Getting the Most from Your Blower Door

Solutions for Success New York 2006
February 1, 2006

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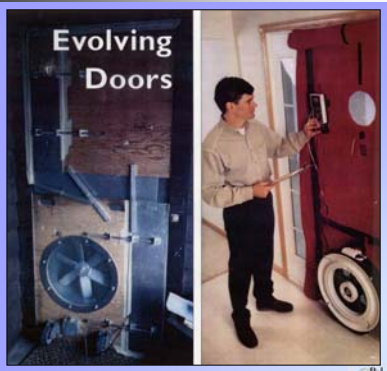
So That's How You Use a Blower Door!



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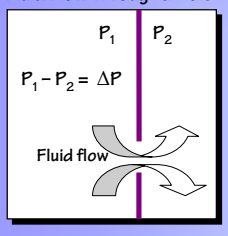
What We Will Talk About

- Introduction to blower doors.
  - Blower door uses.
- Minneapolis Blower Door, Model 3, the most common brand.
- Pre- and post-weatherization testing.
- Blower door guided air sealing.
  - Intuitive and calculated (cost-effective air sealing guidelines).
  - Attic insulation.
  - Basement ceiling.
- Blower doors and acceptable IAQ.
- Thermal imaging with blower doors.
- New construction uses.
- Zone Pressure Diagnostics (ZPD).
- Client education and blower doors.
- Testing for duct leakage.
- Blower door use in multi-family buildings.

Introduction to Blower Doors

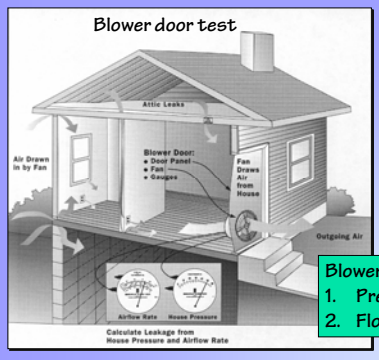
What Causes Air-Leakage?

Fluid Flow Through a Hole



Must have:
1. Hole
2. Pressure difference

Drivers can be:
1. Wind
2. Stack effect
3. Mechanical forces



Blower door measures
1. Pressure
2. Flow

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Blower Door Uses - 1

- Measures leakage rate of house in CFM_{50}.
- Determines effectiveness of air sealing with pre- and post-weatherization tests.
- Helps find air leaks by inspecting house while blower door is operating (blower door guided air sealing).
- Necessary tool for cost-effective air sealing (blower door guided air sealing).
- When blowing attic, can be used to pressurize house for cleaner house and better working conditions in attic.

Blower Door Uses - 2

- Needed to determine if existing house is in compliance with IAQ standards (ASHRAE 62.1 and ASHRAE 62.2).
- Very effective diagnostic tool when used in combination with thermal imaging.
- For construction of new homes to determine the effectiveness of construction tightness efforts.
- Required for Zone Pressure Diagnostics (ZPD & ZPDa).

Blower Door Uses - 3

- Can be used to simulate a fireplace (300 CFM) or other exhaust device during a worst-case draft test.
- Effective client education tool.
- Pressure pan testing and duct leakage to outdoors when used with duct blower.
- Multi-family unit leakage testing.

Blower Door Results Expressed as. . .

- Cubic fee per minute of airflow at 50 Pascals of pressure (CFM_{50}).
- Air changes per hour at 50 Pascals of pressure (ACH_{50}).
- Air changes per hour at natural conditions (ACH_n).
- Equivalent leakage area (based on flow at 10 Pascals), a Canadian metric.
- Effective leakage area (based on flow at 4 Pascals), a USA metric.

Minneapolis Blower Door, Model 3

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The Model 3 Package

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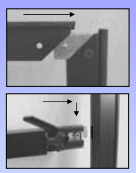
Aluminum Frame

The case



Assembly

Cam lock

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Rings

At a given RPM, these restricting rings reduce fan pressure and increase air speed. This increases the accuracy of the reading.

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Ring Configuration

IF THE FAN FLOW IS TOO LOW FOR AN ACCURATE FAN-PRESSURE READING AT A BUILDING PRESSURE OF 50 PASCALS, INSTALL A LOW-FLOW RING AS SPECIFIED IN THIS CHART. THIS SITUATION USUALLY OCCURS IN TIGHT BUILDINGS.

FAN CONFIGURATION	MINIMUM FAN PRESSURE	INSTALL
OPEN	25 Pa (2400 CFM)	RING A
RING A	25 Pa (900 CFM)	RING B
RING B	25 PA (300 CFM)	RING C[2]

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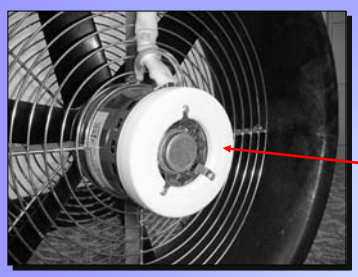
Flow Ring



Flow Ring

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Is There a Maintenance Problem?

This blower measured an actual 3400 CFM_{50} as 1700 CFM_{50}!

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Can't Reach 50 Multipliers

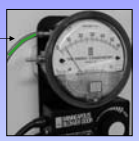
House Pressure, Pa	CRF Multiplier
45	1.1
40	1.2
35	1.3
30	1.4
25	1.6
20	1.8
15	2.2

Zeroing Magnehelic Gauges

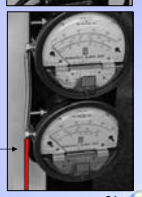
1. Plug fan opening with no-flow ring.
2. House pressure hose to outdoors.
3. Disconnect fan hose.
4. Tap gauges with finger.
5. Zero all gauges.
6. Connect hose to fan.

Depressurization Test

Connect the **Green** hose to the top tap on 60 Pascal gauge.
The 60 Pascal gauge is used to measure building pressure with reference to outside.



Connect the **Red** hose to the bottom tap on bottom gauge.
Fan pressure and fan flow are read from the bottom gauges. Always use the middle fan pressure gauge to read fan flow when the fan pressure is less than 125 Pa.



Reading Magnehelic Gauges

Digital Manometers

from The Energy Conservatory

Depressurization Test Digital Manometer

Connect the **Red** hose to the Channel B Input tap.
Channel B is used to measure Fan pressure and flow.

Connect the **Green** hose to the Channel A reference tap.
Channel A is used to measure building pressure with reference to outside.

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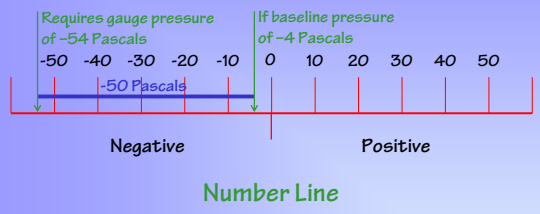
Baseline for Digital Gauges, DG-2 and DG-3



Number Line

Click 3

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DG-700 Manometer

- Easy to incorporate baseline.
- Back-lit screen.
- Hold button.
- Incorporates Can't-Reach-Fifty factor into reading.
- Both channels can be used at the same time.

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Flow-Direction Switch

The flow-direction switch is not to be used for a pressurization test.

For a valid test, the air must flow into the blower on the side that the rings are located.

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Pre- and Post-Wx Blower Door Tests

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Minneapolis Blower Door

Leave blower door set up during weatherization work to take periodic measurements.

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Pre- and Post-Wx Tests

- Best to use same house door for each test.
- Record ring used and indoor and outdoor temperatures (see table below).
- Analyze pre- and post-Wx CFM_{50} values.

Sample Blower Door Readings, Open Fan, Depressurization, at Various Outdoor Temperatures

Outdoor Temperature	Measured CFM50
90	4360
70	4280
20	4073
-10	3944

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Blower Door Guided Air Sealing

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Blower Door Guided Air Sealing - 1

- Inspect inside of house with blower door depressurizing dwelling.
  - Don't have to be at -50 Pa to inspect.
  - Almost close interior doors on increase air speed.
  - Very important to inspect basement.
  - Use your hand (preferred) or titanium tetrachloride smoke.
- Inspect attic with blower door pressurizing the dwelling.

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Blower Door Guided Air Sealing - 2

- Use weatherization cost-effective guidelines (WCEG) when air sealing.
- Use blower door with thermal imaging.
- Conduct basement post-weatherization ceiling leakage test with basement door open to find leaks.
- Conduct appropriate Zone Pressure Diagnostics (ZPD).

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Attic Bypass in Rhode Island

From basement to attic

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Finding Leaks with Blower Door

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Finding Leaks with Smoke

Titanium Tetrachloride

Smoke bottle with refill ampoules

Finding leaks at panned joists

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Cost-Effective Guidelines

- Determines the cost-effective air sealing guideline for a 100 CFM_{50} reduction, for example, $125.92.
- If crew can lower by 100 CFM_{50} for less than the guideline, continue air sealing. If not, stop air sealing.
- Can't be used for new homes.

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Cost-Effective Guidelines

ZipTest Pro² Software

```
CEG/100 CFM50=$125.92
CFM50gl/Worker Hr=55
CLZN=2 STRY=2.0 EXP=2
PBack=10.00 COM=25.00
Hdd=6720    LBL#=14.8
NGas $1.600   Eff=90
---CEG Data Screen---
Press Enter Please
```

```
Reduc=?400
Workers=?2
Time=?67
Cost/100 CFM50=38.53
 CEG/100 CFM50=125.92
CFM50gl/Worker Hr=55
Continue Air Sealing!
     PRESS ENTER
```

```
Reduc=?120
Workers=?2
Time=?70
Cost/100 CFM50=134.17
 CEG/100 CFM50=125.92
CFM50gl/Worker Hr=55
--Stop Air Sealing!--
     PRESS ENTER
```

Formulas are in Minneapolis Blower Door instruction book.

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Blower Door and Attic Insulation

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Blower Door and Attic Insulation

- When blowing attic, pressurize house with blower door to make attic cooler and keep air cleaner for workers and house.
  - In warm weather, install "A" ring in blower to keep motor cooler.
- Also, it often works well to pressurize house while looking for leaks from house to attic.
  - Close access from house to attic and open access from house to basement.

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Open Blow Cellulose in Attic

Pressurization with blower door helps direct dust outdoors and makes attic cooler for crew.

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Don't Need Blower Door to Find This

Bubble wrap doesn't cut it!

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Blower Doors and Basement Ceilings

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Basement Ceiling Leakage

- Do not seal penetrations in basement ceiling unless:
  - Such sealing will minimize health and safety problems, or
  - Such penetrations are leaking to the outdoors.
    - After walls and attic are insulated and all air sealing is complete, depressurize house with blower door with house access to basement open. Check for leaks in the basement ceiling. Seal any signification leaks.

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Blower Door and Acceptable IAQ

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Blower Door and Acceptable IAQ

- Blower door test is needed to ensure that house ventilation system is in compliance with ASHRAE 62.1 (BTL or BTLa) or ASHRAE 62.2.
  - ASHRAE is American Society of Heating, Refrigerating and Air Conditioning Engineers.

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Blower Door and Thermal Imaging

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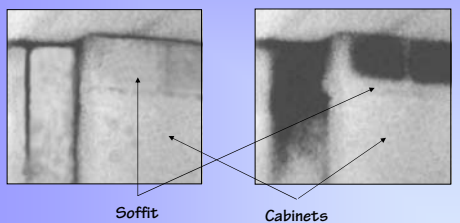
Thermal Imaging with Blower Door

Without blower door running

With blower door running



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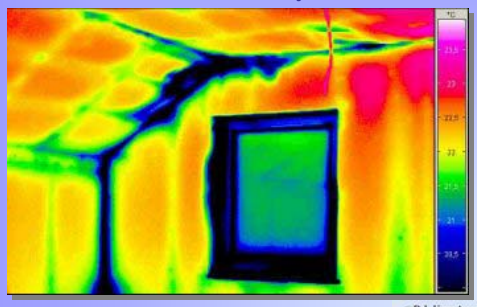
Thermal Imaging with Blower Door

- Best to do thermal imaging before blower door test and then with blower door operating. Do not perform blower door test before thermal initial thermal scan.
  - Thermal image before blower door test shows surface or transmission heat transfer (integrity of insulation).
  - Thermal image just after or during blower door test shows surface or transmission heat transfer AND air leakage (integrity of air barrier).

Thermal Image with Depressurization



Blower Doors and New Construction

Blower Doors & New Construction

- After constructing a new home, use blower door to determine the effectiveness of construction tightness efforts.
  - After improvements in construction technique are made, compare one house with the next.
- After house is closed in, use blower door testing to determine how much each phase tightens building (for example, air barrier, drywall, etc).

Blower Doors for Zone Pressure Diagnostics (ZPD)

Zone Pressure Diagnostics (ZPD)

- Allows analyst to find pressure difference and air flow from house to zone, zone to outdoors, and total path (house to outdoors through zone.
- The CFM_{50} flow rate can be divided by 10 to approximate the square inches of leakage between house and zone or zone to outdoors.

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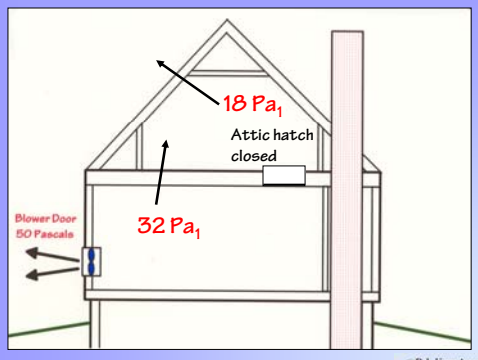

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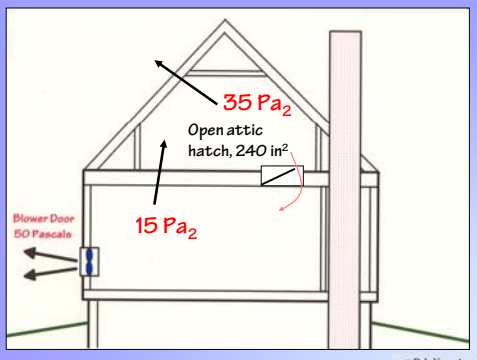

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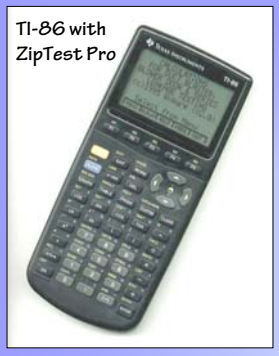
TI-86 with ZipTest Pro



Zone Pressure Diagnostics Screen

```
                    CFM50's
BLD/ZONE ----> 1419
ZONE/OUT ----> 2062
TOTAL PATH --> 1062
ENTERED DATA:
32  18 1 240   15  35
     HOLE METHOD
```

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Blower Door can Simulate a Fire Place for a Worst-Case Draft Test

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Fireplace Simulation

With "B" ring in place, can simulate 300 CFM

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Blower Doors are an Effective Client Education Tool

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Client Education Tool

A blower door is a good way to get a client involved with the weatherization process.

Use blower door to:
1. Find and explain air leaks to client.
2. CFM_{50} divided by 10 approximates the TOTAL leakage area.

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Blower Doors and Testing for Duct Leakage

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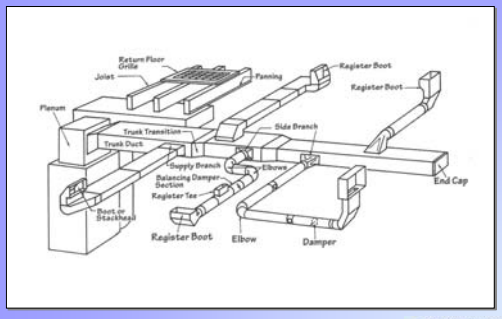
Ducted Distribution



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Blower Door Subtraction Method

- Has a number of drawbacks:
  - Typically underestimates duct leakage because of connections between the inside of the house and the ducts.
    - May use correction factors to minimize this problem.
  - Brings into play the repeatability of the blower door test before and after duct system sealing.
- OK to use if duct system is not well connected to house when taped off.

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Blower Doors & Pressure Pans

- Pressure pans must be consistently used from house to house and from test to test.
- Pressure pans read the ratio of pressures at any given register.

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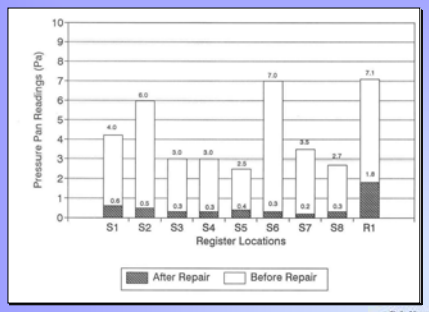
Pressure Pan Readings



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Pressure Pan

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Factors That Influence Pressure Pan Readings

- Register position (open or closed).
- Number of registers.
- Filter type and condition.
- Coil clean or dirty.
- Belly pressure WRT dwelling (mobile home).
- Interior door position.
- The square inches of inside holes.

Adjusting Pressure Pans

Belly Pressure	Multiplier
10	5
20	2.5
25	2
30	1.6
40	1.25
45	1.1

Blower Door & Duct Blower

A blower door is often used with a duct blower to find leakage to the outdoors.

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Duct Blaster™ Package

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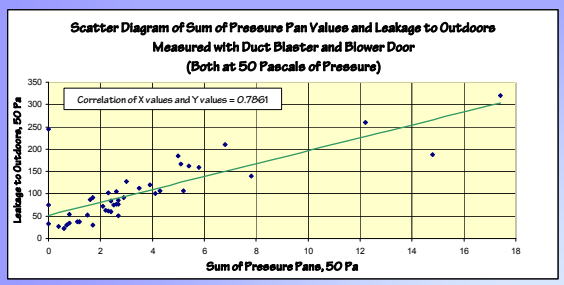
Pressure Pan vs. Duct Blower



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Is Your Attic Connected to your Basement?

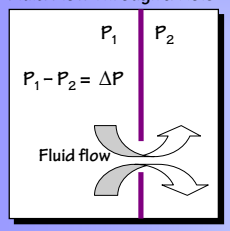
Leakage Riddles

- High leakage in basement can include leakage to attic. How can you determine this?
- Air is flowing out of kitchen base cabinets during blower door test. How can you determine where this air is coming from?
- How can you determine if a knee wall area is connected to the basement?

Blower Doors for Multi-Family Buildings

What Causes Air-Leakage?

Fluid Flow Through a Hole



Must have:

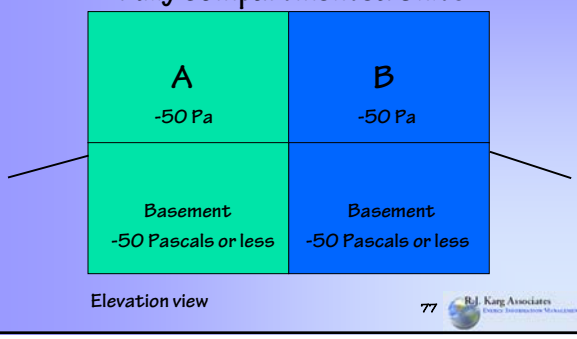
1. Hole
2. Pressure difference

Drivers can be:

1. Wind
2. Stack effect
3. Mechanical forces

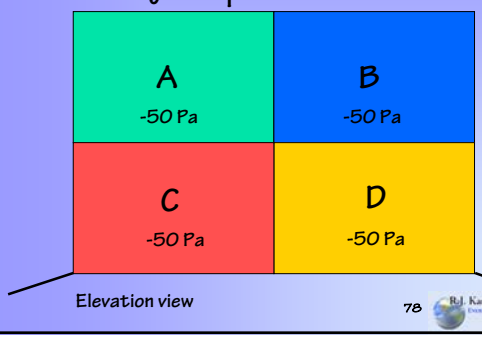
Multi-Family Blower Door Testing – 1

Fully Compartmented Units



Multi-Family Blower Door Testing – 2

Fully Compartmented Units

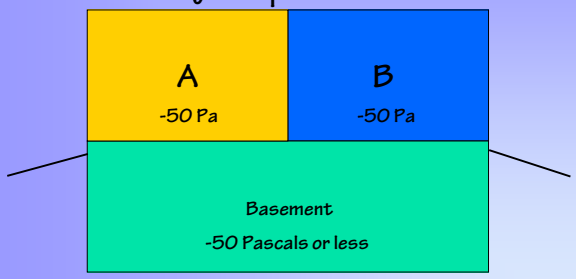


Fully Compartmented Units

- If possible, use blower door in each unit that has common pressure barriers to subject unit. This will eliminate leakage to adjacent units.
- If can't simultaneously test adjacent units, document setup so that pre- and post-testing can be accurately compared and effectiveness of air sealing can be determined. Good luck!

Multi-Family Blower Door Testing – 3

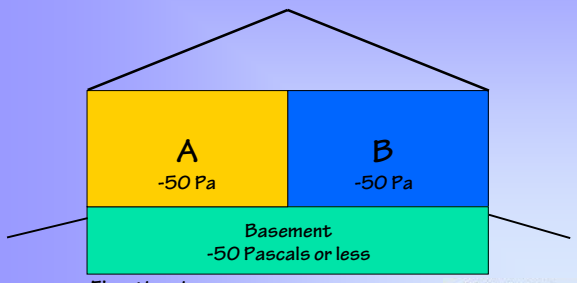
Partially Compartmented Units



Elevation view

Multi-Family Blower Door Testing – 4

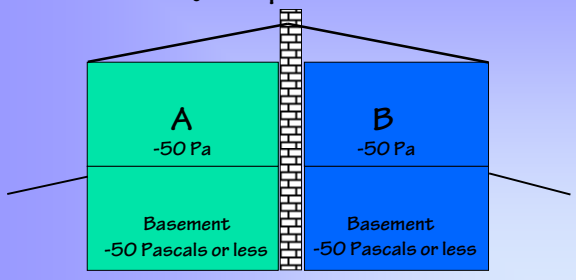
Partially Compartmented Units



Elevation view

Multi-Family Blower Door Testing – 5

Partially Compartmented Units



Elevation view

Partially Compartmented Units

- While testing units A and B simultaneously:
  - Eliminate pressure difference in common zone with separate blower door (-50 Pa).
    - Yields lower CFM_{50} than actual for living space.
  - Open common zone to outdoors.
    - Yields higher CFM_{50} than actual.
  - Close common zone to outdoors.
    - Sum of unit CFM_{50} values similar to what it would be from whole building test.

This Setup Will Do Most Buildings

Infiltec blower doors with stacked fans