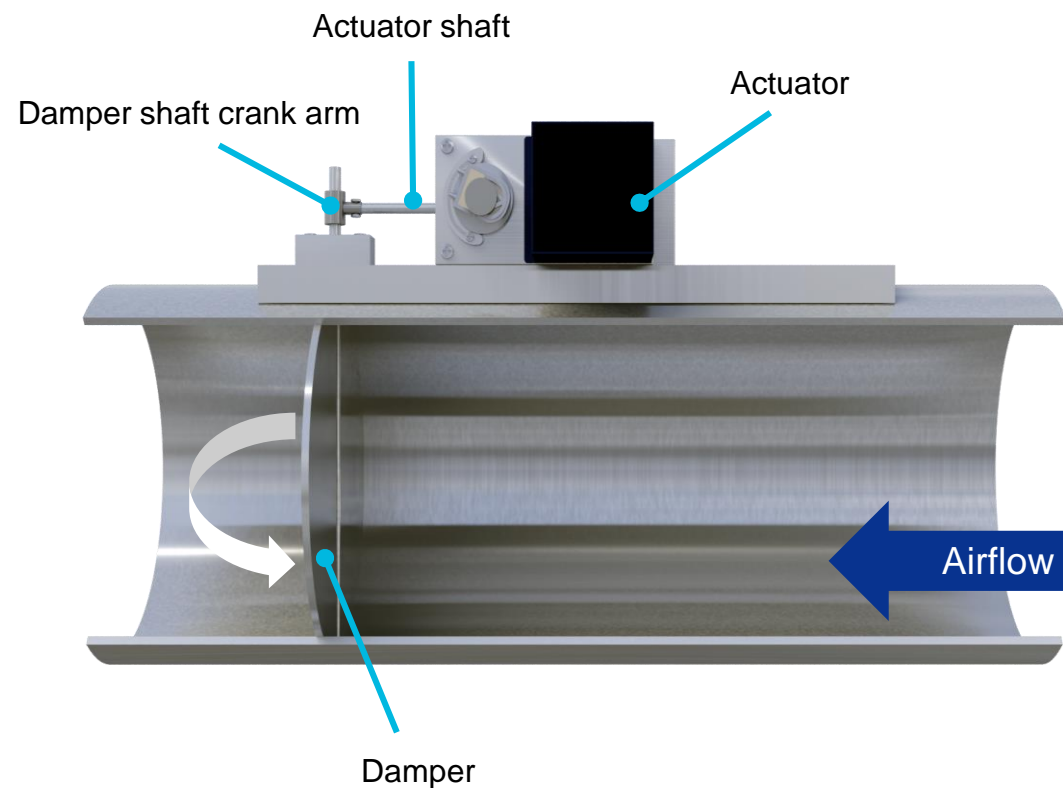


Venturi Valve vs. Butterfly Damper

Venturi Valve



Single Blade Damper



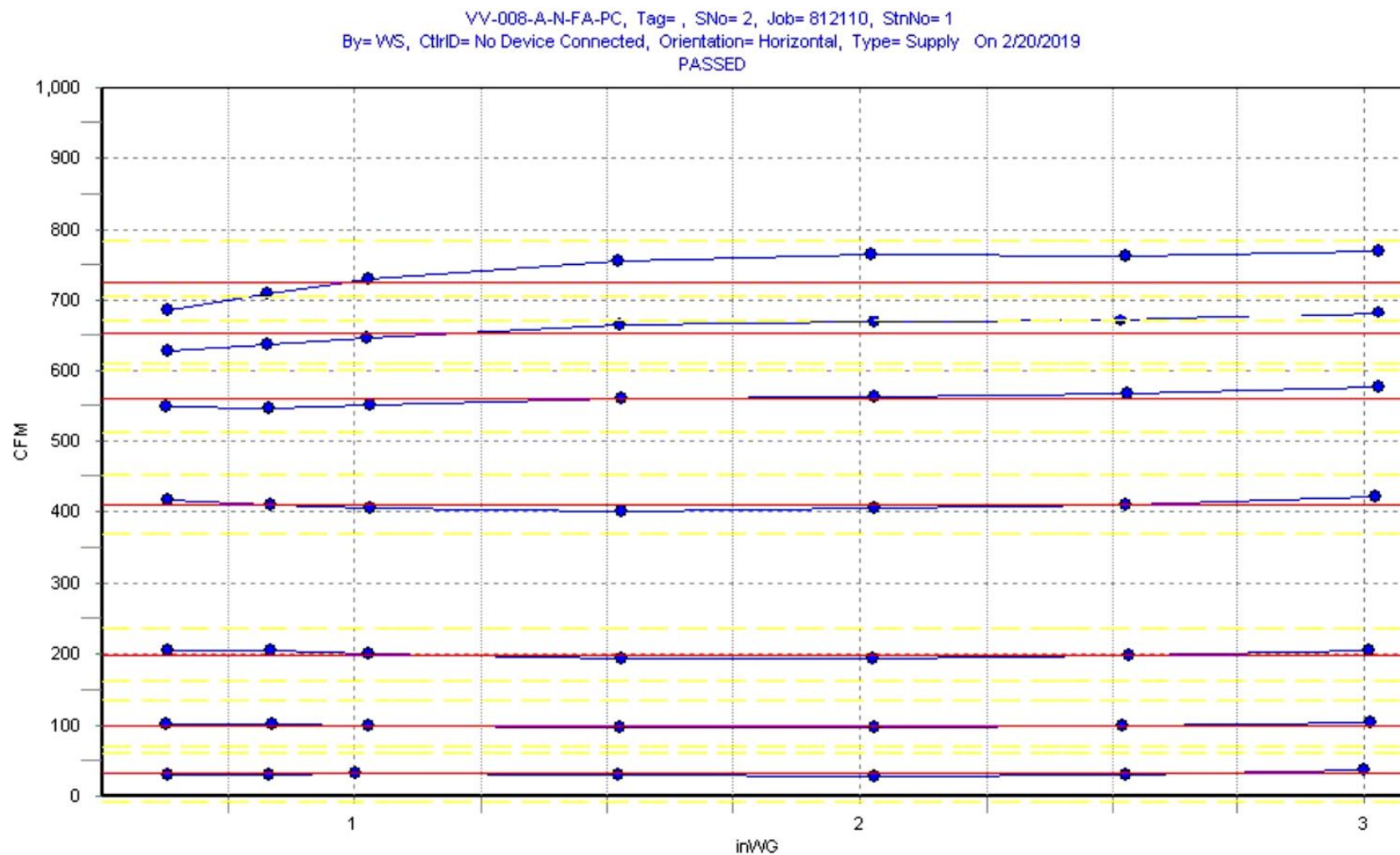
Venturi Valve Calibration

Calibration is a very important part of every valve manufacturer's process



Venturi Valve Calibration

Venturi Valve Calibration Curve



Venturi Valve Review

- Proven technology used in vast majority of lab projects
- Cost efficient solution to flow control with minimal energy usage.
- Pressure independent and accurate to within +/- 5% of the flow set point... and ± 0.0010 "wc control resolution.
- Venturi valves have proven themselves to providing repeatable airflow rates regardless of the static pressure.
- No routine maintenance required
- Cone and spring assembly gives the valve it's pressure independence and requires no maintenance



The brown Heresite® coating protects the valve against nasty chemicals in the air stream

Air Control Methodologies: Fume Hoods

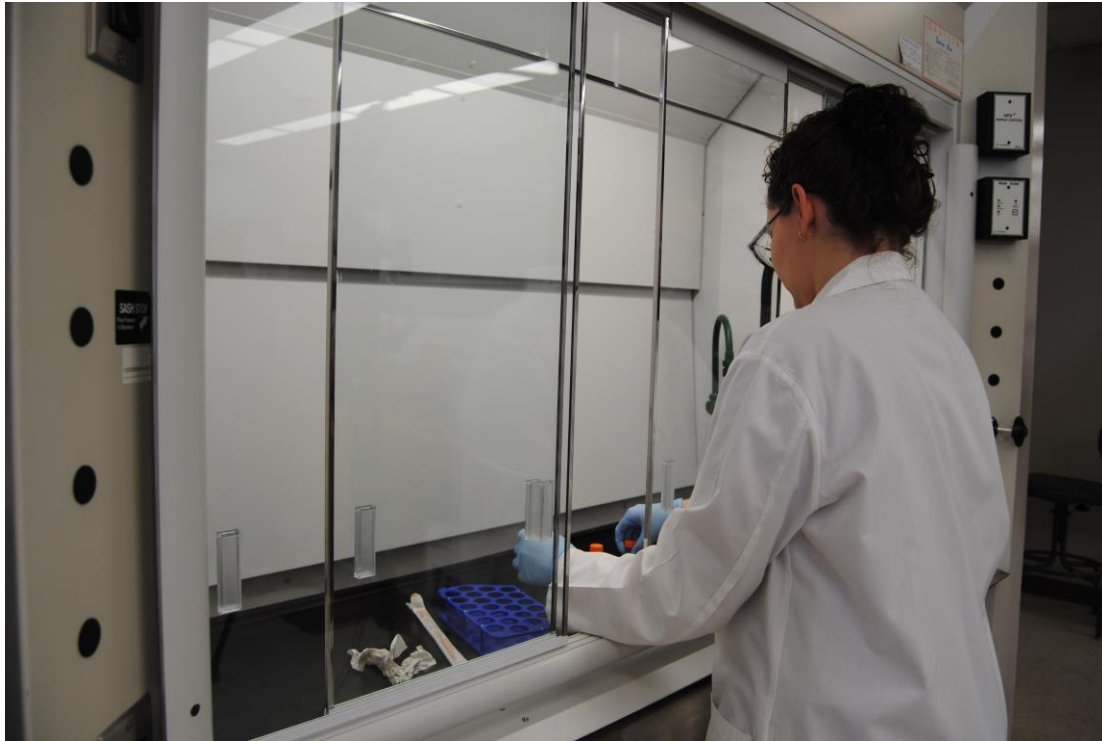


Fume Hood Control Methods

- Open loop, sash position sensing only
- Closed loop, velocity sensing only
- Closed loop, sash sensing with velocity sidewall sensing

Types of Fume Hoods

Constant Volume Hoods

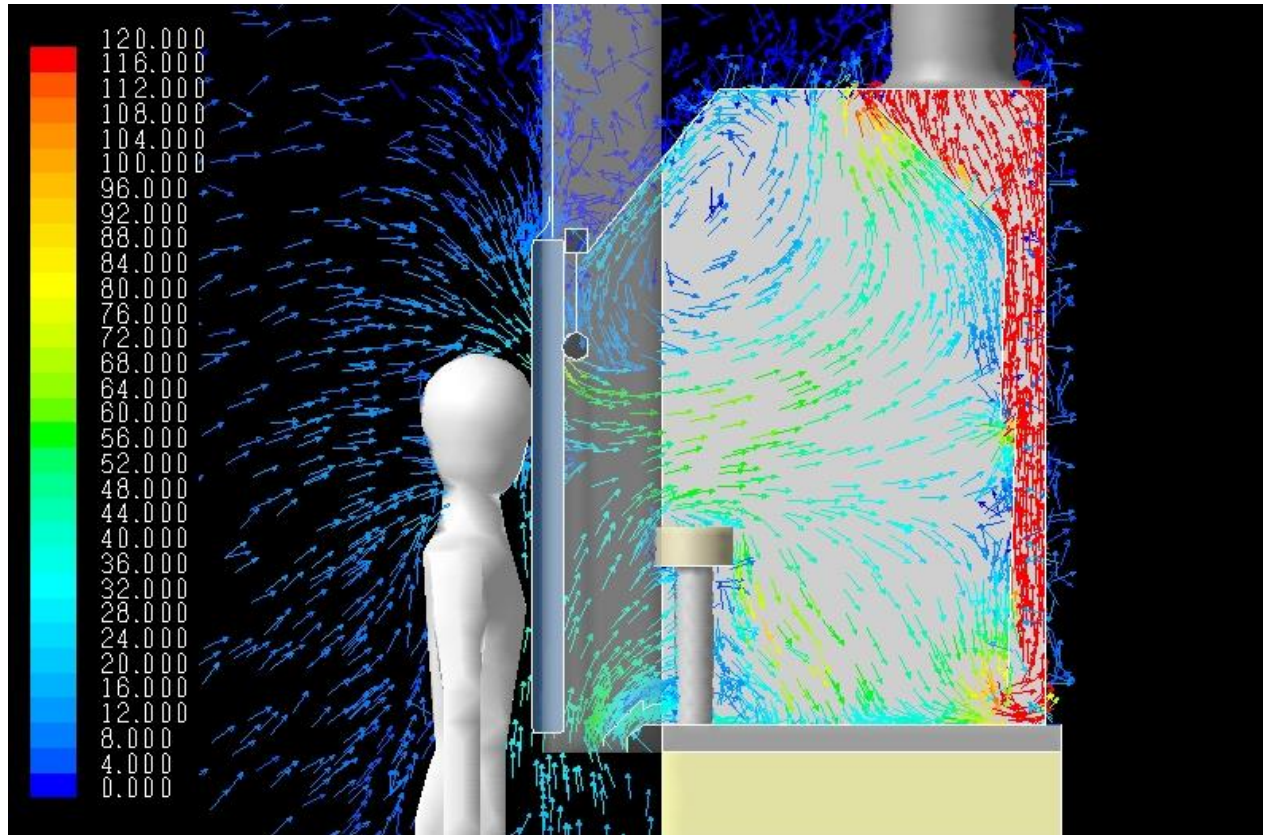


Variable Air Volume Hoods



What Constitutes a Safe Fume Hood?

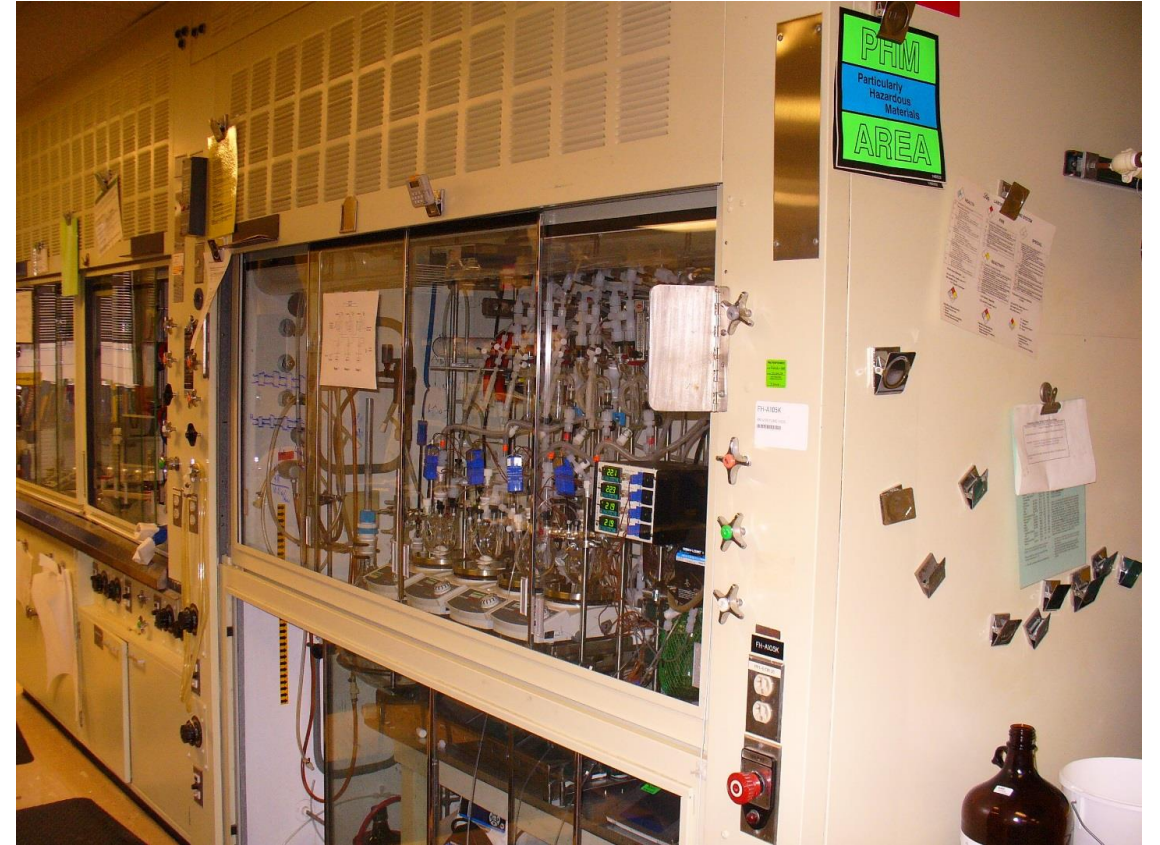
Proper Hood Containment



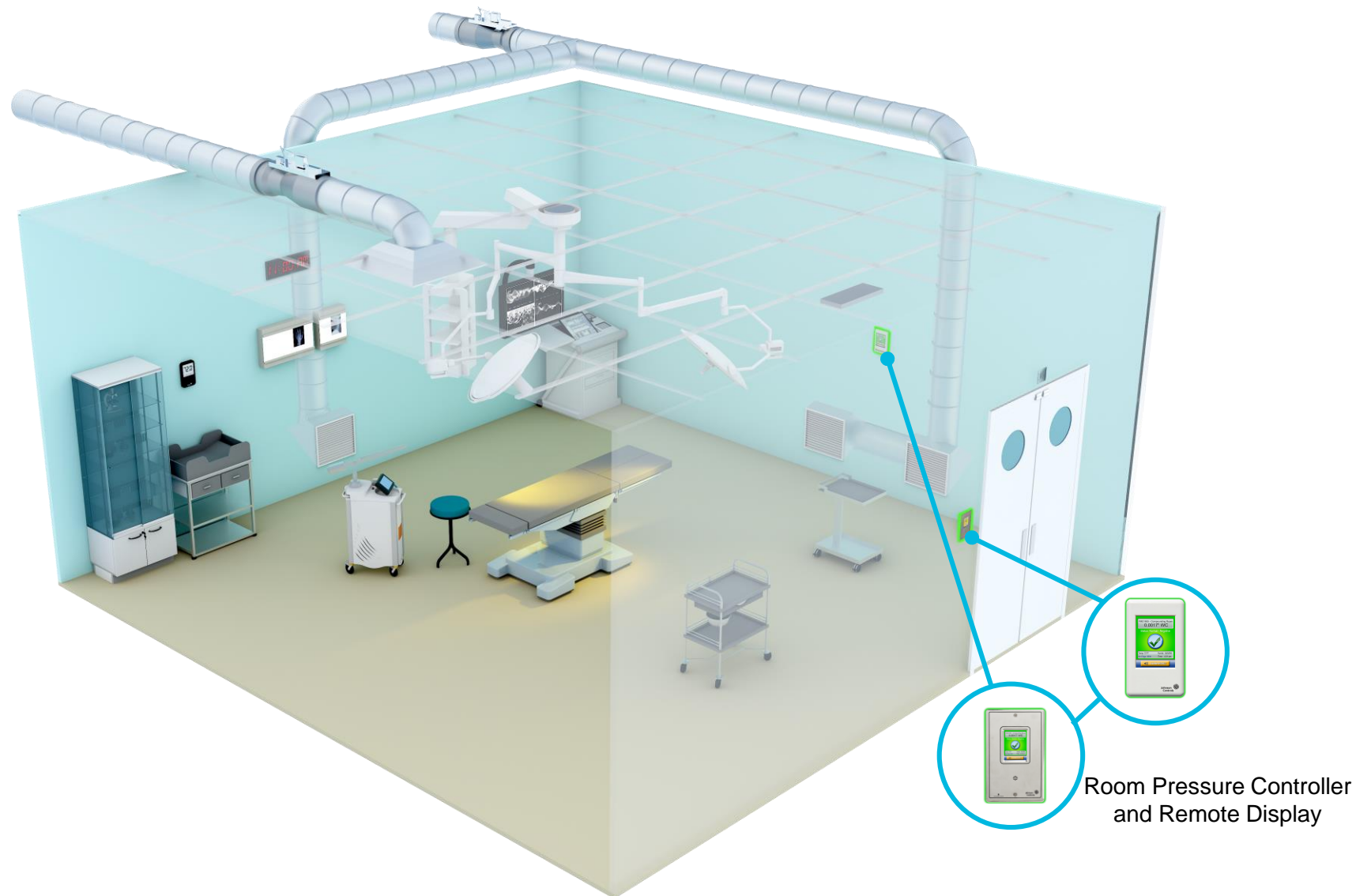
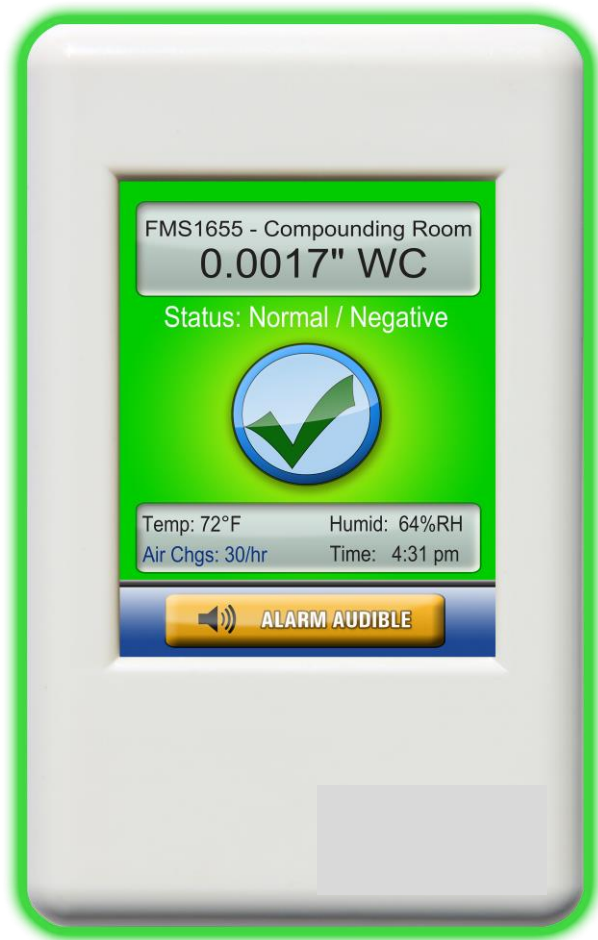
- Face velocity is not a measurement of safety
- Containment = safety
- ASHRAE 110-2016

Fume Hood Safety Concerns

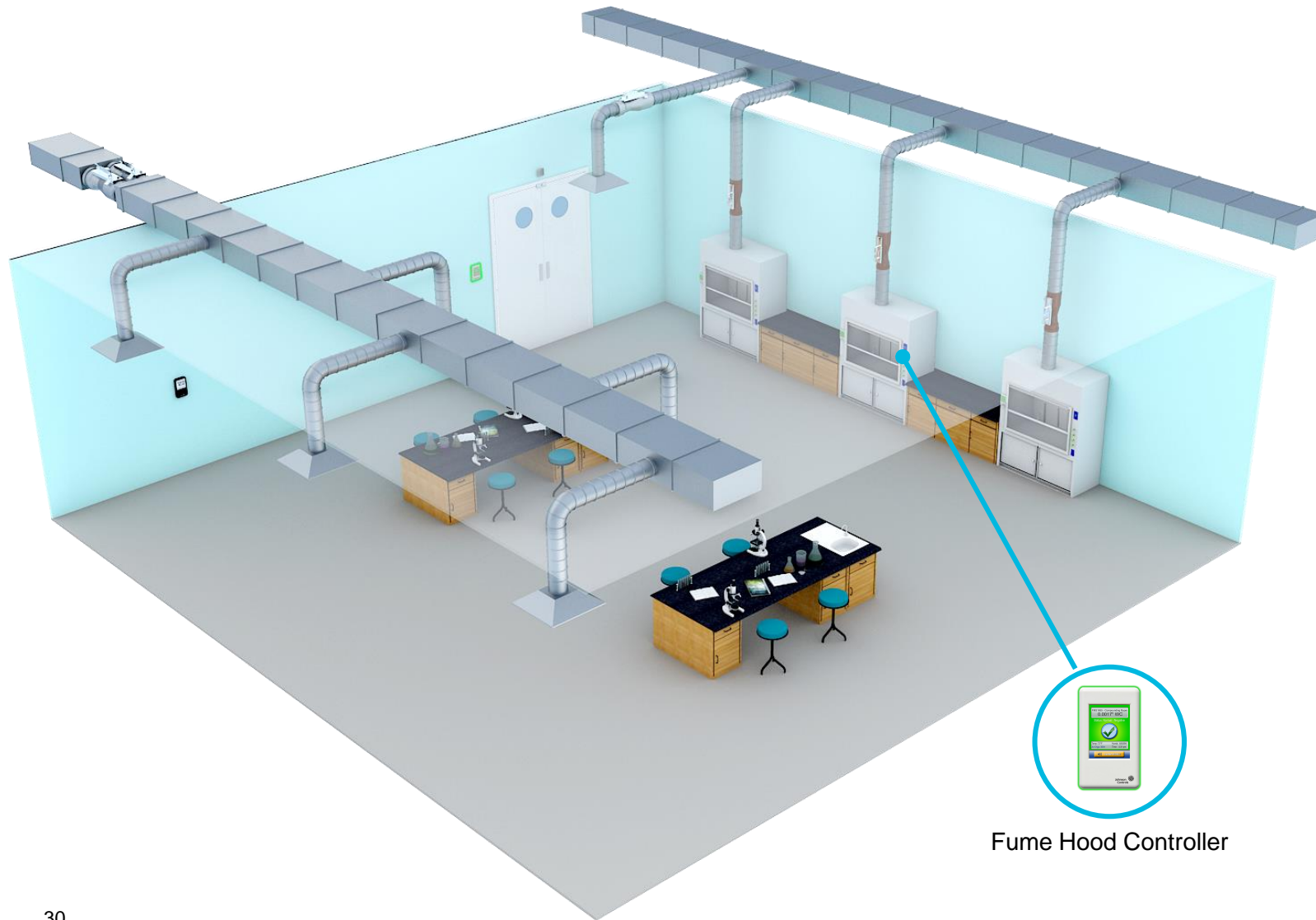
- Dynamic changes in sash position
- Too low a velocity: the hood will not be capable of containing generated fumes
- Too high of a velocity: can cause turbulence and fumes to escape and bring them back into the user's breathing zone
- Operator movement
- Blockages of the fume hood opening
- Pedestrian traffic in front of the hood
- Room static pressure changes
- Duct static pressure challenges
- Fan failures
- Air distribution
- Thermal convection
- Container storage within the hood



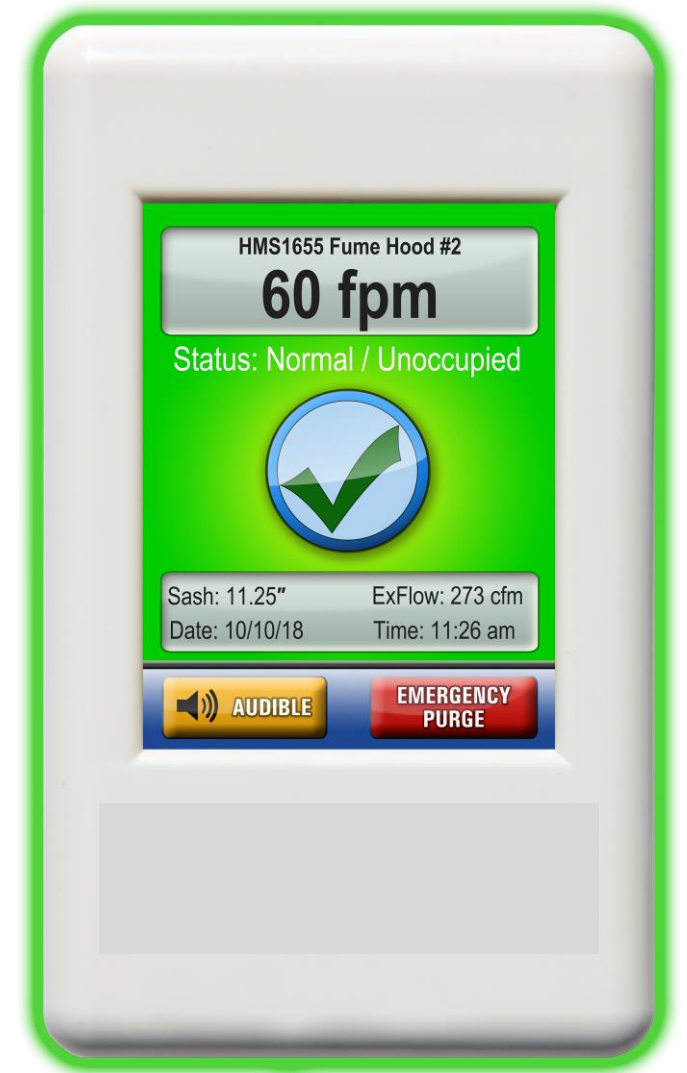
Airflow Control Methodologies: Room Pressure Controller



Airflow Control Methodologies: Fume Hood Controller



Fume Hood Controller



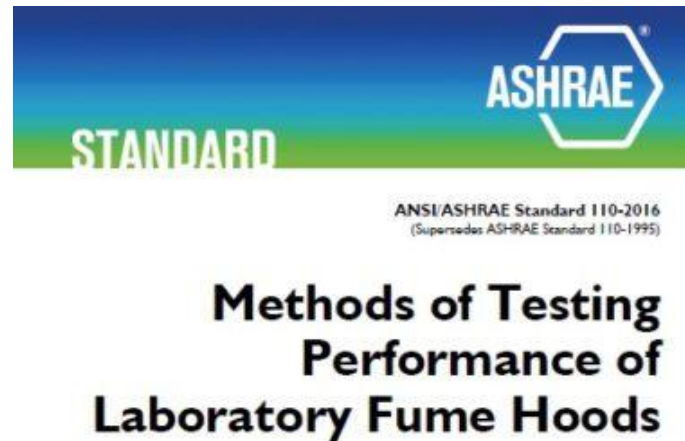
Current Codes and Standards

Be aware of all governing codes in your location as well as applicable standards, and design practices

NFPA 45



ASHRAE 100

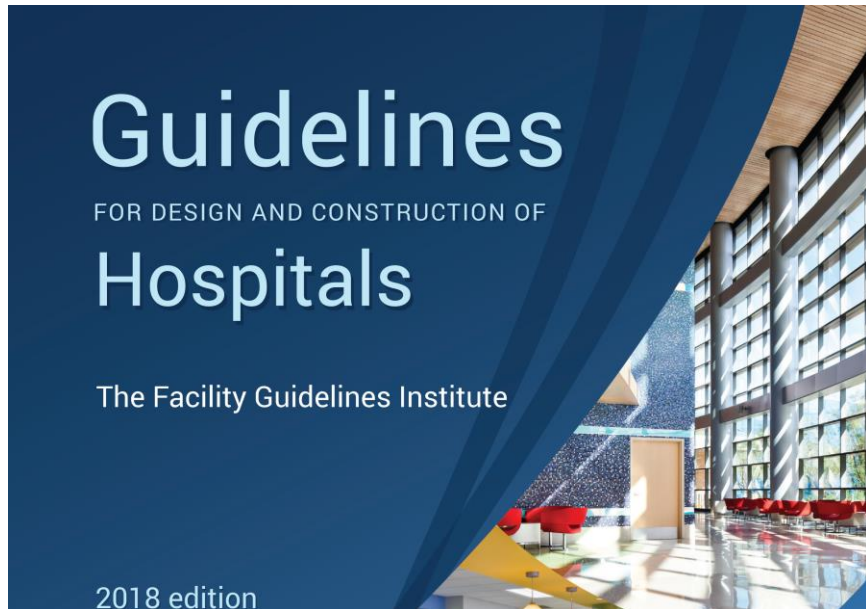


Local & State Building Codes



Current Codes and Standards

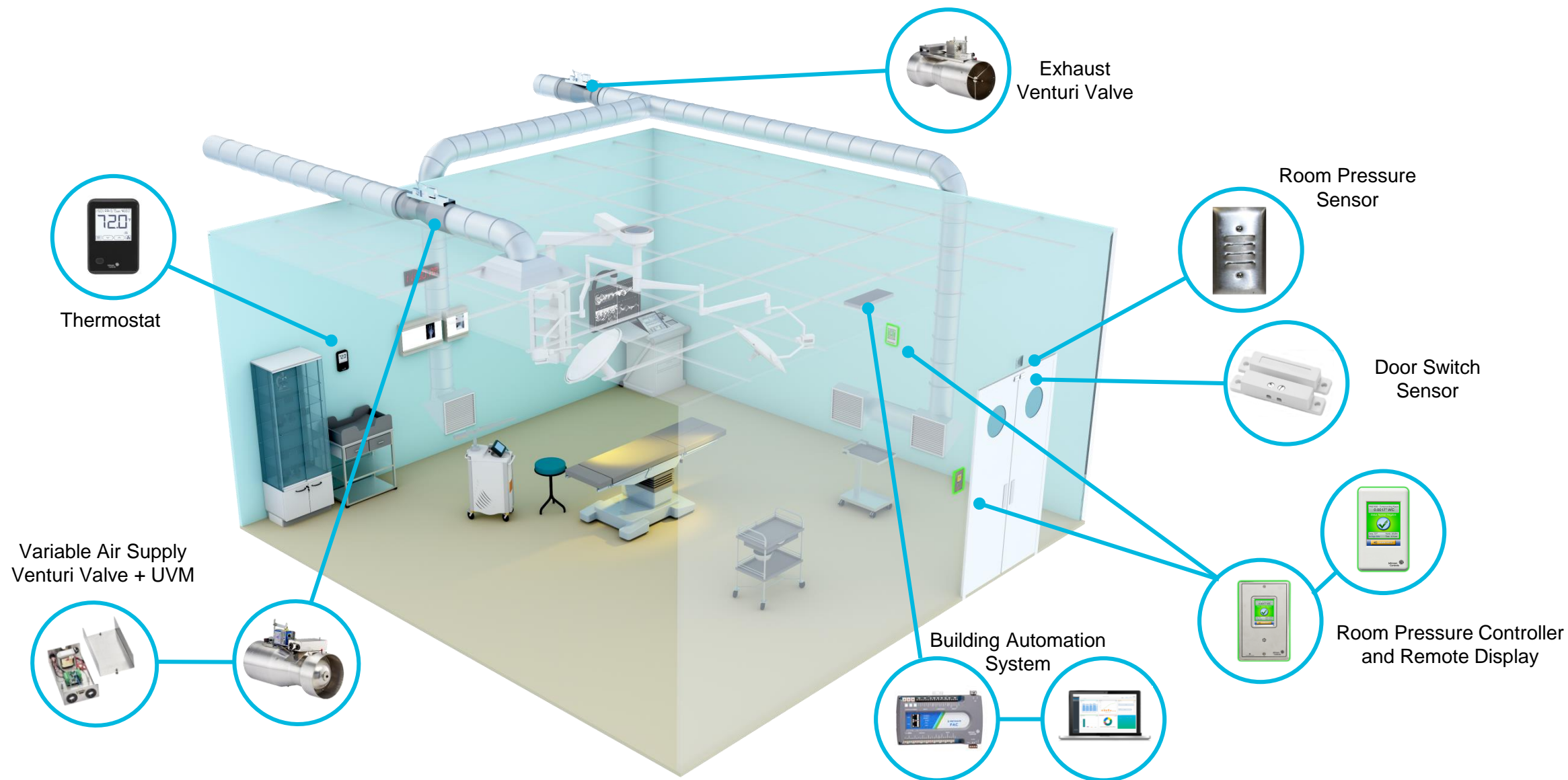
It is important to note significant driving forces in critical environment design



Putting It Together

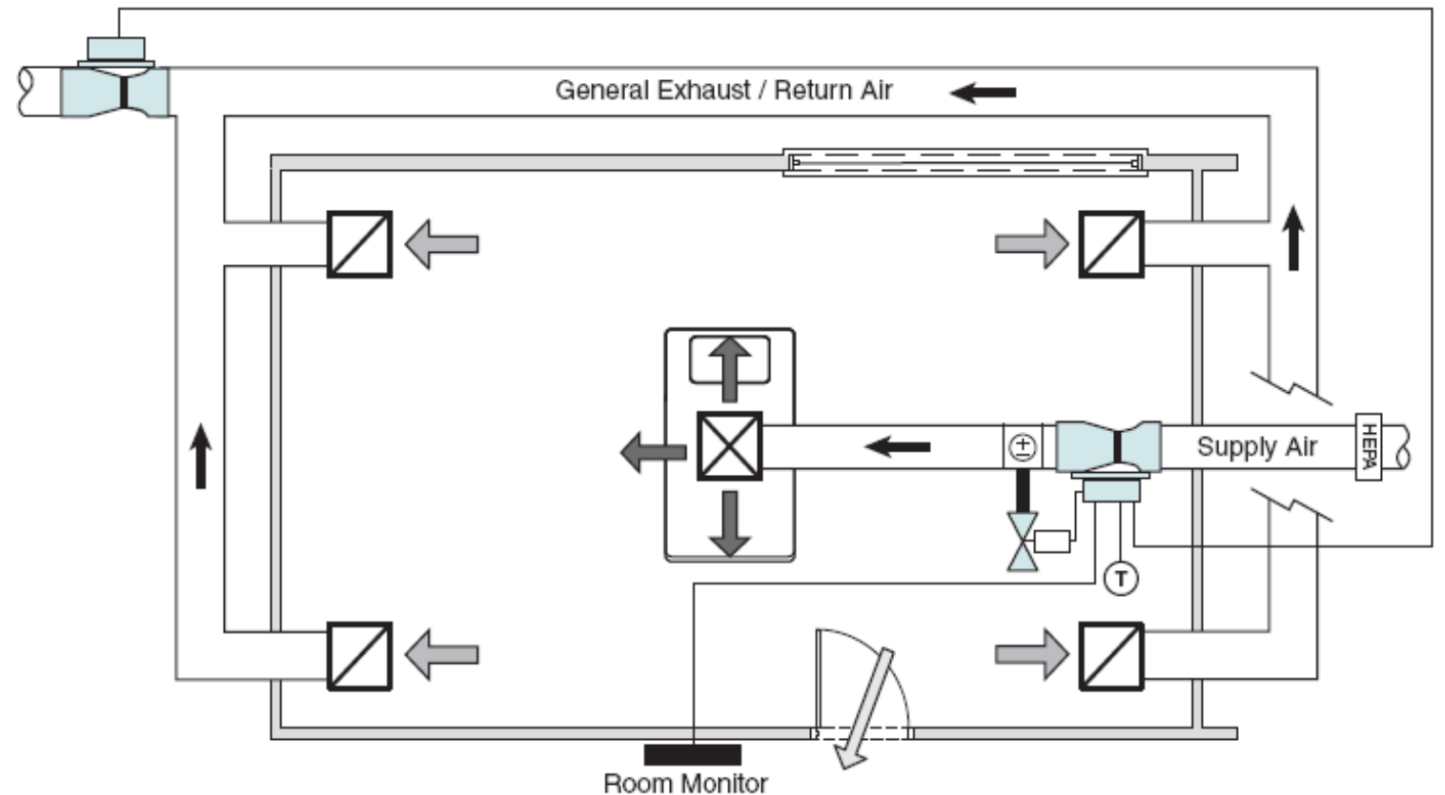


Surgical Suite

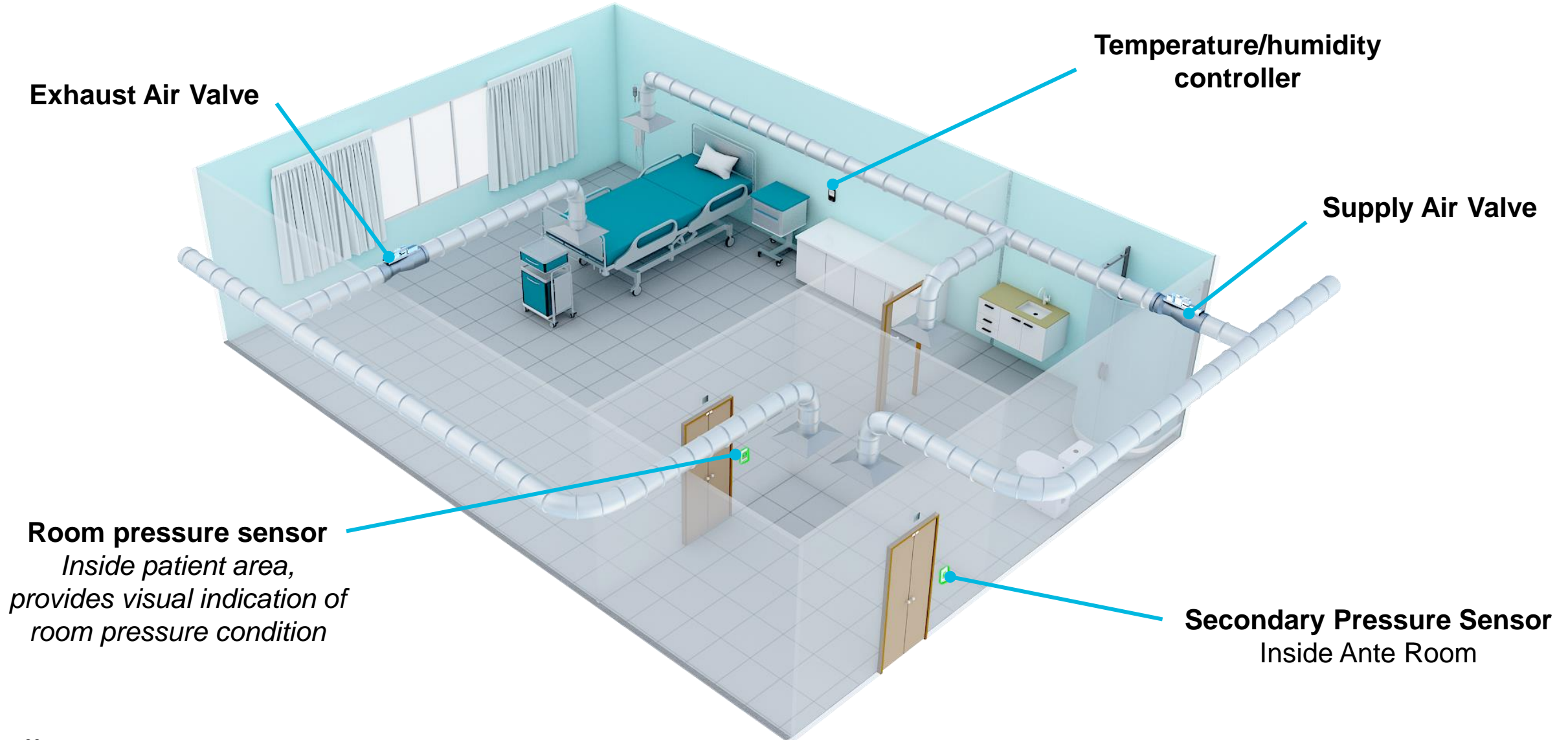


Tracking Pair vs. Direct Pressure Control

- VAV or 2-Position
- Occupancy modes
- Pandemic modes
- Temperature sensor
- Humidity sensor
- FMS pressure monitor
- Remote monitoring
- Duct temp sensor
- Decontamination capability
- Min ACH = 20 (4 Outside Air)



Isolation Room with Ante Room

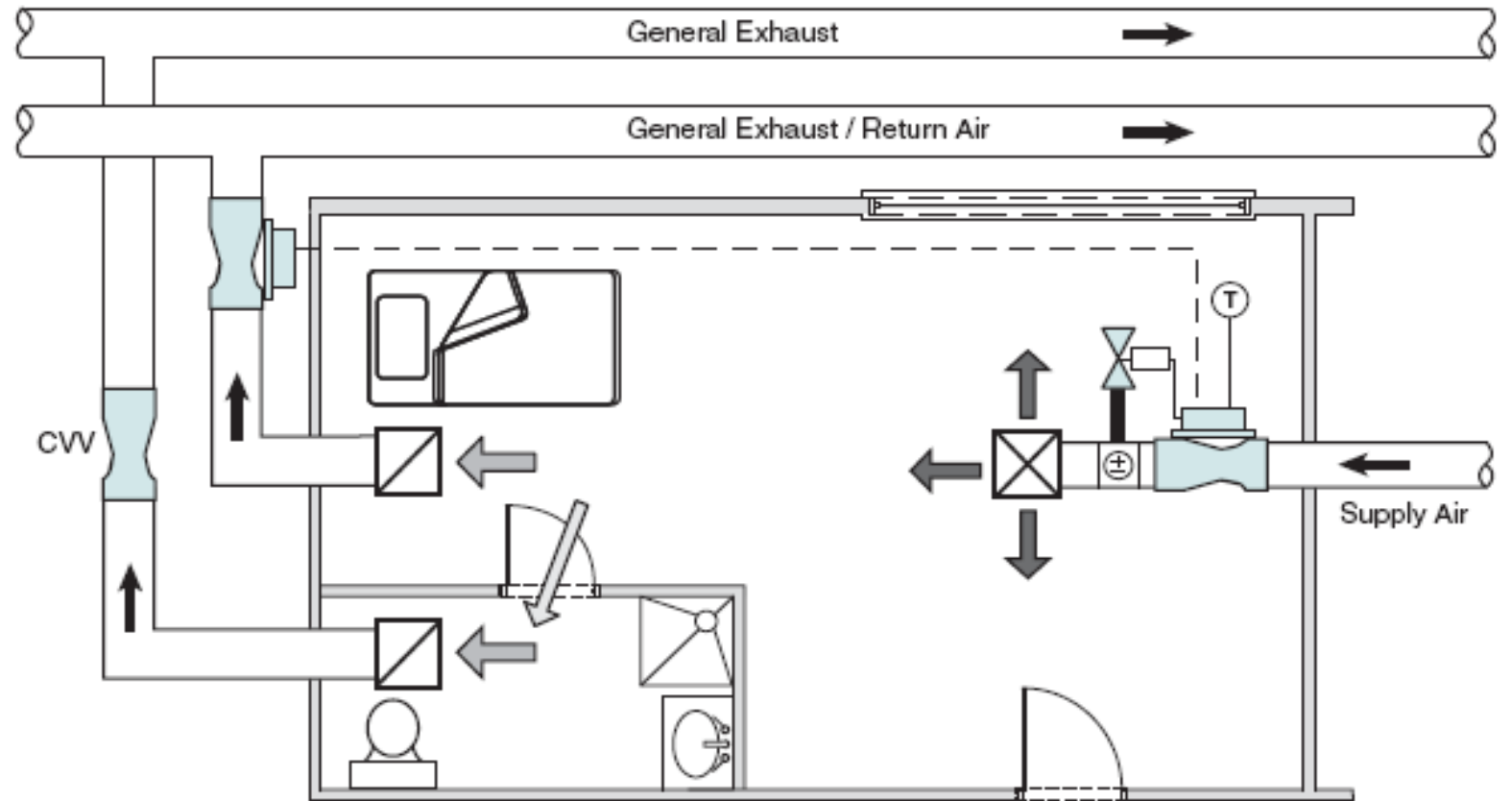


Patient Room

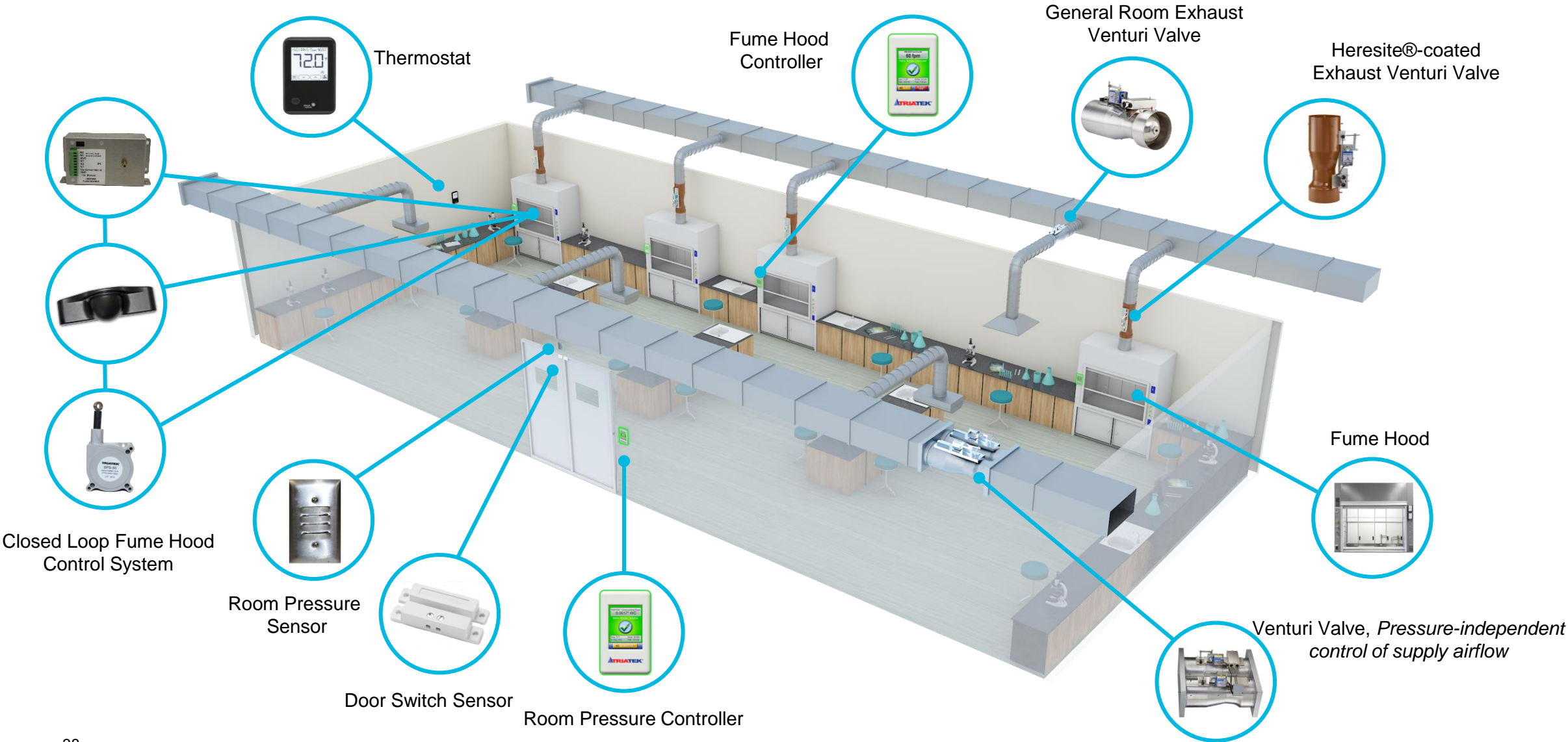
Tracking Pair (TP)

- Can be CV
- VAV or 2-position with occupancy modes available
- Temperature control

Min ACH = 6 (2 outside air)

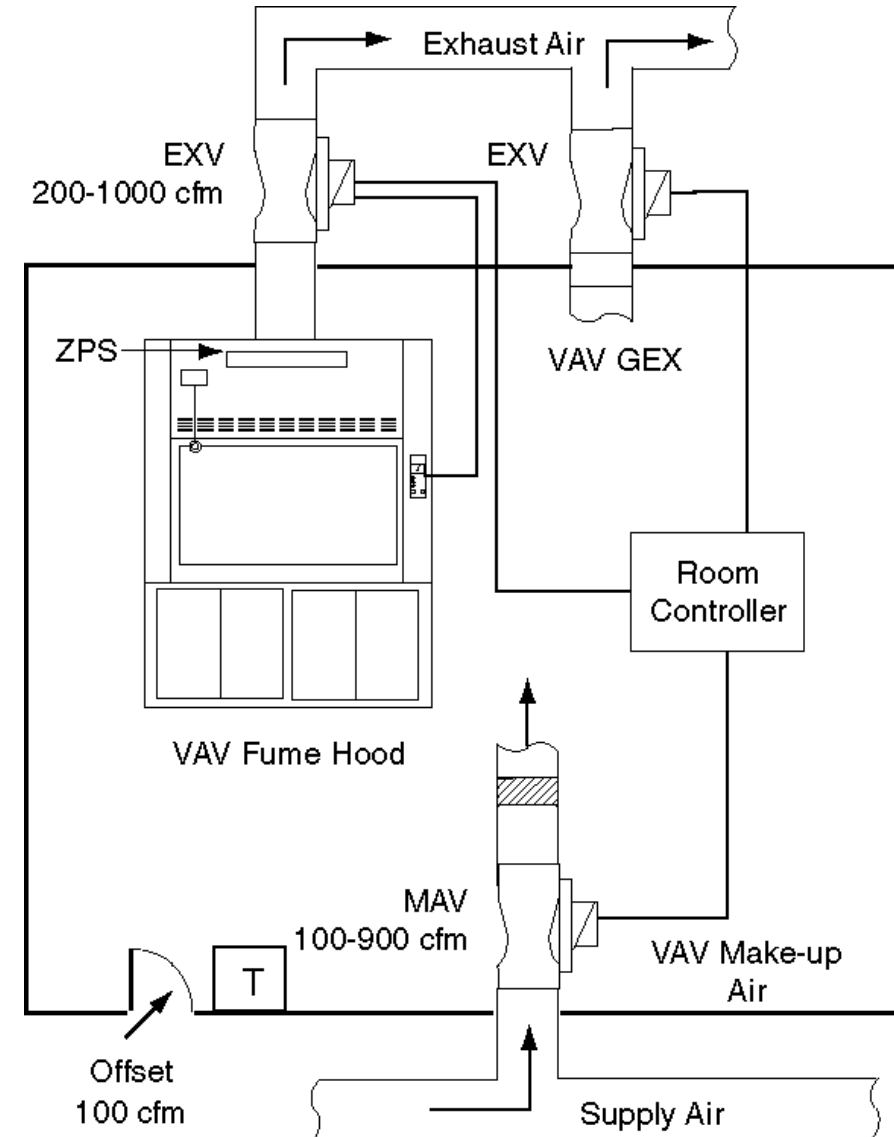


Laboratory



Laboratory

- **Types of spaces**
 - Fume hood labs
 - Bench labs
 - Adjacent areas
- **Device level airflow control**
 - Fume hoods – containment flow
 - Point exhaust – extraction
- **Space pressurization**
 - Supply and exhaust control



Thank you for your time!

Joe Pustai, PE, LEED-AP
Project Development Engineer - Critical
Environment Controls

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