Changing AirFlows Ahead

Advancements in Airflow Measurement Capabilities in ANSI/RESNET/ICC 380-2022

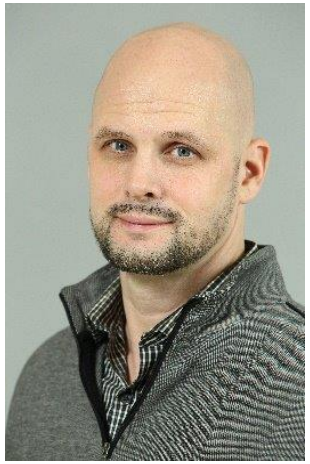
Jeremy Begley – HVAC 2 Home Performance

Leo Jansen – Energy Efficient Homes Midwest, Inc.

HVAC 2 Home Performance

From Delivering Comfort 2 Controlling it

Who We Are



Jeremy Begley

Founding Shareholder

Day to Day Operations/Sales

15 Years of HVAC and High-Performance Homes Experience

What We Do

HVAC and Full MEP Design Services

Residential , Commercial, Mixed Use/Multifamily

Test and Balance and Functional Testing

Residential , Light Commercial

Green Building Verification

Residential , Commercial, Mixed Use/Multifamily

Training

HVAC, Green Building, Home Performance

Leo Jansen

Owner / Primary Quality Assurance Designee

3rd Party Rating Provider Managing Over 13,000 Ratings Annually

RESNET Board Member Provider Representative

Voting member of SDC 900 and SDC 1600

Chair of the RESNET QA Checklist Staff Advisory Committee

Air Flow Basics - Pressure

Pressure

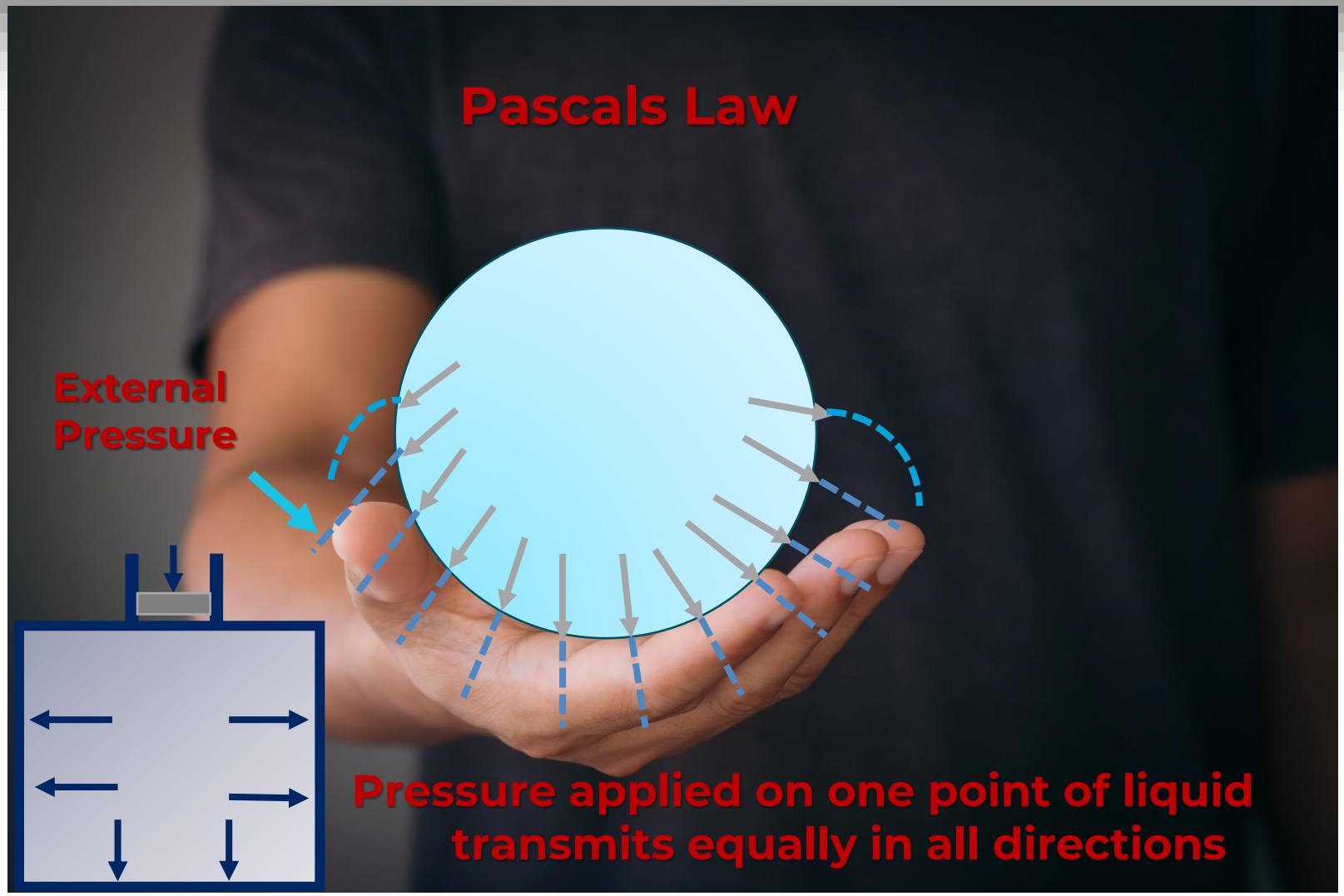
The amount of force applied per
Unit area on an object's surface

$$\text{Pressure} = \frac{\text{Force (N)}}{\text{Area } (M^2)} \quad \text{Or} \quad P = F/A$$

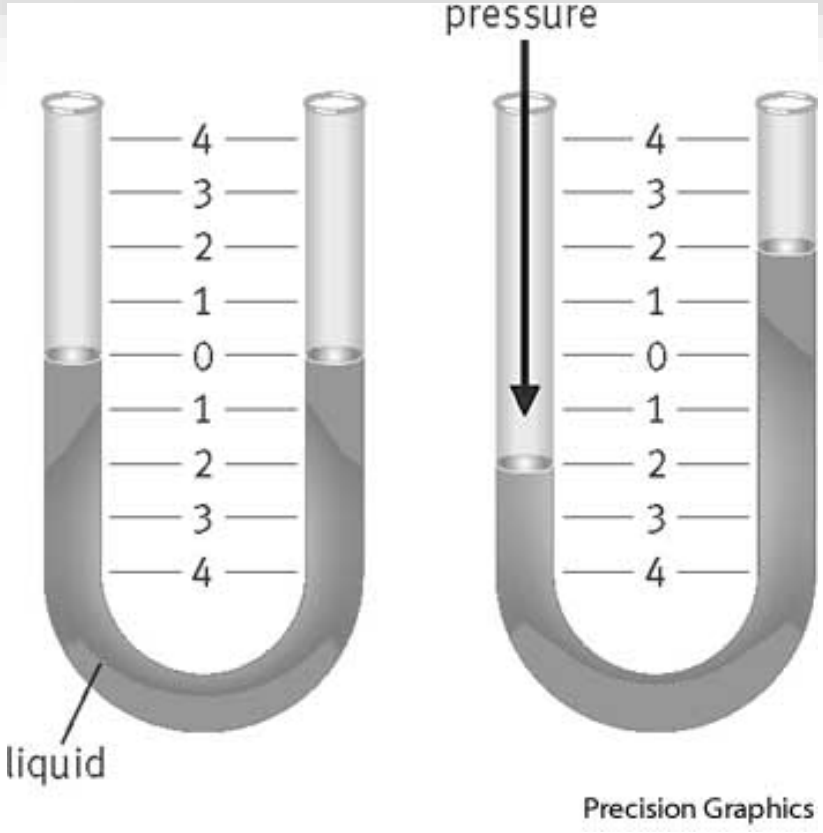
The unit for pressure is the Pascal (PA)

$$1Pa = 1\ N/m^2$$

Air Flow Basics - Pressure



Air Flow Basics – Inch Of Water Column (InWc)



Low pressures are often measured in **inches of water column or "InWc**.

in a water manometer 1" of water column is literally the **amount of force it takes to raise the column of water by 1**".

While some water manometers (water tube) are still in use the vast majority are either dial or digital gauges that use the same scale

Air Flow Basics - Pressure

- Measured in inches of water content (w.c.)
- 1 pound per square inch of gauge pressure (psig) is equal to 27.72” w.c.
- Types of pressure
  - **Velocity pressure** – moving through a seam of air; also known as dynamic pressure
  - **Static pressure** – pressure that does not move or lacks movement; referred to as bursting pressure
  - **Total pressure** – combination of velocity and static pressures

Air Flow Basics – Pressure

Static Pressure

Static Pressure is the difference between the inside and outside atmospheric pressure

Units; expressed in inches of water column (InWc) or pascals (PA)
1” InWc = 250 PA

EXAMPLE : When exhaust fan runs, it creates negative pressure in the house. Inside and outside pressure difference (static pressure) rises and allows outside air to move into the home

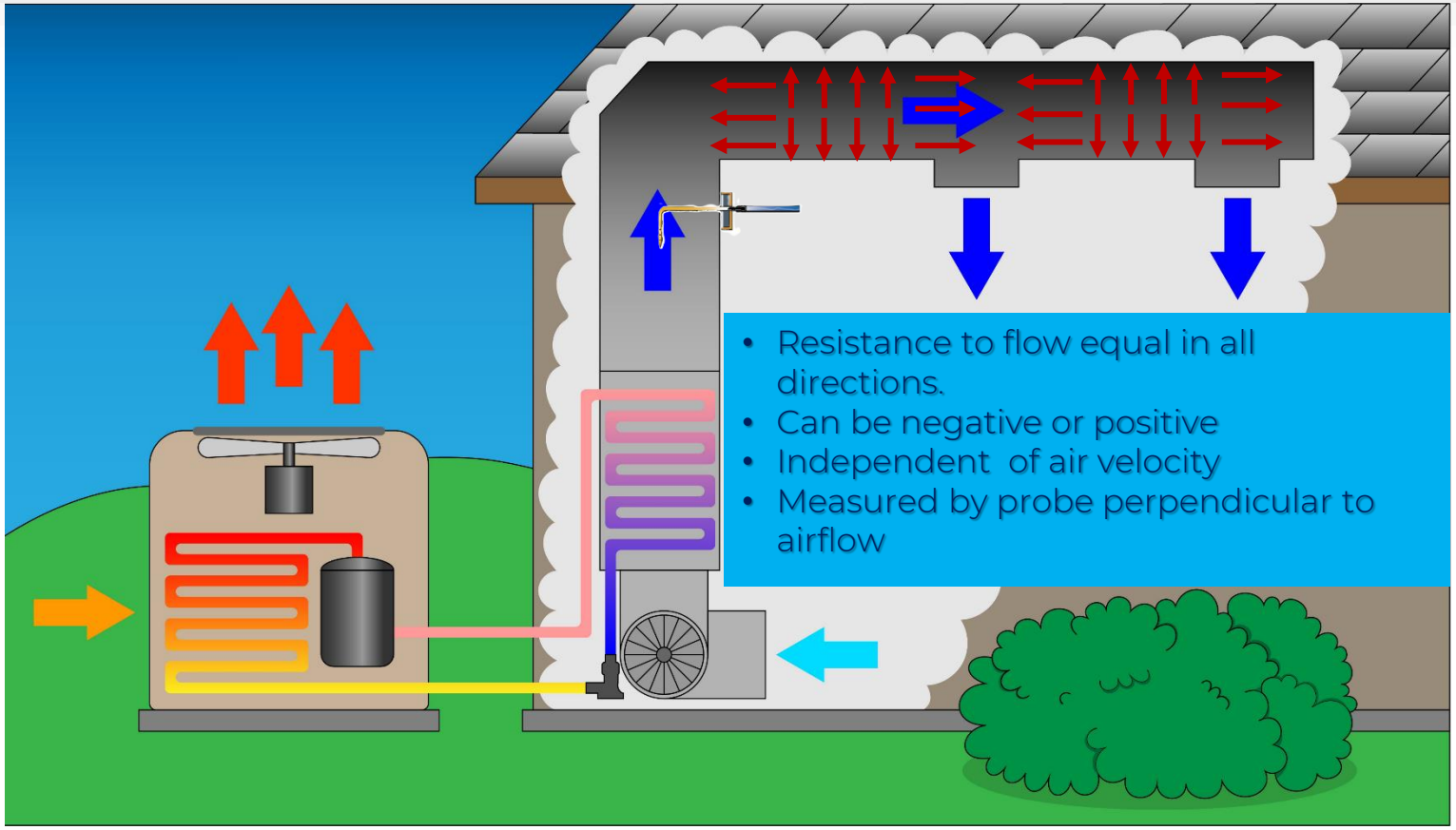
Air Flow Basics – Pressure

Static Pressure

Static Pressure Probe

Air Flow Basics – Pressure

Static Pressure



Air Flow Basics – Pressure

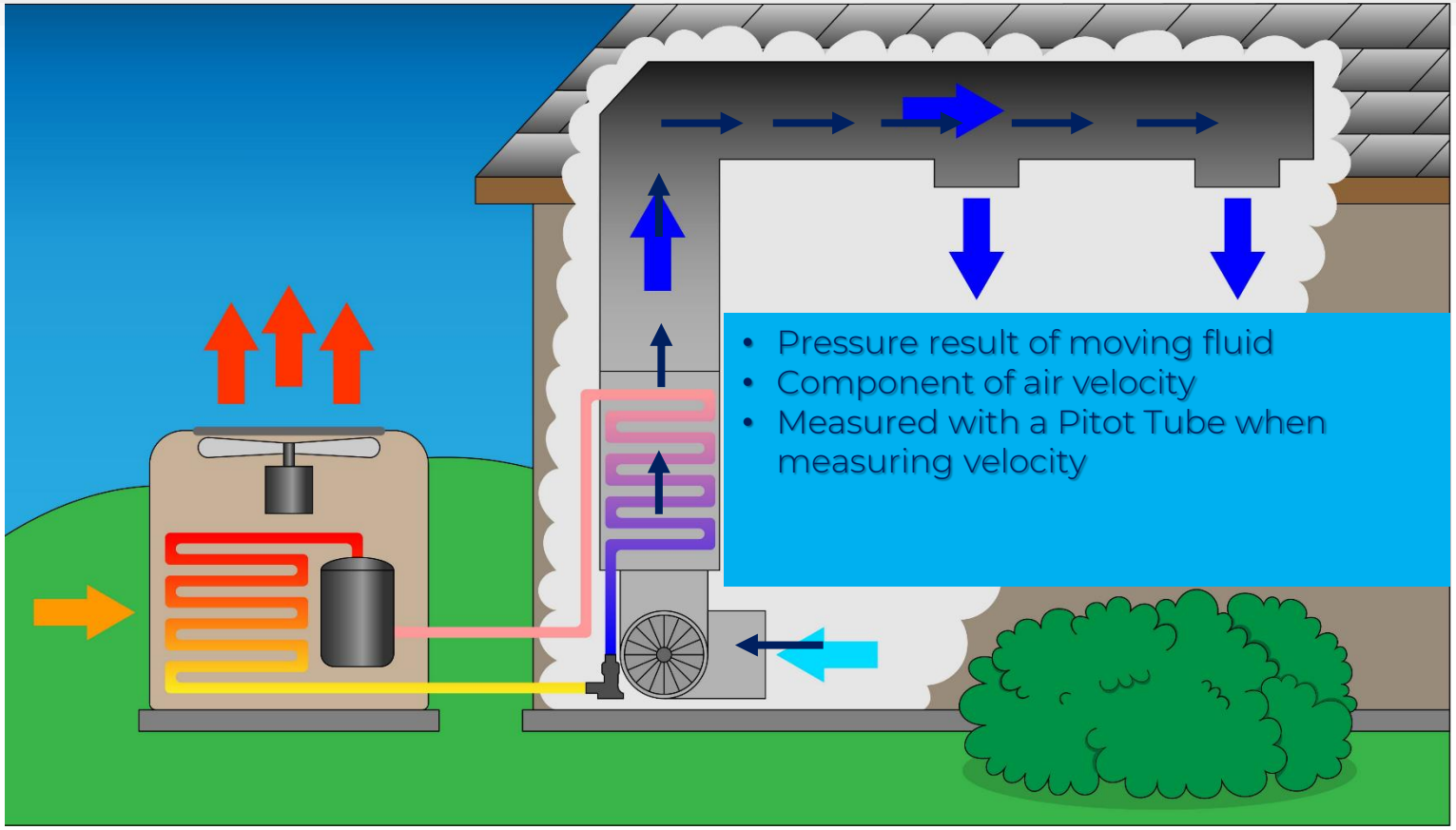
Dynamic or “Velocity” Pressure

Dynamic Pressure, also known as velocity pressure, is the pressure caused by the velocity of the fluid.

Dynamic pressure is a pressure exerted perpendicular to the direction of the flow and is represented by the symbol q.

Air Flow Basics – Pressure

Dynamic Pressure



Air Flow Basics – Pressure

Total Pressure AKA Stagnation Pressure

Static Pressure + Dynamic Pressure = Total Pressure

It is called "total" pressure because it considers both the pressure at rest and the pressure due to fluid motion.

Air Flow Basics – Velocity

- Velocity is a measure of the speed and direction of the motion of an object
- Dynamic pressure of a fluid is proportional to the square of its velocity.
- By measuring the dynamic pressure of a fluid, we can deduce the velocity of the fluid.

Air Flow Basics – Velocity

Bernoulli's Equation

The Bernoulli equation states that,

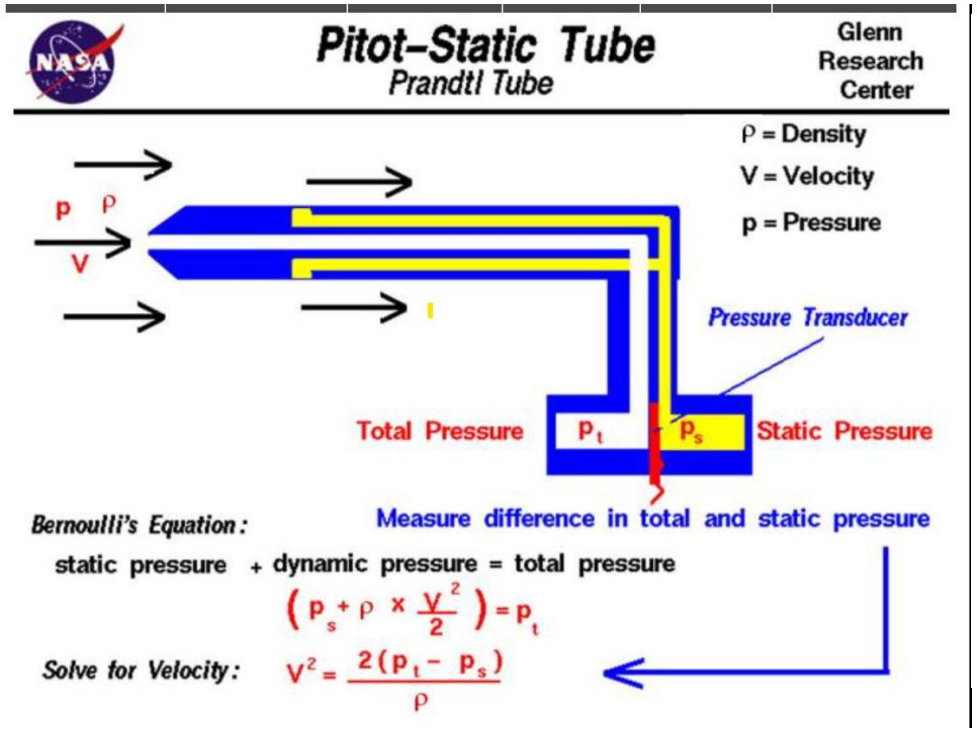
where

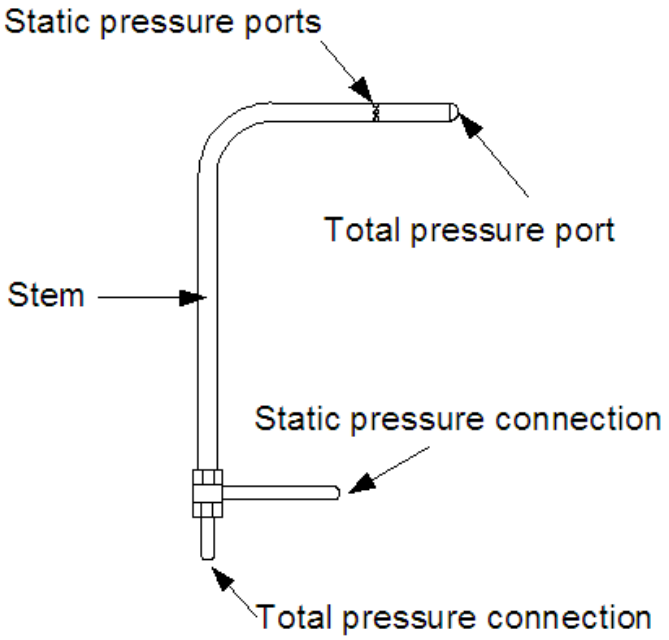
points 1 and 2 lie on a streamline,
the fluid has constant density,
the flow is steady, and
there is no friction.

One of the most immediate applications of Bernoulli's equation is in the measurement of velocity with a Pitot-tube. The Pitot tube (named after the French scientist Pitot) is one of the simplest and most useful instruments ever devised.

Air Flow Basics – Velocity

Pitot Tube





- Need to mention minimum straight line duct length

Air Flow Basics – Velocity

Pitot Tube

Straight Pitot
AKA “Air Foil”

Traditional Pitot

Air Flow Station
Pitot

Air Flow Basics – Velocity

Hot-wire Anemometer

A simple hot wire anemometer consists of a small piece of wire which is heated by an electric current and positioned in the air or gas stream whose velocity is to be measured. The stream passing the wire tends to cool it, the rate of cooling being dependent on the flow velocity.

Air Flow Basics – Velocity

Vane Anemometer

Vane Anemometers work on the principle that a freely spinning turbine will rotate at a speed that is directly proportional to the wind speed. With a quick calibration, a device can then display a wind speed measurement.

The faster the blades turn around – ie. the stronger the air velocity – the higher the electrical current that is produced. So if you can measure the current you have a basic means of measuring air velocity or wind speed.

Air Flow Basics – Velocity

Capture Vane Anemometer

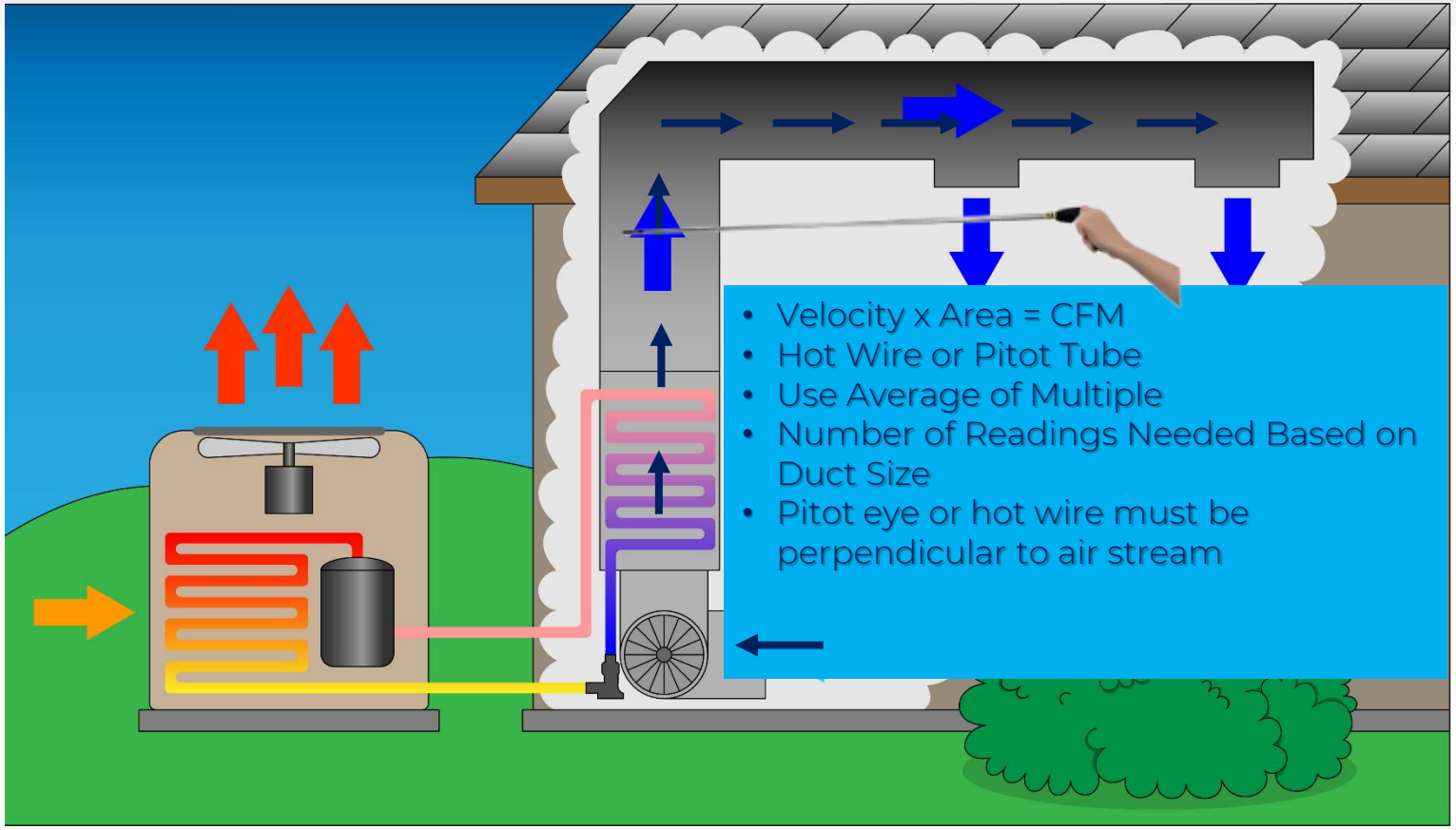
Capture Vane Anemometers use a known area eliminating the need for a traverse Avg reading

Air Flow Basics – Velocity – CFM

- Measured in feet per minute (fpm)
  - V = cfm/A
  - Cfm = A (*) V
- Duct area (A) **must** be measured in square feet
  - Most cases, duct dimensions are in inches
  - Divide the width and height by 144
- Example
  - If a 24” x 8” duct has a velocity of 900 fpm…
  - The cfm = A (*) V or [(24 (*) 8)/144] (*) 900 or 1200 cfm

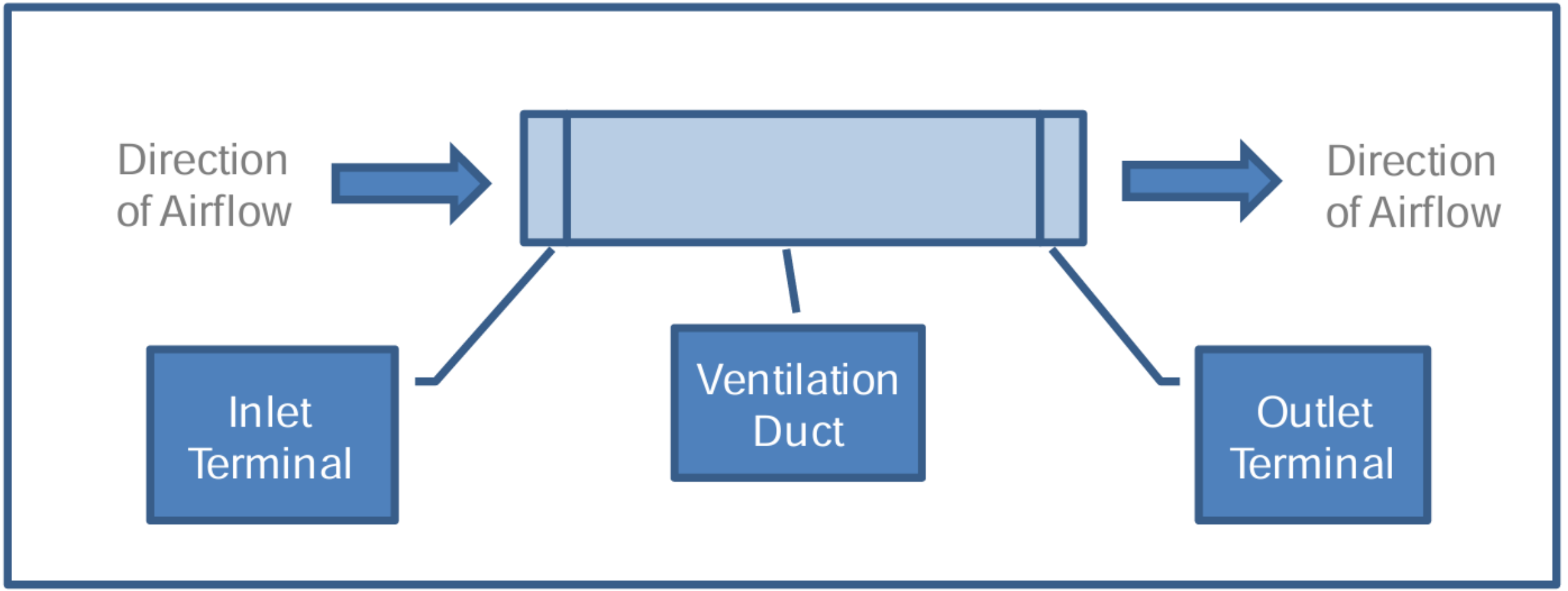
Air Flow Basics – CFM

Measuring CFM in The Duct Airstream



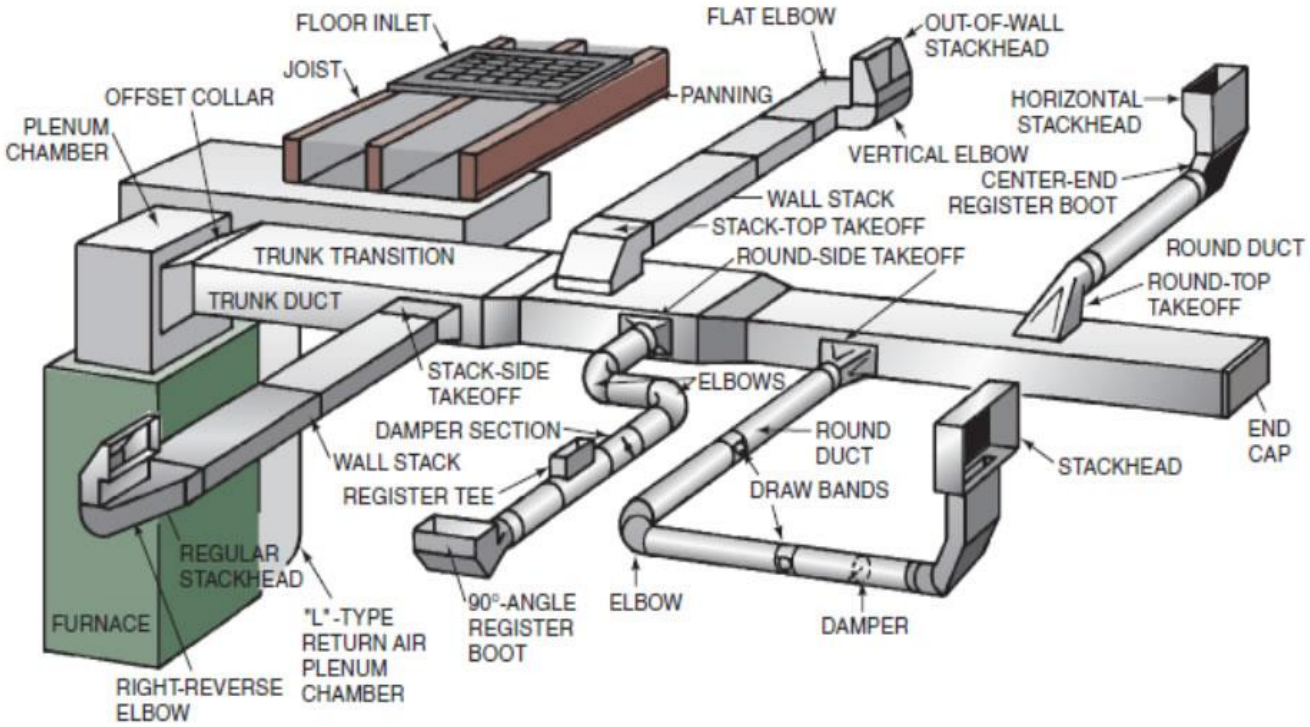
Basic Ventilation System Design

Figure 1: Location of Terminals in Generic Mechanical Ventilation System.



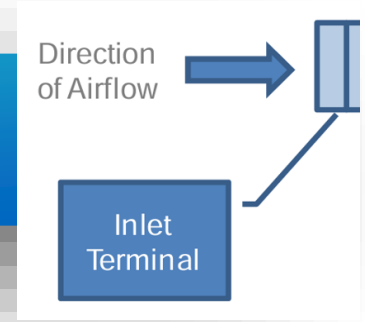
Where to test airflow?

- Dependent on a number of factors:
  - Duct construction type
  - Cost of equipment
  - Comfort level with equipment
  - Compliance vs figuring it out
  - Repeatability
- Goal of this session to demonstrate as many of the allowed processes as possible to build your confidence in the Field.



Photos secured from the below websites:
https://www.quinju.com/blog/wp-content/uploads/2016/12/duct-work-map-1.jpg

Allowed Equipment at Inlet Terminal



Powered Flow Hood

380-2019 & 380-2022

Device: Maximum error of 5 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Airflow Resistance Device

380-2019 & 380-2022

Device: Known opening area and air tight perimeter seal

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Passive Flow Hood

380-2019 & 380-2022

Device: Maximum error of 5 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Vane anemometer with hood

380-2022 Only

Device: Maximum error of 5 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Photos secured from the below websites:
https://stage.retrotec.com/flow-finder-mk2.html
https://retrotec.com/flow-box.html?srsltid=AfmBOoqZI9Xez4yGF-i80Ly0g1iAK3S4dhJuozk2-ilsVB3EsMCkud6R
https://www.energyconservatory.com/wp-content/uploads/2019/01/exfanmeter-1.jpg
https://tsi.com/products/ventilation-test-instruments/alnor/alnor-abt-balometer-capture-hoods/alnor-abt-balometer-capture-hood-abt711
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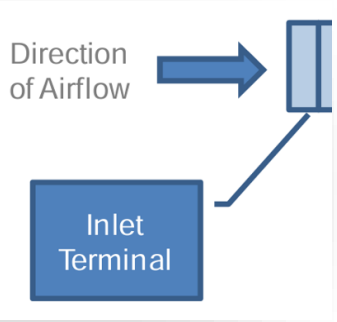
Airflow Resistance Device Tips



Each manufacturer's device / ring setup is rated for a minimum and maximum amount of airflow

- If you are measuring a 500 CFM Kitchen Range Hood for compliance with ENERGY STAR (i.e. over 100 CFM) this tool can work, but not ideal for accuracy

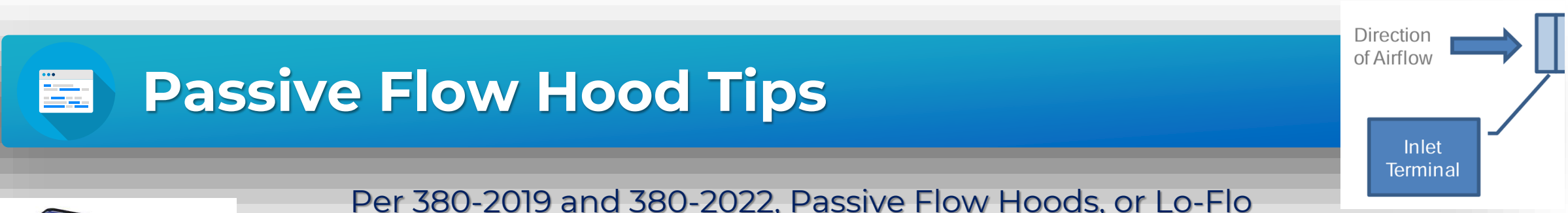
For TEC's device, both PR/FL and PR/PR methods can be used. For PR/PR readings, simply compare the Pa reading to the table on the side of the device

This tool **cannot** be used to measure supply flow / positive pressure. Using an older manometer like a DG-700 with this tool will give you **a reading**, but it will not be **a correct reading**.

- Newer manometers from both manufacturers will throw warnings if you attempt to use the device in this manner

Photos secured from the below websites:
https://retrotec.com/flow-box.html?srsltid=AfmBOoqZI9Xez4yGF-i80Ly0g1iAK3S4dhJuozk2-ilsVB3EsMCkud6R
https://www.energyconservatory.com/wp-content/uploads/2019/01/exfanmeter-1.jpg

Passive Flow Hood Tips



Per 380-2019 and 380-2022, Passive Flow Hoods, or Lo-Flo Balometers are technically allowed for return side / negative pressure readings only

The main brand you will see with these is the TSI – ALNOR

The commercial TAB world uses these extensively for both return side / negative pressure and supply side / positive pressure

In the TAB world, Evergreen Telemetry's tools are considered the elite, and are regularly used for large commercial TAB projects

Photos secured from the below websites:
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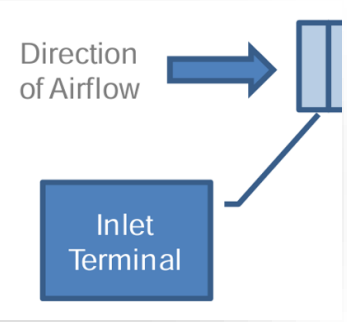
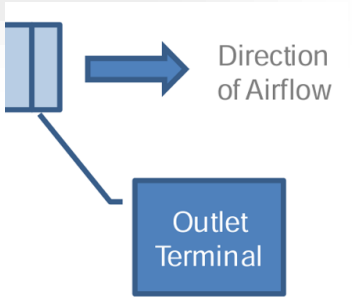
https://img1.wsimg.com/isteam/ip/a3cb8563-340e-41b0-af11-2e1965d0fece/unnamed-e5eaaca.jpg/:/cr=t:17.88%25,l:20.43%25,w:62.46%25,h:62.5%25/rs=w:388,h:517.3333333333334,cg:true,m

Powered Flow Hood Tips

The most versatile airflow tool on the market, a Powered Flow hood is authorized for use return side / negative pressure and supply side / positive pressure readings

Currently, the only device to meet these specifications is the MK2-Flow Finder from RetroTec





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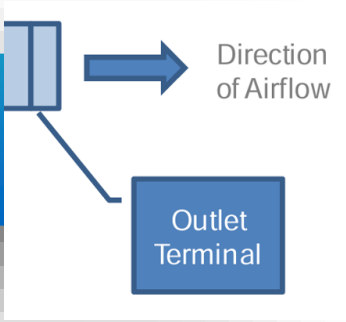
Allowed Equipment at Outlet Terminal



Powered Flow Hood

380-2019 & 380-2022

Device: Maximum error of 5 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Vane anemometer with hood

380-2022 Only

Device: Maximum error of 5 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Bag Inflation Device

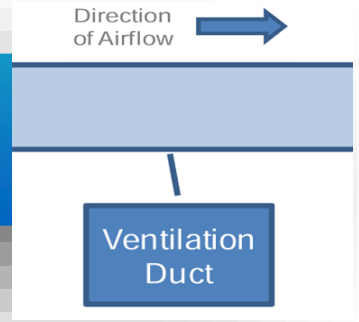
380-2019 & 380-2022

Device: Maximum error of 5 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Photos secured from the below websites:
https://stage.retrotec.com/flow-finder-mk2.html
https://tsi.com/products/ventilation-test-instruments/alnor/alnor-abt-balometer-capture-hoods/alnor-abt-balometer-capture-hood-abt711
https://m.media-amazon.com/images/I/71vj5Jv8LIL.jpg

Allowed Equipment Mid-Stream in the Duct



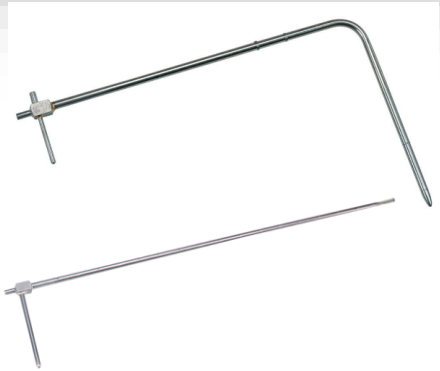
Airflow Measurement Station

380-2019 & *** 380-2022 ***

Device: Maximum error of 10 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

* 380-2022 has removed the option to use this as a temporary measure, meaning the probe must be **permanently installed** to count



Velocity Pressure Probe

380-2022 Only

Device: Known opening area and air tight perimeter seal

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Hot wire anemometer

380-2022 Only

Device: Maximum error of 5 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

Integrated Diagnostic Tool

380-2019 & 380-2022

Device: Maximum error of 5 percent or 5 CFM

Manometer: Maximum error of 1 percent of reading or 0.25 Pa

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Change to Airflow Measurement Station

380-2019

6.4.1. Equipment Needed

6.4.1.1. Airflow Measurement Station. An Airflow Measurement Instrument capable of simultaneously measuring and averaging velocity pressure across a duct diameter with a maximum error of 10% or 5 CFM (2.5 L/s), whichever is greater, coupled with a section of permanently installed smooth-walled ductwork designed to facilitate accurate readings. The Airflow Measurement Instrument shall either be temporarily inserted into the Station for the duration of the procedure or be permanently installed as part of the Station.[45] The Airflow Measurement Instrument shall contain a port that allows it to be connected to a Manometer. Any temporary air flow station shall have its calibration checked at the manufacturer's recommended interval, and at least annually if no time is specified.

380-2022

6.4.1.1.1 Airflow measurement station. A permanently installed airflow measurement instrument capable of measuring average velocity pressure across a duct diameter or static pressure across an in-line aperture of known area. The airflow measurement instrument shall contain a port that allows it to be connected to a manometer. The airflow measurement instrument must have a calculation procedure provided by the manufacturer to convert the measured velocity pressure or static pressure into volumetric airflow with a maximum error of 10 percent or 5 CFM (2.5 L/s), whichever is greater.

Rectangular Duct Traverse Methodology

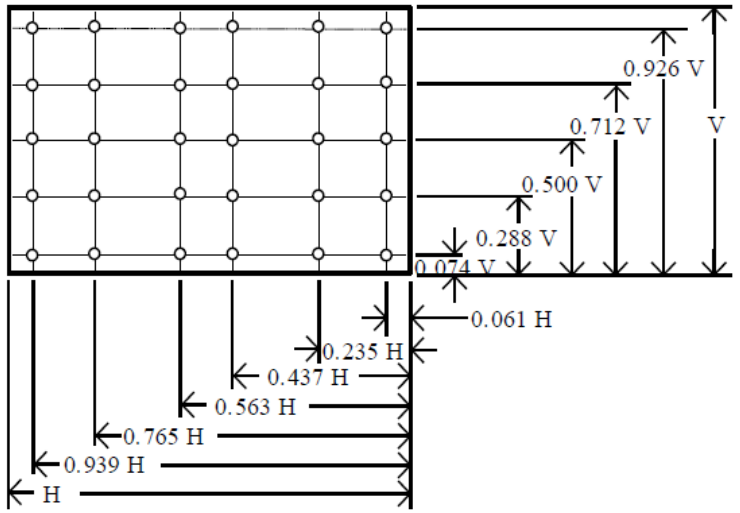

Figure 2: Location of measuring points for traversing a rectangular duct using log-Tchebycheff method

For this duct, a 30-36" horizontal dimension requires 6 points (or 6 traverse lines). For this duct, a vertical dimension less than 30" requires 5 points (or 5 traverse lines).

# of Points or Traverse Lines per Side	Position Relative to Inner Wall
5	0.074, 0.288, 0.500, 0.712, 0.926
6	0.061, 0.235, 0.437, 0.563, 0.765, 0.939
7	0.053, 0.203, 0.366, 0.500, 0.634, 0.797, 0.947

Photos secured from the below websites:
TRAVERSING A DUCT TO DETERMINE AVERAGE AIR VELOCITY OR VOLUME – TSI AIRFLOW INSTURMENTS

Round Duct Traverse Methodology

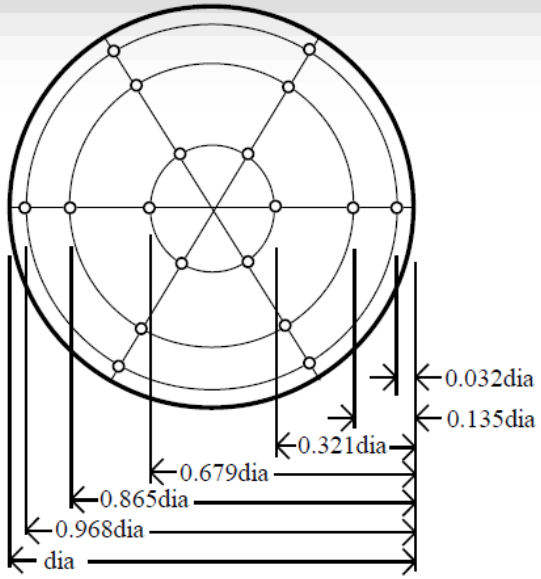

Figure 1: Location of measuring points when traversing a round duct using log-Tchebycheff method

#of Measuring Points Per Diameter	Position Relative to Inner Wall
6	0.032, 0.135, 0.321, 0.679, 0.865, 0.968
8	0.021, 0.117, 0.184, 0.345, 0.655, 0.816, 0.883, 0.979
10	0.019, 0.077, 0.153, 0.217, 0.361, 0.639, 0.783, 0.847, 0.923, 0.981

Photos secured from the below websites:
TRAVERSING A DUCT TO DETERMINE AVERAGE AIR VELOCITY OR VOLUME – TSI AIRFLOW INSTURMENTS

THANK YOU