Energy Boot Camp for Builders

Building Science and Changes to the Montana Energy Code

New Construction
PTCS Duct Sealing & Blower Door Training

December 2013
Presented by Dale Horton, Architect
National Center for Appropriate Technology
AIR FLOW BASICS

- For air to move, you need a hole and a pressure difference.
- Air always flows from high (or positive) pressure to low (or negative) pressure.
- CFM in always equals CFM Out.
What Is Pressure?

- Force pressing against a surface
- Weight per unit area
- Pounds per square inch
- Inches of water column
- Pascal: Newtons per meter squared

(850 lbs per 2 small feet)
A Simple Manometer

What a manometer is:
- A pressure gauge

What a manometer does:
- Measures the pressure difference between two areas.

The original manometer
A Simple Manometer

This rudimentary manometer is displaying a pressure difference of 4 inches of H20.

What does this equal in Pa?

1 InH20 = 250 Pa

4 x 250 = 1000 Pa
Examples of House Pressure Measurements

- Wind (Ave. 4 Pa)
- Stack Effect (1-3 Pa)
- Furnace plenum (120 Pa)
- Boot (5 Pa)
- Flue (-3 Pa)
- Bedroom with doors closed (up to 10 Pa)
- Room with a big exhaust fan (-20 Pa)
- House pressurized by blower door (50 Pa)
- Potential Back Draft Problems (-3 Pa)

Source: PTCS
Typical Performance Testing Equipment

- Blower Door
- Fan
- Duct Blaster
- Digital Manometer
- Exhaust Flow Hood
- Pressure Pan
- Blower Door Frame
There are several different types of manometers:

- Energy Conservatory DG 700
- Retrotec DM-2
- Infiltec DM-4

For PTCS trainings, we use Energy Conservatory Equipment.
Key references for the discussion of performance testing are available on the web at:

http://www.energyconservatory.com/support/support5.htm

- Blower Door Operation Manual
- Quick Guide #DEP700-CR - 1 Point Depress Test with DG-700
- Duct Blaster Operation Manual
- Quick Guide #PR700-CR - 1 Point Total Leakage Press Test with DG-700
- Quick Guide #PR700 (Outside) - 1 Point Leakage to Outside Press Test with DG-700
The Digital Manometer

Measures the pressure *difference* between two areas.

Input = 1\textsuperscript{st} area

Reference = 2\textsuperscript{nd} area
The DG-700 manometer also has 2 channels:

Channel A

Channel B
The Digital Manometer

The Manometer Mantra:

("Input Nipple") with reference to ("Ref Nipple")

(WRT)

Input
DG700 Tips

Always Start With “Mode”

Perform Baseline from left to right on 3rd row of buttons

Source: PTCS
The Digital Manometer

- Displays the *difference* in pressure between the input and the reference.

- *Does not display the difference in pressure between channels.*
Configuring the Manometer

**MODE**
Tells manometer what measurements to display (e.g., pressure or flow)

**DEVICE**
Tells manometer what equipment is being used

**CONFIG**
Tells manometer what the equipment configuration is (ring number)
Configuring the Manometer - MODE

Tell it what you want to read

**Mode**

- **PR/PR**: Measures the pressure difference between “input” and reference on both channels A and B.
- **PR/FL**: Measures the amount pressure recorded on channel A, and the amount of air flowing through device on channel B.
- **PR/FL@50**: Calculates the amount of air that would flow through device on channel B if pressure on channel A was 50 Pa. (for homes only).
- **PR/FL@25**: Calculates the amount of air that would flow through device on channel B if pressure on channel A was 25 Pa. (for ducts).
Configuring the Manometer - Device

Tell it what you’re connected to

- **BD3**: Blower Door Model 3
- **DB A**: Duct Blaster Model A (White Fan)
- **DB B**: Duct Blaster Model B (Black Fan)
- **TF, EXH, BD4, etc.**: TrueFlow Plate and other Energy Conservatory Equipment.
Tell it how big the hole is (what ring)

- **Open**
  - Open fan, no ring attached
- **A1**
  - Ring A (Blower door); Ring 1 (Duct Blaster)
- **B2**
  - Ring B (Blower Door); Ring 2 (Duct Blaster)
- **C3**
  - Ring C (Blower Door); Ring 3 (Duct Blaster)
List of Performance Tests in *Action Order*

1. Dominant Duct Leakage Test
2. Room Zonal Pressure Difference Test
3. Combustion Appliance Zone Test
4. Blower Door Test*
5. Zonal & Pressure Pan Tests w/ BD fan
6. Total Duct Leakage Test*
7. Duct Leakage to the Outside Test*
8. Exhaust Fan Flow Test

* - Indicates test related to code
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Dominant Duct Leakage

Not a Code Required Test
Dominant Duct Leak Test
Return Leaks

STEPS

1. Set manometer to PR/PR.

2. Connect probe from outside to side A.

3. Close exterior doors and open interior doors.

4. Turn OFF dryer, all fans and combustion equipment.

5. Record pressure reading on side A (baseline pressure).

6. Turn on the furnace fan.

7. Record reading on side A. If the house becomes more depressurized (compared to baseline) you have more supply leaks than return leaks.

If there are more return leaks than supply leaks outside the house, air is being pulled from outside the house instead of from the house. This makes the pressure inside the house positive.

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Dominant Duct Leak Test
Supply Leaks

STEPS
1. Set manometer to PR/PR.
2. Connect probe from outside to side A.
3. Close exterior doors and open interior doors.
4. Turn OFF dryer, all fans and combustion equipment.
5. Record pressure reading on side A (baseline pressure).
6. Turn on the furnace fan.
7. Record reading on side A. If the house becomes more depressurized (compared to baseline) you have more supply leaks than return leaks.

If there are more supply leaks than return leaks outside the house, air is being blown outside the house instead of into the house. This makes the pressure in the house negative.
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Room Zonal Pressure Difference

Not a Code Required Test
The NWESH program requires that the pressure between bedrooms and common area be tested to assure that the pressure difference is no more than 3 Pa.
Zonal Pressure Test

Measure pressure difference between room and central zone of home.

What is the pressure in the room WRT the central zone?
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Combustion Appliance Zone Test

Not a Code Required Test
What’ A CAZ?

Any zone in the house, including the garage, that contains a vented combustion appliance.
Causes of CO in Homes

- Urban Traffic
- Cars started in garages
- Unvented combustion equipment
- Backdrafting combustion equipment
- Failed heat exchangers
- Really dumb stuff (barbecuing indoors, running generators indoors etc)
- If there is Combustion there might be CO
# Carbon Monoxide (CO)

<table>
<thead>
<tr>
<th>PPM CO in air</th>
<th>Percent CO in air</th>
<th>Symptoms experienced by healthy adults</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 35 ppm</td>
<td>0.00%</td>
<td>No effect in healthy adults</td>
<td>35 ppm is WISHA 8-hour average permissible limit</td>
</tr>
<tr>
<td>100 ppm</td>
<td>0.01%</td>
<td>Slight headache, fatigue, shortness of breath, errors in judgment</td>
<td></td>
</tr>
<tr>
<td>200 ppm</td>
<td>0.02%</td>
<td>Headache, fatigue, nausea, dizziness</td>
<td>200 ppm is the WISHA ceiling limit</td>
</tr>
<tr>
<td>400 ppm</td>
<td>0.04%</td>
<td>Severe headache, fatigue, nausea, dizziness, confusion, can be life-threatening after 3 hours of exposure</td>
<td></td>
</tr>
<tr>
<td>800 ppm</td>
<td>0.08%</td>
<td>Headache, confusion, collapse, death if exposure is prolonged</td>
<td></td>
</tr>
<tr>
<td>1500 ppm</td>
<td>0.15%</td>
<td>Headache, dizziness, nausea, convulsions, collapse, death within 1 hour</td>
<td>Levels greater than 1500 ppm are considered “immediately dangerous to life or health” (IDLH)</td>
</tr>
<tr>
<td>3000 ppm</td>
<td>0.30%</td>
<td>Death within 30 minutes</td>
<td></td>
</tr>
<tr>
<td>6000 ppm</td>
<td>0.60%</td>
<td>Death within 10-15 minutes</td>
<td></td>
</tr>
<tr>
<td>12,000 ppm</td>
<td>1.20%</td>
<td>Nearly instant death</td>
<td></td>
</tr>
</tbody>
</table>
Carbon Monoxide (CO)
Unvented Combustion Equipment - Not Safe
<table>
<thead>
<tr>
<th>Class</th>
<th>Venting Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Negative Pressure Venting</td>
</tr>
<tr>
<td></td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>Class II</td>
<td>Negative Pressure Venting</td>
</tr>
<tr>
<td></td>
<td>Condensing</td>
</tr>
<tr>
<td>Class II</td>
<td>Positive Pressure Venting</td>
</tr>
<tr>
<td></td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>Class IV</td>
<td>Positive Pressure Venting</td>
</tr>
<tr>
<td></td>
<td>Condensing</td>
</tr>
</tbody>
</table>
Why Category I Appliances Vent
The Driving Forces That Change Air Pressure in a House

- Wind
- Stack (the Chimney effect)
- Exhaust Fans
- Duct leakage
- Unbalanced forced air systems (interior door closure)
Stack Effect: The most persistent consistent pressure effect.

Positive Pressure

Neutral Pressure Plane

Negative Pressure
Wind creates positive and negative pressures within the house.

Wind Driven Pressures

Infiltration
Positive Pressure
Negative Pressure
Exfiltration

Wind Direction
The Two Paths of Air in a Furnace

House Air

Combustion Air

Buoyancy is the driving force that moves the air in the combustion air path

The HVAC fan is the driving force that moves the air in the house air path
Correct Venting, Gas water Heater Venting Successfully
Large Kitchen Fan Backdrafting Gas Water Heater
Good Venting – Tight Exterior Ducts

Good venting of combustion appliances occurs when the pressure in the room is positive or neutral, and the pressure inside the flue is negative. This allows the flue gases to be pushed up the flue and exhausted from the house.
Backdrafting of combustion appliances may occur when the room (the CAZ) is negative due to a) exterior supply duct leaks, b) interior return duct leaks, or c) big exhaust fans or appliances. These cause the pressure inside the room to be negative which may effectively pull flue gases down the flue into the room.
Home Appliance Induced Depressurization
Beware of Over Sized Fans

- Tim Allen “More Power”
  Kitchen fans are sometimes rated at 1,200 CFM.

- Installed in a commercial environment, code would require make up air.
The Water Heater is -3Pa WRT to House

When the pressure in the flue is negative with respect to the CAZ, successful venting occurs (air moves from high to low pressure)
Large Kitchen Fan
Backdrafting Gas Water Heater

When the pressure in the flue is positive with respect to the CAZ backdrafting occurs. (air moves from high to low pressure)
SUPPLY LEAK INSIDE HOUSE
RETURN LEAK INSIDE CAZ

Depressurize d CAZ
RETURN LEAK OUTSIDE HOUSE

Pressurized CAZ
SUPPLY LEAK OUTSIDE HOUSE

Depressurize d CAZ
CAZ (Combustion Appliance Zone) Test

STEPS
1. Stand in the combustion appliance zone (CAZ) (e.g. in the house, if the atmospherically vented combustion appliance is in the house).

2. Set Manometer to PR/PR. Connect hose from reference on side A to outside.

3. Read baseline pressure in the CAZ on side A.

4. For the three conditions outlined below, set up the house as described then read the pressure. How much did it change? If it went down by 3 Pa or more compared to baseline, there may be a risk of backdrafting
   A) Turn on the air handler
   B) Close Interior Doors
   C) Turn on all exhaust appliances such as fans and dryer (note: this step is not required by PTCS)

Net Depressurization Example
“Net” equals how much the pressure goes down when the air handler is turned ON (compared to baseline).

<table>
<thead>
<tr>
<th>Air Handler ON Reading</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3 Pa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Handler OFF Reading</td>
<td>-3 Pa</td>
<td>-2</td>
<td>-1</td>
<td></td>
</tr>
</tbody>
</table>

Net Depressurization is -4 Pa
Setting Up the CAZ Test

If zone behind closed door is

**Positive** WRT CAZ
Leave door closed

**Negative** WRT CAZ
Open door
Fixing The Problem

- Make more holes in the house
- Push more air into the house
- Suck more air out of the venting system
- Get rid of the back drafting appliance
- Get rid of the source of depressurization
Removing the Source of Depressurization

- Seal holes in top of building
- Seal return duct leaks in the CAZ
- Seal supply leaks outside the envelope of the house
- Eliminate high speed on oversized kitchen fans
Combustion Appliance Zone Pressure Test Example

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Baseline</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline in CAZ</td>
<td>-3 Pa</td>
<td>Adjusted</td>
</tr>
<tr>
<td>Air Handler On</td>
<td>-4 Pa</td>
<td>-1 Pa</td>
</tr>
<tr>
<td>Basement Bath Fan</td>
<td>-6 Pa</td>
<td>-3 Pa</td>
</tr>
<tr>
<td>1st Floor Bath Fan</td>
<td>-8 Pa</td>
<td>-5 Pa</td>
</tr>
<tr>
<td>Kitchen Fan</td>
<td>-14.5 Pa</td>
<td>-11.5 Pa</td>
</tr>
<tr>
<td>2nd Floor Bath Fan</td>
<td>-17 Pa</td>
<td>-14 Pa</td>
</tr>
<tr>
<td>Clothes Dryer</td>
<td>-19 Pa</td>
<td>-16 Pa</td>
</tr>
</tbody>
</table>

![Combustion Appliance Zone Pressure Test Example](image-url)
## House Depressurization Limits (HGL) Per EC

<table>
<thead>
<tr>
<th>Appliance Type</th>
<th>Depressurization Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Natural Draft Water Heater (WH)</td>
<td>2 Pa</td>
</tr>
<tr>
<td>Natural Draft WH &amp; Natural Draft Furnace or Boiler</td>
<td>3 Pa</td>
</tr>
<tr>
<td>Natural Draft WH &amp; Induced Draft (ID) Furnace/Boiler</td>
<td>5 Pa</td>
</tr>
<tr>
<td>Individual Natural Draft Furnace/Boiler</td>
<td>5 Pa</td>
</tr>
<tr>
<td>Individual ID Furnace/Boiler</td>
<td>15 Pa</td>
</tr>
<tr>
<td>Power Vented &amp; Sealed Combustion Appliances</td>
<td>&gt;25 Pa</td>
</tr>
</tbody>
</table>

From the *Minneapolis Blower Door Operation Manual* published by the Energy Conservatory
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Blower Door Test

A Code Required Test (for all homes)
The Blower Door

Blower Door
Measure how much air leaks through cracks and ducts

If the fan is blowing 2,000 cfm out of the house, and it’s staying at the same pressure (-50 Pa), there must be 2,000 cfm of air leaking through holes in the house.

Source: PTCS
## Typical House Tightness Levels

<table>
<thead>
<tr>
<th>Description</th>
<th>ACH50</th>
<th>CFM 2000 SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older Homes</td>
<td>10+</td>
<td>&gt;2600</td>
</tr>
<tr>
<td>Typical New Home ~2000</td>
<td>7</td>
<td>1800</td>
</tr>
<tr>
<td>2009 IECC Tightness Limit Zone 6</td>
<td>7</td>
<td>1800</td>
</tr>
<tr>
<td>Montana State Energy Code</td>
<td>4</td>
<td>1050</td>
</tr>
<tr>
<td>Proposed MT State Energy Code</td>
<td>4</td>
<td>1050</td>
</tr>
<tr>
<td>Energy Star Homes</td>
<td>4</td>
<td>1050</td>
</tr>
<tr>
<td>Idaho New Homes 2013</td>
<td>3.6</td>
<td>930</td>
</tr>
<tr>
<td>2012 IECC Tightness Limit Zone 6</td>
<td>3</td>
<td>800</td>
</tr>
</tbody>
</table>

Example based on 2,000 Ft² house with n = 14.5.
The Blower Door Parts - Rings

- Fan
  - (no ring=open config)
- Ring A
- Ring B
- Fan Cover
The Blower Door – The Skin

Hose Eyelets
Blower Door Parts – the Pressure Sensor Ring

- Pressure sensor on front side of fan
- Manometer measures pressure difference
- The higher the pressure drop, the bigger the flow
- Given the same configuration (ring size) the higher the pressure, the bigger the flow

Higher Pressure = More Flow
The Measurement

[Image of a blower door test setup]

[Table]

<table>
<thead>
<tr>
<th>House Pressure</th>
<th>CRF Factor</th>
<th>House Pressure</th>
<th>CRF Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 Pa</td>
<td>1.1</td>
<td>25</td>
<td>1.6</td>
</tr>
<tr>
<td>40</td>
<td>1.2</td>
<td>20</td>
<td>1.8</td>
</tr>
<tr>
<td>35</td>
<td>1.3</td>
<td>15</td>
<td>2.2</td>
</tr>
<tr>
<td>30</td>
<td>1.4</td>
<td>10</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Pressurizing the House

Pressure x hole size = flow

<table>
<thead>
<tr>
<th>Energy Conservatory Blower Door Model 3</th>
<th>Flow Range (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Configuration</td>
<td></td>
</tr>
<tr>
<td>Open Fan</td>
<td>6300 – 2430</td>
</tr>
<tr>
<td>Ring A</td>
<td>2800 – 915</td>
</tr>
<tr>
<td>Ring B</td>
<td>1100 – 300</td>
</tr>
<tr>
<td>Ring C</td>
<td>330 – 85</td>
</tr>
</tbody>
</table>

The larger the opening, the greater the flow.
Safety Mandates

1. Do not use the blower door if you see one of these!
   • Fire (Pressurize the home = blast furnace)
   • Ash (Depressurize the home = ashes spread)

2. All gas appliances (combustion furnaces and water heaters) must be off (set it to pilot)

3. House should be inspected for potential asbestos contamination
Blower Door Test
Depressurizing a House

STEPS
1. Install blower door with fan exhausting air from house. Rings must be to the inside of the house.

2. Connect hoses as shown.

3. Manometer MODE should read PR/FL, CONFIG should reflect ring used (open, A, B, or C), and DEVICE should reflect BD3.

4. Open all interior doors. Close all exterior doors and windows.

5. Turn OFF airhandler, dryer, all fans and combustion equipment.

6. Turn on blower door, depressurize house to -50 Pascals (side A reading). +/- 0.5 Pa. (hint: canvas should be bulging inward). Use the smallest ring possible to get to -50 Pa. If you have to change the ring, be sure to reflect that in the manometer CONFIG setting.

7. Record reading on side B. This is your house cfm leakage at 50 Pa.

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One-point and Multi-point Blower Door Test Procedures
(assumes DG-700)

- Perform baseline measurement (with fan sealed)
- Choose and install appropriate flow ring
- Select Device in DG-700 (i.e., BD-3)
- Select flow ring configuration in DG-700 (i.e., A1)

For One-point Test choose a mode setting of PR/FL@50, increase fan speed until channel A is to within 5 Pa of 50, Channel B will display the one-point leakage estimate.

For Multi-point test take readings such as 60, 50, 40, 30 Pa, use Tectite software to correlate data, use during windy periods or if greater accuracy is desired.
Blower Door De-pressurization Test

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

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

To Fan

To Outside
Can’t Reach Fifty Factor

For DG-700 users, adjustment is made automatically if performing a one point test in PR/FL@50 mode.

For DG-3 users if you can’t depressurize house to 50 Pa with an open fan then adjust measured air flow with CRF.

Example: House can only be depressurized to 28 Pa with measured fan flow of 5,600 CFM.

CRF = 1.46 so adjusted flow is

5,600 x 1.46 = 8,176 CFM
To calculate air changes per hour at 50 Pa:

\[ \text{ACH}_{50} = \frac{\text{CFM}_{50} \times 60}{\text{House Volume}} \]

The volume is cubic feet enclosed by the conditioned space boundary.

To convert air change rate at 50 Pa to the air change rate at natural conditions:

\[ \text{ACH}_{\text{nat}} = \frac{\text{CFM}_{50} \times 60}{n \times \text{House Volume}} \]

n – The correlation factor shown on the following slide.
Converting CFM50 to Air Change Values
(Provides Approximate Values)

n-Factor Table

<table>
<thead>
<tr>
<th>Zone</th>
<th># of stories</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Well-shielded</td>
<td>18.6</td>
<td>16.7</td>
<td>14.9</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>15.5</td>
<td>14.0</td>
<td>12.4</td>
<td>10.9</td>
</tr>
<tr>
<td></td>
<td>Exposed</td>
<td>14.0</td>
<td>12.6</td>
<td>11.2</td>
<td>9.8</td>
</tr>
<tr>
<td>2</td>
<td>Well-shielded</td>
<td>22.2</td>
<td>20.0</td>
<td>17.8</td>
<td>15.5</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>18.5</td>
<td>16.7</td>
<td>14.8</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>Exposed</td>
<td>16.7</td>
<td>15.0</td>
<td>13.3</td>
<td>11.7</td>
</tr>
<tr>
<td>3</td>
<td>Well-shielded</td>
<td>25.8</td>
<td>23.2</td>
<td>20.6</td>
<td>18.1</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>21.5</td>
<td>19.4</td>
<td>17.2</td>
<td>15.1</td>
</tr>
<tr>
<td></td>
<td>Exposed</td>
<td>19.4</td>
<td>17.4</td>
<td>15.5</td>
<td>13.5</td>
</tr>
<tr>
<td>4</td>
<td>Well-shielded</td>
<td>29.4</td>
<td>26.5</td>
<td>23.5</td>
<td>20.6</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>24.5</td>
<td>22.1</td>
<td>19.6</td>
<td>17.2</td>
</tr>
<tr>
<td></td>
<td>Exposed</td>
<td>22.1</td>
<td>19.8</td>
<td>17.6</td>
<td>15.4</td>
</tr>
</tbody>
</table>
An alternative means of quantifying building tightness is to estimate the leakage area associated with a specific air flow.

House Air Leakage Area Estimates

1. Divide CFM50 by 10 to get square inches of leakage area. (Simple but approximate)

2. Use TECTITE™ software from the Energy Conservatory with multi-point blower door test.
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Zonal and Pressure Pan Test w/ BD Fan

Not a Code Required Test
Zone Pressure Testing

**Set Up:** Set up house for basic blower door test.
Zone Pressure Testing

Return Zone With Respect to (WRT) Interior
Read Zone Pressure

Example: This Air handler (AH) is totally outside the conditioned area of the house.
House WRT outside

Manometer Exercise Sheet

Room A

Room B

Air Handler

Supply

Return

House with reference to outside
House WRT outside

Manometer Exercise Sheet

Room A

Room B

Return

Air Handler

Supply

House with reference to outside
House WRT Attic

House with reference to attic
House WRT Attic
Room A wrt Room B

Room A with reference to room B
Supply ducts wrt house
House wrt attic
Room A WRT Room B

Room A with reference to Room B

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Room A WRT Room B
Pressure Pan Test

50 PA

-50 PA
Pressure Pan Test

45 PA

-50 PA
Pressure Pan Test

-50 PA

5 PA
Pressure Pan Test

25 PA

-50 PA
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Total Duct Leakage

A Code Required Test (for some homes)
Duct Blaster Parts

The Rings

The Fan

The Snorkel
Flow = Pressure x Size of Hole

You control the pressure with the fan speed controller.

The rings change the size of the hole.
Ring CFM Capacity

Fan Configuration Flow Range (cfm) for Series B DB

- Open (no ring)  1,500 – 600 cfm
- Ring 1    800 – 225 cfm
- Ring 2    300 – 90 cfm
- Ring 3   125 – 10 cfm
Total Duct Leakage Test

Duct blaster blows air into duct system (increases pressure)

Air blows out the leaks in the system (registers are blocked)

Air blowing in has to be blowing out (leaks)
Total Duct Leakage Test

Digital Manometer
Supply Registers
Return Registers
Duct Tester Fan
Supply and Return Registers Must Be Sealed
Open Door
Air Handler
Total Duct Leakage Set Up

- Side A measures duct pressure
- Side B measures fan pressure, and manometer reflects it as CFM
Attaching to the Return Grille
Attaching to the Air Handler
Direct Attachment to the Air handler
Steps for Total Duct Leakage Test

1. Seal Registers, Remove Filters
2. Connect duct blaster
3. Insert Pressure probe in one of the registers
4. Configure Manometer
5. Connect hose from register to manometer, and fan pressure fitting to the manometer
Total Duct Leakage Test

Total Duct Leakage

2. Read the Fan Pressure
(Channel B, Red)

Door Open to Outside
Total Duct Leakage Test

Total Duct Leakage

2. Read the Fan Pressure
(Channel B, Red)

Door Open to Outside
Can’t Reach Pressure (CRP) Correction Factors

**Example:** The results of the test show a leakage area of 275 CFM at a duct pressure of 35 Pa. The correction factor for a pressure of 35 Pa is 1.26.

\[
275 \text{ CFM} \times 1.26 = 346.5 \text{ CFM50}
\]

The test doesn’t give any indication of where to find the holes, just an estimate of the collected hole size. As CFM50 values get larger, they will tend to be less accurate.

<table>
<thead>
<tr>
<th>Reference Pressure</th>
<th>CRP Factor 50 PA</th>
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<tbody>
<tr>
<td>10</td>
<td>2.85</td>
</tr>
<tr>
<td>15</td>
<td>2.19</td>
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<tr>
<td>20</td>
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<td>30</td>
<td>1.39</td>
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<tr>
<td>35</td>
<td>1.26</td>
</tr>
<tr>
<td>40</td>
<td>1.16</td>
</tr>
<tr>
<td>45</td>
<td>1.07</td>
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</tbody>
</table>
Interpreting Results:
The CFM50 is a measure of the total collected hole size in the system. As an approximation the CFM50 divided by 10 gives the total effective leakage area in square inches.

Example: 400 CFM50/10 = 40 square inches of total leakage area. Using this approximation during sealing can help estimate how many and how big the holes are that you are looking to seal.
PTCS Duct Training – New Construction

Duct Leakage to the Outside

A Code Required Test (for certain homes)
Duct Leakage to the Exterior

**Standard New Construction:** For certification, the measured CFM50 must not exceed 0.06 CFM50 x floor area served by the system (in square feet) or 75 CFM50 whichever is greater.
Duct Leakage to Outside Test
Part 1 Pressurize the House

**STEPS**

1. Install blower door with fan bringing air into house.

2. Turn OFF airhandler, dryer, all fans and combustion equipment.

3. Tape off grilles/registers.

4. Open all interior doors. Close all exterior doors and windows.

5. Connect hose as shown (house wrt outside on Side A).

6. Manometer MODE should read PR/PR.

7. Turn on blower door, pressurize house to 50 Pascals (side A reading). Use cruise control if possible.
Duct Leakage to Outside Test
Part 2 Pressurize the Ducts

**STEPS**

8. Connect manometer to DuctBlaster; side A to ducts (usually supply side) and side B to fan.

9. Configure manometer;
   **MODE:** PR/FL
   **DEVICE:** DBA (if white) or DBB (if black)
   **TIME AVERAGE:** 1
   **CONFIG:** ring you are using

10. Pressurize the ducts (blowing air into the ducts) until the pressure in the ducts side A reads 0 (with respect to the house – which means the ducts and house are both at 50 Pa with respect to outside).

11. Use the smallest ring possible to get to 0 Pa. If you have to change the ring, be sure to reflect that in the manometer **CONFIG** setting.

12. Check blower door reading (house pressure wrt outside). Readjust to 50 Pa if necessary.

13. Reconnect the manometer to the DuctBlaster. The CFM reading is the leakage to outside at 50 Pa.
Long or crimped exhaust fan ducts can significantly reduce actual exhaust flow.

Not a Code Required Test
PTCS New Construction Duct Leakage Limits

Allowable Leakage = 0.06 CFM50 x conditioned floor area or 75 CFM50, whichever is greater.

Example 1: What is the duct leakage limit for a 1000 SF house?

0.06 CFM50 x 1000 SF = 60 CFM, but since 75 CFM50 is greater the allowable leakage is 75 CFM50

Example 2: What is the duct leakage limit for a 3000 SF house?

0.06 CFM50 x 3000 SF = 180 CFM which is greater than 75 CFM so the allowable leakage is 180 CFM
PTCS Minimum Ventilation Level

MVL Based on known occupancy:
MVL = (# of occupants) x (15 cfm/occupant)

MVL Based on bedrooms:
MVL = (3 of bedrooms + 1) x (15 cfm/bedroom)

MVL Based on ACH and Volume
MVL = (0.35 ACHnat x House Volume in ft³) / 60 minutes

Most Restrictive Should be Applied.