Passive House Air Tightness Testing

Presented By:

Gary Nelson

The Energy Conservatory

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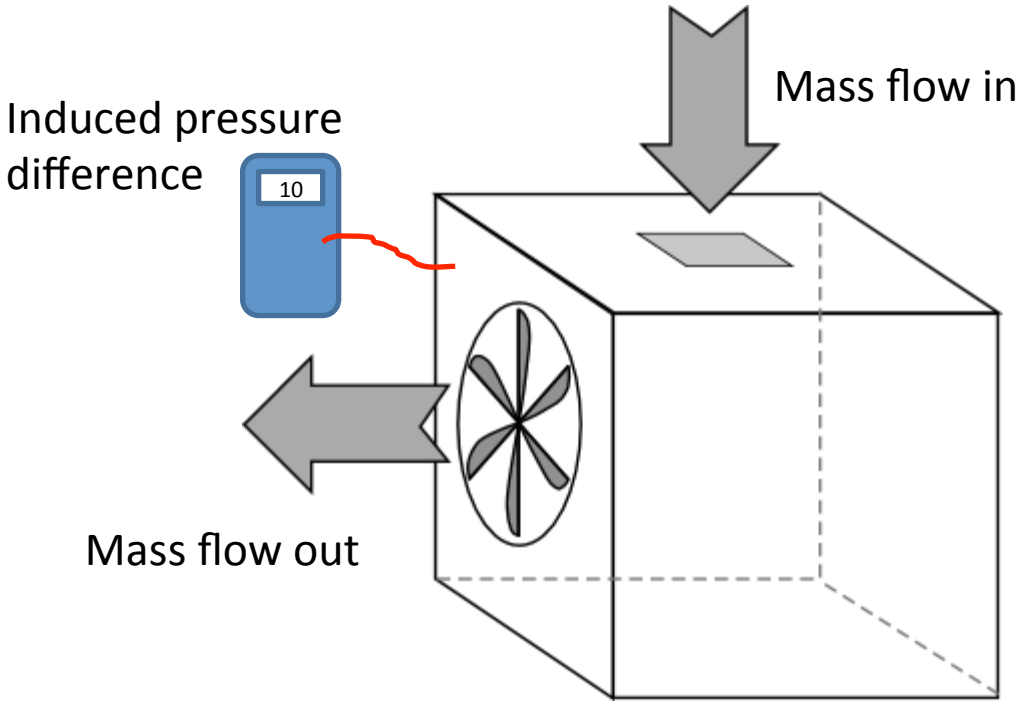
Why Airtight Buildings?

- Durability (moisture)
- Comfort
- Energy

Fan Pressurization Airtightness Test



Airtightness Units (Mesmerizing Metrics)

- Airflow at a test pressure:
  - CFM at 50 or 75 Pascals (CFM50, CFM75)
  - Can be measured directly by blower door
- Leakage Area
  - ELA (4 Pa)
  - EqLA (10 Pa)

Metrics continued

- Airflow at a test pressure normalized by volume

  ACH50 = CFM50*60/Volume
- Airflow at a test pressure normalized by surface area

  CFM50/SQ FT CFM75/SQ FT (USACE)

  Surface area includes below grade surface areas or not
- Leakage Area normalized by an area

  SLA = ELA (4 Pa)/Conditioned Floor Area (both in same units)

And on and on

Comparison between ACH50 and CFM50/ft2
For a 2000 ft2, .6 ACH50 house

House is 50 X 40 X 8
Volume = 16,000 ft3
Surface area = 50 X 40 X 2 + 180 X 8 = 5440 ft2
CFM50 = (.6 X 16000)/60 = 160 cfm
CFM50/ft2 = 160/5440 = .029 CFM50/ft2

Proposed PHIUS standard is .05 CFM50/ft2
USACE standard is .25 CFM75/ft2 (about .19 CFM50/ft2)

Typical new Swedish commercial buildings are .08 CFM50/ft2

Increase height to 2 story
.6 ACH50

House is 50 X 40 X 16
Volume = 32,000 ft3
Surface area = 50 X 40 X 2 + 180 X 16 = 6880 ft2
CFM50 = (.6 X 32000)/60 = 320 cfm
CFM50/ft2 = 320/6880 = .047 CFM50/ft2

Just barely meets proposed new PHIUS standard

Air barrier is 58% leakier per square ft. than 1 story although ACH50 is the same

Increase size to 100 X 100 X 100
.6 ACH50

Volume = 1,000,000 ft3

Surface area = 60,000 ft2

CFM50 = (.6 X 1000000)/60 = 10,000 cfm (2 blower door fans)

CFM50/ft2 = .17 CFM50/ft2

More than 3 times greater than new PHIUS standard

Air barrier is 5.7 times leakier per square ft. than 1 story

At .05 CFM50/ft2 CFM50 = 3000 cfm (1 blower door fan)

ACH50 = .18

At .029 CFM50/ft2 CFM50 = 1765 (1 Duct Blaster® fan)

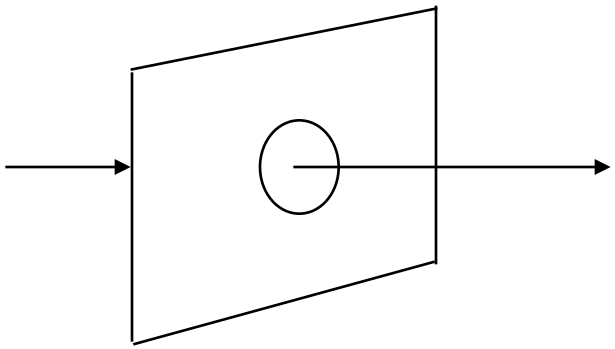
ACH50 = .11

ORIFICE FLOW

- Hole in a thin flat material (special case).
- Dimensions of the hole should be less than 1/2 the dimensions of the flat material.
- Near sea level: $CFM = 1.07 \times A \times \sqrt{(\triangle P)}$

where: A = area of the hole in sq. inches

$\triangle P$ = pressure drop across the hole (Pa)



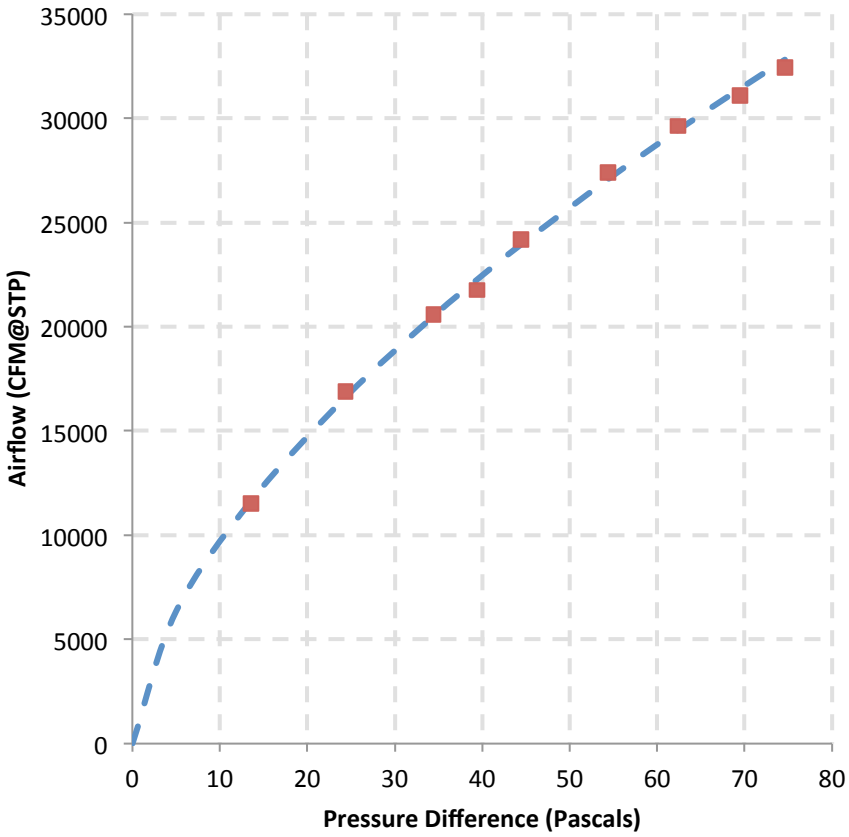
Note: Works well for exhaust fans, but not supply. Need still air on the inlet side of the hole.

Multipoint regression test E779, USACE

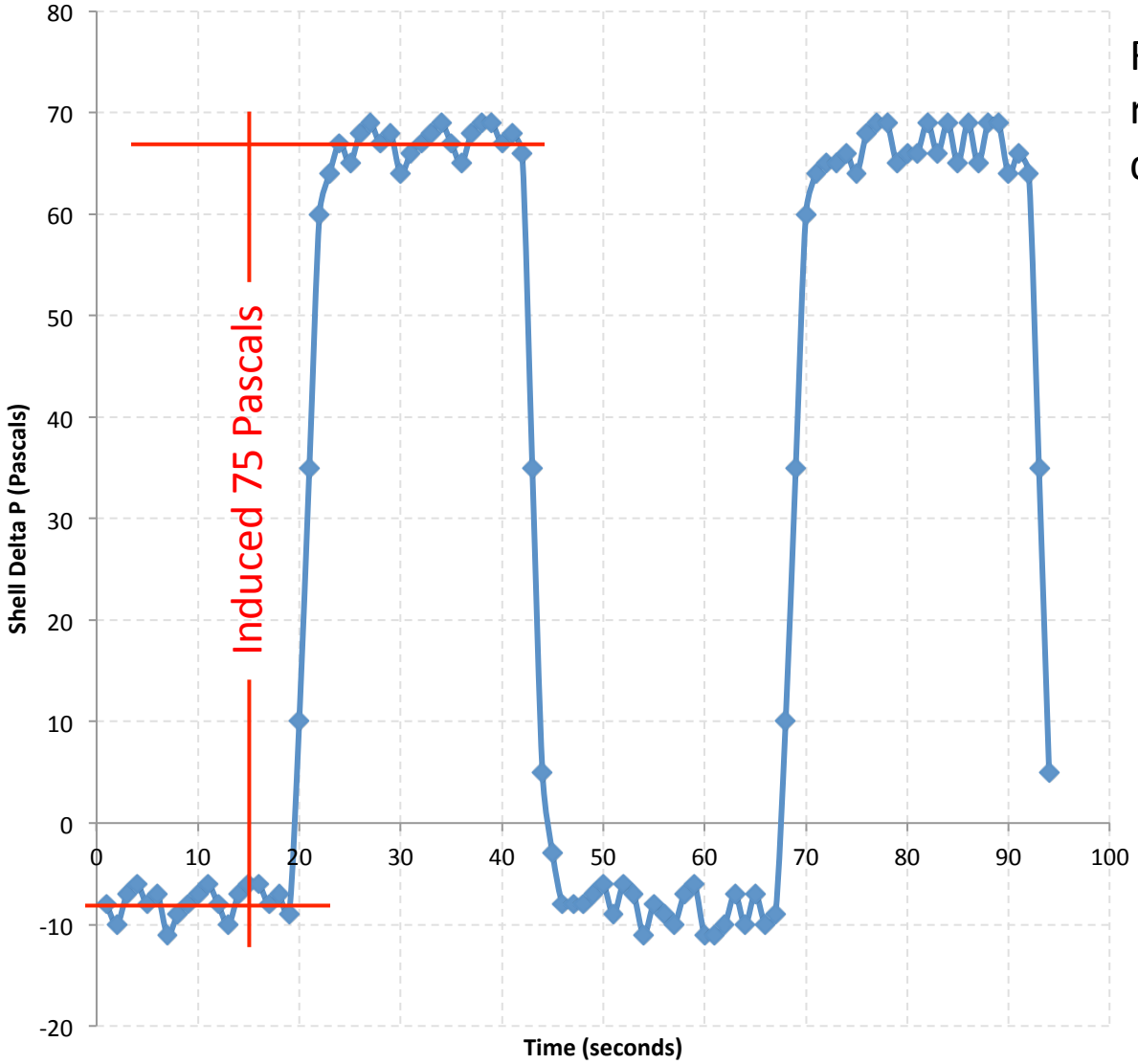
Regression analysis on
Transformed Nonlinear Function: (E779)
$Q_{cfm} = C*(\Delta P_{pascals})^{n}$

Where C = flow coefficient
n = flow exponent ($0.5 \leq n \leq 1.0$)

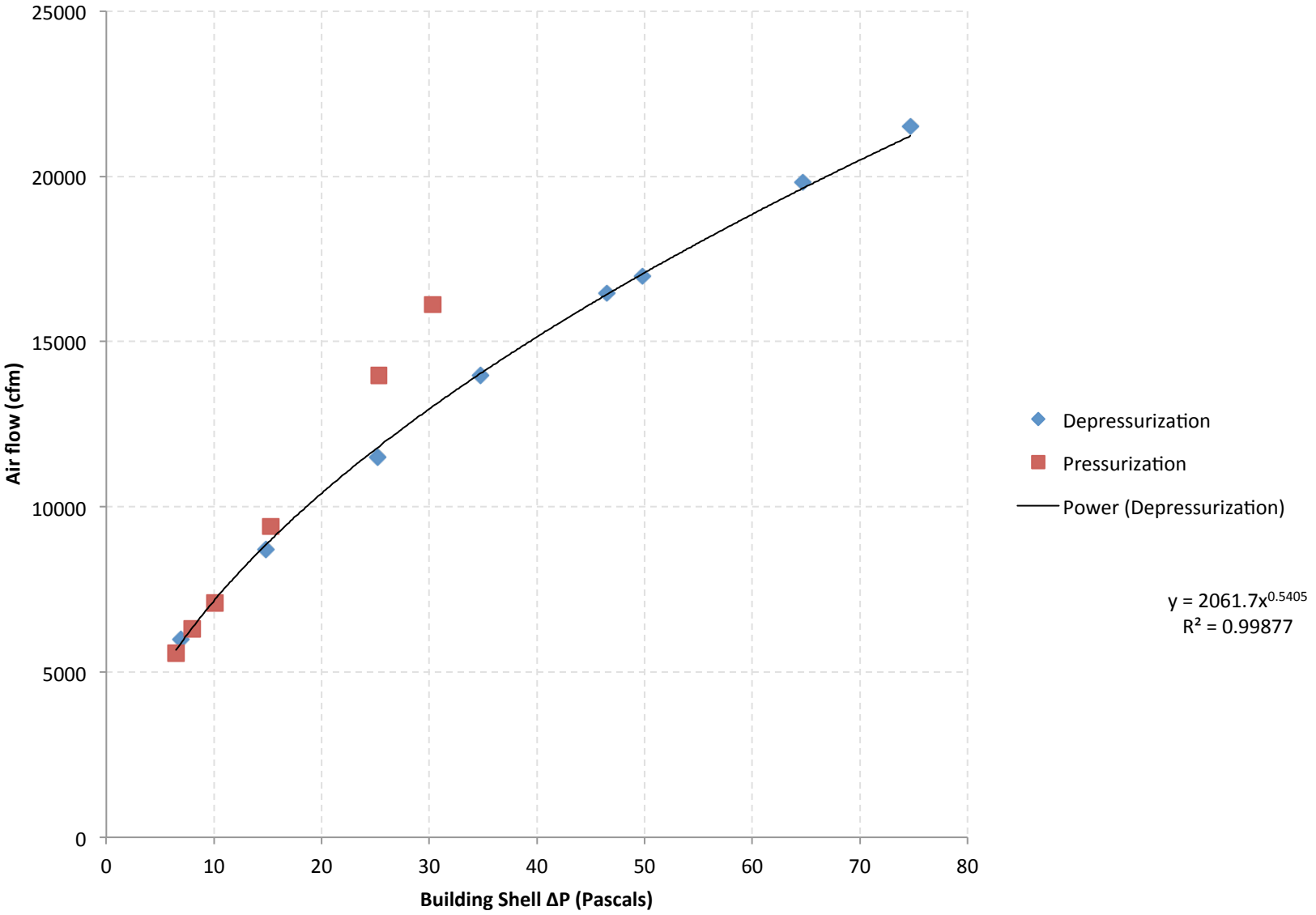
If it takes three fans to get to 25 Pascals it will take less than three more to get to 50.



This is a simplification. Air density and viscosity also affect flow and the leakage curve really isn't a power law.



Repeated Tests at the reference induced pressure difference. E1827


25000
20000
15000
10000
5000
0
Air flow (cfm)
0
10
20
30
40
50
60
70
80
Building Shell ΔP (Pascals)
Depressurization
Pressurization
Power (Depressurization)
y = 2061.7x^0.5405
R² = 0.99877

Sources of Uncertainty in Airtightness Testing

- Error in pressure difference across the shell
- Error in flow measurements
- Error in normalizing to volume or enclosure area
- Error in setting up building