AIR MONITOR
FLOW MEASUREMENT AND CONTROL

Accurate Measurement For Precise Control

Driving the Need for Accurate Airflow Measurement in Todays HVAC Applications

- Indoor Air Quality (IAQ)
- Energy Conservation
- Sustainability
- Space - Comfort and Control
- Building Pressurization

AIR MONITOR
FLOW MEASUREMENT AND CONTROL

To control something, you must first ***measure*** *it…*

Lord Kelvin

If you can't **measure** it, you can't improve it…

Peter Drucker

The highly dynamic nature of air flow in buildings makes accurate measurement critical to maintaining proper air balance, pressurization, and IAQ.

AIR MONITOR FLOW MEASUREMENT AND CONTROL

Air Monitor Corp.

- Founded in 1970 with the invention of the first multi-point, self-averaging airflow measuring station. Purchased by ONICON, Inc. mid-2015
- First solid-state electronic transmitter to monitor airflow with spans below 0.5 IN w.c.
- Multiple measurement technologies, each ideally-suited for specific applications (no one-size-fits-all)
- First incorporation of Pitot-Fechheimer technology to address duct turbulence and **reduce straight run requirements**
- First dedicated outside air measurement system to meet requirements of ASHRAE 62

AIR MONITOR
FLOW MEASUREMENT AND CONTROL

Air Monitor Corp.

- All products engineered, manufactured, & configured to specific applications & installations
- First AMCA certified airflow measuring stations and probes
- First networked architecture, field-serviceable thermal dispersion airflow measurement system
- 100% made in America. Engineering & manufacturing in Santa Rosa, CA; customer service in Largo, FL
- Supported by well-developed, experienced sales rep network
- Purchased by ONICON Incorporated in 2015. Became a unit of TASI Flow Group in 2019.
- Products configured & calibrated specific for specific application
- 100% made in America

AIR MONITOR
FLOW MEASUREMENT AND CONTROL

Air Monitor Corporation

- Founded in 1970 with the invention of the first multi-point, self-averaging airflow measuring station
- Multiple measurement technologies, each ideally-suited for specific applications (no one-size-fits-all)
- First 1% accuracy, ultra low span differential pressure transmitters with natural spans down to 0.05 IN w.c.
- First dedicated outside air measurement system to meet ASHRAE 62
- Purchased by ONICON Incorporated in 2015. Became a unit of TASI Flow Group in 2019.
- Products configured & calibrated specific for specific application
- 100% made in America

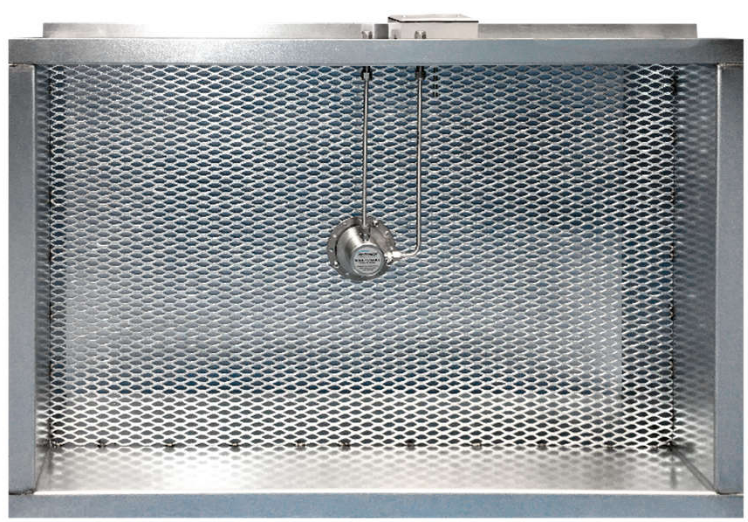
Airflow Measurement Technologies

Thermal Dispersion (Mass)

Differential Pressure (DP)

Differential Static Pressure (DSP)

Vortex*



* AMC does not offer vortex-sensing devices

Factory Warranty

1 YEAR NO FAULT WARRANTY
3 YEAR MANUFACTURER WARRANTY

Warranty second-to-none in the industry!

3-Year Manufacturer Warranty

1-Year No Fault Warranty

AMCA Certification

VOLU-probe, VOLU-flo OAM, & FAN-E airflow stations are licensed to bear the AMCA Certified Ratings Seal for Airflow Measurement Performance

AMCA Certification certifies that the VOLU-probe and FAN-E are licensed to bear the AMCA Certified Ratings Seal for Airflow Measuring Performance guaranteeing measurement accuracy of ±2% (OAM +/- 5%)

Air Monitor Corporation
Commitment and Capabilities

AMCA Certification

AMCA Certification certifies that the VOLU-probe and FAN-E are licensed to bear the AMCA Certified Ratings Seal for Airflow Measuring Performance guaranteeing measurement accuracy of ±2%.

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.

Air Monitor's Testing Facility

Constructed per ANSI / AMCA 610

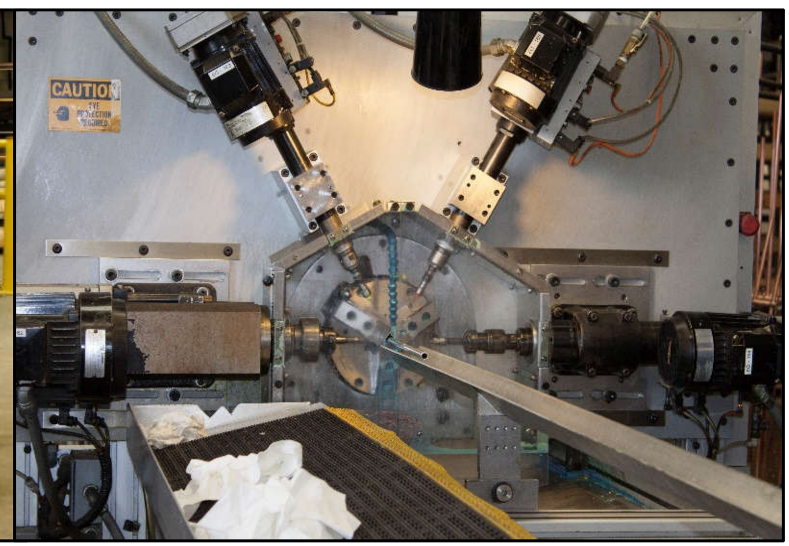
100 HP motor with VFD – 36,000 CFM DWDI centrifugal fan.

Completely configurable duct system - Allows meter performance to be verified in "real world" duct configurations.

N.I.S.T. certified laboratory-grade instrumentation. Fully pressure and temperature compensated.

Air Monitor Manufacturing Capabilities
CNC Drilling Machines

- Used to manufacture all Pitot-Fechheimer flow elements
- Ensures manufacturing accuracy and repeatability
- Exclusive manufacturing methodology
- In-house engineered and constructed by Air Monitor



What's Driving the Need for Accurate Airflow Measurement in Todays HVAC Applications?

- Indoor Air Quality (IAQ)
- Building pressurization
- Energy Conservation
- Space - Comfort and Control

HVAC Airflow Measurement Applications

ASHRAE 62.1 – Indoor Air Quality

Prescribes ventilation rates and standards for acceptable indoor air quality,
But does **not** mandate airflow measurement

ASHRAE 90.1 – Energy Conservation

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

ASHRAE 55 – Environmental conditions

The standard for indoor comfort.

ASHRAE 189.1 – USGBC (sustainability)

Mandates direct outside air measurement

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

HVAC Air Flow Measurement Applications, Installations and Strategies

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

Ducted Airflow Measurement

- Best location for making airflow measurements
- Provides accurate area measurement locations for velocity profiling
- Common duct obstructions can be quantified in terms of flow profile disruptions and straight run requirements.

Outside Air Measurement

- Extremely low velocities (as low as 150 FPM)
- Directional and variable wind loads can affect measurement
- Ambient temperatures ranging from –20° F to 120° F
- Variable humidity; 30 to 100% condensing
- Presence of airborne particulate
- No available straight runs of duct typically available

Air Side Economizer

- Used for “free cooling” when possible
- Calculations for use of economizer generally based on outside air temperature and humidity: Enthalpy control
- Common in northern climates, mandated by ASHRAE 90.1
- Virtually unheard of in southern climates
- Ducts tend to be oversized in terms of OA measurement - to account for the maximum flow required in economizer mode

Fan Inlet Measurement

- Alternate measurement point in the absence of a ducted location
- Typically a high velocity measurement >5000 fpm
- Recent trend toward using smaller fans resulting in higher typical velocities
- Fans are also commonly banked to make a fan array which has unique measurement challenges

AIRFLOW DYNAMICS & MEASUREMENT STANDARDS

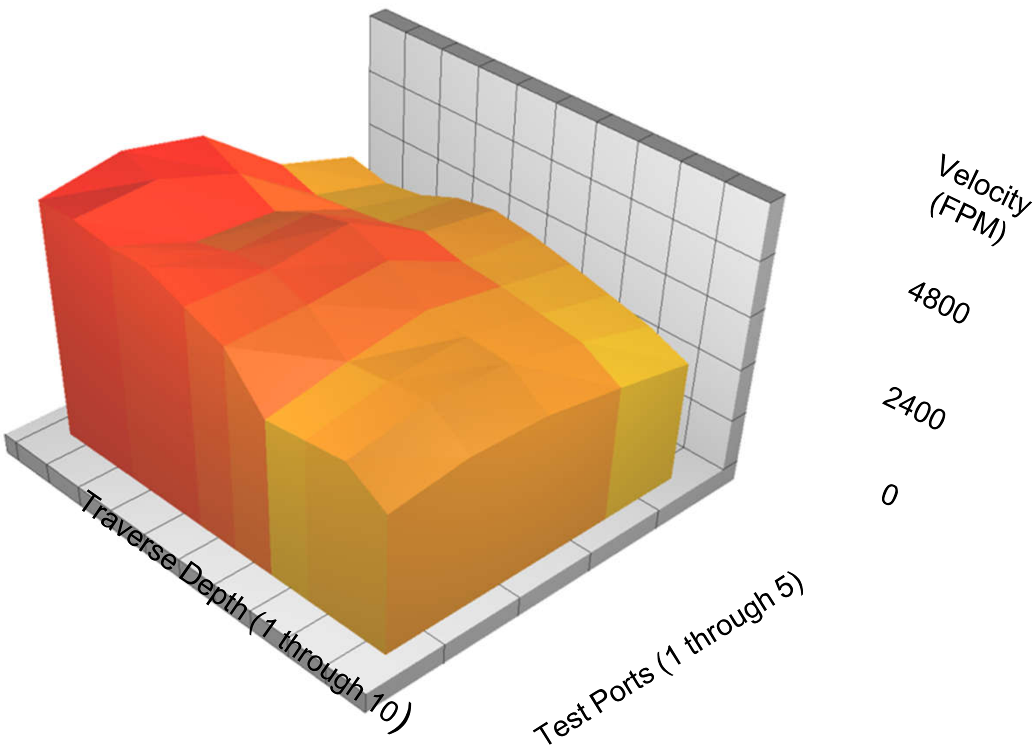
Airflow Dynamics

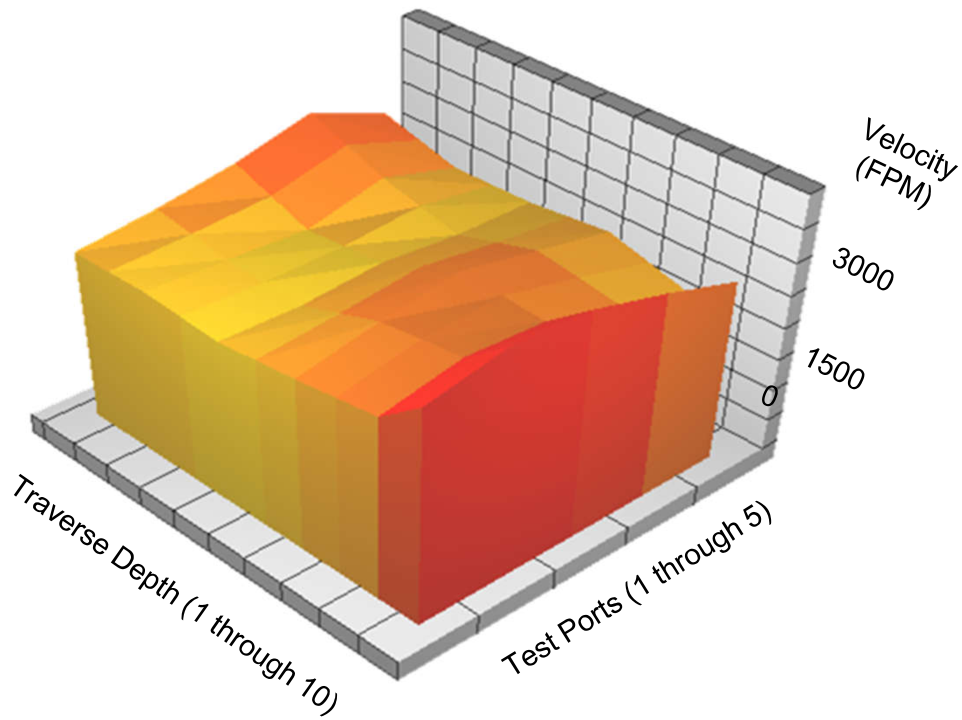
- Airflow is extremely dynamic - compressible
- Velocity profiles can shift based on proximity to upstream/ downstream disturbance and/or the airflow velocity
- Accurate measurement requires multiple sensing points across measurement plane
- The more points of measurement, the better the measurement accuracy

Need for Multi-Point Measurement

Few installations have enough straight run available

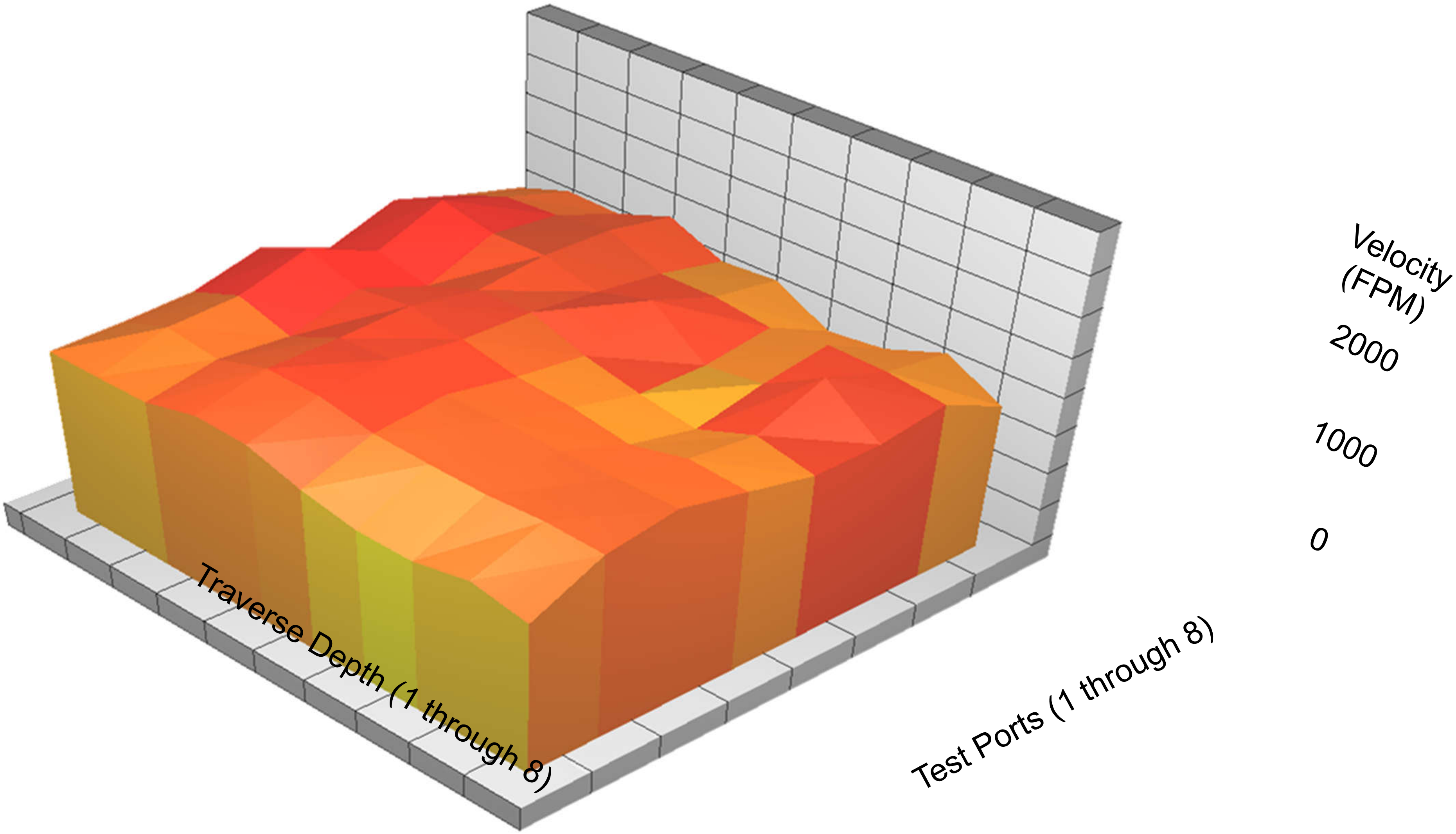
Two 3D traverse tests in the same duct at different rates of total airflow





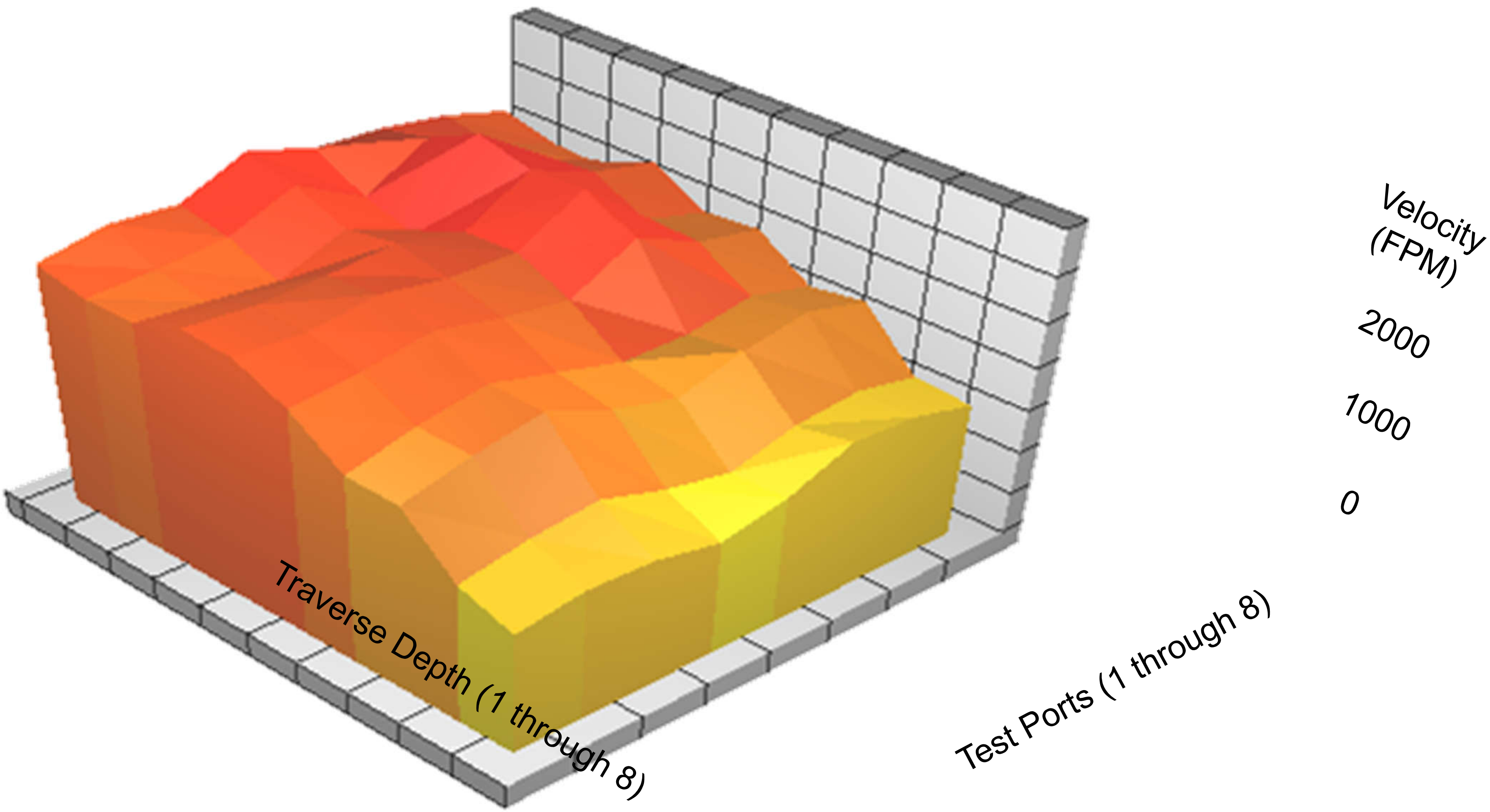
Need for Multi-Point Measurement

Velocity profile at 12 duct diameters downstream of an elbow



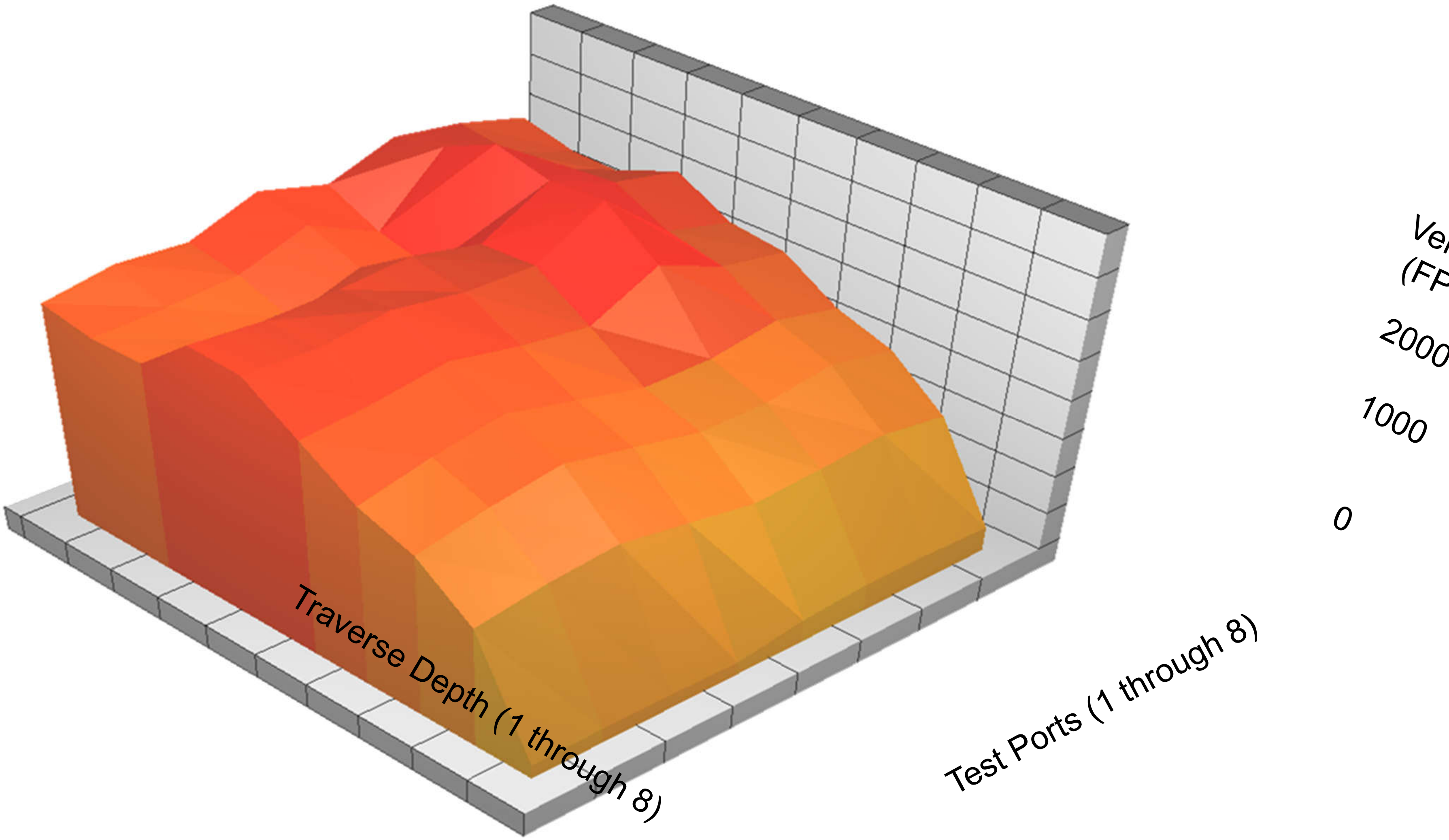
Need for Multi-Point Measurement

Velocity profile at 4 duct diameters downstream of an elbow

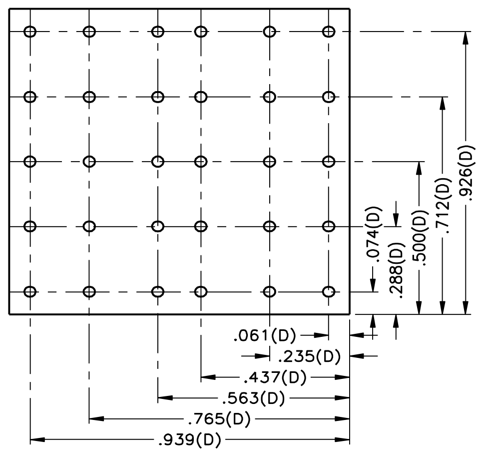


Need for Multi-Point Measurement

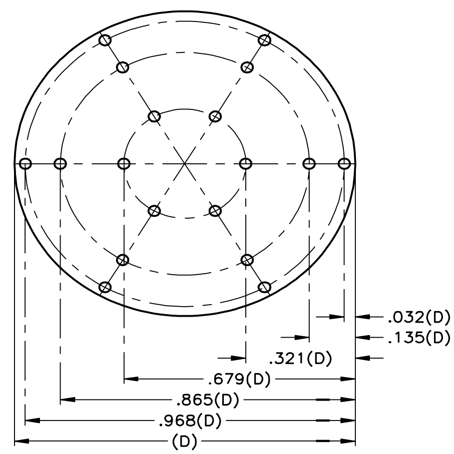
Velocity profile at 0.5 duct diameters downstream of an elbow



log-Tchebycheff Distribution



NO. OF POINTS OR TRAVERSE LINES	POSITION RELATIVE TO INNER WALL
5	.074, .288, .500, .712, .926
6	.061, .235, .437, .563, .765, .939
7	.053, .203, .366, .500, .634, .797, .947

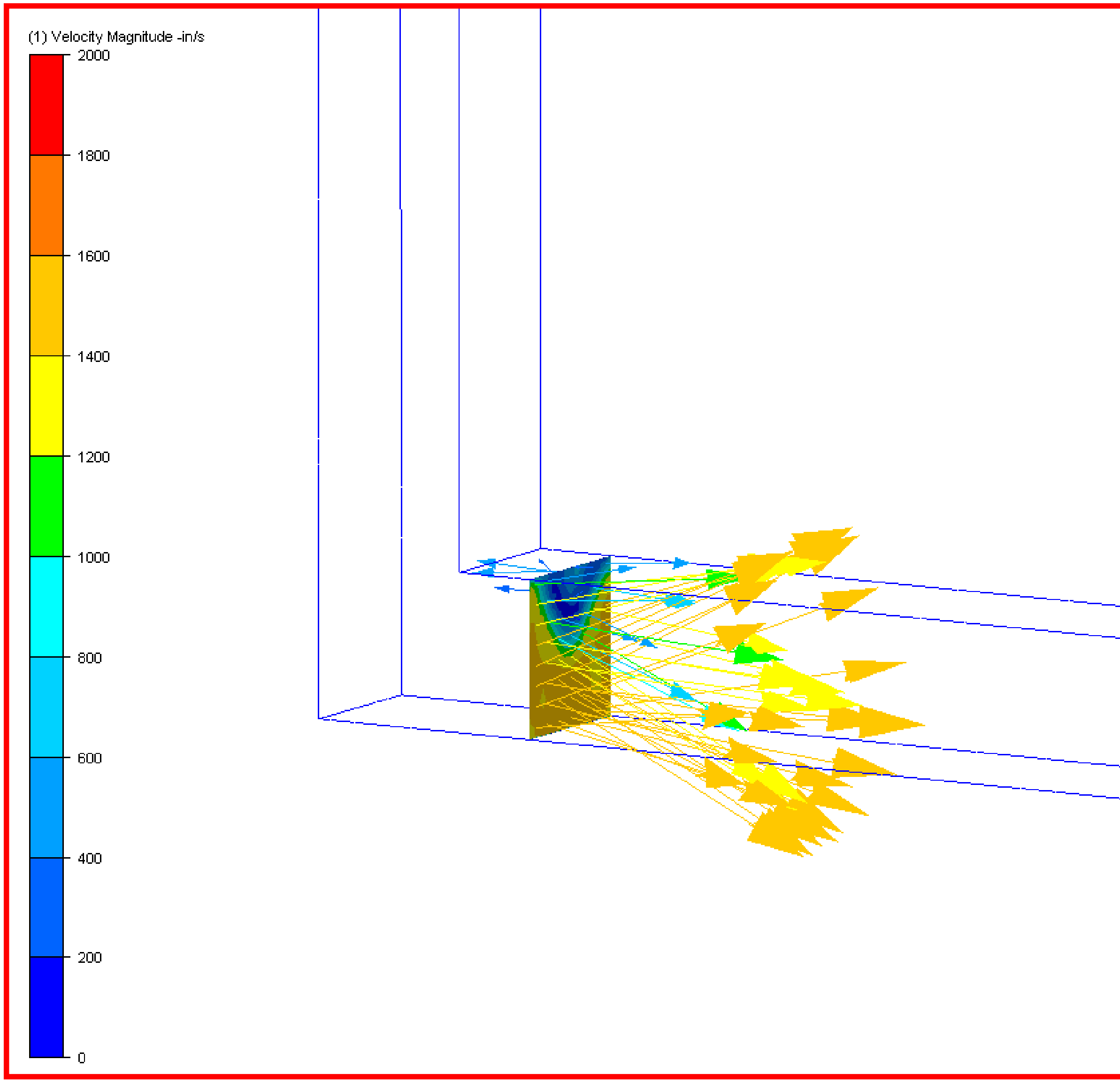


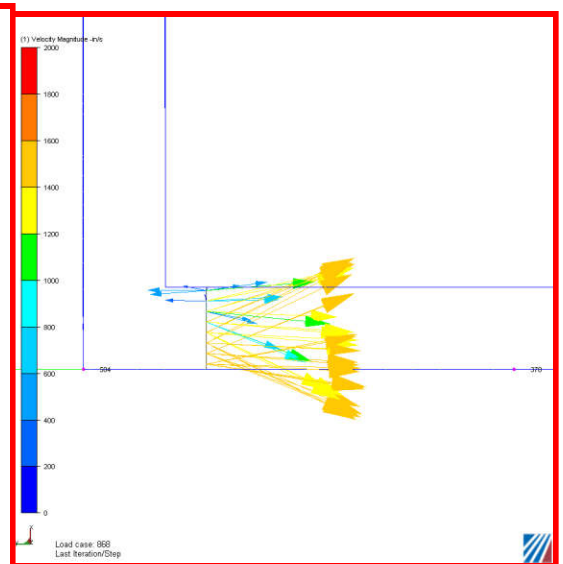
NO. OF MEASURING POINTS PER DIAMETER	POSITION RELATIVE TO INNER WALL
6	.032, .135, .321, .679, .865, .968
8	.021, .117, .184, .345, .655, .816, .883, .979
10	.019, .077, .153, .217, .361, .639, .783, .847, .923, .981

Recommended method by ASHRAE Fundamentals Handbook with a minimum of 25 points of measurement for rectangular and 18 points for circular

Similar to log-Linear with perimeter-biased sensing points

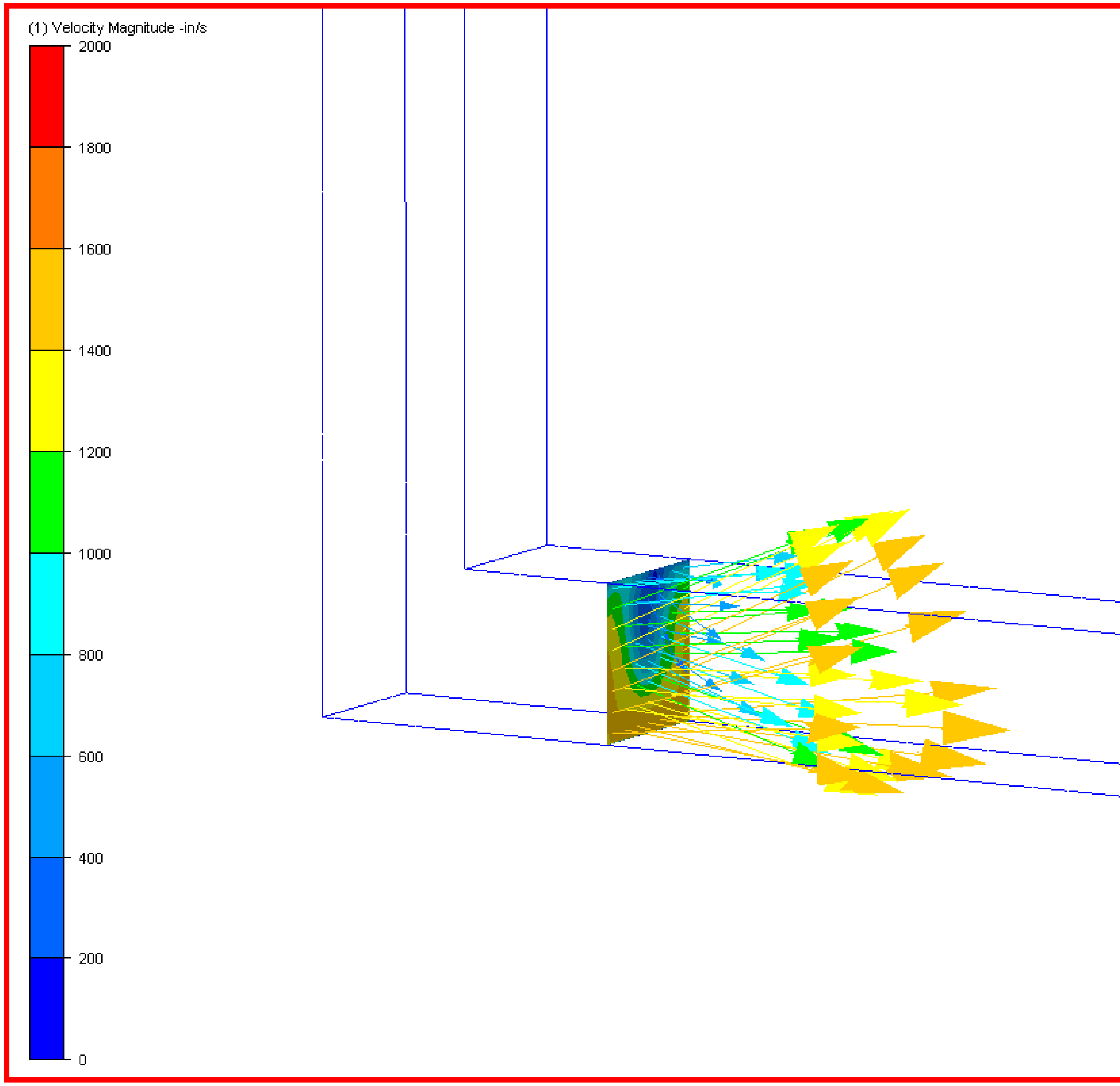
CFD Modeling – Unvaned 0.5D

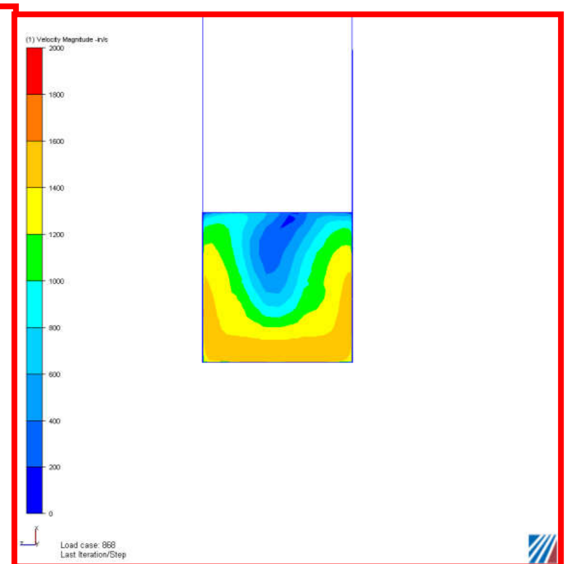


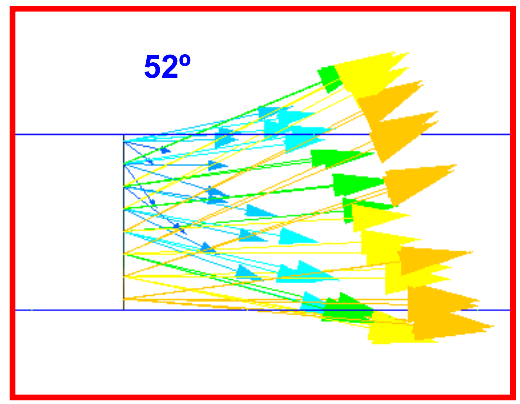


>90º

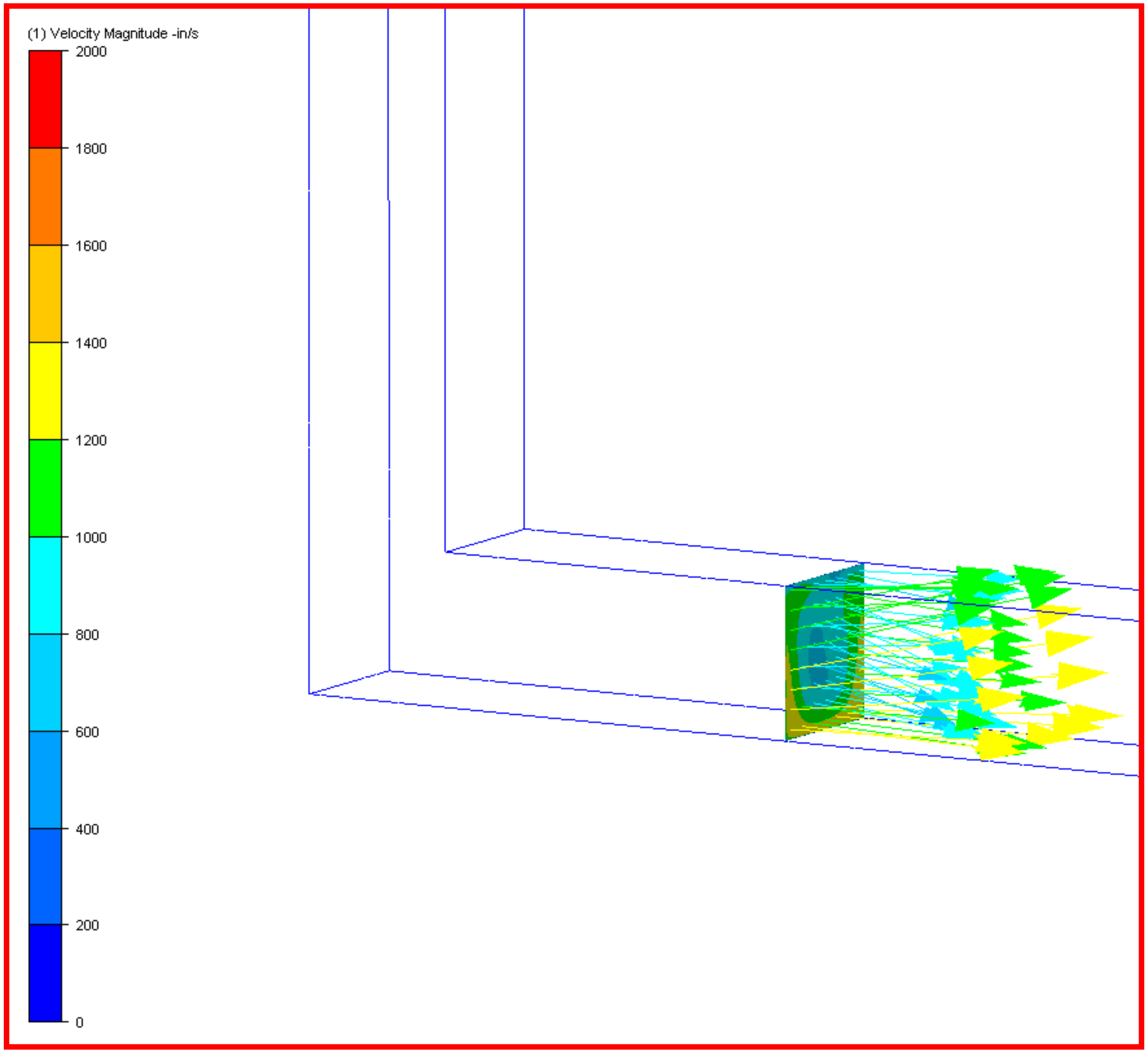
CFD Modeling – Unvaned 1.0D

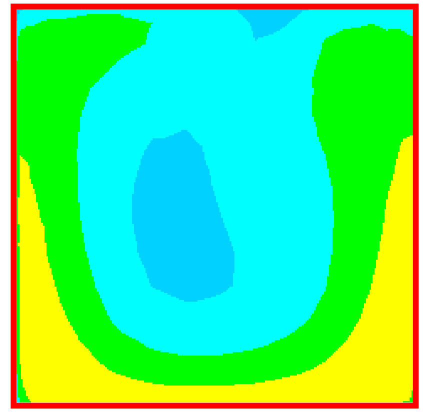






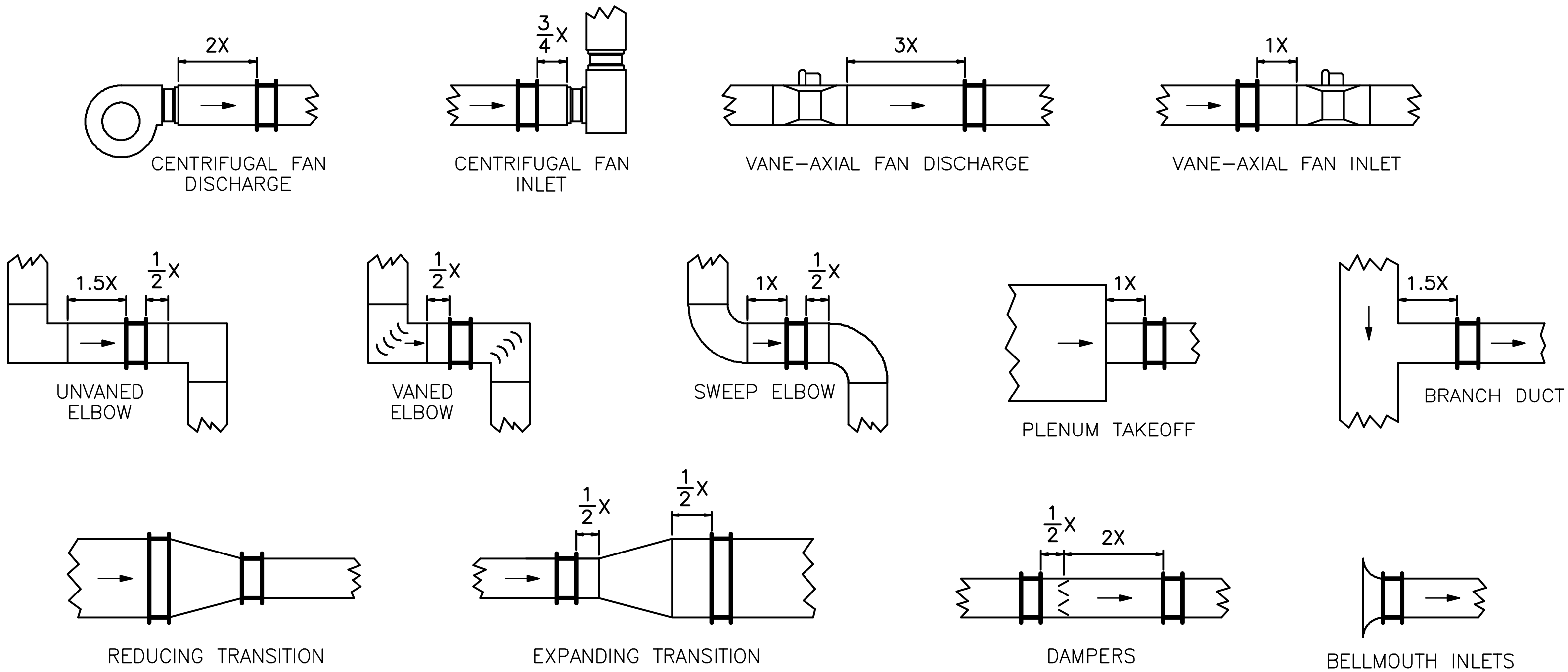
CFD Modeling – Unvaned 2.5D





20º

Minimum Installation Requirements

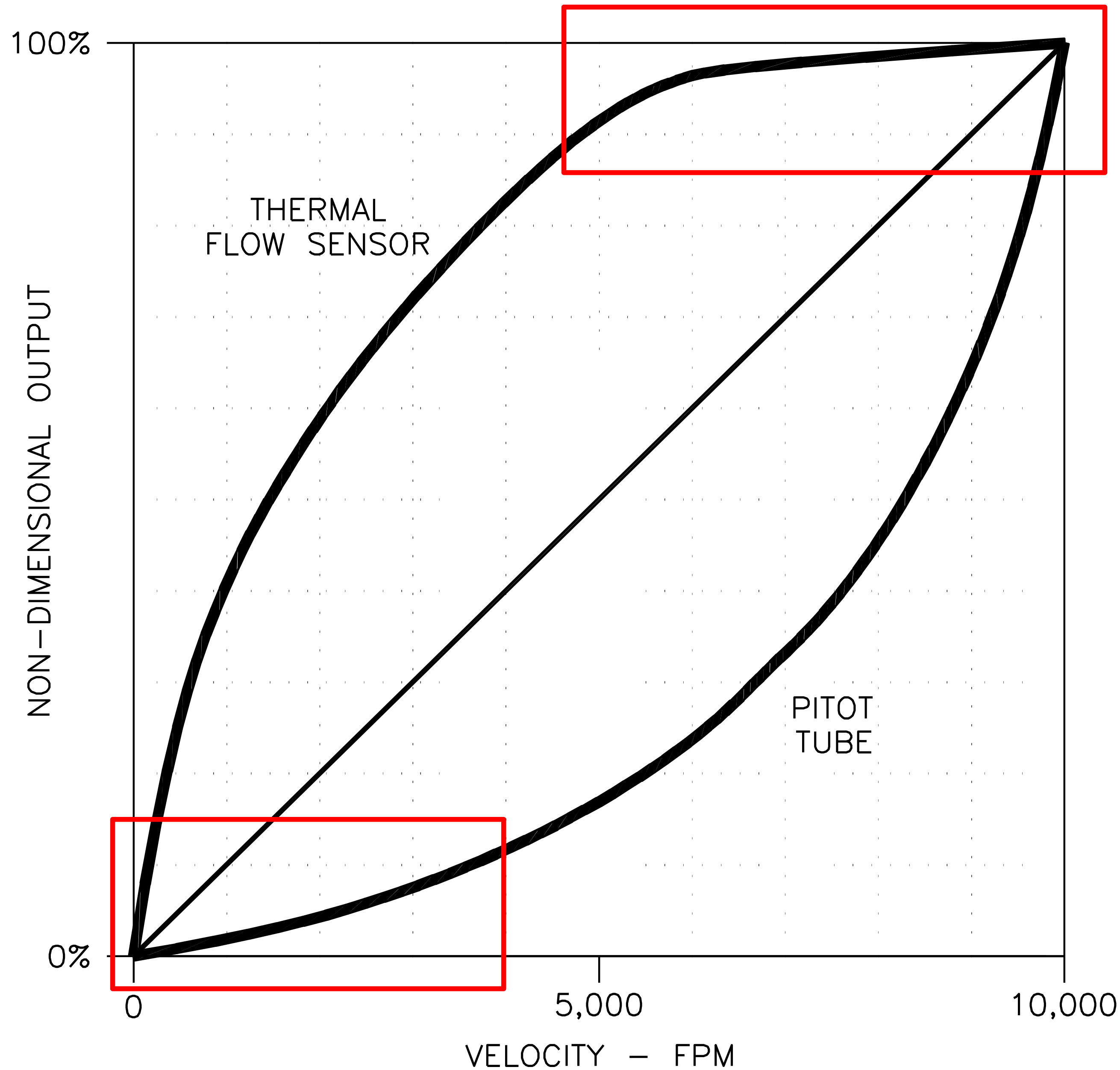


Circular duct X = diameter

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

AMC ELECTRA – flo
Thermal Dispersion Airflow Measurement Products

Thermal Dispersion vs. Pitot



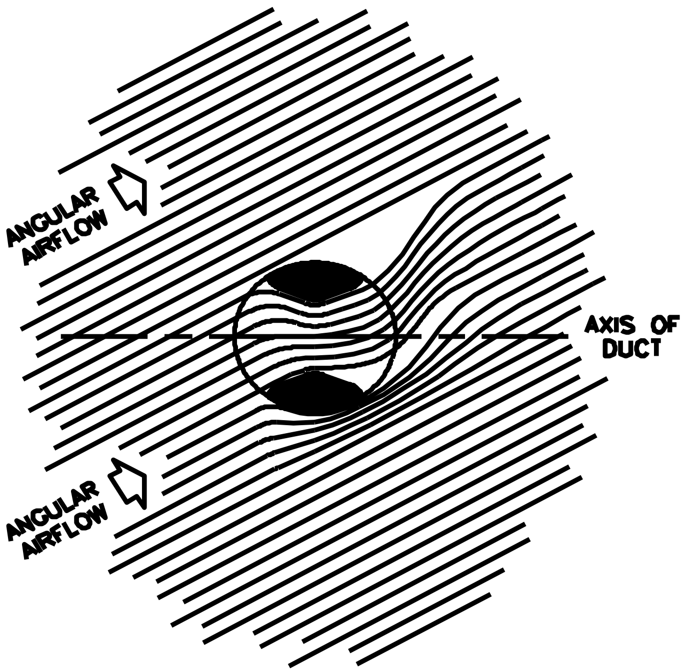
Upper portion of the curve indicates thermal has little output signal change over large velocity change above 5000 FPM

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

Thermal Dispersion Technology Air Monitor's Approach

- Each point of measurement utilizes two precision matched thermistors for **temperature** measurement
- **Constant Temperature Method -** One thermistor measures airflow temperature. The other sensor is externally heated to a set differential above the airflow temperature.
- Heat is transferred from the externally heated thermistor to the air stream; as airflow velocity increases, the rate of heat dispersion increases.
- The relationship between airflow velocity and applied power is defined by an algorithmic function.

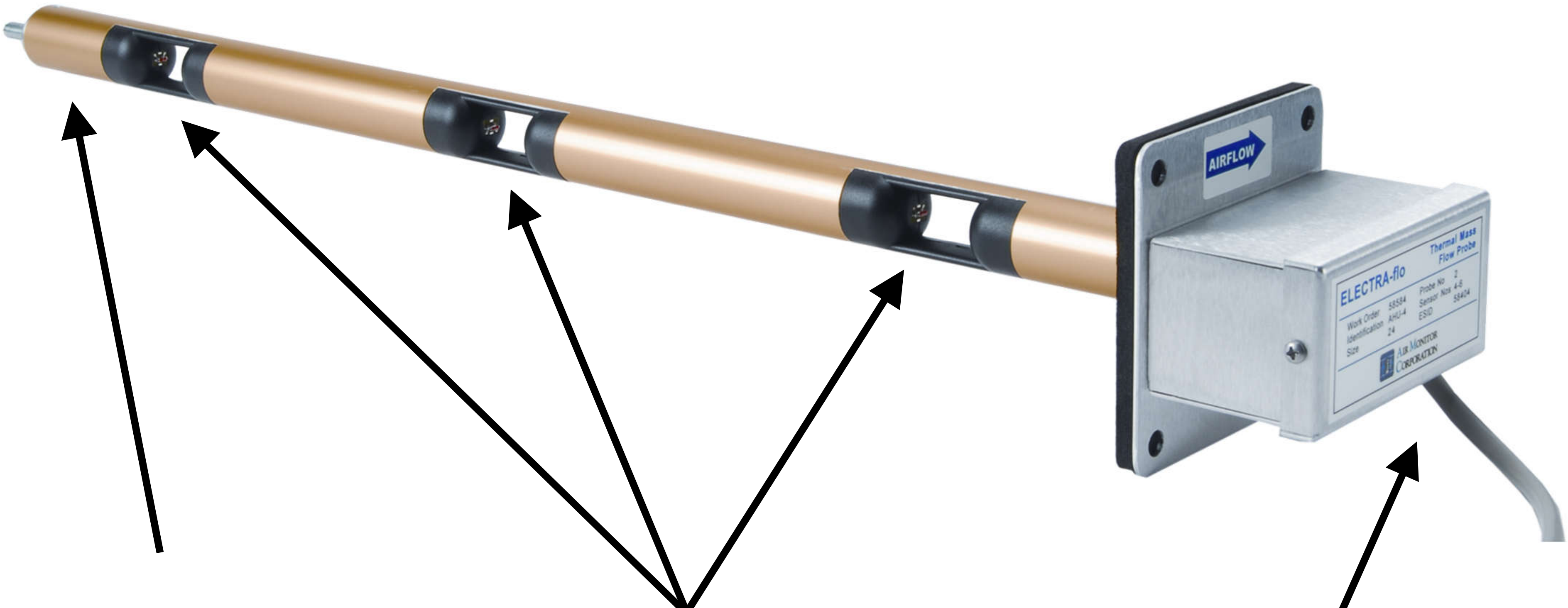
ELECTRA-flo Aperture Engineering



- 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
- Wind tunnel testing to prove design performance – measuring the effect of pitch and yaw angularity
- Air contact with sensors is maintained at all velocities

ELECTRA-flo Probe

NO electronics in air flow stream!



Type 6063 Anodized Extruded Aluminum Probe

Engineered Injection Molded Sensing Apertures

Plenum cable with DIN connectors

ELECTRA-flo Transmitter

- Standard backlit 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
- Up to 32 individual points of measurement
- Individual sensor diagnostics
- UL873 Listing
- Native BACnet and Modbus

ELECTRA-flo
True Dual Channel Transmitter

Allows single transmitter to measure two separate air streams!

- Takes advantage of 32 sensor capability!
- Information available on display via analog outputs or over the network

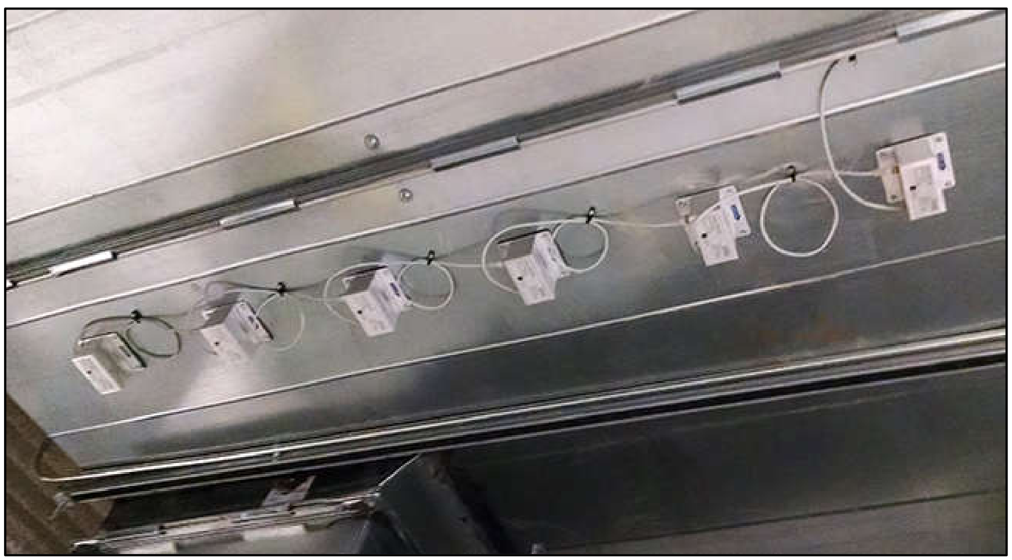
Measure after the duct split

- Does not have to break the bank
- Smart transmitter knows how to do math!

Lower Installation Cost

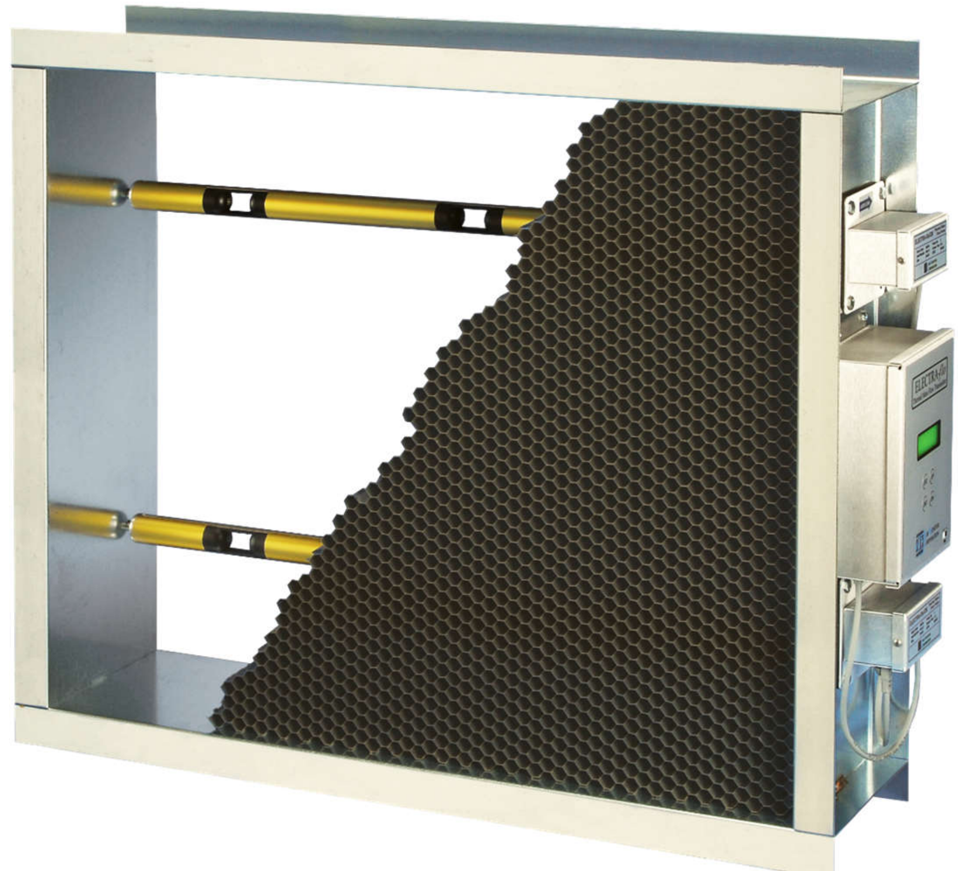
ELECTRA-flo Probe Array

- Up to 32 points of measurement for better averaging
- Networked architecture allows daisy-chained probe connections and single home-run to transmitter – no need to wire individual probes to transmitter. Greatly simplifying installation.
- Field-replaceable sensors allow for ease of maintenance



ELECTRA-flo/CM Station

- Probe arrays can be mounted in pre-fabricated stations which greatly simplify installation.
- Stations with straightening honeycomb improve performance in short duct runs.



Three Levels of Sensor Density

ELECTRA Level 1

Long Dimension in Inches (columns) / Short Dimension in Inches (rows)

	12	18	24	30	36	42	48	54	60	66	72	84	96	108	120
12	2	2	3	3	4	5	6	6	7	7	8	9	10	11	12
18	2	4	6	6	8	8	8	8	10	12	12	14	14	16	16
24	3	6	9	9	12	12	12	12	15	18	18	18	21	21	21
30	3	6	9	9	12	12	12	15	18	18	18	18	21	21	21
36	4	8	9	12	12	12	18	18	18	18	18	18	21	21	21
42	5	8	9	12	12	18	18	18	18	18	18	18	21	21	24
48	6	8	12	12	18	18	18	18	18	18	18	21	21	24	24
54	6	8	12	15	18	18	18	18	18	18	21	21	24	24	24
60	7	10	15	18	18	18	18	18	18	21	21	24	24	24	28
66	7	12	18	18	18	18	18	18	21	21	24	24	24	28	28
72	8	12	18	18	18	18	18	21	21	24	24	24	28	28	28
84	9	14	18	18	18	18	21	21	24	24	24	28	28	28	32
96	10	14	21	21	21	21	21	24	24	24	28	28	28	32	32
108	11	16	21	21	21	21	24	24	24	28	28	28	32	32	32
120	12	16	21	21	21	24	24	24	28	28	28	32	32	32	32

- Three levels of sensor densities, Level 1 being the highest (best), Level 2 being the HVAC commercial market typical, and Level 3 being the most economical.
- At Level 2, our straight duct requirements meet or beat our competition.
- Level 1 sensor density will have the highest accuracy and require the least amount of straight run.
- Addition of CM stations provides greater accuracy and/or reduced straight run requirements.

Air Monitor ELECTRA-flo SD

- Small diameter thermal dispersion probe - designed for duct sizes 4” to 16”
- Dual analog outputs or BACnet® serial communications
- Each probe receives a N.I.S.T. traceable wet calibration
- Ideal solution for individual VAV monitoring, critical space fan tracking and relief / exhaust applications utilizing small ducts

Thermal Dispersion Strengths

- Unmatched accuracy in low velocity applications
- Output is inherently temperature compensated
- Single-source system prevents substitution of inferior components

THERMAL DISPERSION
FAN INLET AIRFLOW MEASUREMENT

Fan Array Measurement Challenges

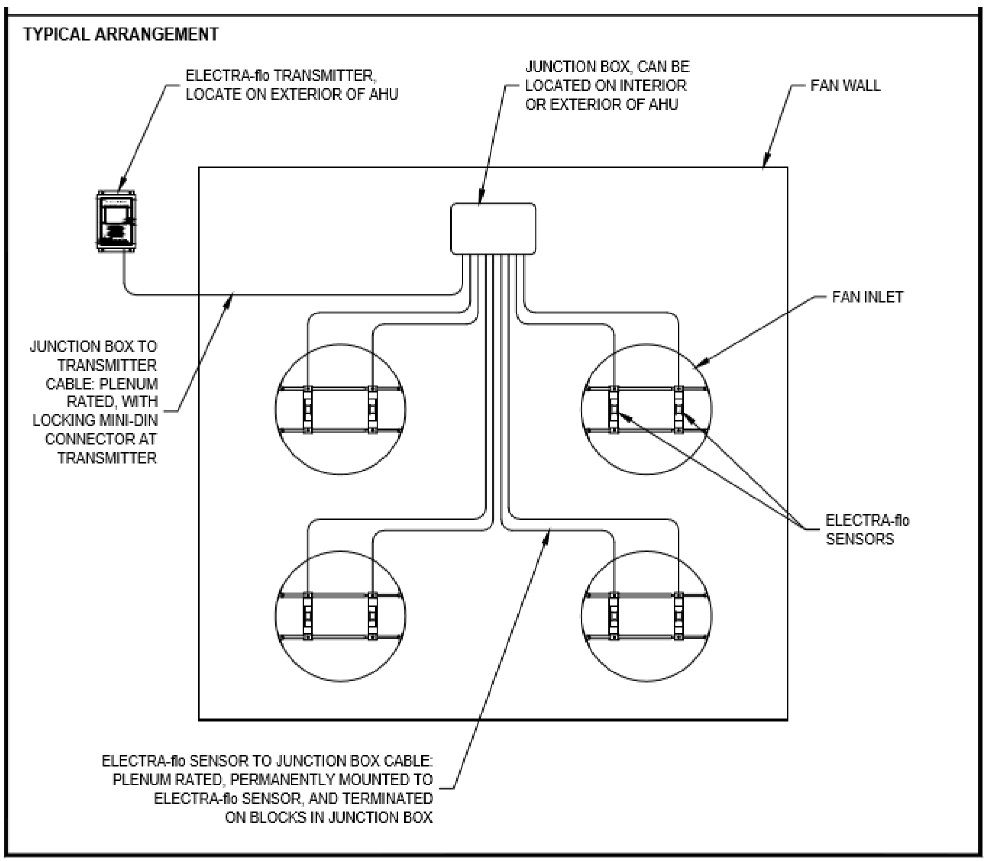
- Cost-effectively and accurately measure multiple fans in lieu of a single large fan
- Provide individual fan performance information in addition to total array airflow
- Measure when all fans are not operating or operational

Fan Array Measurement Non-Solutions

- Assumptive measurement – all fans controlled by common VFD. Measure single fan and multiply by number in array

- Manifold measurement – all fans controlled by common VFD. Connect flow element from each fan to common transmitter

ELECTRA-flo / FI
Fan Array Thermal Measurement System



Outside Airflow Measurement
The Need:

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

Outside Airflow Measurement
The Challenge:

- Extremely **low minimum velocities** (often <400 fpm)
- Little or **no straight run of duct** typically available
- Directional and variable wind loads
- Very wide ambient temperatures range
- Variable humidity with **condensing moisture**
- Presence of unfiltered airborne particulate
- Often measured in close proximity to modulating damper

OUTSIDE AIRFLOW MEASUREMENT – THE SOLUTION!

AMC VOLU-flo / OAM
FIXED RESISTANCE DIFFERENTIAL PRESSURE
How It Works

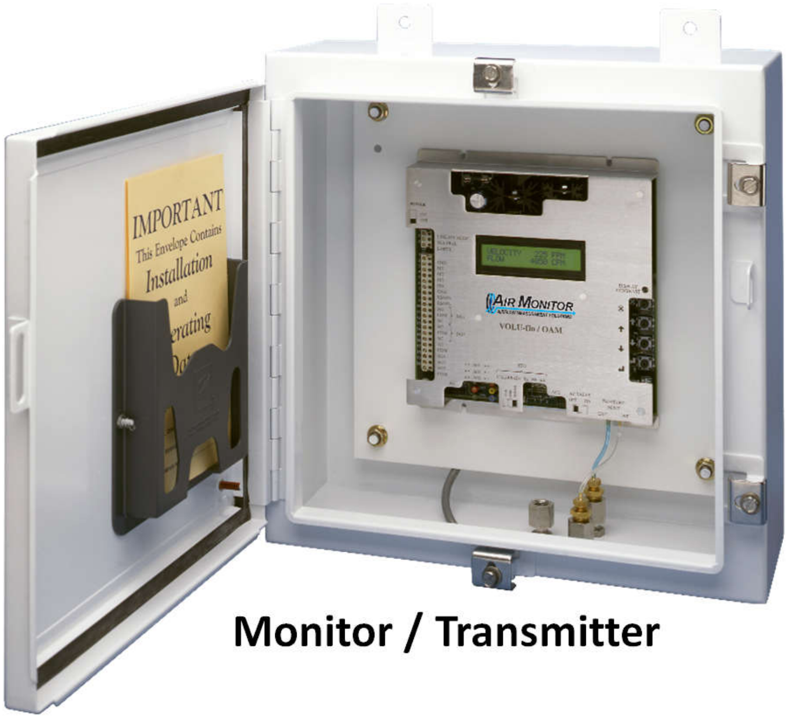
- Each louver or intake screen is a fixed resistance device, with its own unique mathematical relationship between airflow velocity and pressure drop
- The VOLU-flo/OAM measures the pressure drop generated by a fixed resistance device in the OA intake and determines the airflow based on that relationship

VOLU-flo / OAM
OPERATING CHARACTERISTICS

- Unaffected by wind pressure or direction
- Adaptable to any inlet size
- Unaffected by the presence of airborne moisture or dirt
- Provides altitude compensation
- Performs ambient temperature compensation
- Easily retrofitted onto packaged air handlers and built up system installations without sheet metal modifications or damper replacement

VOLU-flo / OAM

Minimum Outdoor Air Monitor

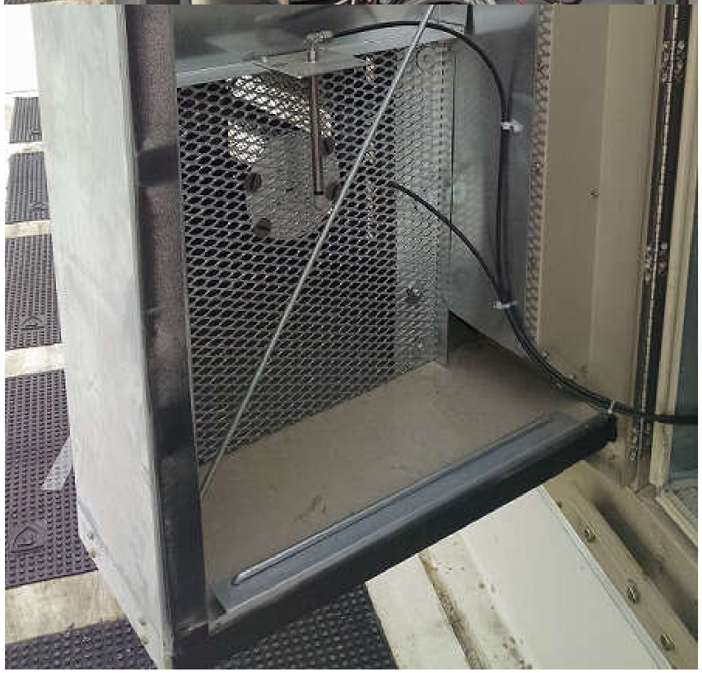


Monitor / Transmitter

***NEW* Uni-Sensor Design**
Combination Inlet Airflow and Outside Reference Sensor

VOLU-flo / OAM PERFORMANCE

- Measurement accuracy ±5%
- Inlet velocities as low as 150 fpm
- 16:1 turndown capability
- Single and multiple inlet configurations
- Flow and temperature outputs
- 316 stainless steel sensors
- Guarantees compliance with ASHRAE Standards 62 and 189.1



VOLU-flo /OAM Station

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

VOLU-flo/OAM Applications Single Louver

- VOLU-flo/OAM Sensors mounted upstream and downstream of single or multiple louvers to measure differential pressure
- Thermal probes may be inappropriate due to environmental exposure and positional effects of mounting

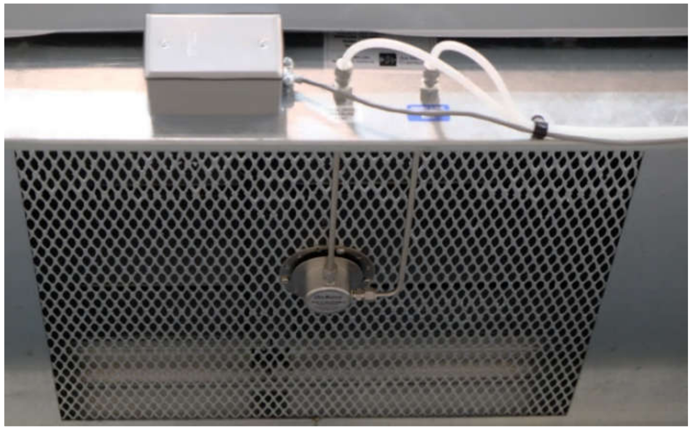
VOLU-flo/OAM Applications Dual / Multiple Louver

- Multiple Volu-flo /OAM 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

VOLU-flo/OAM AFS
Installations

- OAM AFS – Rain hood "slide-in" installation
- Simplified installation
- Using AFS simplifies commissioning (pre-configured at factory)



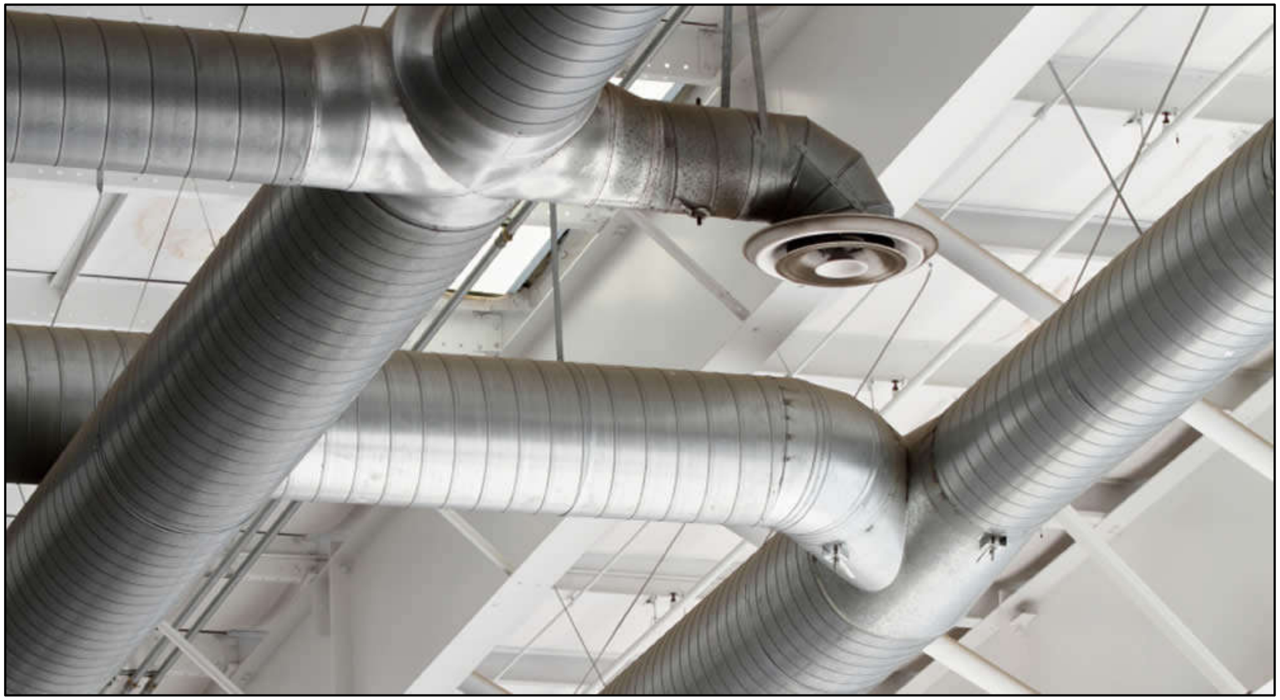
VOLU-flo/OAM
Field Characterization

- All VOLU-flo/OAM systems are factory calibrated and configured for the fixed resistance device (OAM Station, inlet louver, etc.) and application specific flow rate
- Actual installation conditions may required field calibration. The calibration consists of performing a traverse of the inlet and entering the measured velocity value into the microprocessor

DIFFERENTIAL PRESSURE (DP) TECHNOLOGY

Differential Pressure

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

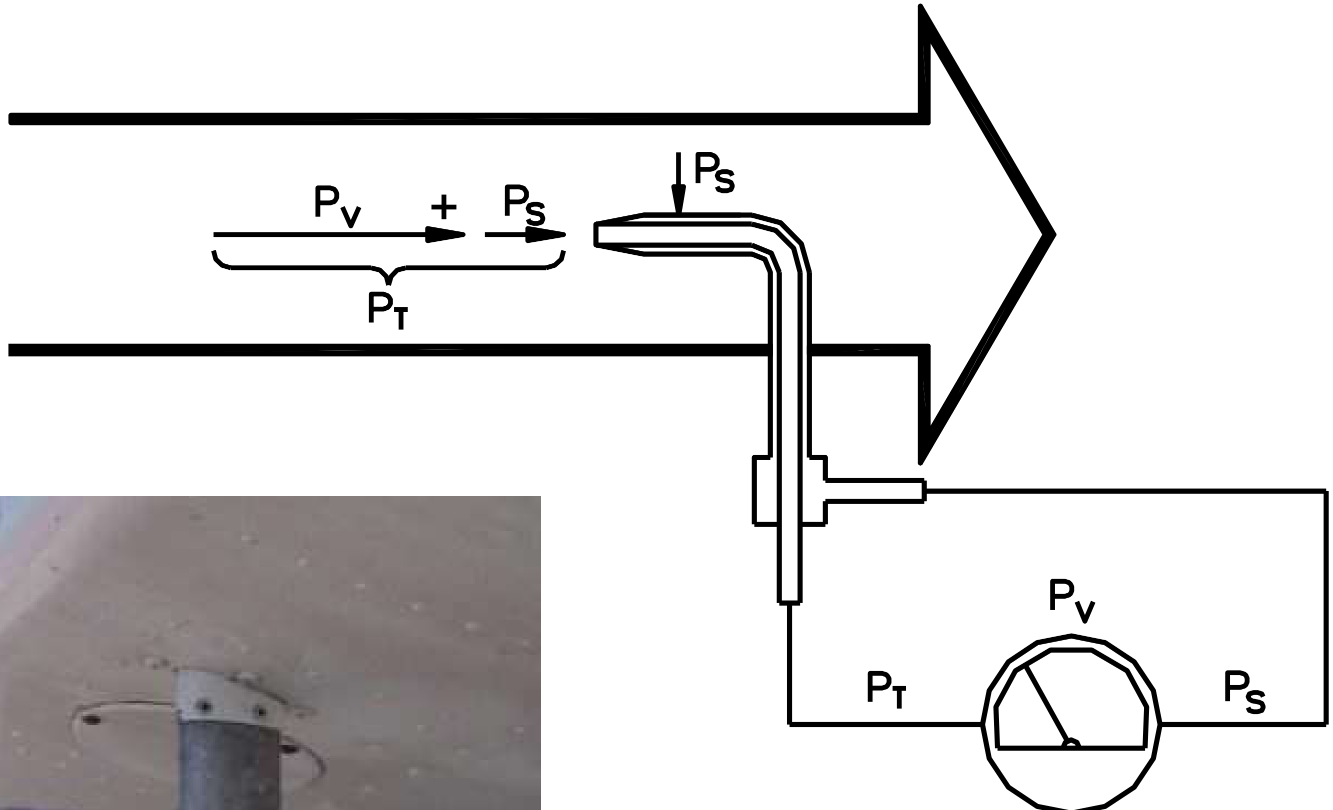


Differential Pressure

Velocity pressure cannot be measured directly.

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

Standard Pitot Tube



Pitot Equation

Velocity pressure is converted to velocity in feet per minute

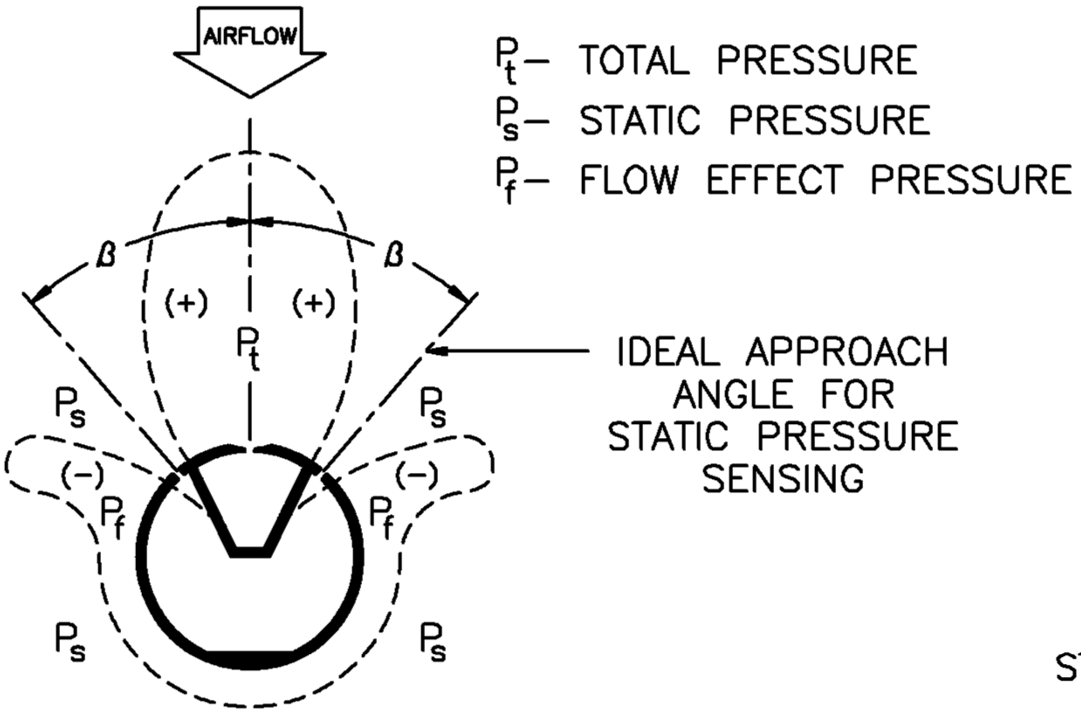
$$Air\ Velocity\ (FPM) = K\ x\ 1096.7\sqrt{\frac{Velocity\ Pressure}{Density\ of\ \ Air}}$$

HVAC systems work with standard conditions (68° F and 29.92” Hg) which yields an air density value of 0.075 lbs/ft^3

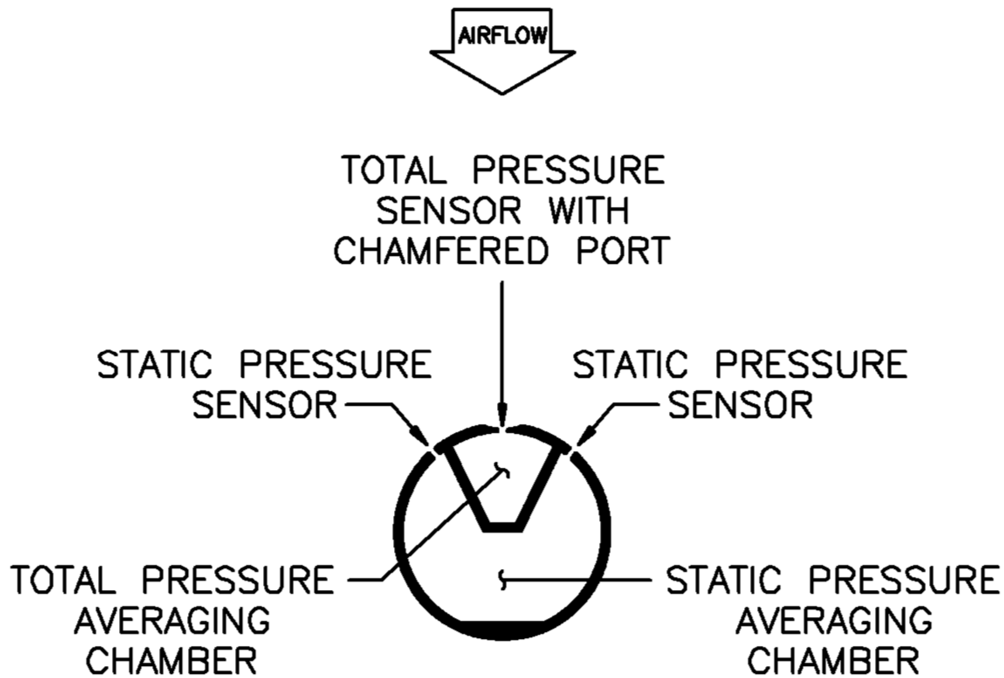
Air Monitor’s Pitot-Fechheimer method has a K-factor = 1.0

$$Air\ Velocity\ \ (FPM\ ) = 4005\sqrt{Velocity\ \ Pressure}\ \ (IN\ \ w.c.)$$

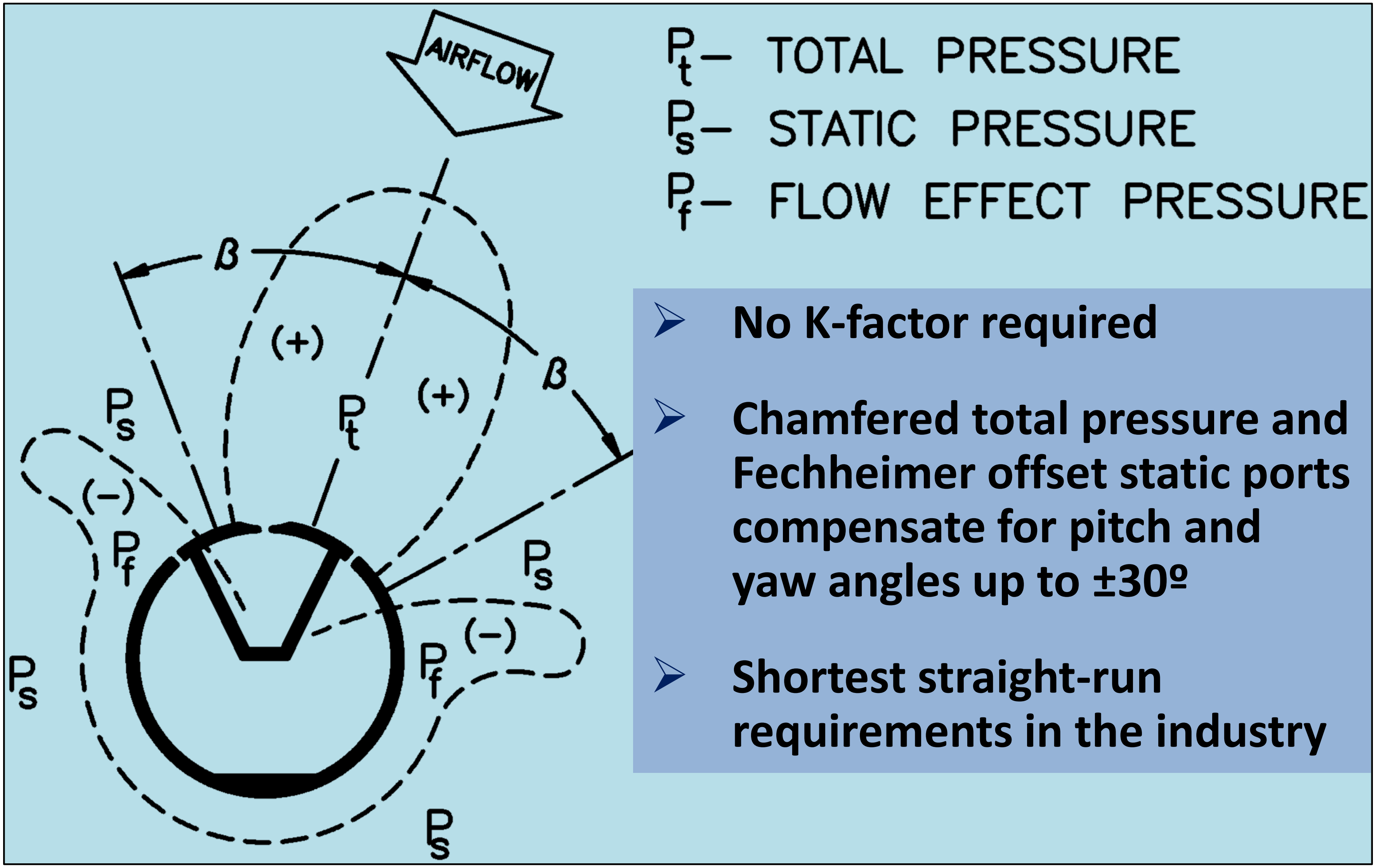
Pitot-Fechheimer Method



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



Pitot-Fechheimer Method



- **No K-factor required**
- **Chamfered total pressure and Fechheimer offset static ports compensate for pitch and yaw angles up to ±30º**
- **Shortest straight-run requirements in the industry**

Pitot Strengths

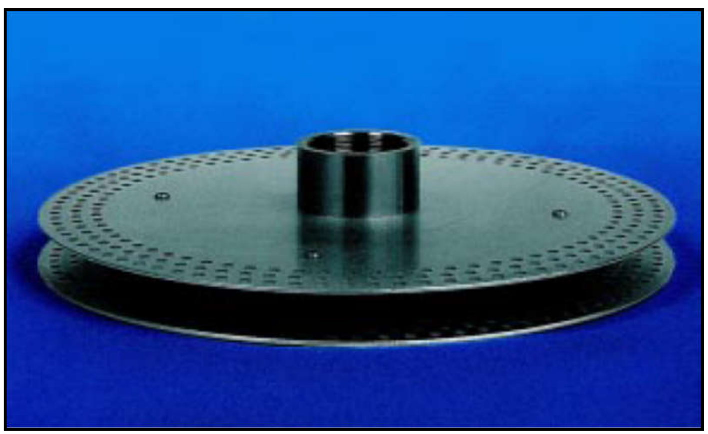
- Extremely low cost per sensing point – provides good performance in ducts with limited straight run
- Sensor density meets or exceeds AMCA, ASHRAE, and CFR recommendations for the number of sensing points
- Broadest functional velocity range of any technology – 400 fpm to 18,000 fpm
- Measurement accuracy not adversely impacted by variable humidity or condensing moisture

DIFFERENTIAL PRESSURE PITOT – DUCTED AIRFLOW MEASUREMENT SOLUTIONS

STATIC PRESSURE SENSING – FOR BUILDING PRESSURIZATION

S.A.P.

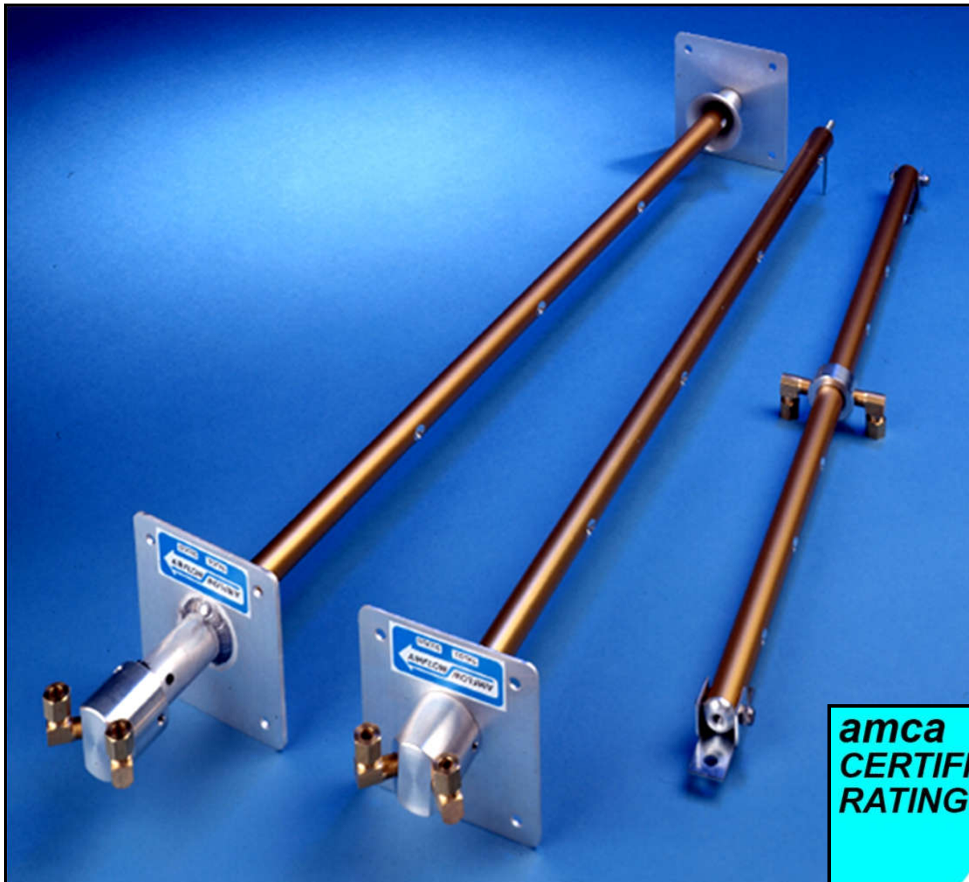
Indoor static pressure sensors
Four mounting styles
Aluminum or Stainless
Most commonly used in isolation/room-pressurization applications



S.O.A.P

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

VOLU-probes



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RATINGS
AIRFLOW
MEASUREMENT
STATION
AIR
PERFORMANCE
AIR
MOVEMENT
AND CONTROL
ASSOCIATION
INTERNATIONAL, INC.®

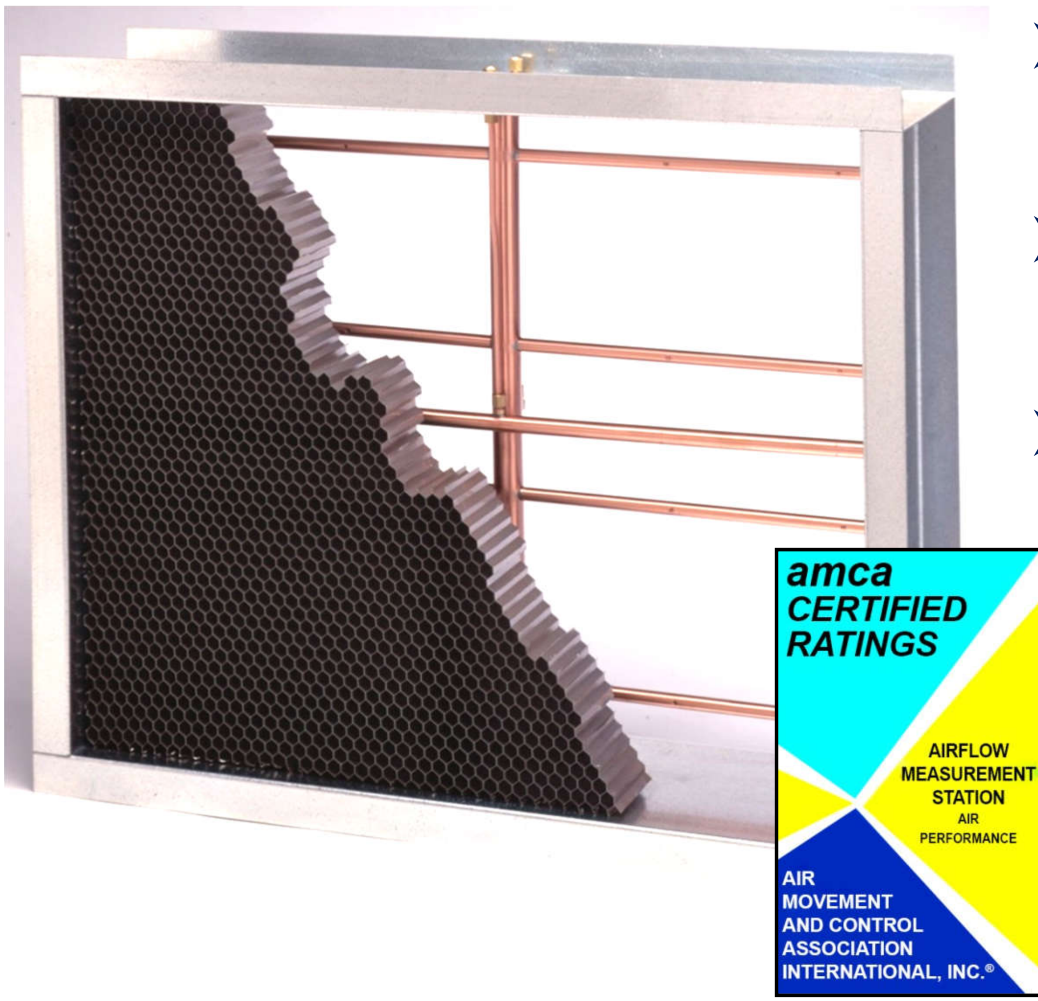
- Anodized extruded aluminum dual-manifolded probes
- Fechheimer offset static pressure sensing ports
- Chamfered total pressure sensing ports
- Multiple mounting options

VOLU-probe/VS Stations

amca
CERTIFIED
RATINGS
AIRFLOW MEASUREMENT STATION
AIR PERFORMANCE
AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.®

- Welded 14 ga. galvanized sheet metal casing
- Anodized extruded aluminum dual-manifold probes
- Fechheimer offset static pressure sensing ports
- Chamfered total pressure sensing ports

FAN-Evaluator

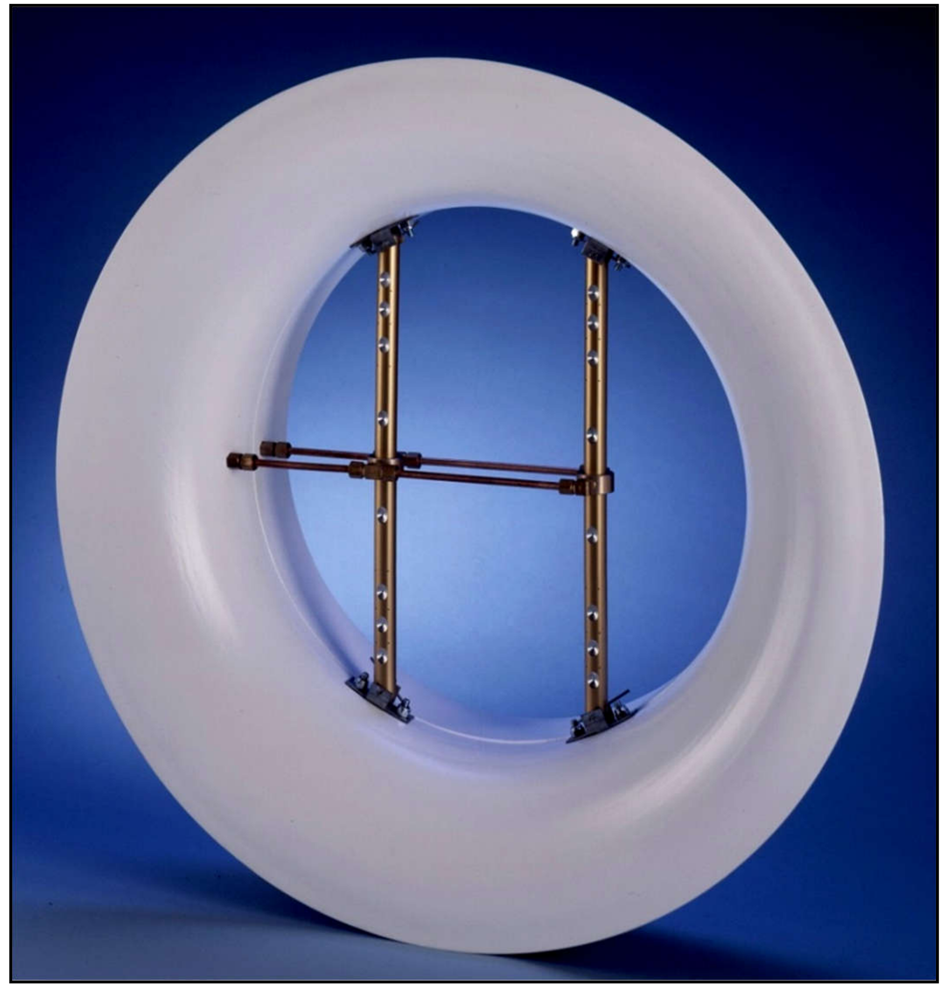


- Welded 15 ga. Galvanized sheet metal casing
- Copper total and static manifolds
- Fechheimer offset static ports

DIFFERENTIAL PRESSURE PITOT-FAN INLET AIRFLOW MEASUREMENT SOLUTIONS

VOLU-probe / FI
Fan Inlet Airflow Traverse Probe

- 2-3% accuracy without field calibration
- No turndown limitation
- Small fan inlets may experience minor capacity reduction



Transmitter Selection & Accuracy

VELTRON Transmitter Family
Differential Pressure/Flow

VELTRON DPT2500

VELTRON DPT2500-plus

VELTRON II

VEL-trol II

Transmitter Selection

The accuracy of any differential pressure measurement system is dependent on both the sensing element **and** the Transducer / Transmitter.

Specifying the entire metering package, sensor and transmitter, as a matched pair, will ensure the system measurement accuracy required is achieved.

Transmitter Terms and Definitions

Reference Accuracy: Transmitter accuracy at natural span

Natural Span : Maximum range (IN w.c.) of the transducer head of the transmitter

Operating Point : Actual differential pressure in IN w.c. at the airflow velocity being measured

Turndown : Natural Span/Operating Point

Accuracy at Operating Point : Actual accuracy of the transmitter at the airflow velocity being measured

Reference Accuracy x Turndown = Accuracy at Operating Point

Transmitter Selection Example

Application Parameters:

Supply Air Duct System

Design Operating Flow (Max) = 20,000 CFM

Station Size = 24” x 48” = 8 Sq. Ft.

Minimum Operating Flow (Min) = 4,000 CFM

Transmitter Selection

Application Parameters:

Station Size = 24" x 48" = 8 Sq. Ft.

Maximum Operating Flow (Max) = 20,000 CFM
Maximum Operating Velocity (Max) = 2,500 FPM
Maximum Operating Velocity Pressure = 0.39 in. w.c.

Minimum Operating Flow = 4,000 CFM
Minimum Operating Velocity = 500 FPM
Minimum Operating Velocity Pressure = .015 in. w.c.

$$Air\ Velocity\ (FPM) = 4005\sqrt{Velocity\ Pressure}\ (IN\ w.c.)$$

Transmitter Selection

Range:

Natural Span

0 to 25.00 in w.c.
0 to 10.00 in w.c.
0 to 5.00 in w.c.
0 to 2.00 in w.c.
0 to 1.00 in w.c.
0 to 0.50 in w.c.
0 to 0.25 in w.c.
0 to 0.10 in w.c.

Accuracy:

0.25% of natural span, including non-linearity, hysteresis, and non-repeatability.

DP Transmitter Accuracy Comparison

Flow Rate CFM:	Velocity FPM:	Vel Press In H2O:	Transmitter #1 Natural Span:	Transmitter #1 Accuracy:	Transmitter #1 Accuracy at Flow Rate:	Transmitter #2 Natural Span:	Transmitter #2 Accuracy:	Transmitter #2 Accuracy at Flow Rate:
22,648	2,831	0.500	0.5	0.25%	0.25%	1.0	1.00%	2.00%
20,000	2,500	0.390	0.5	0.25%	0.32%	1.0	1.00%	2.56%
17,500	2,188	0.298	0.5	0.25%	0.42%	1.0	1.00%	3.36%
15,000	1,875	0.219	0.5	0.25%	0.57%	1.0	1.00%	4.57%
12,500	1,563	0.152	0.5	0.25%	0.82%	1.0	1.00%	6.58%
10,000	1,250	0.097	0.5	0.25%	1.28%	1.0	1.00%	10.30%
7,500	938	0.055	0.5	0.25%	2.28%	1.0	1.00%	18.18%
5,000	625	0.024	0.5	0.25%	5.13%	1.0	1.00%	41.67%
4,000	500	0.016	0.5	0.25%	8.02%	1.0	1.00%	62.50%

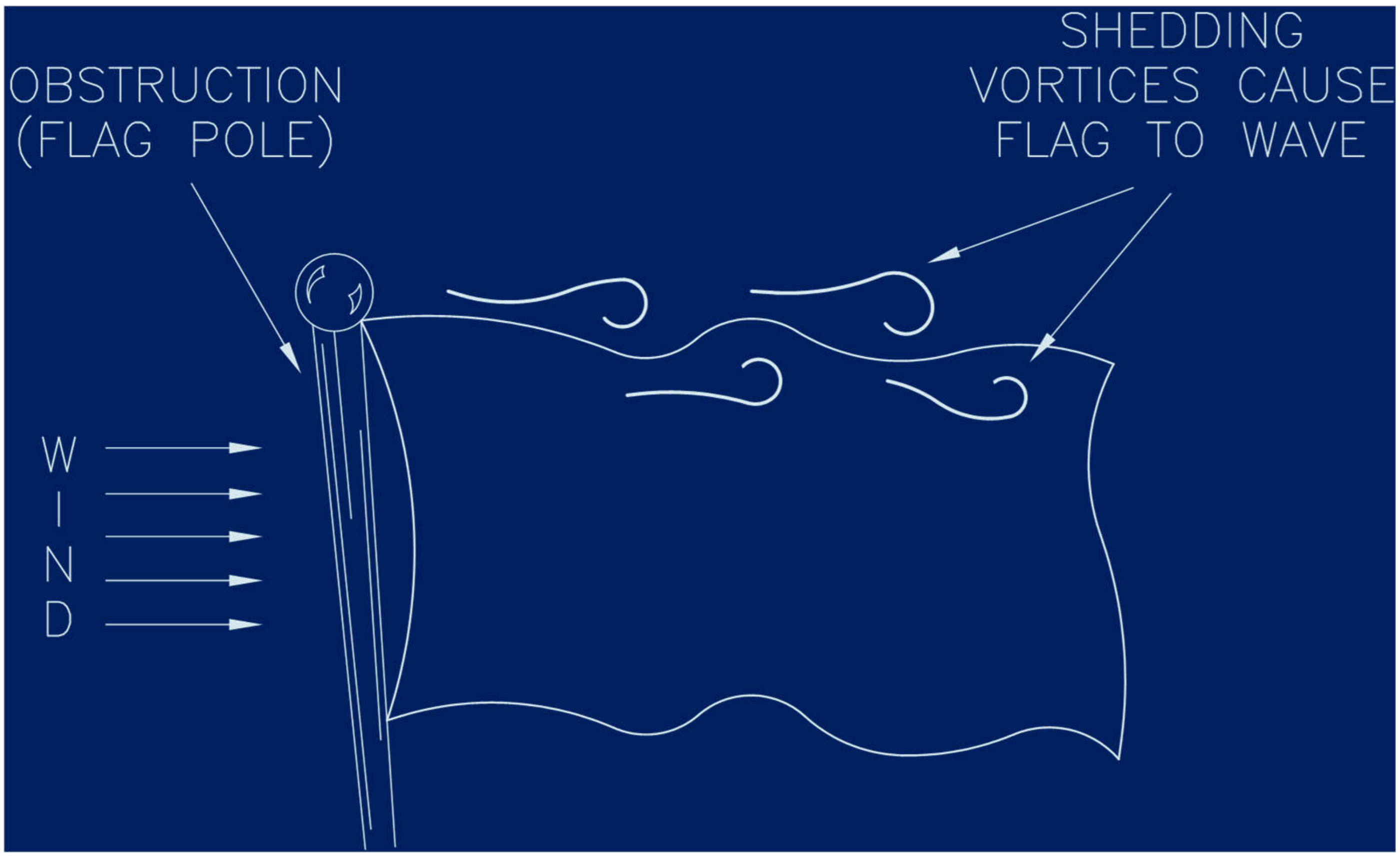
Span: 0.5” wc +/- 0.25% = +/- 0.00125” wc
Span: 1.0” wc +/- 1.0% = +/- 0.01” wc

Other Technologies

VORTEX SHEDDING

Vortex Shedding

Based on the phenomenon that swirling eddy currents, or vortices, are generated whenever fluids flow around an obstruction

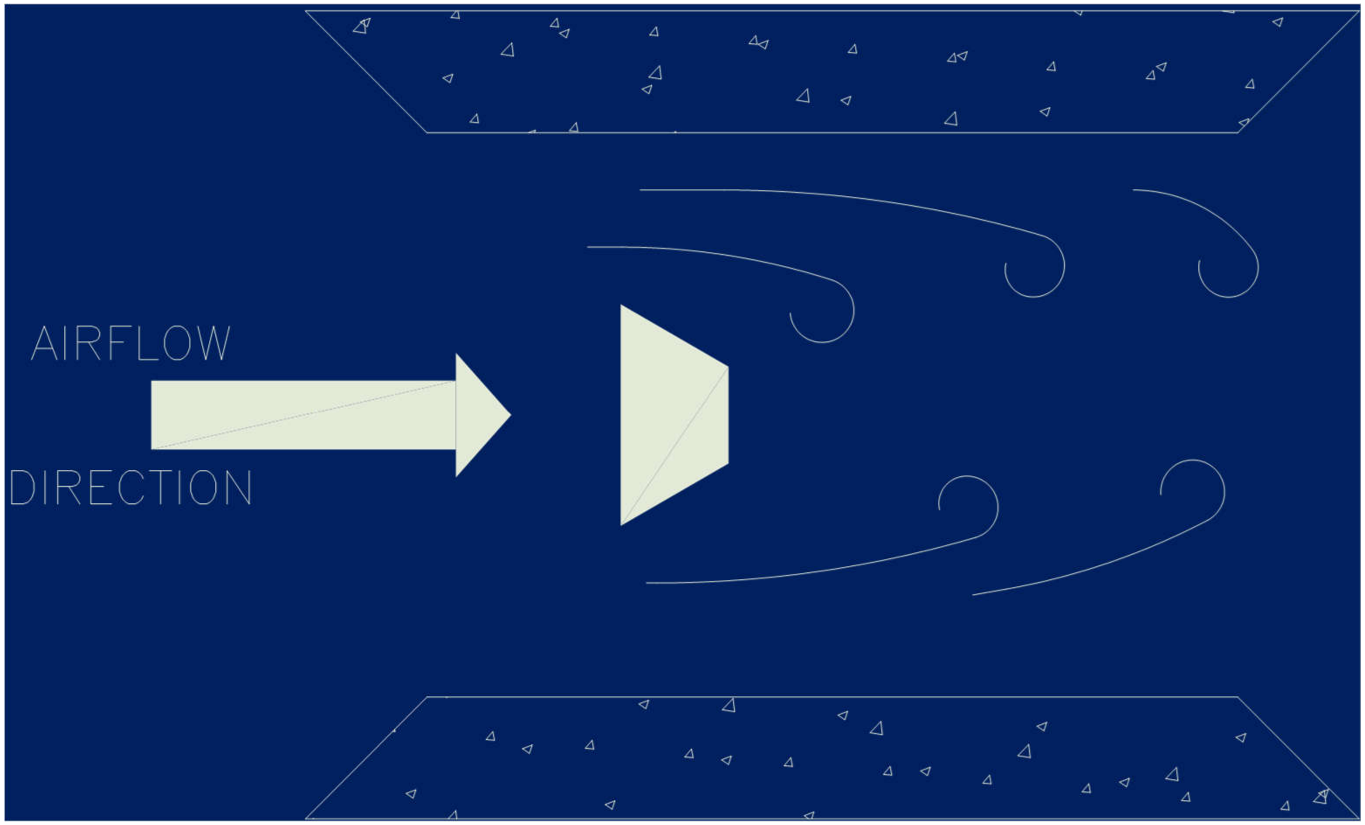


Vortex Shedding

An obstruction is intentionally placed in the path of the airflow

Frequency of vortex pulsation is measured

Pulsation frequency varies in a linear relationship with the velocity of the air



Vortex Shedding Strengths

- Relatively good turndown; i.e., 10:1
- Generally not affected by moisture or particulate in the airstream

Vortex Shedding Weakness

- Minimum velocity 400-500 fpm – Not Suitable for OA Applications
- Each sensor is a point of cost, limiting total number of sensors to remain cost competitive
- Needs significant straight run > 5 diameters for accurate measurement

FLOW MEASUREMENT TECHNOLOGY VS. APPLICATION

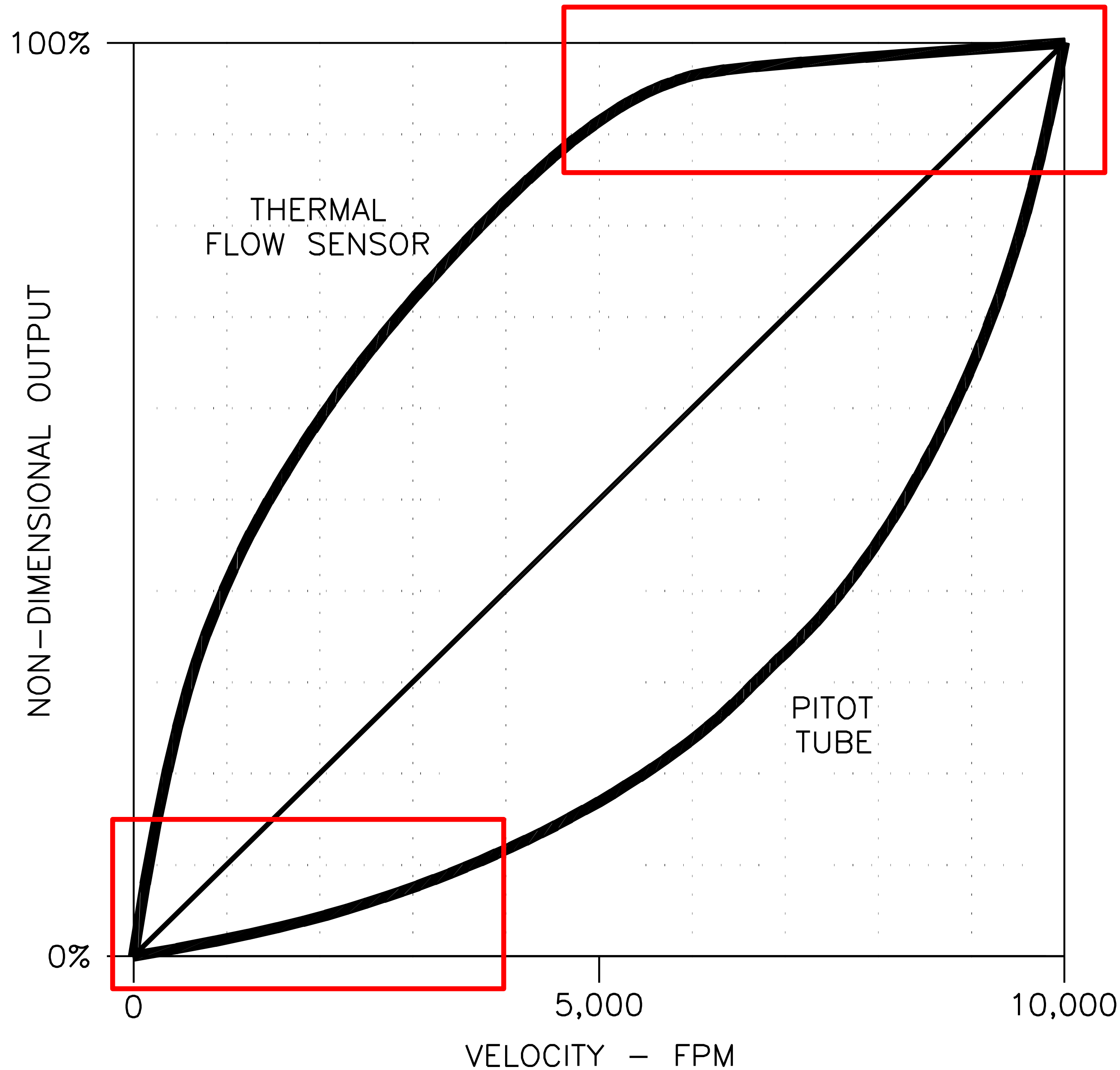
Thermal Dispersion vs. Pitot

	THERMAL DISPERSION	PITOT
METHODOLOGY	Inferentially determines airflow velocity by measuring power consumed to offset heat dispersed into the airflow	Directly measures the components (TP and SP) of airflow velocity
FLOW EQUATION	Proprietary algorithm to calculate airflow velocity from measured power consumption	Standard mathematical equation to convert measured velocity pressure into airflow velocity
VELOCITY MEASUREMENT	Infers velocity from power consumption	Directly measures airflow velocity
TURNDOWN	Wide turndown range	5:1 or 10:1 (transmitter dependent)
VELOCITY RANGE	150 – 5000 fpm	400 – 20,000 fpm

Thermal Dispersion vs. Pitot

	THERMAL DISPERSION	PITOT
MOISTURE	Interprets changes in moisture as changes in airflow velocity. Condensing moisture can temporarily render non-functional.	Unaffected by moisture
PARTICULATE	Measurement accuracy adversely impacted by airborne particulate collecting on sensor & resulting change of heat transfer characteristic.	Generally unaffected by low levels of airborne particulate
SENSOR DENSITY	Each sensor is a point of cost. Sensor density limited to maintain competitive price	Sensors are holes – minimal cost Significantly higher density than thermal
MINIMUM INSTALLATION REQUIRMENTS	Must be met to achieve published accuracy	Must be met to achieve published accuracy
OBJECTIVE	Accurate airflow measurement, not point measurement accuracy	

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

Outside Air Measurement
Application Suitability Summary

MEETS APPLICATION CHALLENGE	PITOT	THERMAL	VOLU-FLO/ OAM
Extremely low velocities (150 fpm)	NO	YES	YES
Directional wind loads	MAYBE	MAYBE	YES
Large fluctuations in ambient temperature	MAYBE	YES	YES
Variable humidity; 30-100% condensing	YES	NO	YES
Presence of airborne particulate	NO	NO	YES
No straight duct run available	NO	NO	YES

Joseph Moore
jmoore@aebtech.com
513-305-0700