AABC Commissioning Group

AIA Provider Number 50111116

Understanding New Air Flow Regulations and ASHRAE Air Flow Requirements and Solutions

Course Number: CXENERGY1808

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ONICON

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Flow and Energy Measurement

CONTINUING EDUCATION AIA

Course Description

The important part of any HVAC commissioning or recommissioning for new construction, renovation or energy modernization is the balance of the air flow systems for proper minimum air flow, IAQ and pressurization. Balancing of the air flow system can be cumbersome for the TAB team and time consuming with the various types of air systems and various technologies applied to these systems. This presentation explains new changes in regulations and ASHRAE updates affecting air flow requirements in the HVAC systems and how energy conservation measures affect them.

Learning Objectives

At the end of the this course, participants will be able to:

1. Learn about the new changes in regulations and ASHRAE updates affecting air flow requirements in the HVAC systems and how energy conservation measures effect them.

2. Learn about the various technologies to measure the air flow through HVAC systems and how they work.

3. Learn how to verify the proper operation and accuracy of the measurement systems to assist them in their measurement and balancing of the systems.

4. Learn how to service, verify and calibrate these systems during their continual commissioning programs. Learn how to overcome the specific challenges and proper methods implemented in actual case studies presented.

Agenda Items

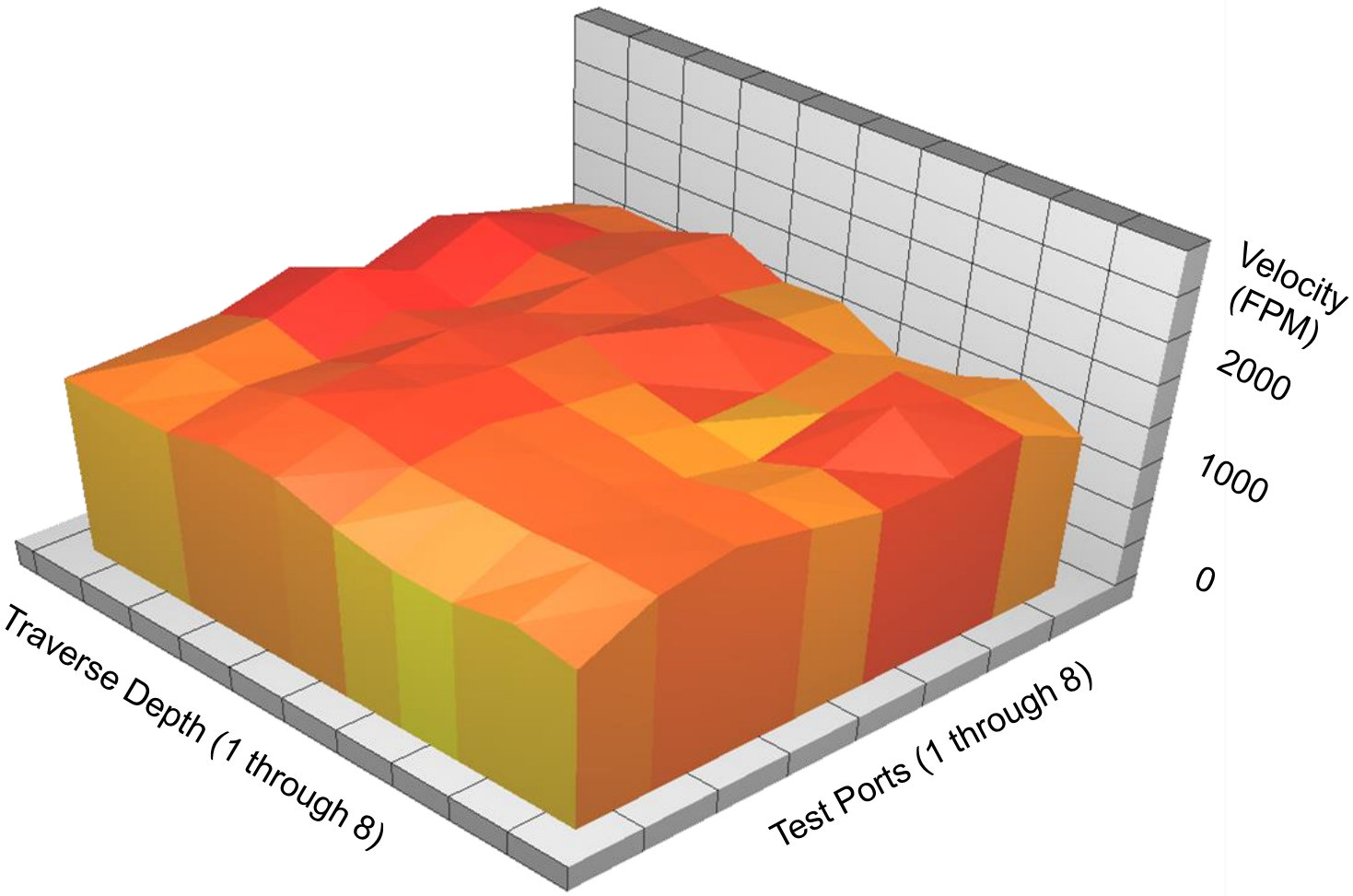
1. Air Flow Technologies And How They Operate
2. Applications and Errors In Implementing Technologies
3. Start-Up, Testing and Troubleshooting The Flow Equipment
4. How Existing and New Regulations Effect the Technologies and the Air Flow Requirements

AMCA Certification

- Third Party Certification on Measurement Equipment is Important!
- The ratings are based on tests and procedures performed in accordance with AMCA Publication 611 and comply with the requirements of the AMCA Certified Ratings Program.
  - **Full Measurement Tests Performed**
  - **Accuracy Statements Confirmed**

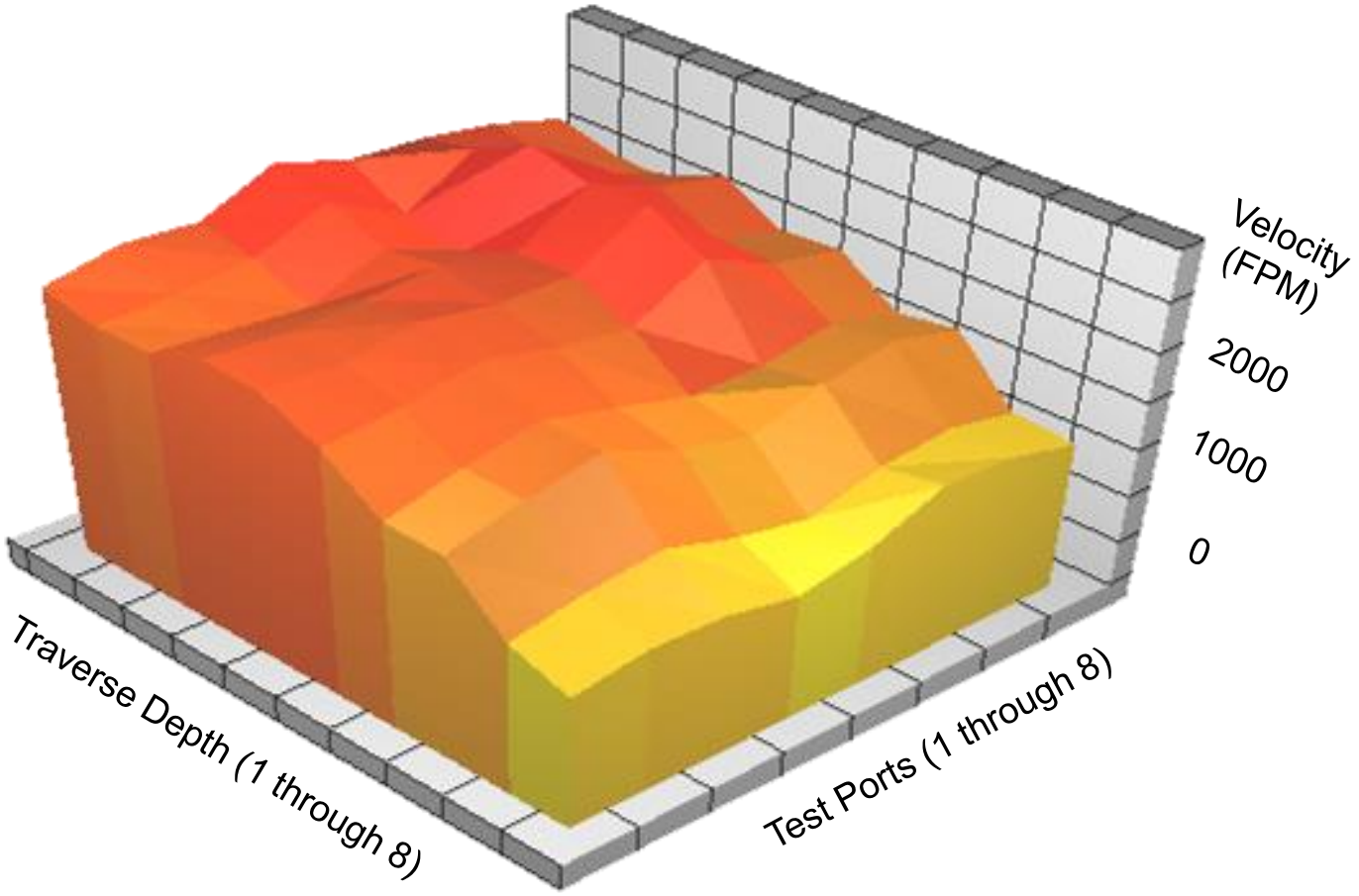
Need for Multi-Point Measurement

Velocity profile at 12 duct diameters downstream of an elbow

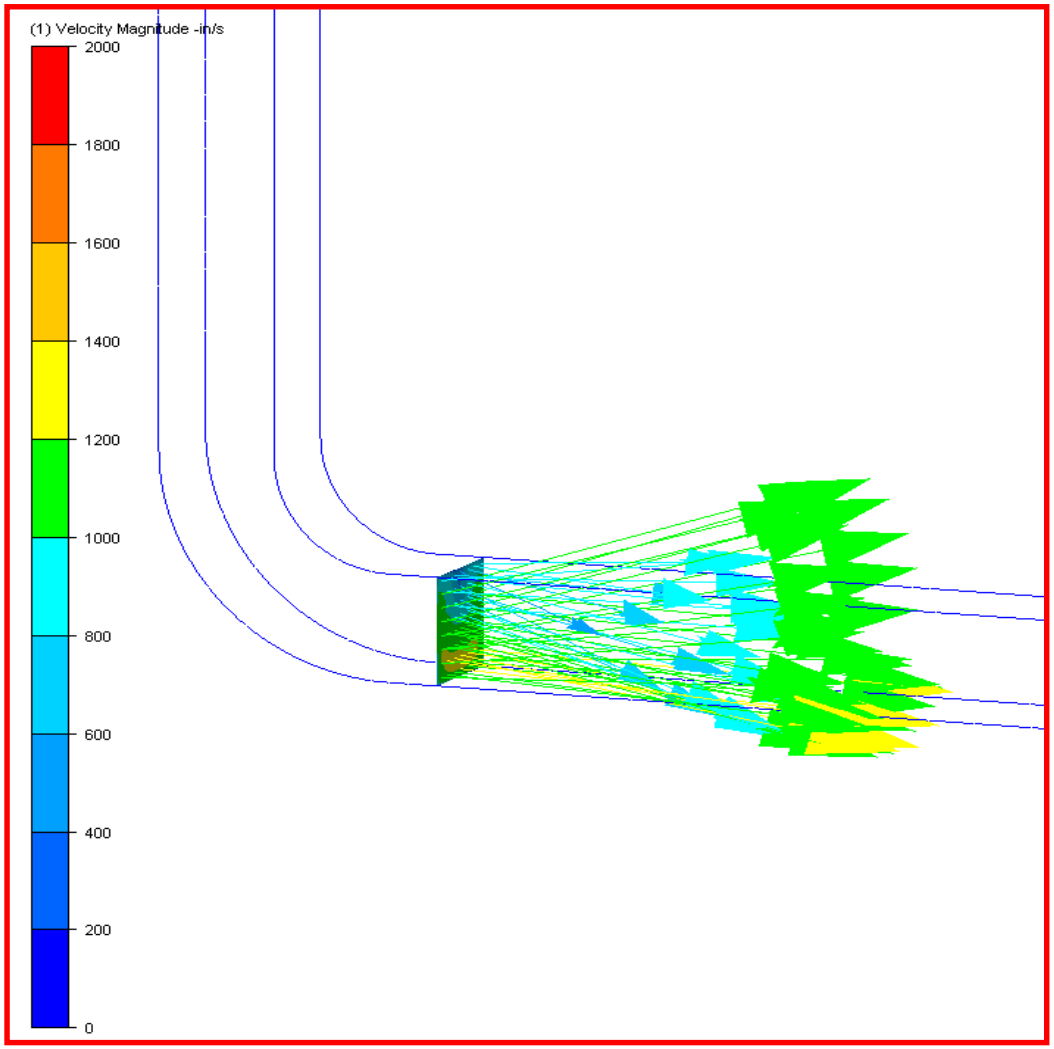


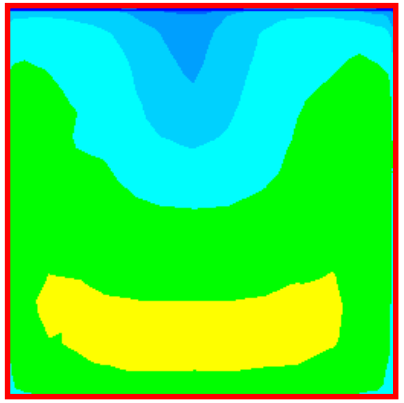
Need for Multi-Point Measurement

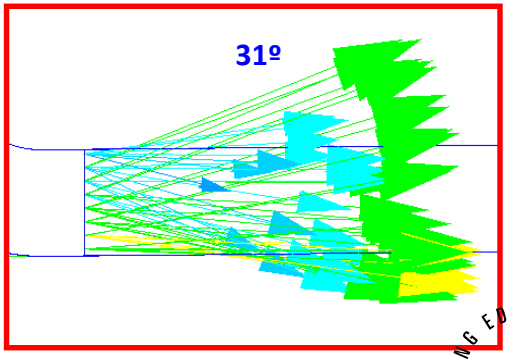
Velocity profile at 4 duct diameters downstream of an elbow



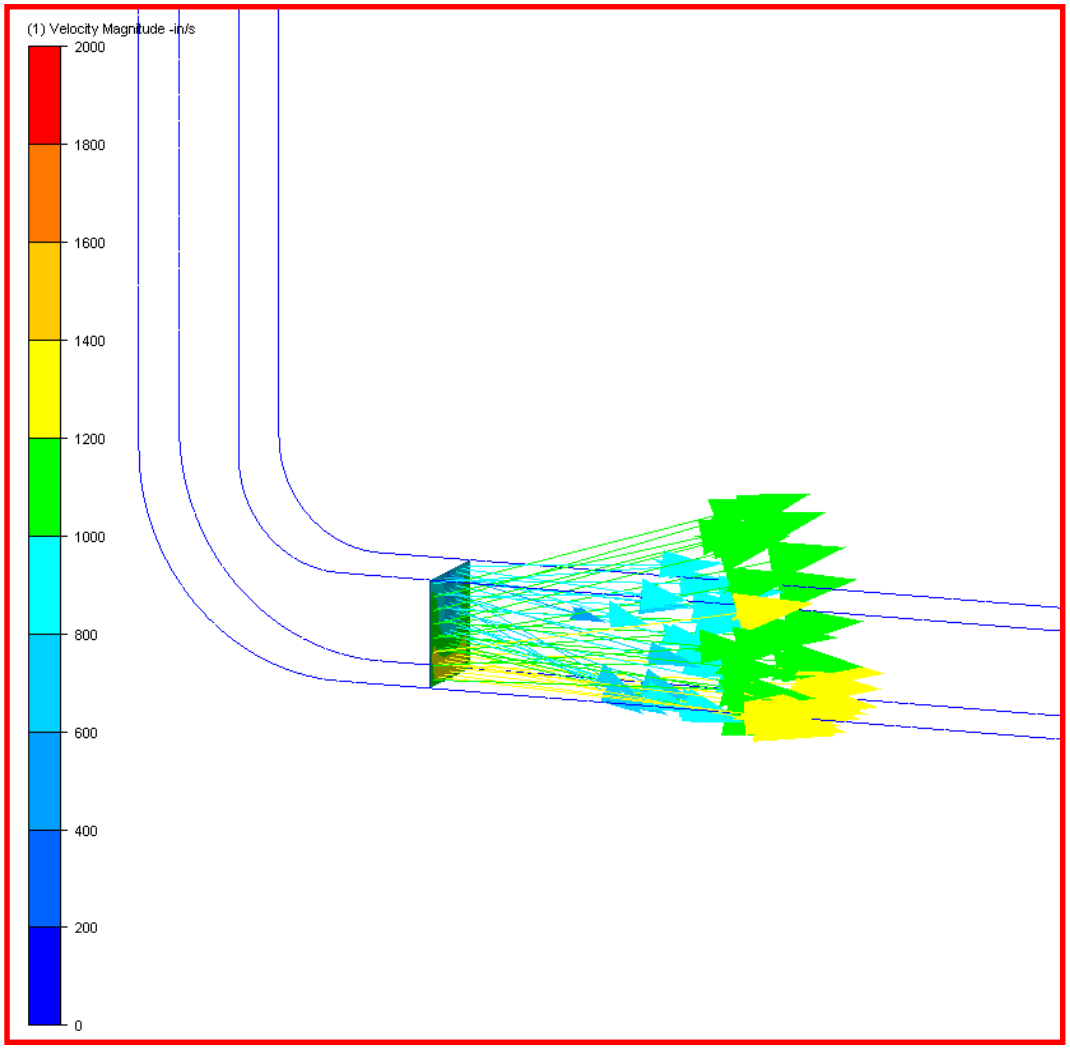
CFD Modeling – Sweep 0.5D

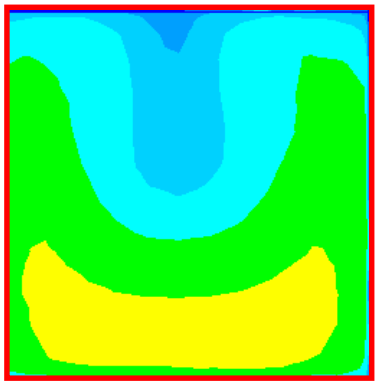


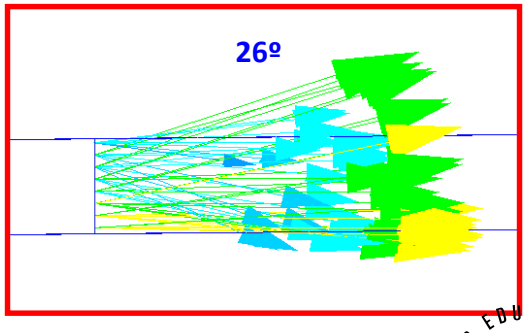




CFD Modeling – Sweep 1.0D



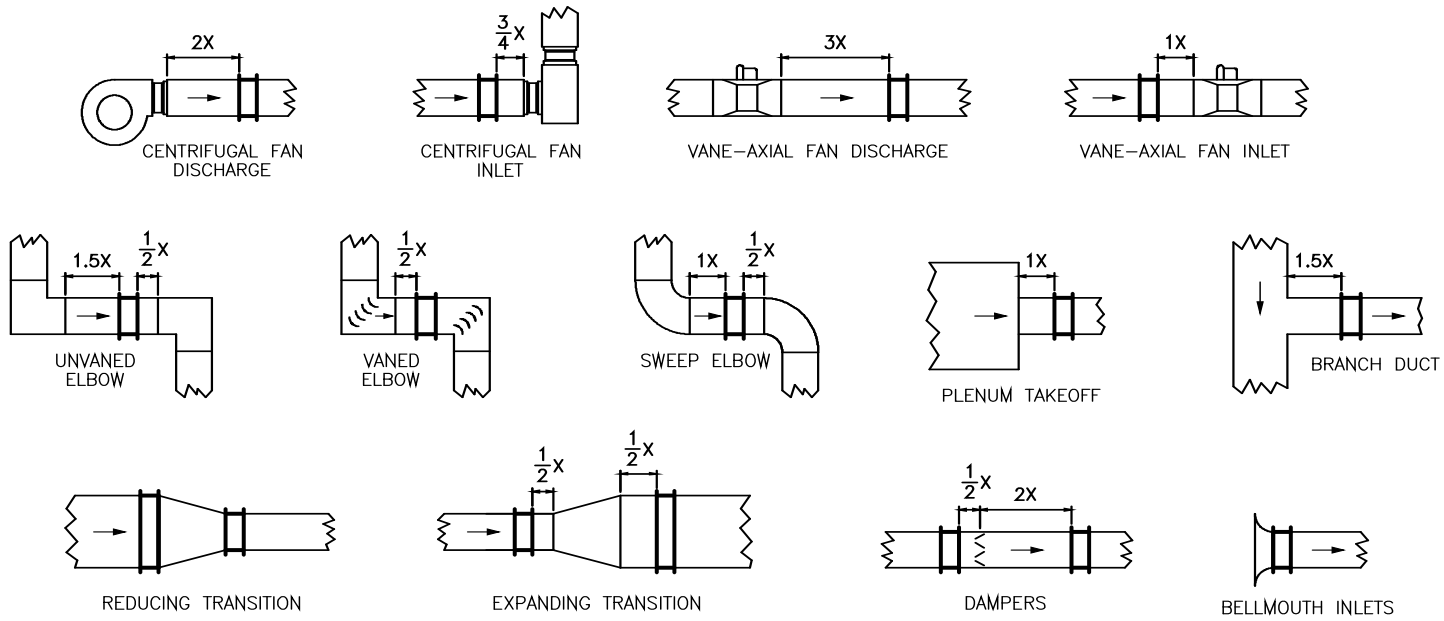




CFD Modeling Summary

	90º Unvaned Elbow		90º Sweep Elbow	
Downstream of Disturbance	Airflow Directions	Airflow Angularity	Airflow Directions	Airflow Angularity
0.5D	Negative	>90º	Positive	31º
1.0D	Stagnant	52º	Positive	26º +
1.5D	Positive	29º +	Positive	22º #
2.0D	Positive	26º	Positive	16º
2.5D	Positive	20º #	Positive	14º
3.0D	Positive	15º	Positive	13º

Minimum Installation Requirements



Circular duct X = diameter

Rectangular duct X = 2(H x W) / (H + W)

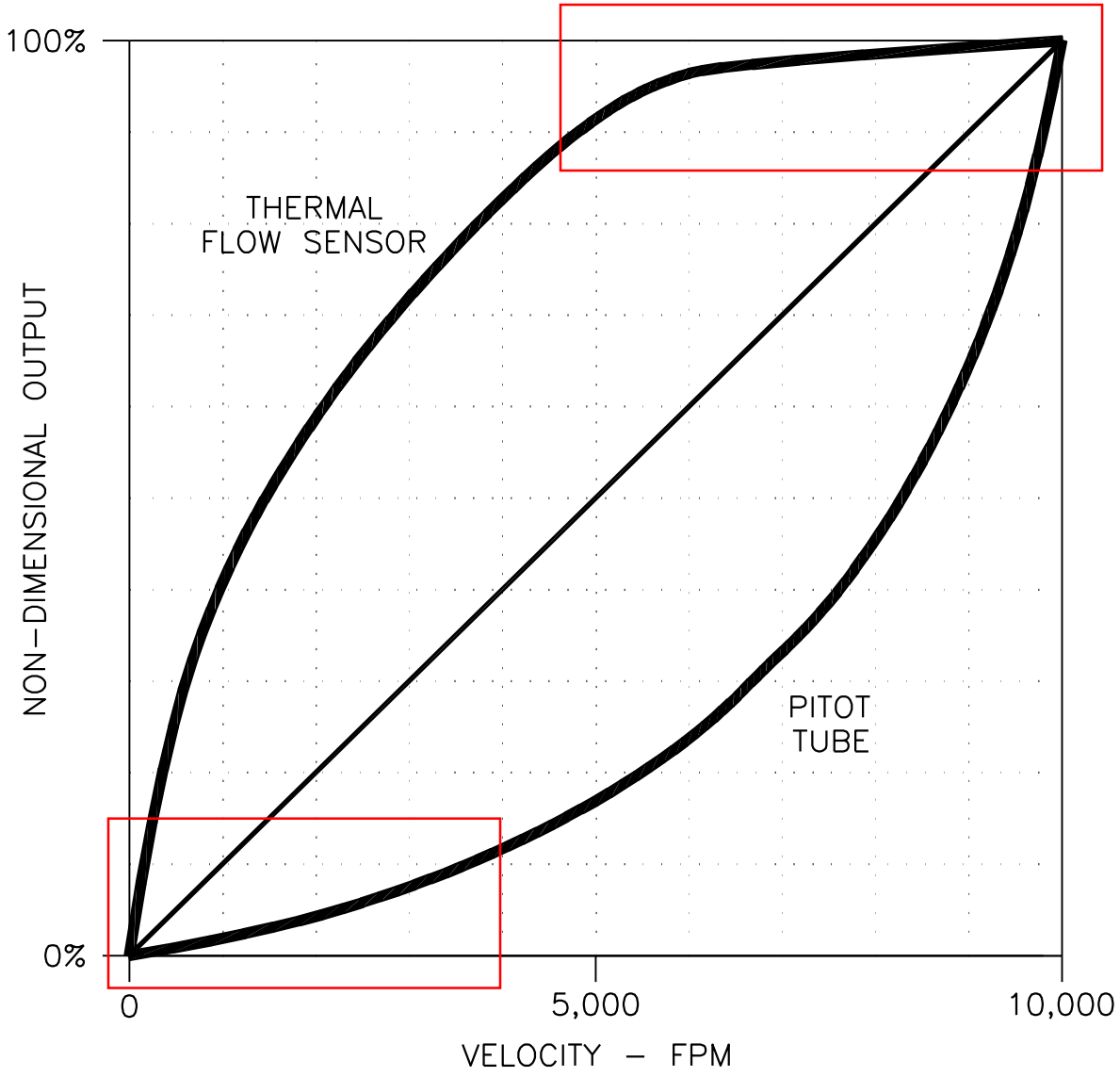
Flow Technologies

HVAC Air Flow Measurement Applications, Installations and Strategies

- Ducted Airflow
- Outside Air
- Fan Inlet
- Air Side Economizer
- Fan Inlet

This is Not A New Technology

Thermal Dispersion vs. Pitot



Upper portion of the curve indicates thermal has little output signal change over large velocity change above 5000 FPM

Lower portion of the curve indicates pitot has little output signal change over lower velocity range, from 0 to 400 FPM

Differential Pressure

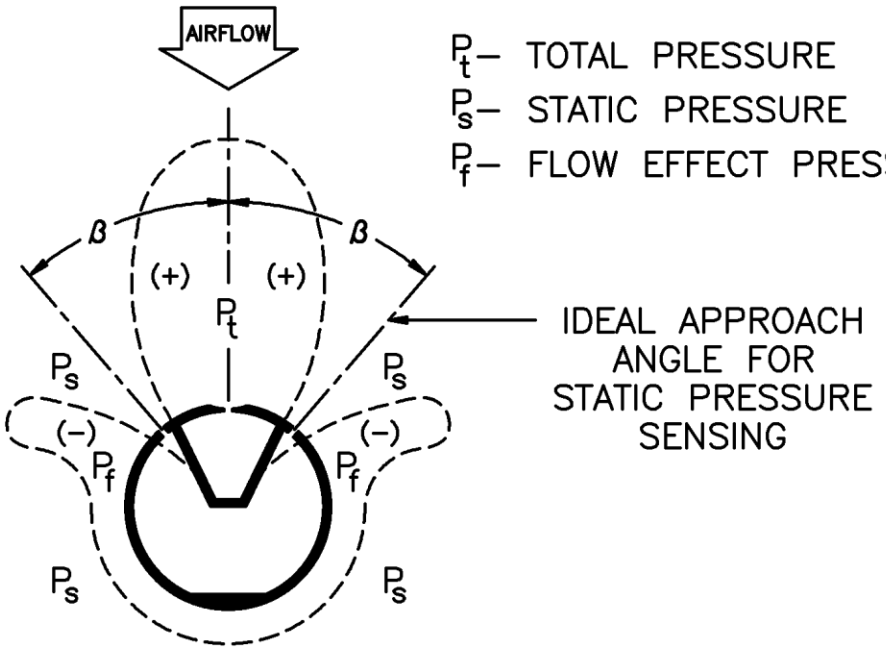
- The recommended method for airflow measurement in the industry, ASHRAE Fundamentals Handbook
- Measures actual components of airflow – total pressure and static pressure

Differential Pressure

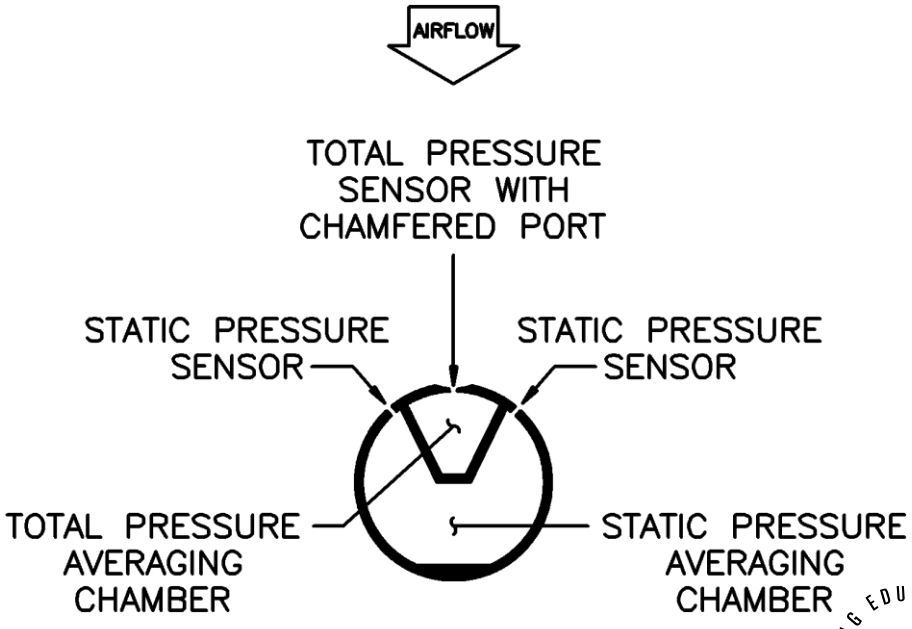
Velocity pressure cannot be measured directly.

$$Velocity\ Pressure = Total\ Pressure - Static\ Pressure$$

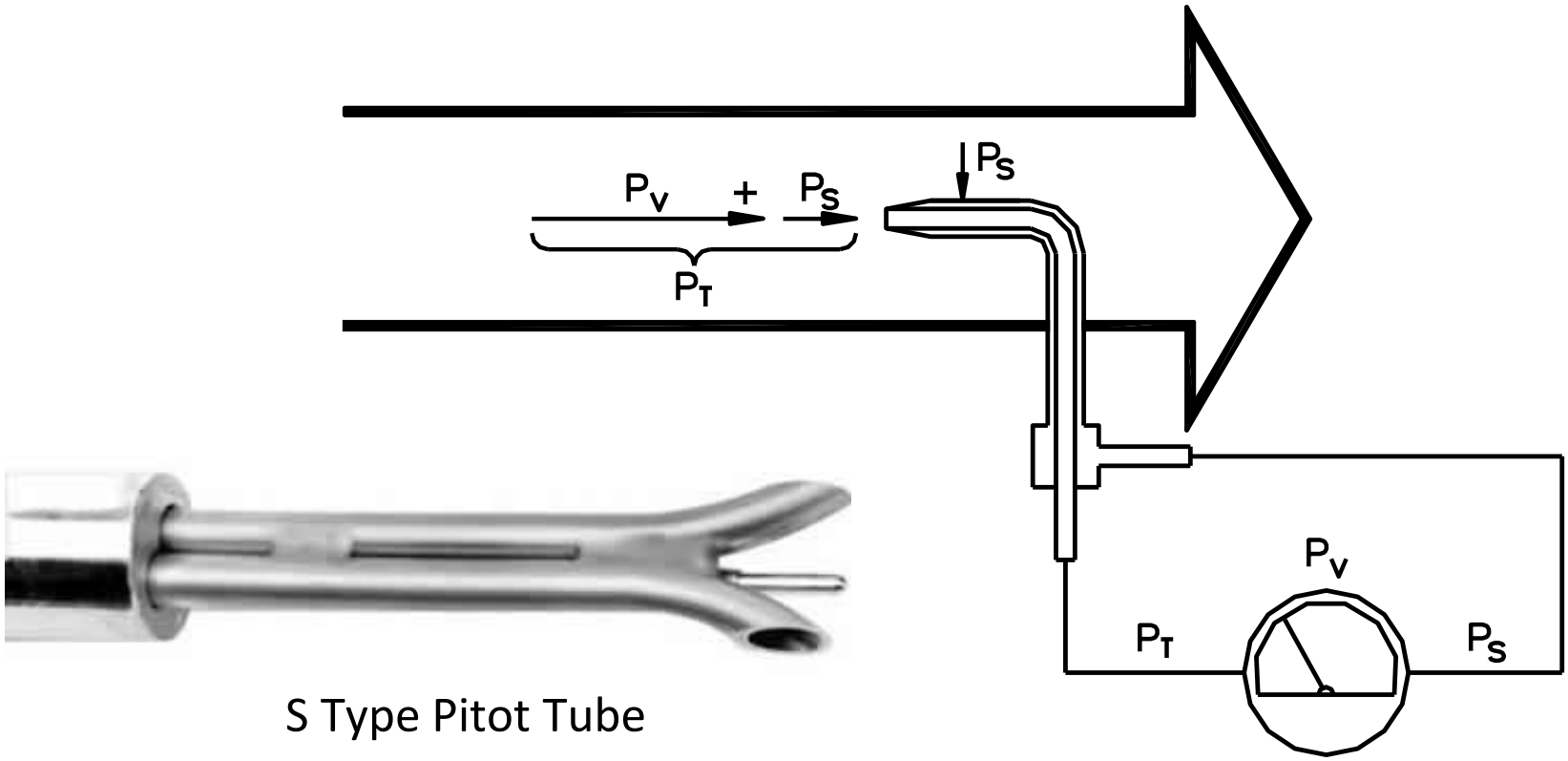
Pitot-Fechheimer Method



Total Pressure (TP) sensing ports having chamfered entrances, helps to eliminate air direction effects.



Standard Pitot Tube



S Type Pitot Tube

Fixed Resistance – Differential Pressure

- A fixed resistance device has a unique mathematical relationship between airflow velocity and pressure drop.
- The pressure drop generated by a fixed resistance, created or existing, in the airflow path can be used to determine the velocity and volumetric airflow based on that relationship.

Outside Airflow Measurement The Challenge:

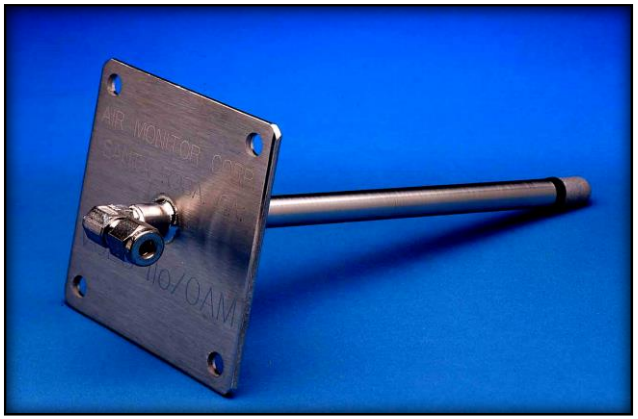
- Extremely low velocities (150 fpm)
- Directional and variable wind loads
- Ambient temperatures ranging from -20ºF to 120ºF
- Variable humidity; 30 to 100% condensing
- Presence of airborne particulate
- No straight run of duct typically available
- Often measured in proximity to a modulating damper

Outside Airflow Measurement
The Need:

Balancing the need for adequate IAQ against the cost of conditioning outside air

Outside Air Measurement System Components

Outside Reference Sensor



Inlet Airflow Sensor

Monitor Module

Applications
Dual / Multiple Louver

- Multiple sensors can be mounted in a split intake, all plumber back to common transmitter.

- Measured flow range turndown of 16:1, with measured velocities as low as 150 FPM

Outside Air Applications
Split Louver

- Split louver / economizer intake installation. Newer version requires only one transmitter for monitoring separate intakes.
- Ensure units are weather proof, connections are complete and tight

Outside Air Stations

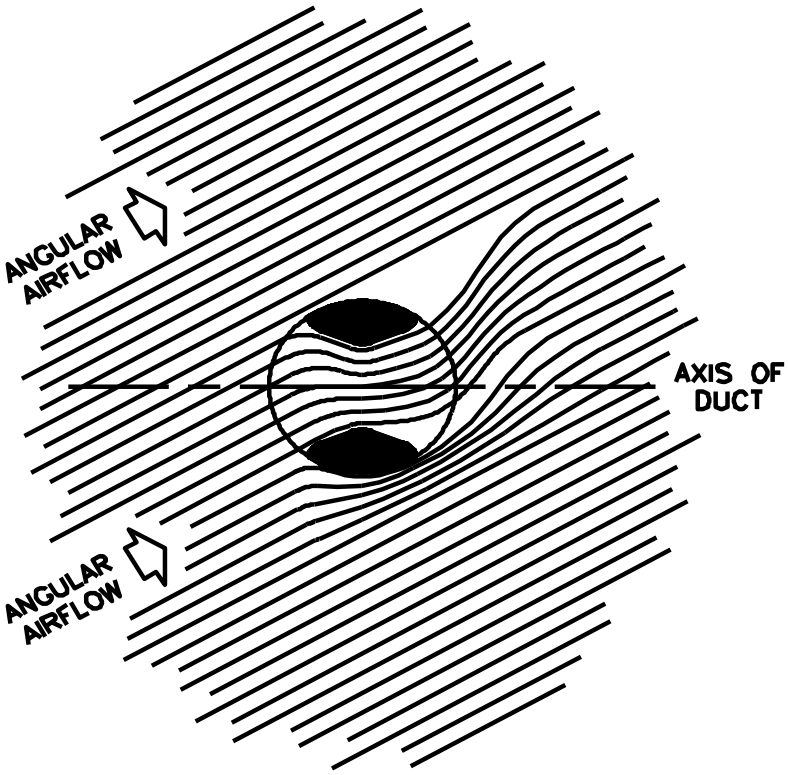
- Fixed resistance device with factory mounted sensors
- Most installations can be installed without field calibration
- Facilitates proper installation and ensures suitable pressure drop for the OAM electronics

Thermal Dispersion Airflow Measurement

Thermal Dispersion Technology

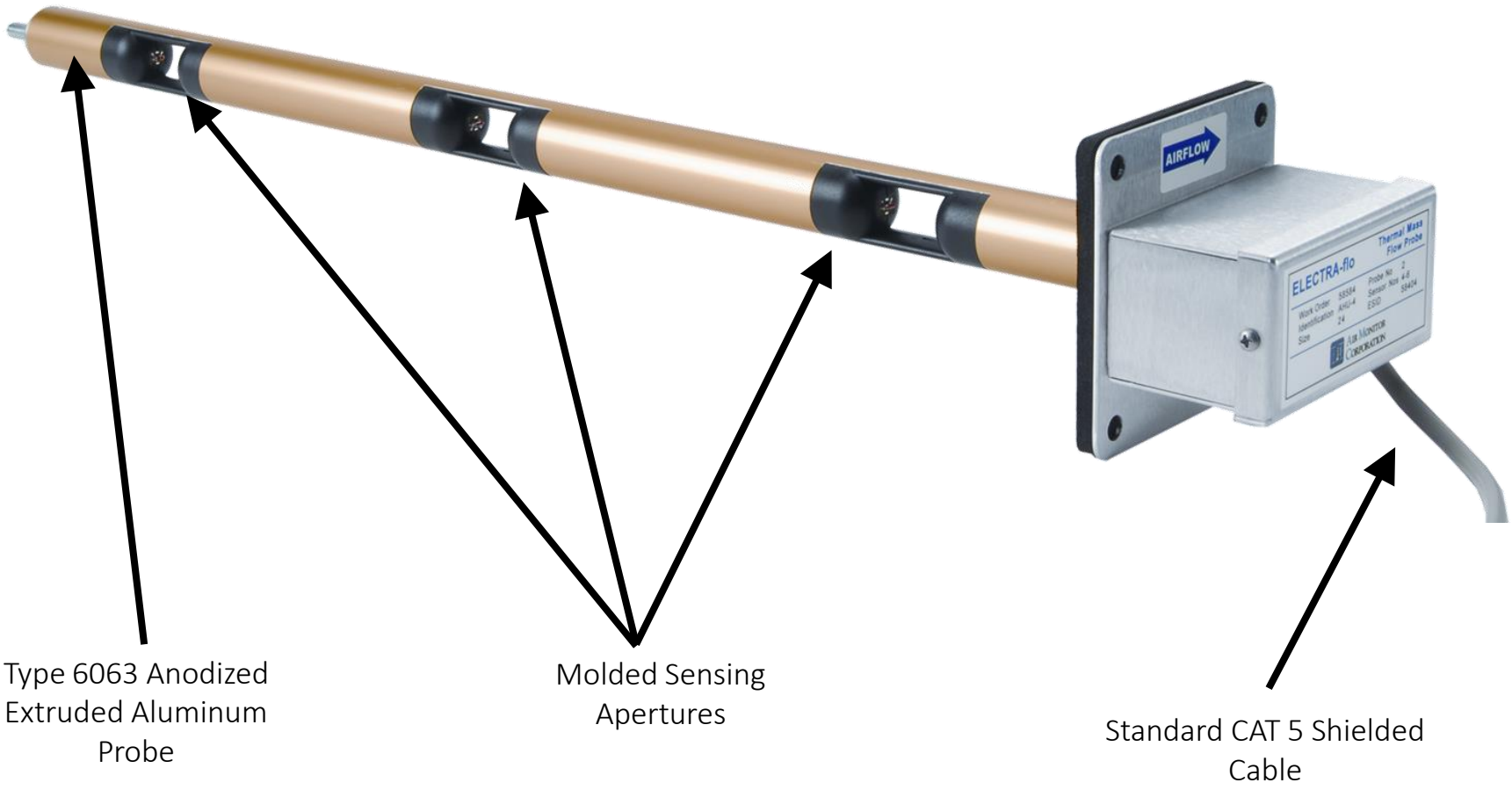
- Each point of measurement utilizes two precision matched thermistors for **temperature** measurement
- Traditional Method - One thermistor measures airflow temperature and the other thermistor is heated to a set differential above the airflow temperature
- Traditional Method - Heat is transferred from the powered (self heated) thermistor to the airstream – as airflow velocity increases, the rate of heat dispersion increases – the differential temperature decreases

Aperture Engineering



- Three dimensional bellmouth shape least sensitive to flow angularity
- Contoured leading edges prevent formation of vortices
- Reduced center cross-section stabilizes and flattens velocity profile
- Air contact with sensors is maintained at all velocities

Thermal Dispertion Probe



Total Flow Transmitter

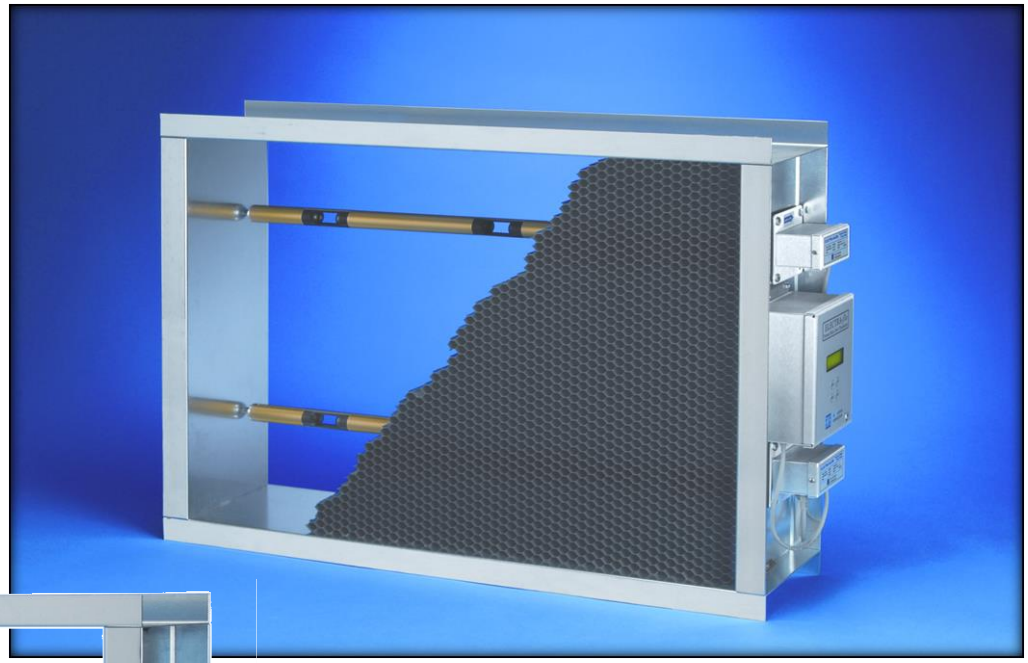
- Display for Volume, Velocity and Temperature
- 0-5000 FPM standard velocity range (0-10,000 FPM for fan inlet applications)
- Temperature accuracy ±0.1° F
- Multi-Variable individual points of measurement (Qty Varies By Mfc)
- Individual sensor diagnostics
- BACnet capable, Analog Outputs

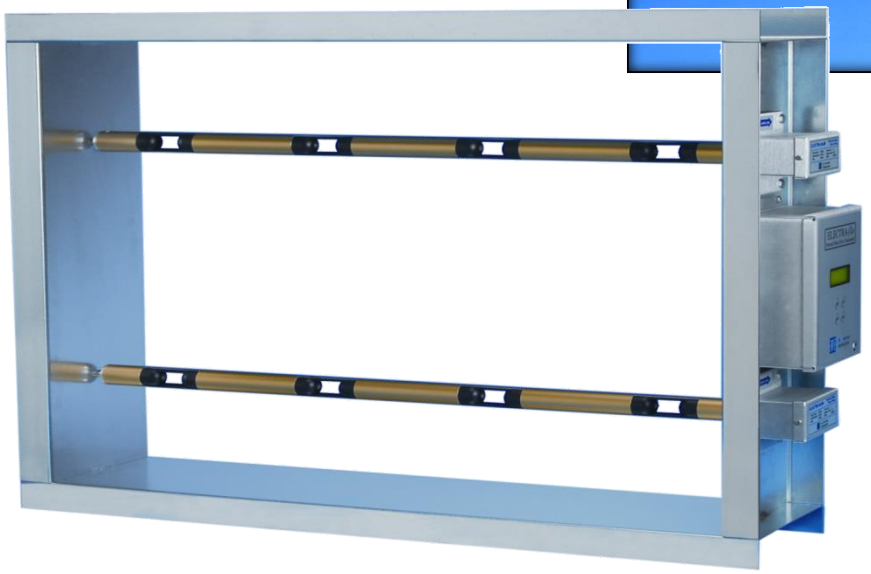
Flexible Installation Probe Array

- Multiple points of measurement for better averaging
- Networked architecture allows daisy-chained probe connections and single home-run to transmitter
- Field-replaceable sensors allow for ease of maintenance

Pre-Mfc Flow Station

- Probe array's can be mounted in pre-fabricated stations
- Stations improve performance in short duct runs, aid in installation.

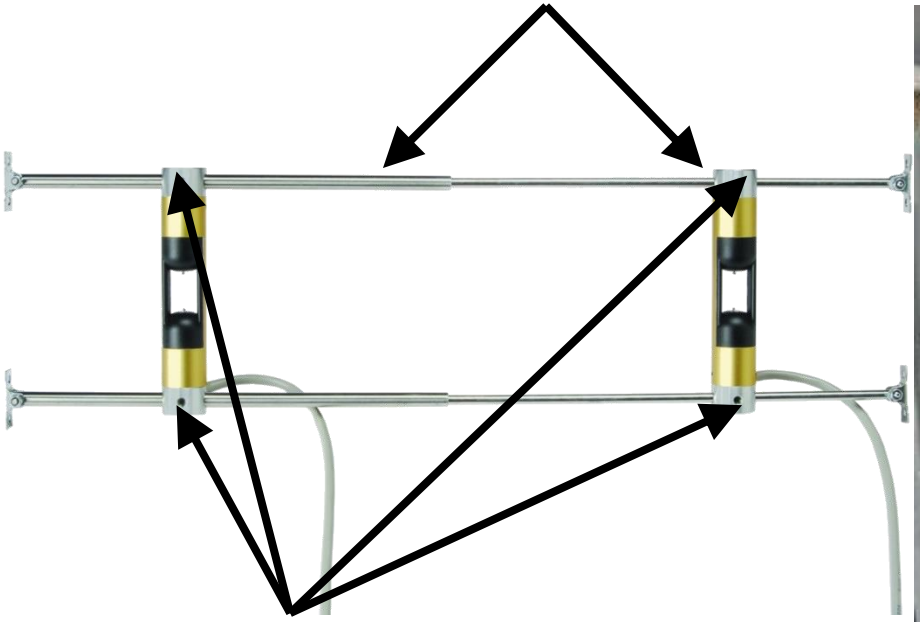




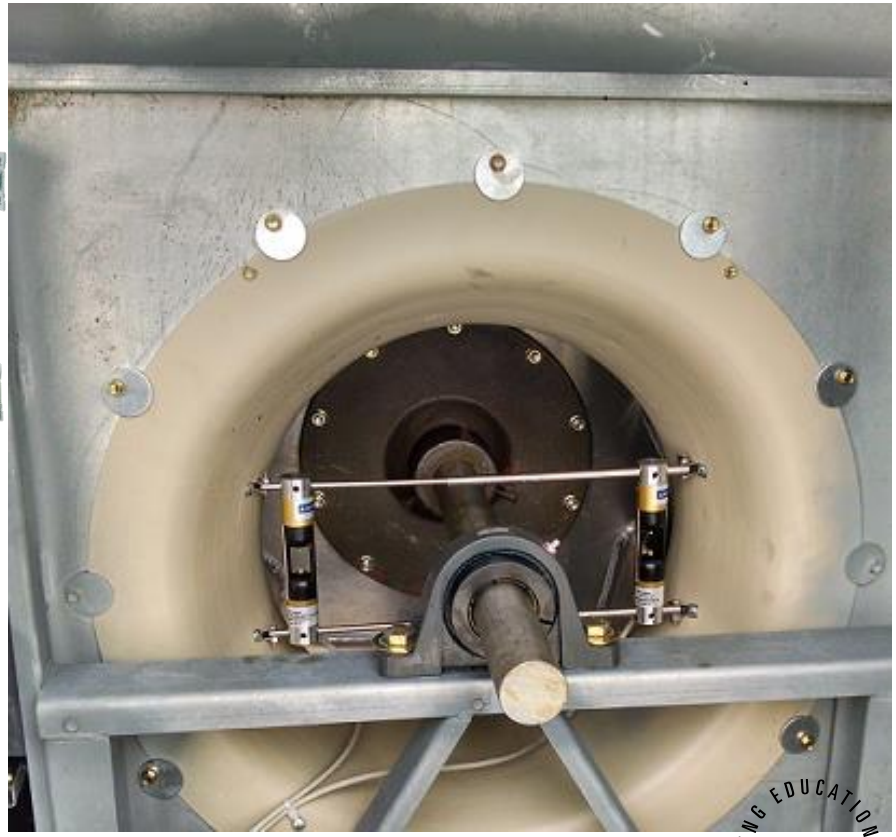
THERMAL DISPERSION
FAN INLET AIRFLOW MEASUREMENT

Field Install Allows Adjustments

Adjustable stainless steel struts



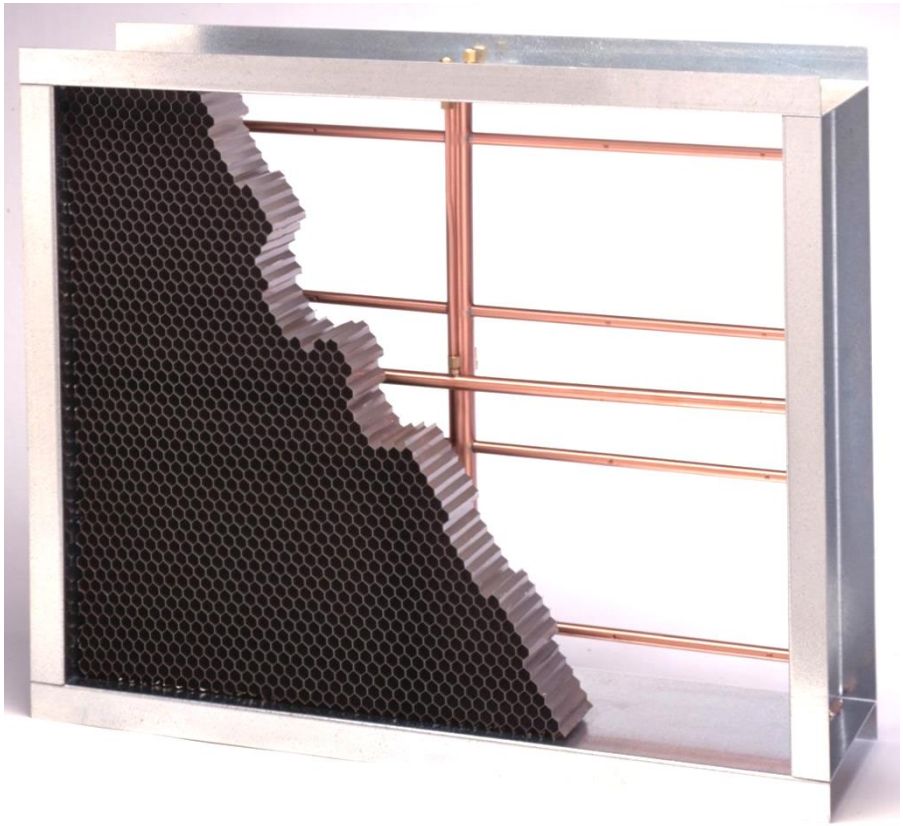
Locator set screws



Pitot-probes

- Anodized extruded aluminum dual-manifolded probes
- Fechheimer offset static pressure sensing ports
- Chamfered total pressure sensing ports
- Multiple mounting options

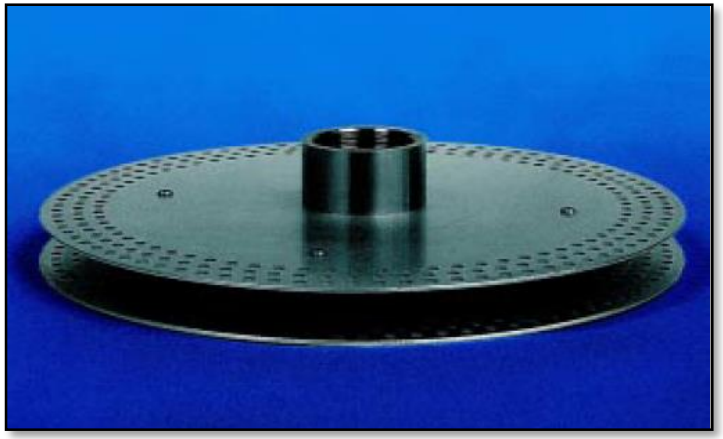
Pitot Available in Stations



- Welded 15 ga. Galvanized sheet metal casing
- Copper total and static manifolds
- Fechheimer offset static ports

STATIC PRESSURE SENSING – FOR BUILDING PRESSURIZATION

Indoor static pressure sensors
Four mounting styles
Aluminum or Stainless
Most commonly used in isolation/room-pressurization applications



Outdoor static pressure sensor
Stainless steel construction
Used for building pressurization measurement

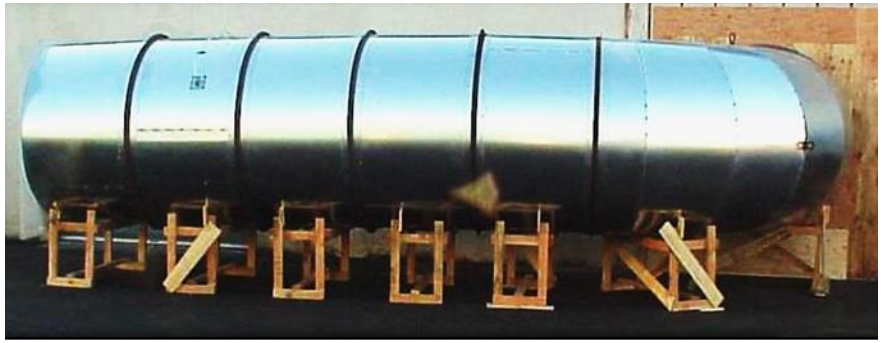
Active Test Chamber

Constructed per ANSI / AMCA 610

100 HP motor with VFD – 36,000 CFM DWDI centrifugal fan

Active Test Duct

Configurable for the testing of virtually any application



Active Fan Test Duct

Four 12” diameter ASME flow nozzles

NIST certified laboratory-grade instrumentation
Fully pressure and temperature compensated

Start-Up and Testing

- Most Suppliers/Manufactures Provide Star-up support
- Schedule In Advance

Tesing

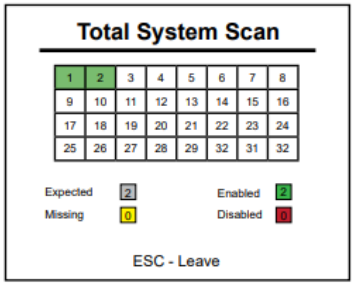
- Ensure Your Access WONT void warranty!
- KNOW what you are doing before hand
- FIND the manuals (most are available online)
- Take Training Courses from Manufactures

Start-Up Service Menus!

SERVICE MENU

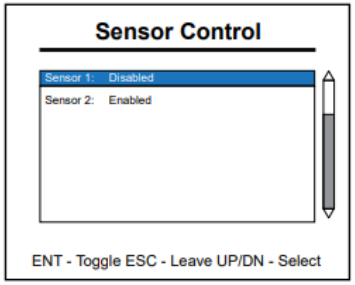
Total System Scan

Displays the current status of all of the system sensors, thus allowing the user to quickly verify all is operating properly. **Expected** (white) and **Enabled** (green) sensor values should be the same unless sensors have been intentionally **Disabled** (red). See below for sensor control. If **Missing** (yellow) is at a value other than zero, the transmitter is not communicating with the associated node.



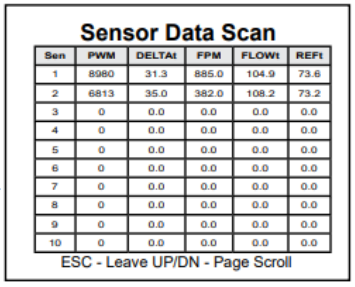
Sensor Control / Sensor Data Scan / Sensor Alert Scan

Sensor Control:
An enabled sensor will report measurement data to the ELECTRA-flo G5 transmitter. This is the default condition after initially powering the system. A disabled sensor will not report measurement data to the ELECTRA-flo G5 transmitter. Disabled sensors may have a malfunction that causes this condition. It may also be desirable to intentionally disable a sensor for troubleshooting purposes. A known bad or suspect sensor can be disabled to remove it from the flow and temperature averages until it can be evaluated and/or repaired if necessary.

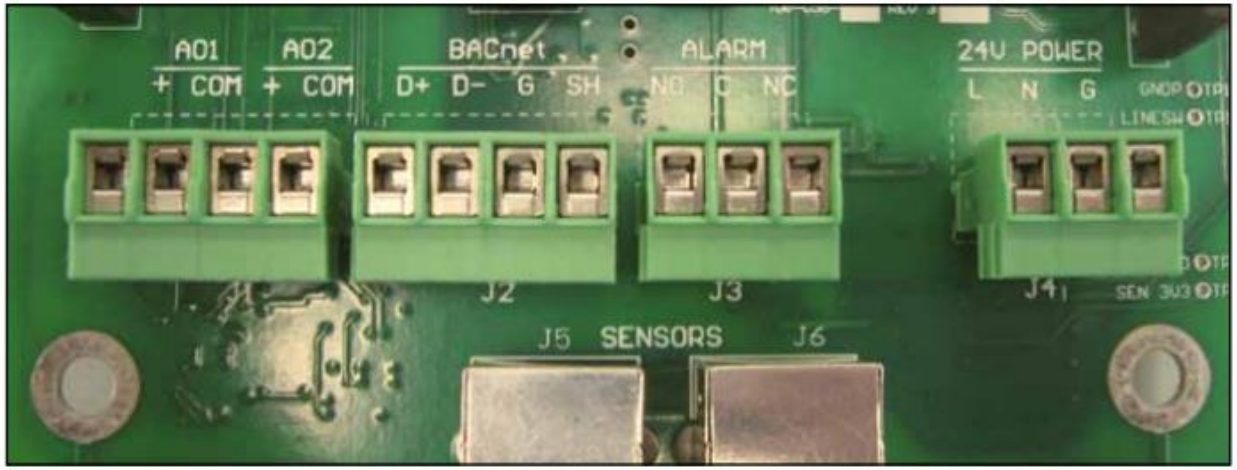


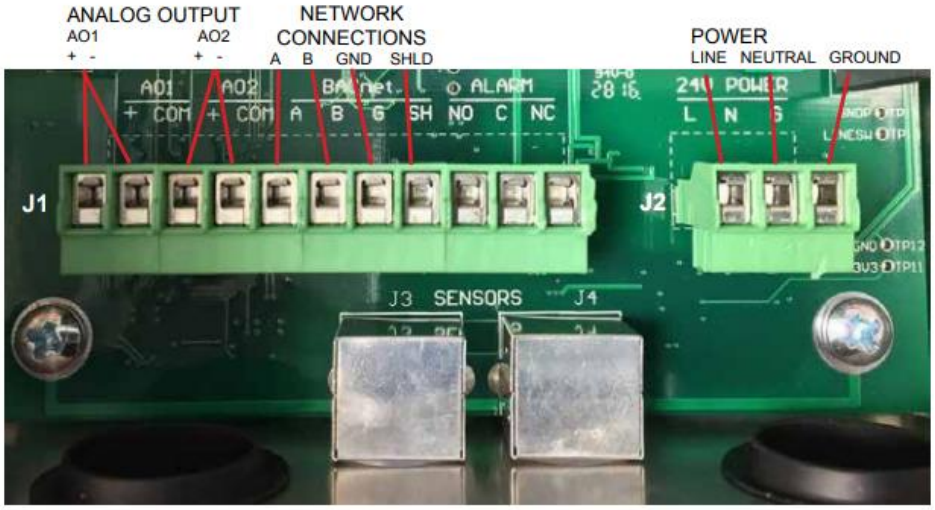
Sensor Data Scan:
Displays sensor number (**Sen**), power input to sensors (**PWM**), temperature difference between flow and temperature sensors (**DELTAt**), velocity (**FPM**), flow temperature sensor (**FLOWt**) and the reference temperature sensor (**REFt**).

This data display screen can be used to further evaluate and troubleshoot the system performance and the application characteristics; e.g., the individual sensor velocities and temperatures will provide comprehensive data regarding the flow profile measured.



Not All Terminations are the Same





Some Displays Will Show Navigations And Errors

The following icons will always be displayed at the top of the normal operating screen. Press **ENT** to enter menu screens. Follow instructions in section 3.6 to navigate.


Transmitter communicating normally on BACnet network

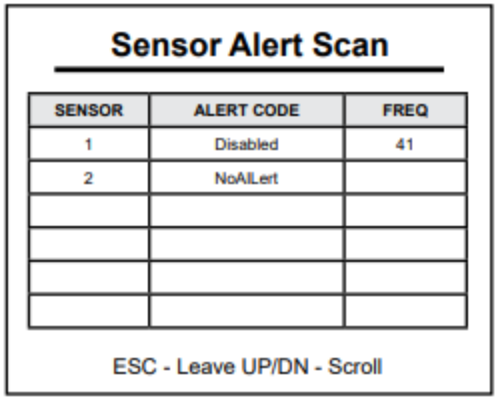

Send/Receive arrows flashing indicates the sensor(s) and transmitter are communicating normally


Transmitter processor normal


Field Characterization has been turned on 

Display Start-Up Errors

Sensor Alert Scan:
Displays alert codes for expected sensors. Sensors operating properly will display **NoAlert**.



Other Alert Codes

Alert Code	Type	Description	Corrective Action
Missing	ALERT	Transmitter cannot communicate with Sensor	Power cycle system and recheck.
SensAOOR or SensBOOR	ALERT	Sensor fault	Replace sensor. Contact Air Monitor.
DeltaOOR	ALERT	Sensor Delta Temperature out of range	Contact Air Monitor.
TempOOR	RANGE	Temperature measurement out of range (-20 to 140 ³F)	Verify application temperature is not outside -20 to 140 ³F. If ELECTRA-flo G5 appears to be reporting incorrectly, contact Air Monitor.
Disabled	ALERT	Sensor resets abnormally	Power cycle system and recheck.
VelOOR	RANGE	Average velocity exceeds 5000 FPM for ducted and 10,000 FPM for Fan Inlet	Verify factory set-up information is correct. If application velocity exceeds 5000 FPM, contact Air Monitor.

Use The “Protocol Data”

Device Object

Property	Defalt Value	Read-Only or Writeable	Comment
Object Identifier	1	Writeable	0 – 4,194,303
Object Name	ELECTRA-flo	Writeable	Alpha-numeric; 16 char limit. Linked to “Custom ID” setting in the Service Menu. Also displays on the bottom of the LCD display on transmitter.
Object Type	Device	Read-only	
System Status	Operational	Read-only	
Vendor Name	Ari Monitor Corporation	Read-only	
Model Name	ELECTRA-flo	Read-only	
Location	Defalt Location	Read-only	
Description	Thermal	Read-only	
Protocol Version	1	Read-only	
Protocol Revision	9	Read-only	
Services Supported	readProperty, readPropertyMultiple, writeProperty, deviceCommunicationControl, reinitilizeDevide, who-Has, who-is	Read-only	
Object Types Supported	Analog-input, Device	Read-only	
Object List	Varies: (device, 1), (analog input, 0 - X) where X = 1 + (No. of sensors *2)	Read-only	
Max ADPU Length	128	Read-only	
Segmentation Supported	No Segmentation	Read-only	
APDU Time-out	3000	Read-only	
# of APDU Retries	3	Read-only	
Max Master	127	Writeable	
Device Address Binding	{}	Read-only	
Database Revision	3	Read-only	

ASHRAE 62

- Prescribes ventilation rates depending on the type of structure and occupancy
- Does **not** mandate airflow measurement
- Requires “maintenance of minimum outside air under any load condition”
- Direct measurement of OA is the **Best** way to ensure compliance.
- ASHRAE 62.1 has been adopted by most State Building Codes

ASHRAE 189.1

The Standard of Design for High-Performance, Green Buildings

MANDATES direct outside air measurement

HVAC Airflow Measurement Applications Energy Conservation

ASHRAE 90.1

The Energy Standard for Buildings – Sets minimum building requirements in terms of energy efficiency – mandates types of systems based on building size.

HVAC Airflow Measurement Space Comfort and Control

ASHRAE 55

The standard for indoor comfort

This concludes The American Institute of Architects
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