Ventilation for Acceptable Indoor Air Quality

Part 2 - Making the Case for Direct Outdoor Airflow Measurement

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Determining Outdoor Airflow Rates

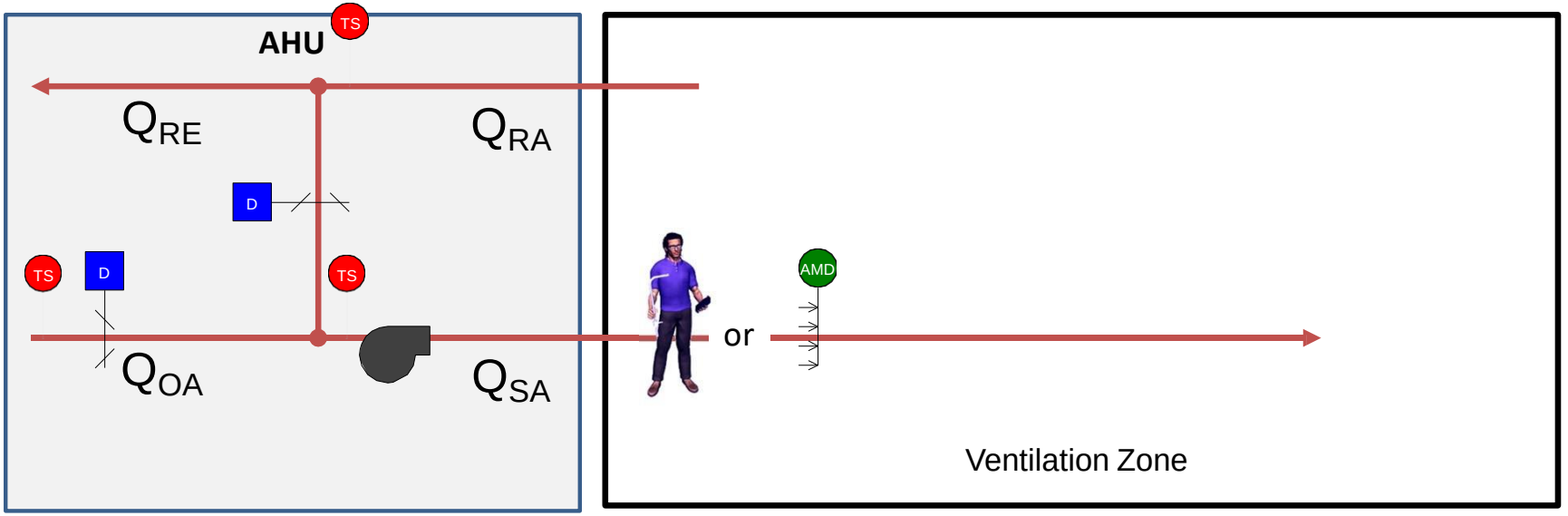
- Indirect Measurement Methods
- Methods Requiring Field Setup
- Direct Measurement Methods

Outdoor Air Intake Flow Rate Determination

The following methods should <u>not be used</u> to verify, calibrate or determine the outdoor airflow rate:

- Temperature Ratio (a.k.a. energy balance or adiabatic mixing)
- Delta CFM (a.k.a. return fan tracking)

Temperature Ratio



ASHRAE Standard 111-2008

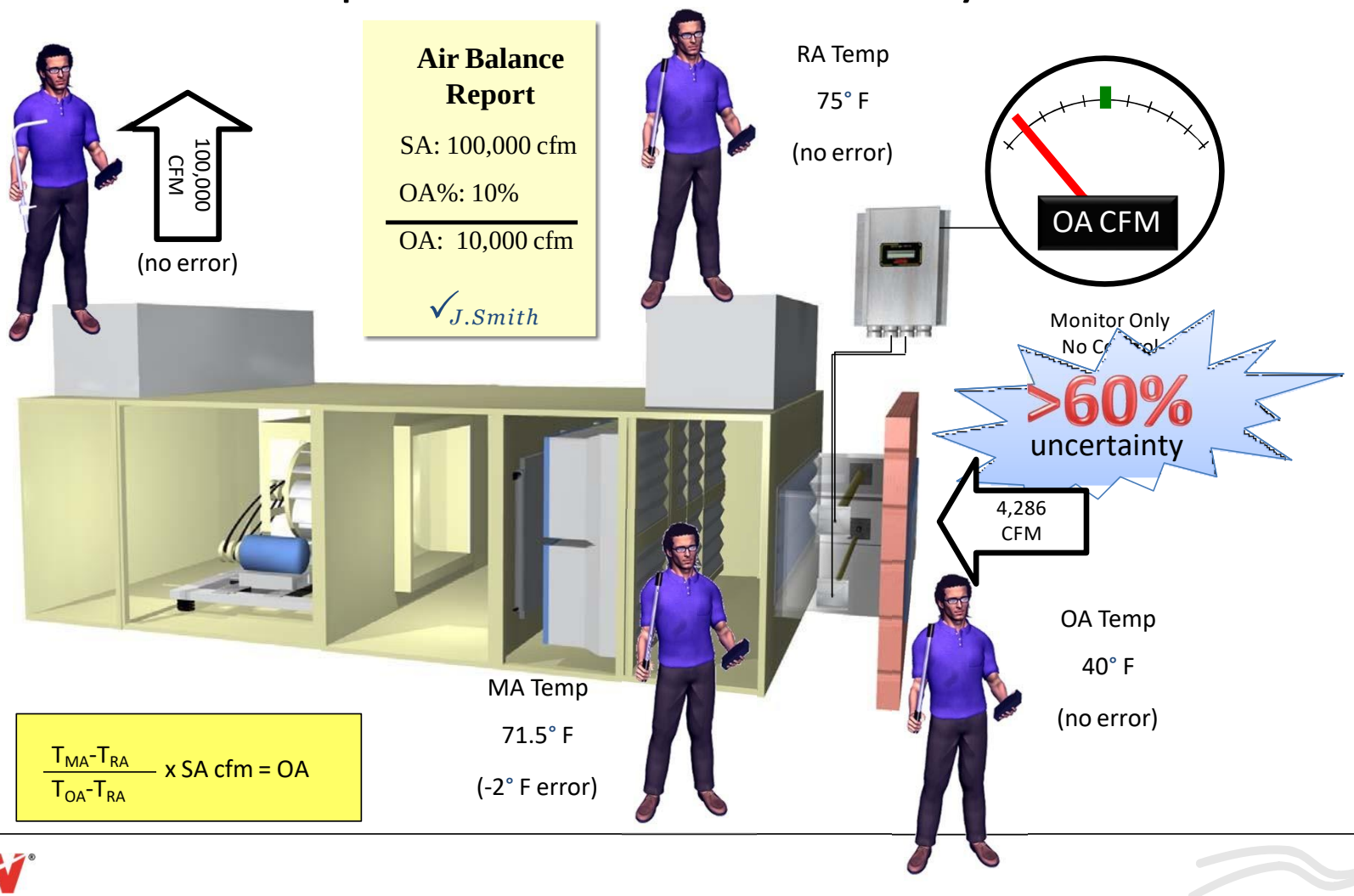
Section 7 – Air System Measurements

7.6.3.3 Flow Rate Approximation by Temperature Ratio. Some components of system airflow are virtually impossible to measure with an anemometer or Pitot tube. For example, outside air measurements are affected by lack of ductwork and unpredictable turbulence.

7.6.3.4 Accuracy. … Overall, the accuracy of the flow rate being determined is dependent on the accuracy of the duct traverse and the temperature measurements of the three airstreams. Under good field conditions, the flow rate determination of the unknown airstreams should be within 10% of the actual flow rate.

Comment: Is the expectation of 10% accuracy realistic for this method?

Temperature Ratio Uncertainty



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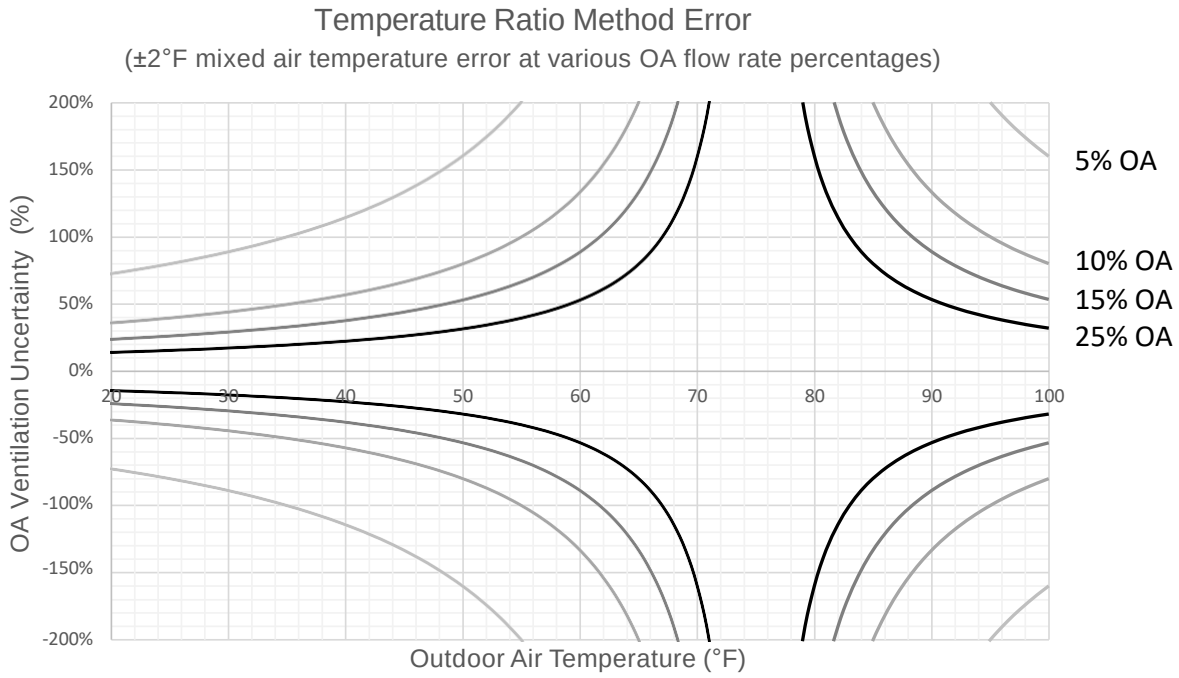
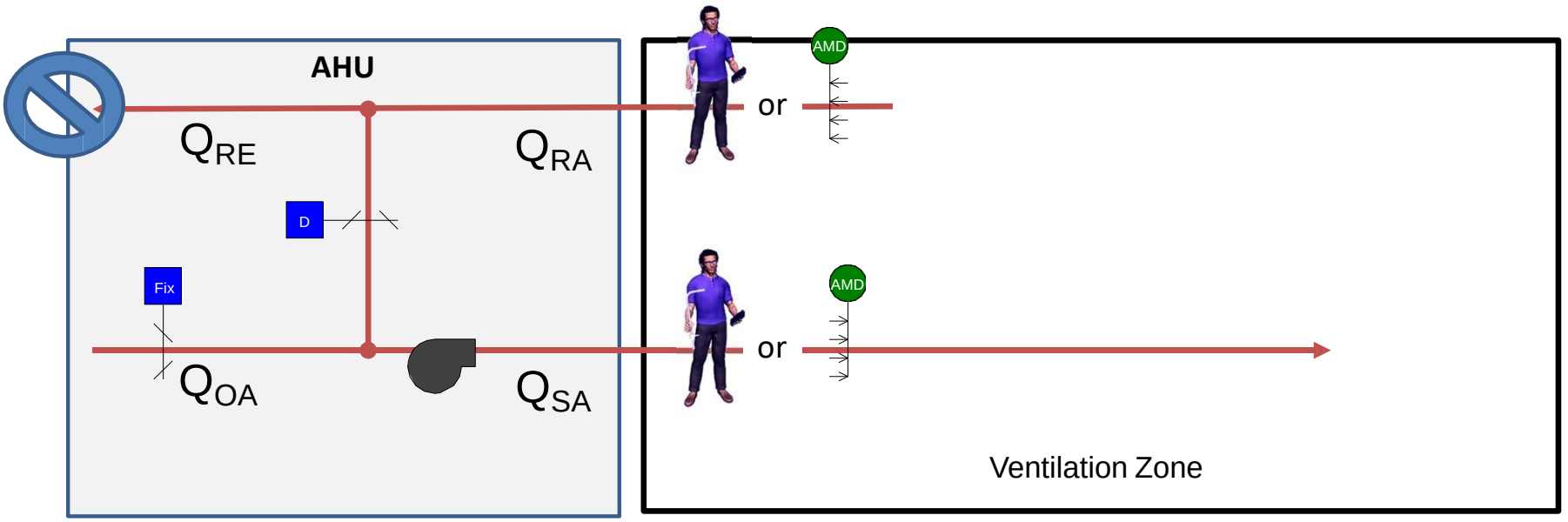
Temperature Ratio Uncertainty



⚠ This method is often used by TAB as an accepted verification method!

Delta CFM



ASHRAE Standard 111-2008 (RA2017)

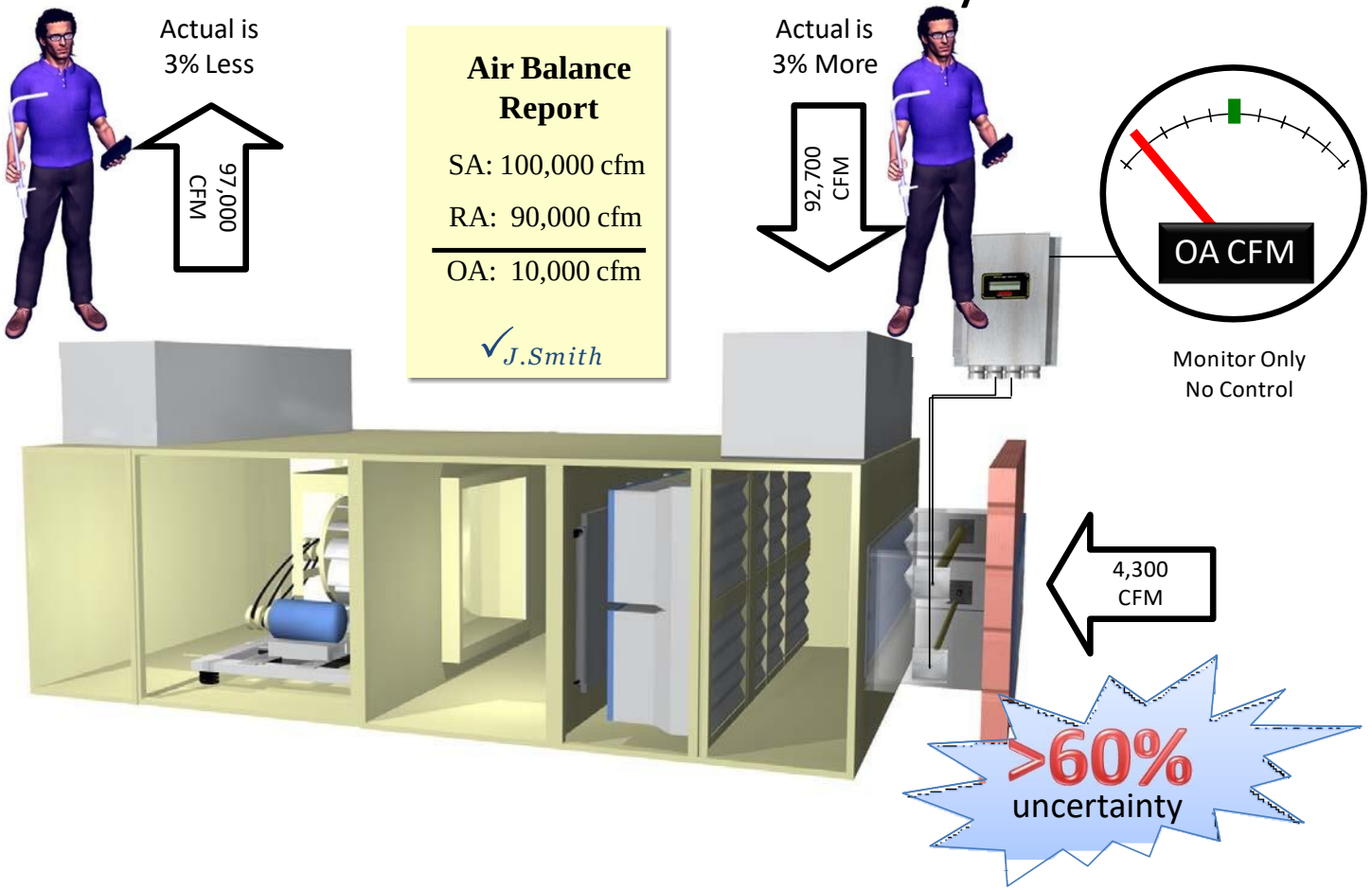
Section 7 – Air System Measurements

7.6.2 Flow in Ducts

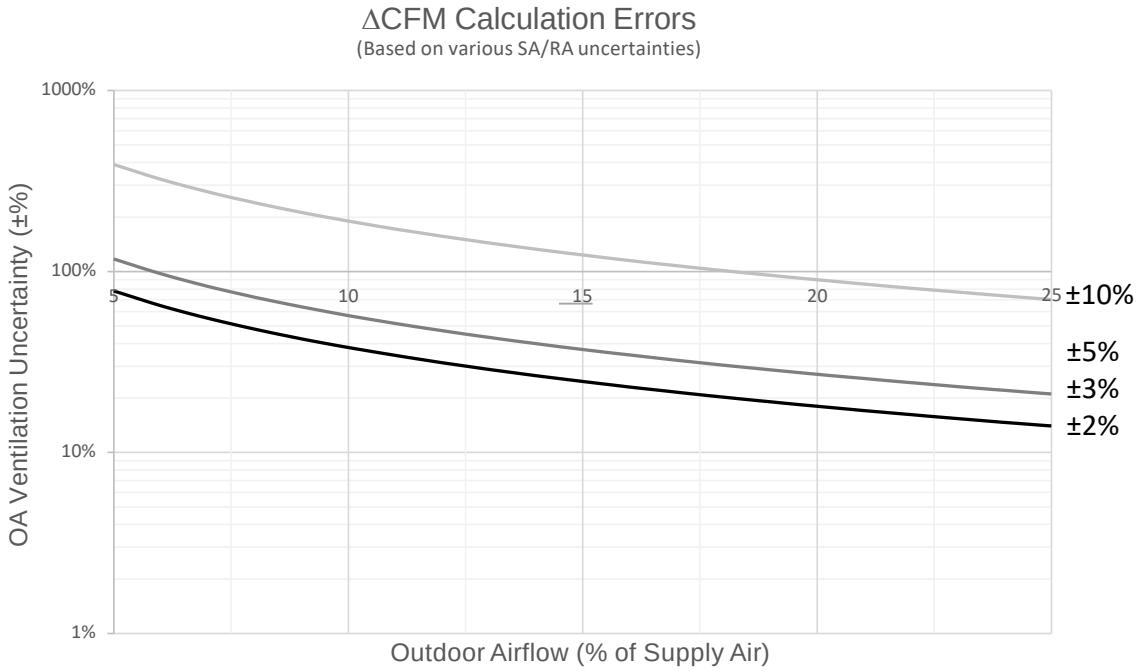
7.6.2.4. Accuracy.

Error analysis shows that flow rate determinations by this method can range from 2% to 10% error. Experience shows that qualified technicians can obtain measurements that range within 5% and 10% accuracy of actual flow under good field conditions.

Delta CFM Uncertainty



Delta CFM Uncertainty

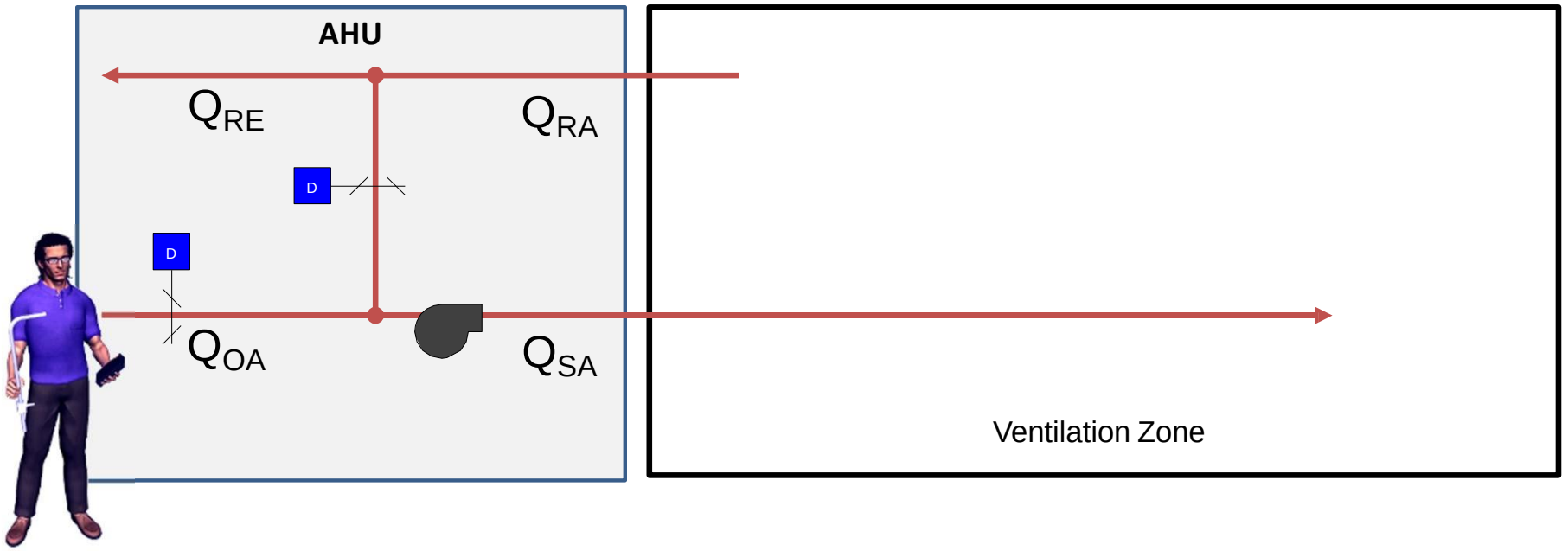


⚠ This method is often used by TAB as an accepted verification method!

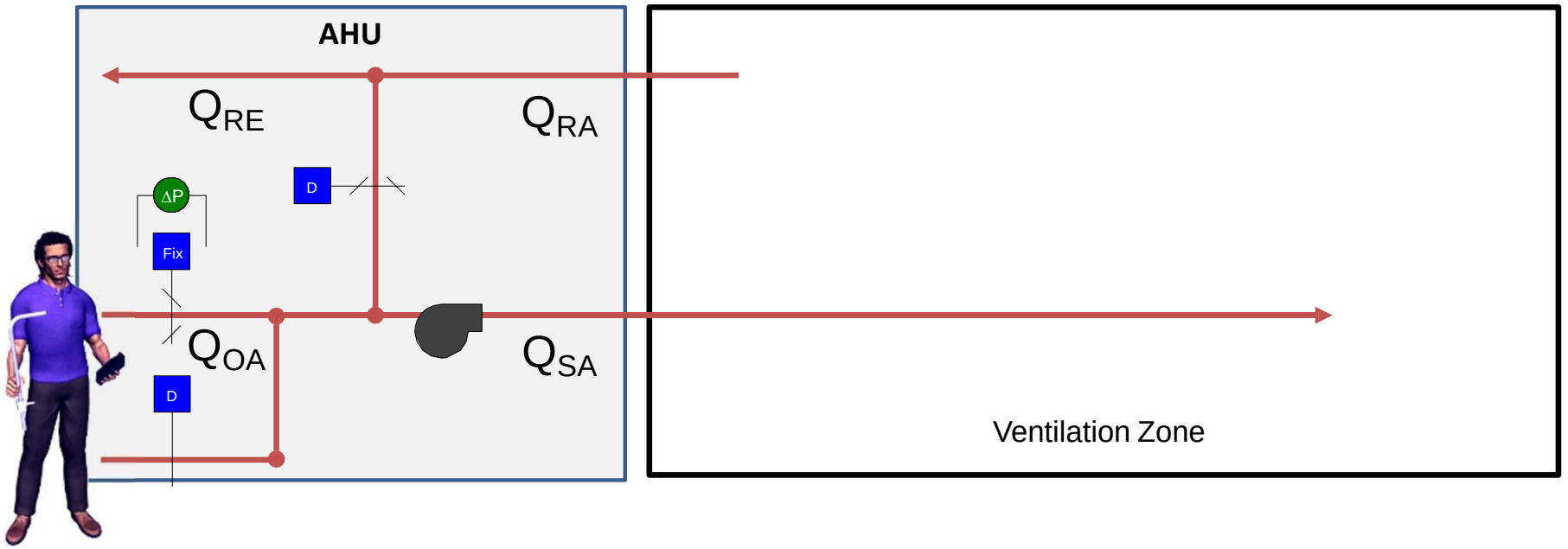
The following methods require field CALIBRATION

- Field measurement uncertainty of OA intakes can exceed ±25% as a result of:
  - intake configuration
  - airflow rates
  - measurement method (issues with ASHRAE Standard 111)
  - balancer skill level
- Field measurements are reported and accepted as "actual" regardless of actual measurement error (this is a problem) so field calibrated measurements are often wrongly accepted as valid.

Fixed Minimum Position Intake Damper Methods (single or multi-position)



Mixed Air Plenum Pressure Control



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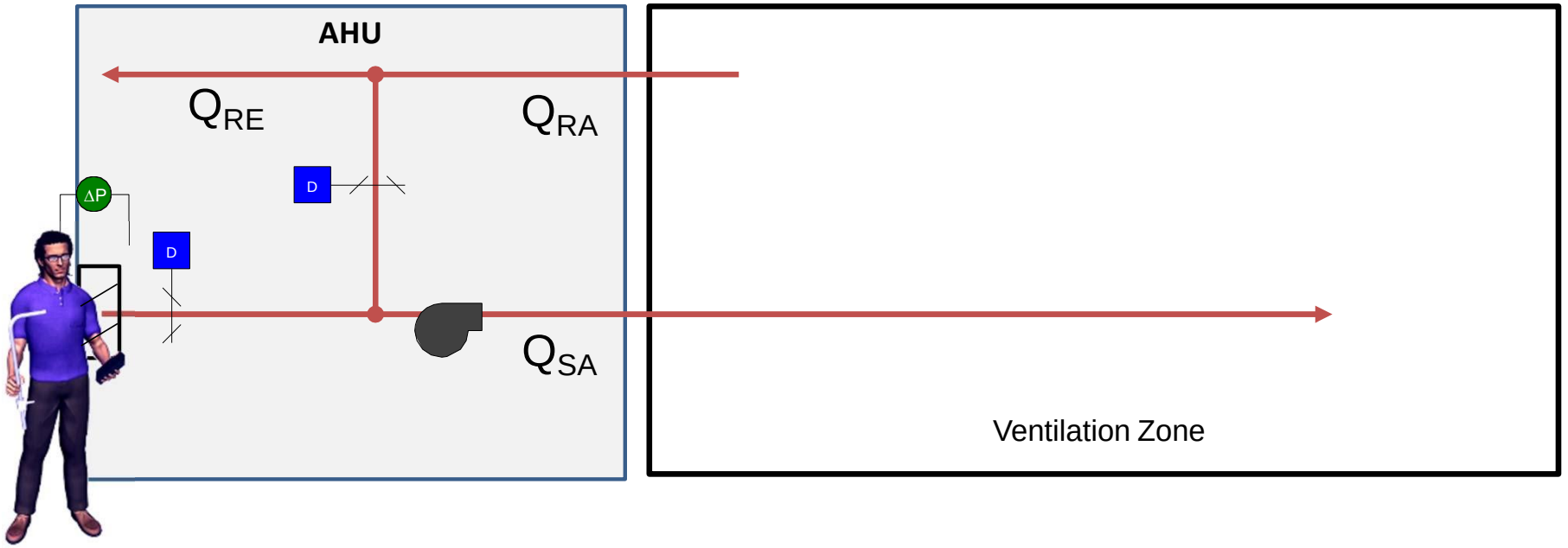
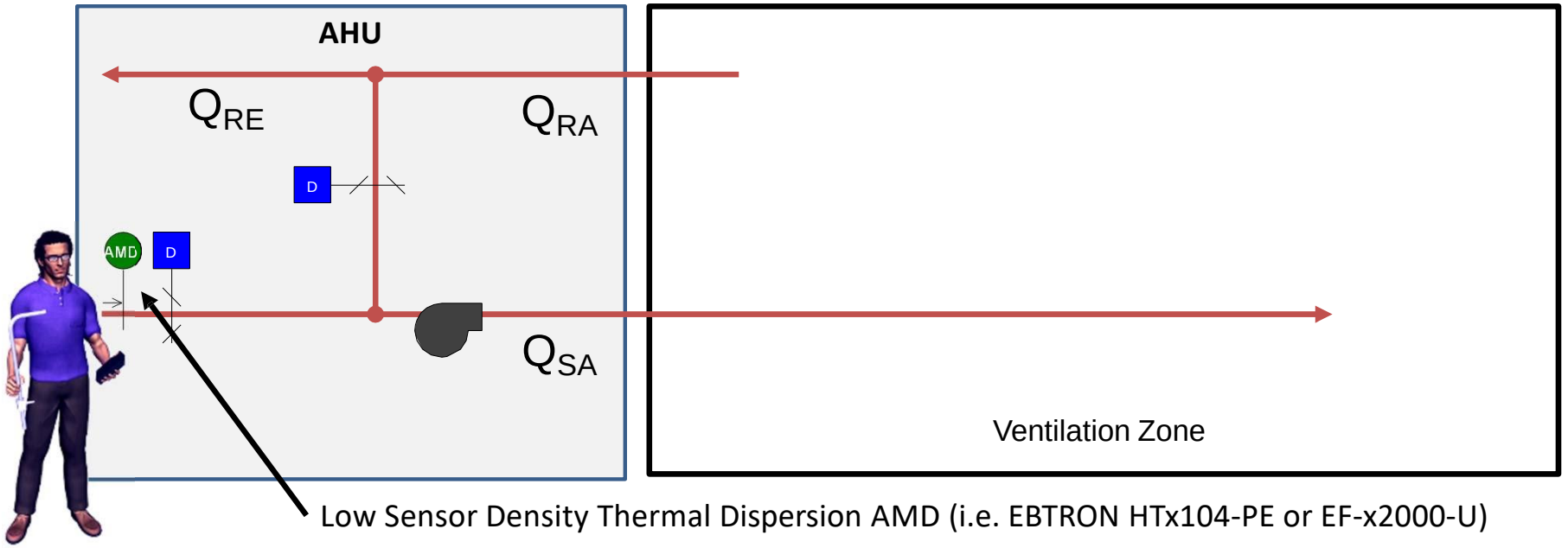
Fixed Orifice Airflow Measurement

Note: If a return fan is part of this system, it may be used as part of the MOA control sequence when there is no relief at the AHU.



Low Sensor Density Direct Outdoor Intake Airflow Measurement

Including low sensor density thermal, pitot arrays (one transducer) and devices that use a small number of obstructions to determine the airflow rate



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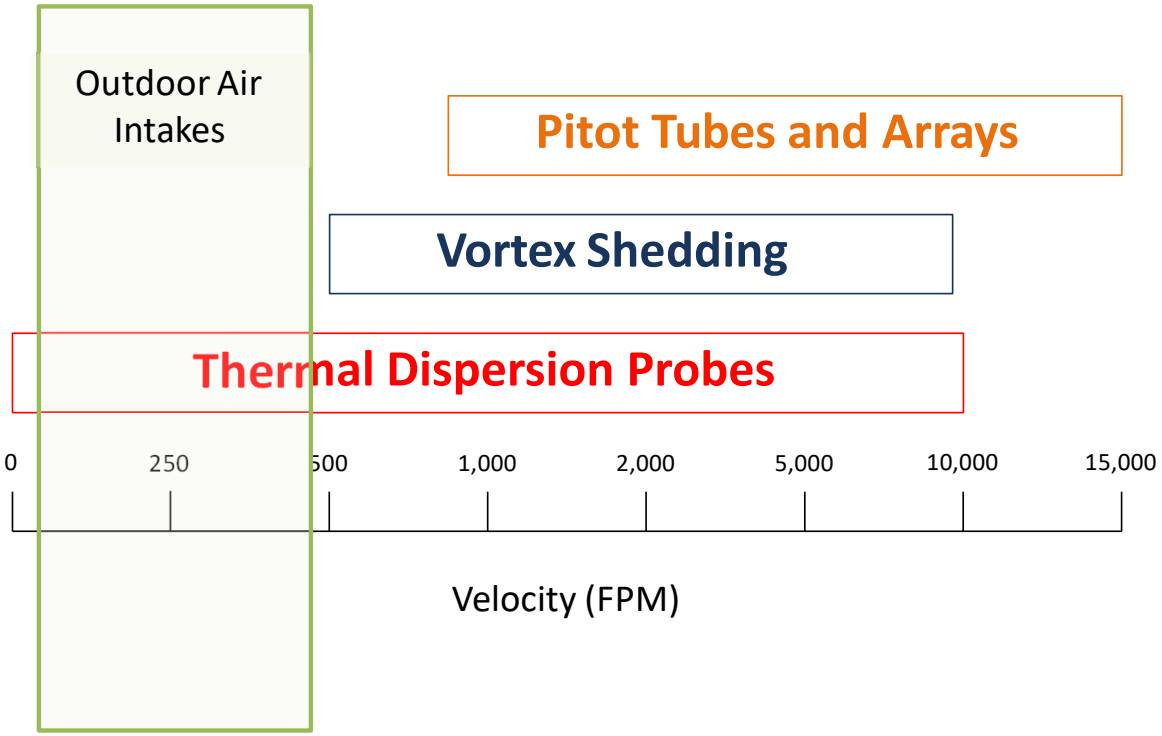
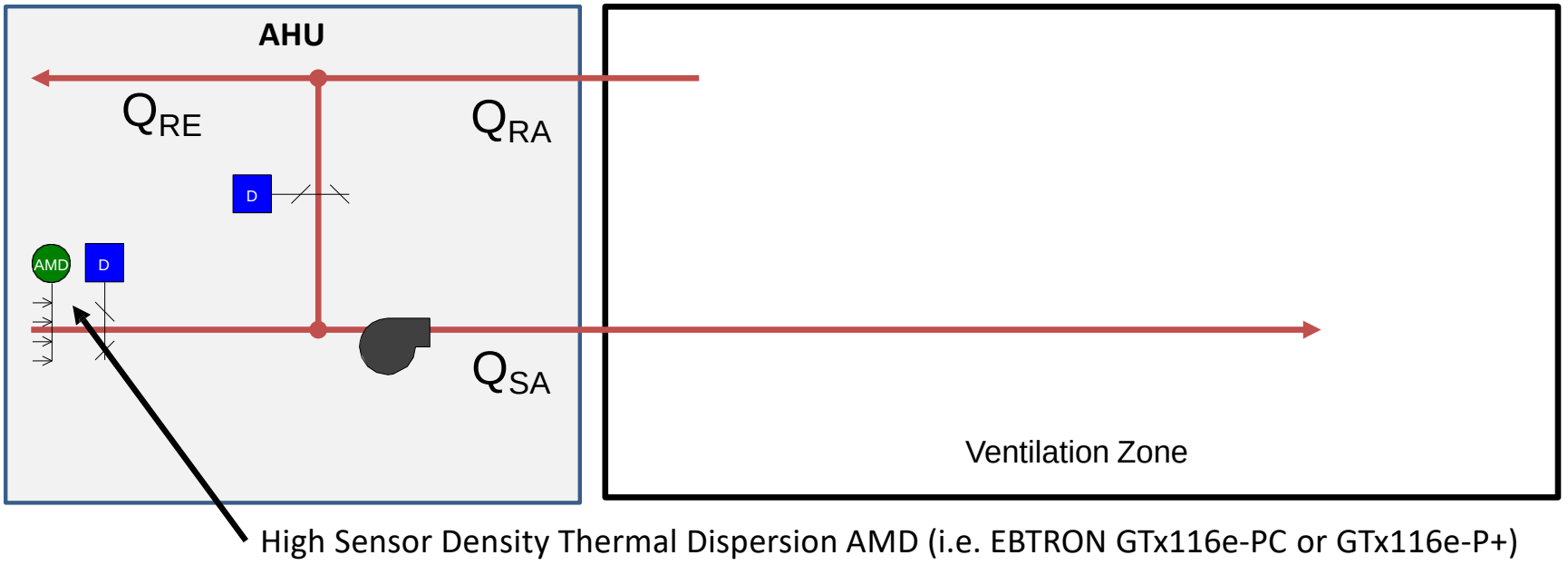
The following method requires field VERIFICATION

- Field measurement uncertainty of OA intakes can exceed ±25% as a result of:
  - intake configuration
  - airflow rates
  - measurement method (issues with ASHRAE Standard 111)
  - balancer skill level
- Field measurements should be used to verify, and not calibrate, measurement devices (i.e. if the measurement is within the tolerance of the field measurement technique – leave it alone!)

Airflow Measurement Technology Application Chart



High-Performance Direct Outdoor Intake Airflow Measurement



OA Intake Determination (Comparison)

	Fan Speed Variations	Wind Pressure Variations	Stack Pressure Variations	Damper Issues	Turndown	Changing Velocity Profiles	Accuracy
Fixed Minimum Position Damper	👎	👎	👎	👎	👎	👎	👎
Two Position Damper w/Proportional Reset	✋	👎	👎	👎	👎	👎	👎
Mixed Air Plenum Pressure Control	✋	✋	✋	👎	👎	👎	👎
Fixed Orifice Airflow Determination	✋	✋	✋	✋	👎	👎	👎
Low Sensor Density Airflow Measurement	✋	✋	✋	✋	✋	👎	👎
High Sensor Density Airflow Measurement	👍	👍	👍	👍	👍	👍	👍

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Section 8 – Indoor Environmental Quality

801.3.1.2 (8.3.1.2) Outdoor Air Delivery Monitoring

801.3.1.2.1 (8.3.1.2.1) System Design for Outdoor Air Intake Measurement. Each mechanical ventilation system shall be configured to allow for the measurement of the outdoor air intake for use in testing and balancing, recommissioning, and outdoor air monitoring as required in Section **801.3.1.2.2 (**8.3.1.2.2**)**

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Section 8 – Indoor Environmental Quality

801.3.1.2.2 (8.3.1.2.2) Monitoring Requirements. Each mechanical ventilation system shall have a permanently installed device to measure the minimum outdoor airflow that meets the following requirements:

a. The device shall employ methods described in ASHRAE Standard 111.
b. The device shall have an accuracy of ±10% of the minimum outdoor airflow. Where the minimum outdoor airflow varies, as in demand control ventilation systems, the device shall maintain this accuracy over the entire range of occupancy and system operation.
c. The device shall be capable of notifying the building operator, either by activating a local indicator or sending a signal to a building monitoring system, whenever an outdoor air fault condition exists. This notification shall require manual reset.

LEED 4.0

EQ Prerequisite: Minimum IAQ Performance

NC, CS, SCHOOLS, RETAIL, DATA CENTERS, WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY

For variable air volume systems, provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow. This device must measure the minimum outdoor air intake flow with an accuracy of +/–10% of the design minimum outdoor airflow rate, as defined by the ventilation requirements above. An alarm must indicate when the outdoor airflow value varies by 15% or more from the outdoor airflow setpoint

LEED 4.0

EQ Prerequisite: Minimum IAQ Performance

HEALTHCARE

For [all] mechanically ventilated spaces (and for mixed-mode systems when the mechanical ventilation is activated), provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow. This device must measure the minimum outdoor air intake flow with an accuracy of +/–10% of the design minimum outdoor airflow rate defined by the ventilation requirements above. An alarm must alert staff whenever the outdoor airflow value varies by 15% or more from the outdoor airflow setpoint.

Thank You!

Questions? More information?

Contact Technical Air Systems, Inc.

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