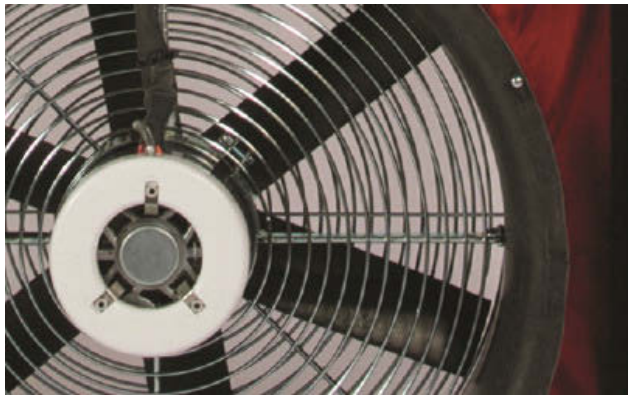
Air Flow Measurements



The Energy Conservatory

Paul Morin

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1 hour** of credit toward **Building Official and Residential Contractors** continuing education requirements."

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Agenda

- Why is measuring airflow important
- How much energy is being delivered to a room
- Commonly used devises for measuring air flow
- Describe lab setup used for this study
- Which devises are the most accurate and why
- Approximate cost of each devise

Why is measuring airflow important

- To confirm we are delivering the designed air flow
- To trouble shoot comfort issues
- Because we are required to do so

How much energy is being delivered to a room

- BTU = 1.07 x air flow in CFM x ΔT in F^{o}
  - ΔT = temperature difference between the air coming out of the register and the temperature in the center of the room

Commonly used devices

- Rule of thumb
- Your hand
- Garbage bag
- Pitot tube / hot wire anemometer
- Rotating vane anemometer
- Balometer – flow hoods
- Powered capture hoods

Methods of Measuring Airflow

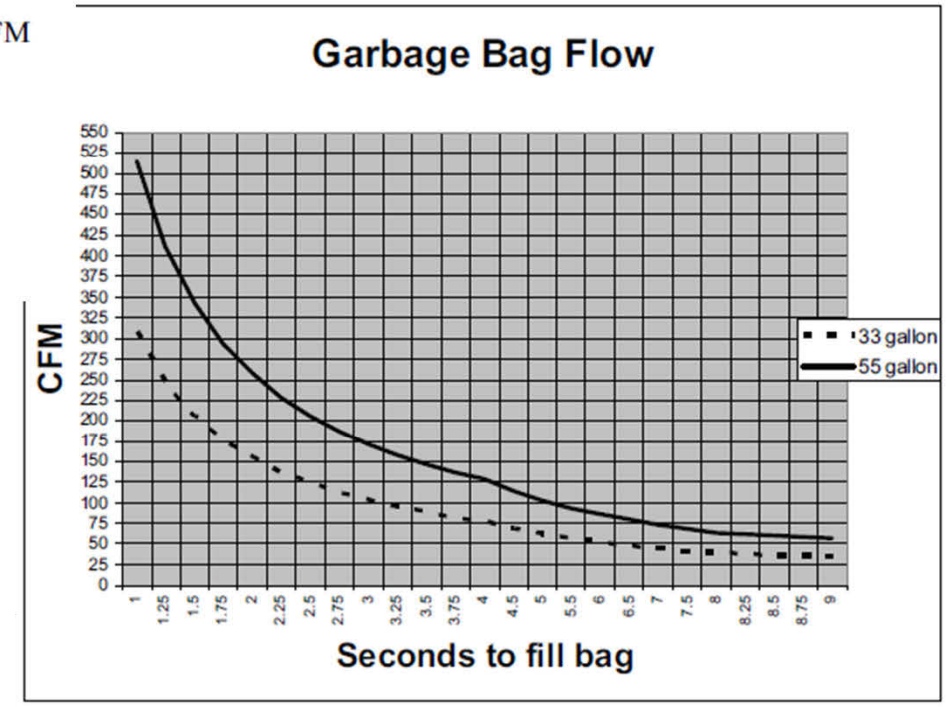
- Time to inflate a known volume
  - Stopwatch and a plastic bag on a hanger

Garbage bag formula:

$$\frac{\text{(bag size in gallons)} \times 0.156 \text{ ft3/gallon} \times 60 \text{ sec/minute}}{\text{seconds to fill bag}} = \text{CFM}$$

Example:

$$\frac{55 \text{ gallon} \times 0.156 \text{ ft3/gallon} \times 60 \text{ sec/minute}}{4 \text{ seconds to fill}} = 129 \text{ CFM}$$



Methods of Measuring Airflow

- Flow through an orifice
- 1.07 x area (sq. inches) x $\sqrt{\text{pressure}}$ (Pa)

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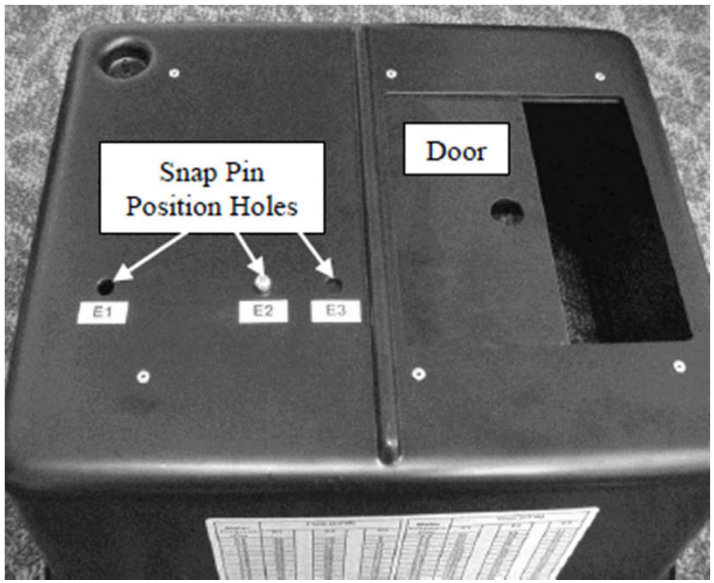
Methods of Measuring Airflow

- Flow through an orifice
  - Exhaust fan flow meter



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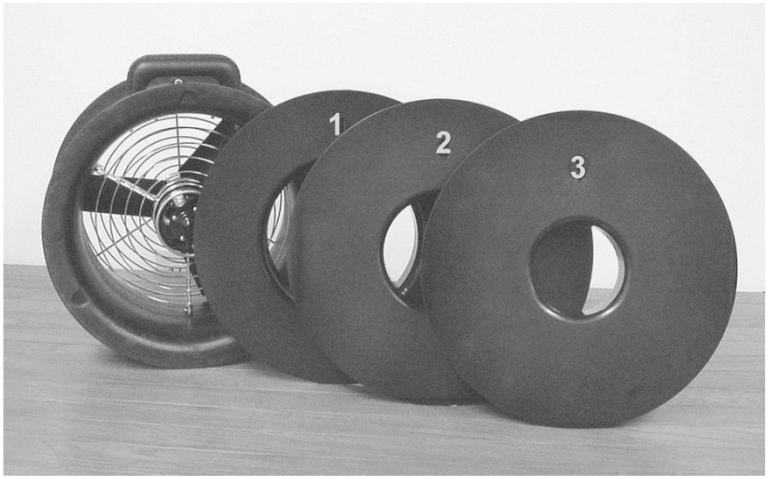
Methods of Measuring Airflow

- Flow through an orifice
  - Blower door
  - Duct Blaster®



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Methods of Measuring Airflow

- Flow through an orifice
  - Duct calibration plate

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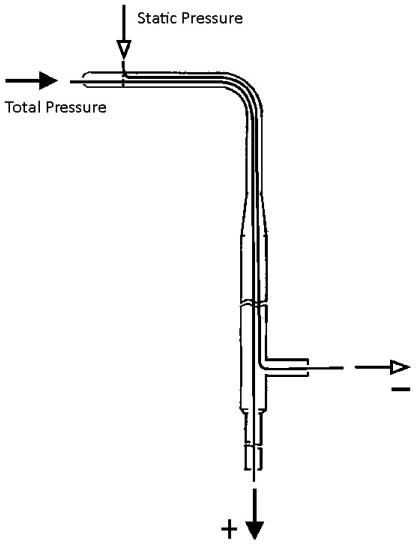
Methods of Measuring Airflow

- Measure velocity and area
  - Pitot tube in a duct
  - 2 tubes – static pressure and total pressure
  - Need to take measurements in multiple locations
  - Long lengths of rigid duct (6” duct = 10’ duct)
  - Velocity in feet per minute x square feet = CFM



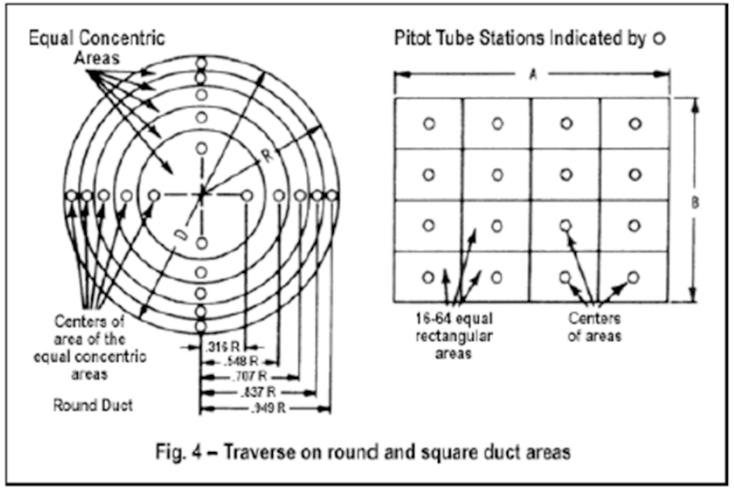


Fig. 4 – Traverse on round and square duct areas

Methods of Measuring Airflow

- Measure velocity and area
  - Rotating Vein Anemometer
  - Directly measures velocity
  - Allows you to input duct cross sectional area
  - Allows for timed or multi point averages

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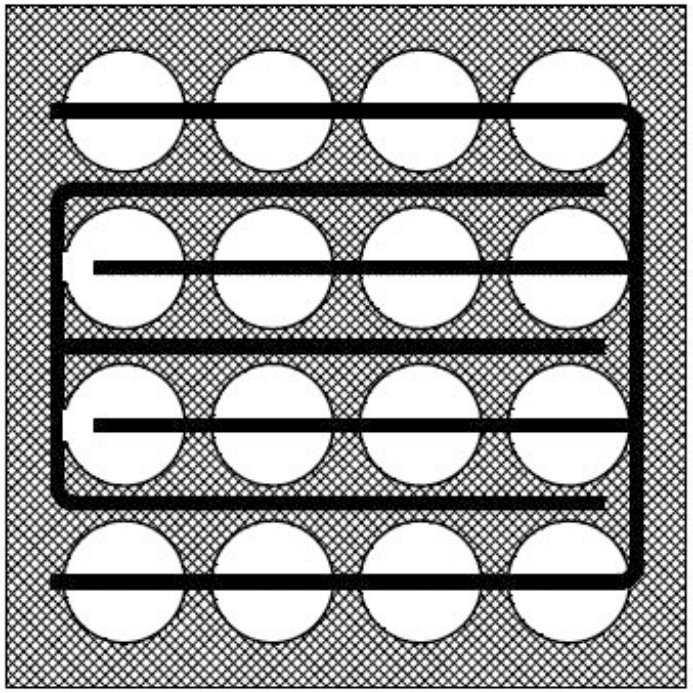
Methods of Measuring Airflow

- Measure velocity and area
  - TrueFlow Air Handler Flow Meter



Methods of Measuring Airflow

» Flow Hoods and Powered Flow Hoods

Goals of the Research

- Measure the insertion loss
- Measure accuracy as it relates to positioning the measurement device over the source

Devices Tested

- ACIN Flowfinder Mk2®
  - powered capture hood

Devices Tested

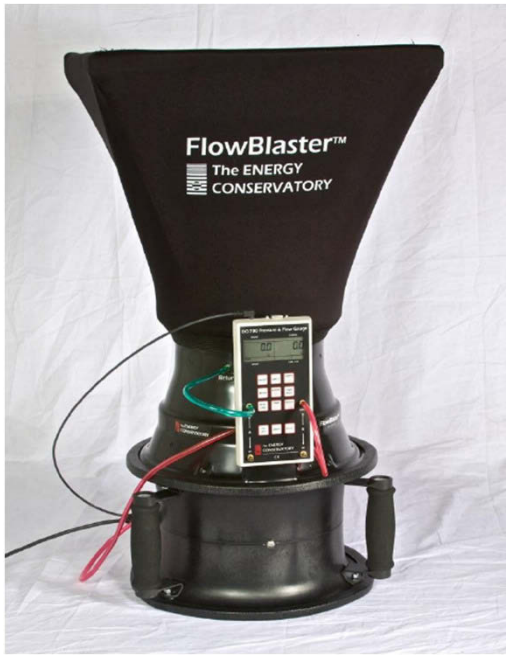
- Alnor® Loflow Balometer®
  - capture hood

Devices Tested

- Testo™ 417
  - vane anemometer with funnel set

Devices Tested

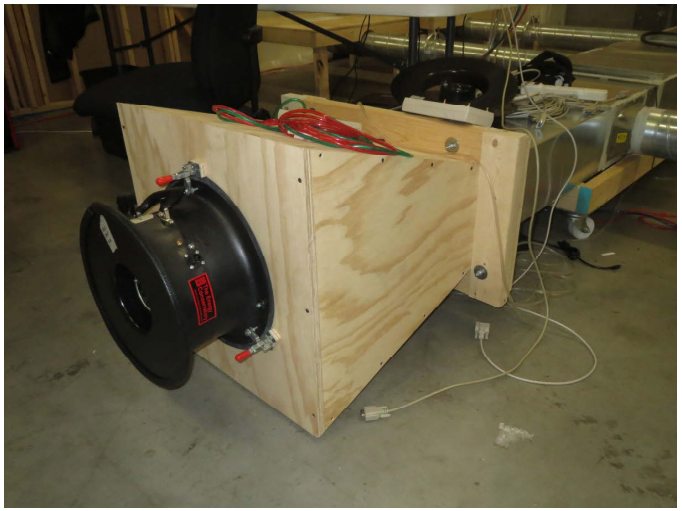
- TEC Flow Blaster®
  - powered capture hood



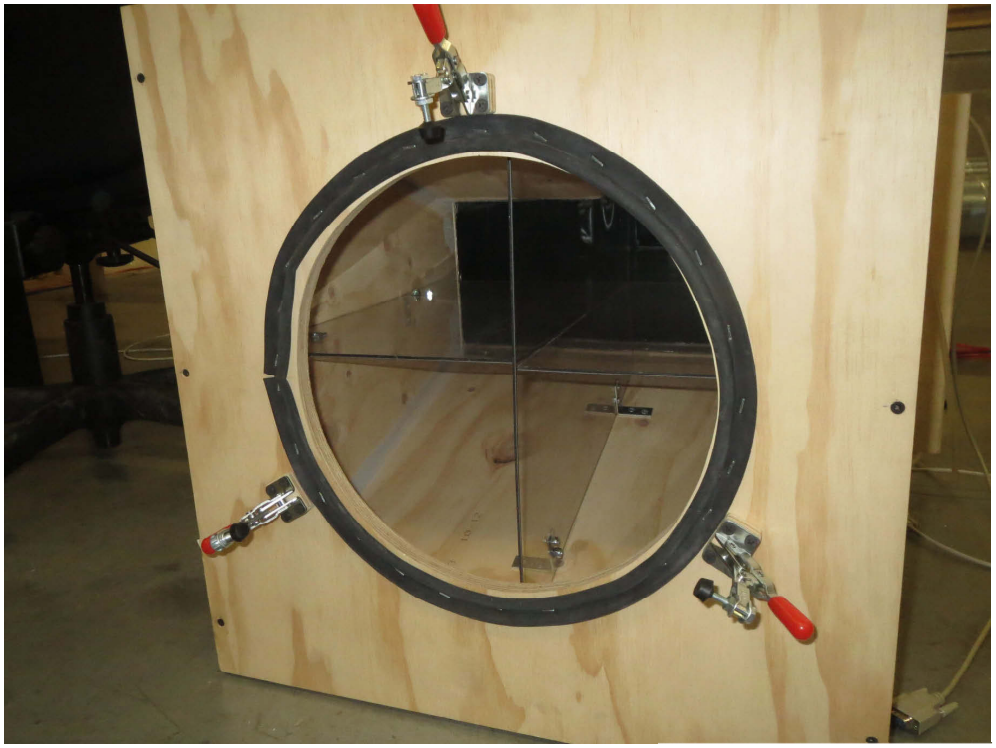
Devices Tested

- TSI™ Accubalance® 8375
  - Capture hood

Test Setup

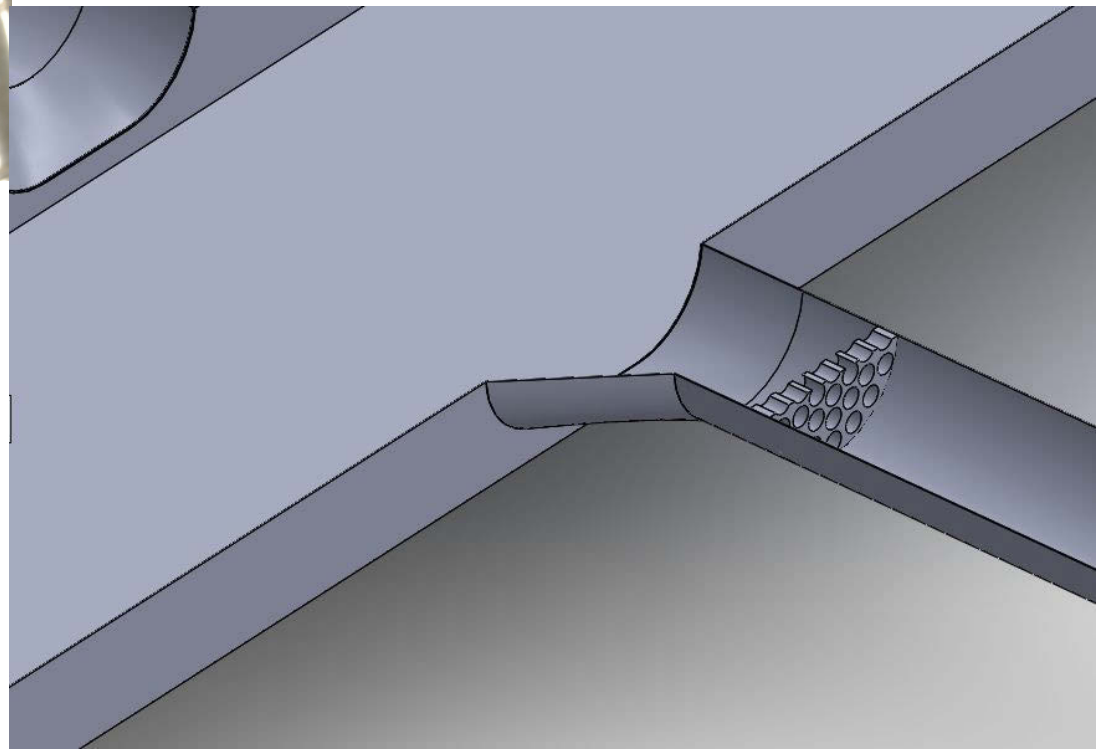


The transition assembly and fan were calibrated using our calibration chamber



Test Setup

A flow conditioner was added in the duct where the branch and trunk meet



Test Setup

An Iris damper was added to

Insertion Loss Test

- Duct Blaster fan set to cruise 400 CFM
- Flow through each register is 100 CFM +/- 2 CFM
- TECLOG3 was used to measure and record pressures and flows
- Methods were devised to get repeatable results with each devise

Devices Test Method

- ACIN Flowfinder Mk2®
  - Results varied based on when the device was told to start displaying real-time flow data
- Procedure used:
  - Place on register and allow it to equalize
  - When the “zero pressure” reading on the Flowfinder screen stopped fluctuating, the device was triggered and allowed to spin up and begin taking flow measurements.

Devices Test Method

» Alnor® Loflow Balometer®

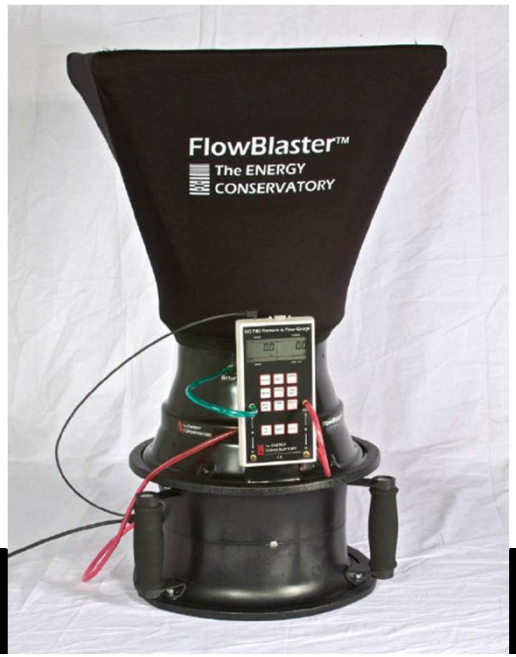
- directly observed for 30 seconds and, because of the stability of their displayed measurements, an average decided upon with an uncertainty of ±1cfm

Devices Test Method

- Testo™ 417
  - A 30 second time-average option was used because there was quite a bit of variability from one instantaneous measurement to the next

Devices Test Method

- TEC Flow Blaster®
  - Results were recorded directly by TECLOG3



Devices Test Method

- TSI™ Accubalance® 8375
  - directly observed for 30 seconds and, because of the stability of their displayed measurements, an average decided upon with an uncertainty of ±1cfm

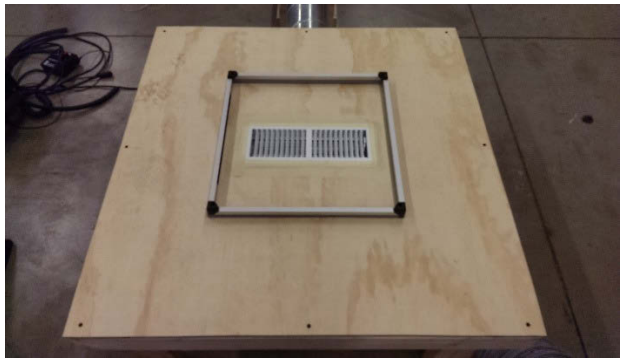
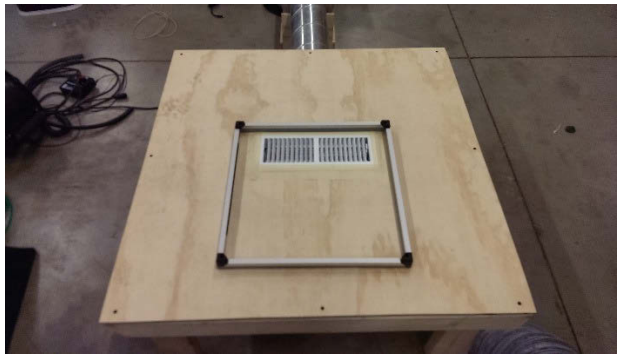
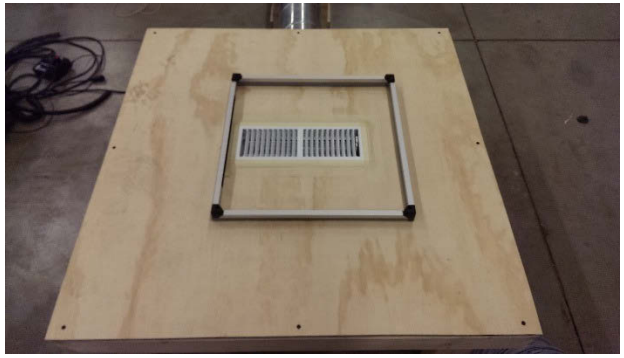
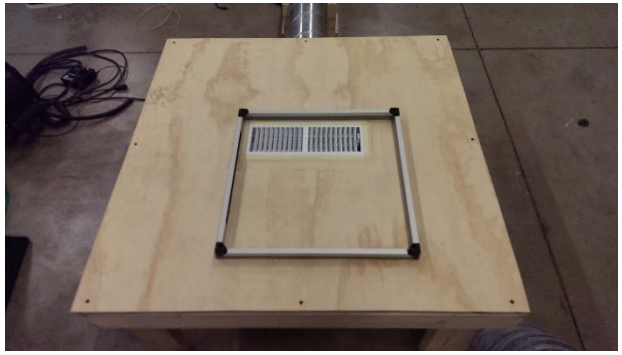
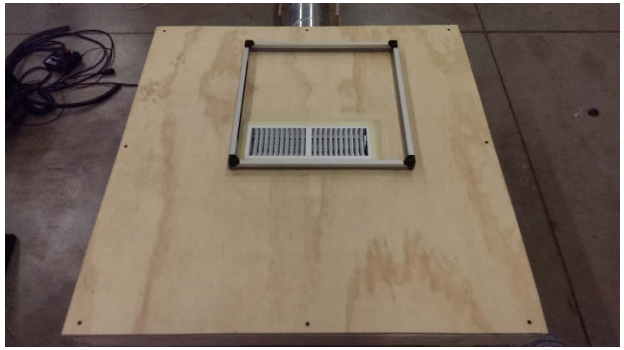
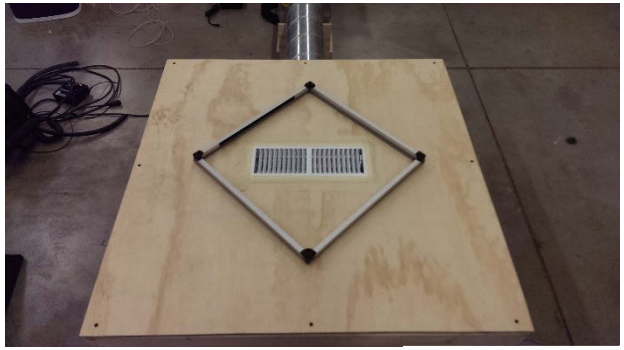
Insertion Loss Test

- Device was centered over each of the four registers and averaged

COMPARISON OF CAPTURE HOOD DEVICES @ 100CFM

Insertion Loss Conclusions

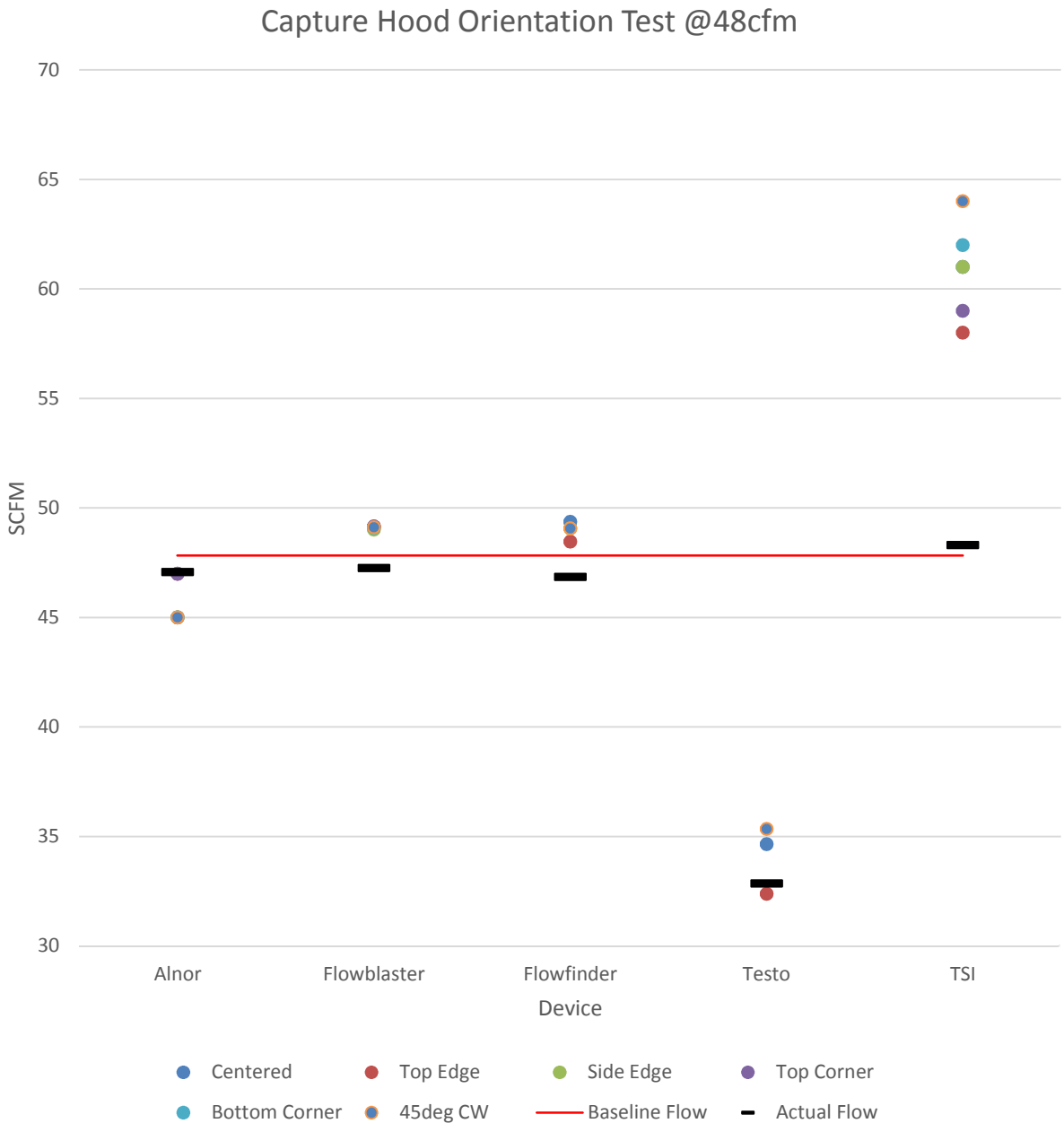
- Powered Flow Hoods minimize insertion loss and read very accuracy
- The Alnor hood had minimal insertion loss, but consistently read 9 CFM too low
- The TSI hood had virtually no insertion loss but measured almost 20 CFM high
- The Testo had 31 CFM of insertion loss and read 9 CFM too high

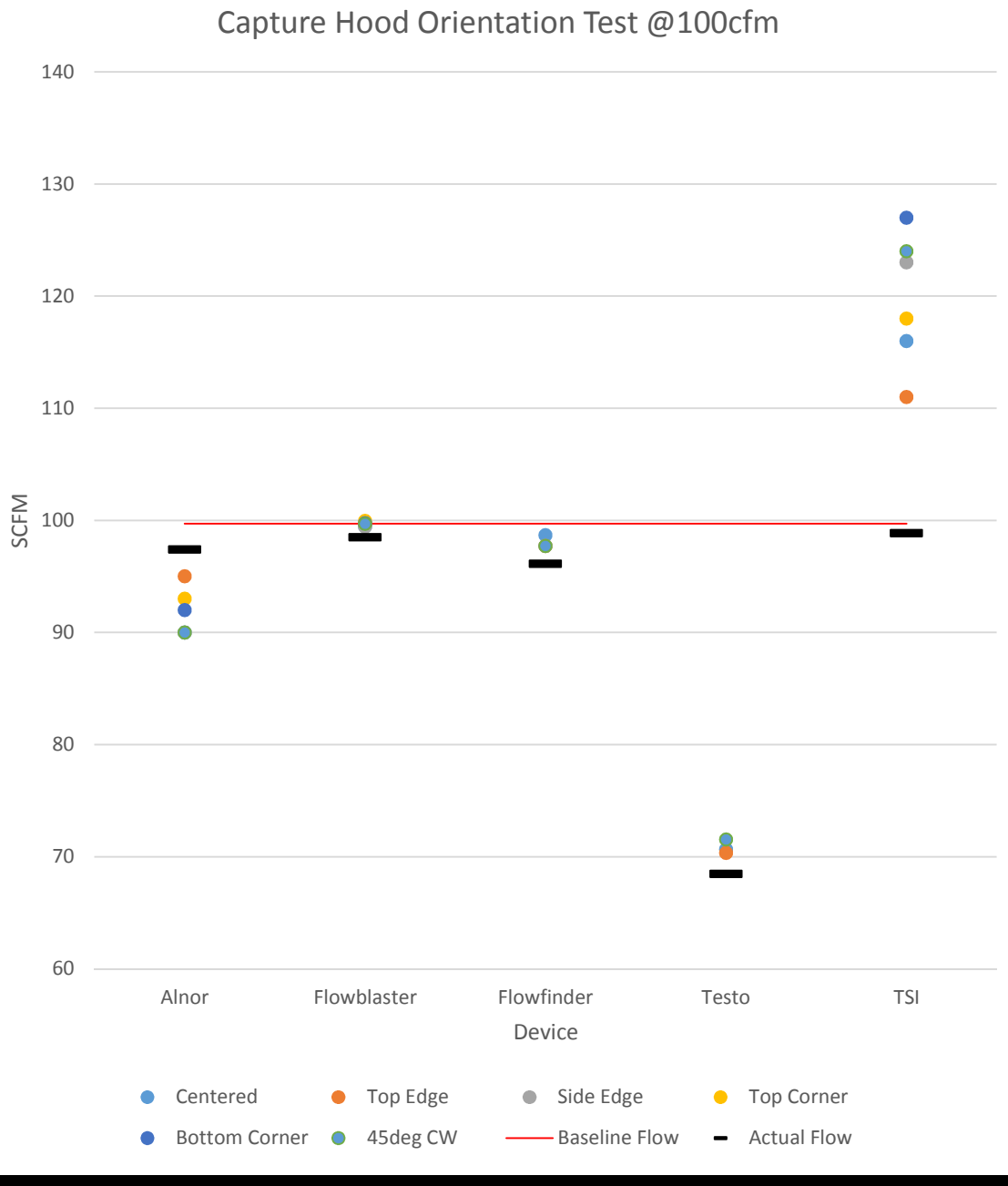







Orientation Tests

Orientation Tests

- Tested at 50 CFM and 100 CFM
- Tests were all performed at register 4


Capture Hood Orientation Test @48cfm
70
65
60
55
50
45
40
35
30
SCFM
Alnor
Flowblaster
Flowfinder
Testo
TSI
Device
Centered
Top Edge
Side Edge
Top Corner
Bottom Corner
45deg CW
Baseline Flow
Actual Flow


Capture Hood Orientation Test @100cfm
140
130
120
110
100
90
80
70
60
SCFM
Alnor
Flowblaster
Flowfinder
Testo
TSI
Device
Centered
Top Edge
Side Edge
Top Corner
Bottom Corner
45deg CW
Baseline Flow
Actual Flow

Orientation Test Conclusions

- Fan assisted devises are the most consistently accurate
- Capture hoods are affected by hood orientation
- Testo devise is not affected much by orientation

Orientation Test Conclusions

- Fan assisted devises are the most consistently accurate
- Capture hoods are affected by hood orientation
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Approximate cost of devises

- Testo 417 w/ hood $725
- Flow Blaster accessory $1140
  - With fan and DG-700 $2765
- Alnor Loflow $1595
- TSI Accubalance $2500
- ACIN Flowfinder $3950

Questions?

Thank you

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