

**Basic Blower Door**

Presented by Regional Consolidated Services  
and BTK Building Inspections and Analysis LLC

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**What are the objectives of an energy audit?**

- ❖ Client health and safety
- ❖ Maintaining building durability
- ❖ Determining the most cost effective retrofits with the shortest payback time
- ❖ Assessing the most practical and safest way for crew/contractor to install retrofits

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No one else that comes to your client's home sees things the way you do!

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### What Is A Blower Door And What Does It Do?

**Blower door**  
*From Wikipedia, the free encyclopedia*  
**A blower door is a device for testing the airtightness of a building. A blower door consists of a calibrated fan for measuring an air flow rate and a pressure sensing device to measure the pressure created by the fan flow. The combination of pressure and flow can be used to estimate the airtightness. The airtightness of a building is useful knowledge when trying to increase [energy conservation](#) or decrease [indoor air pollution](#).**

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### The History Of The Blower Door

Professional Blower Door

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## Early Blower Door Trivia

First used in 1977 in Sweden.

Was brought to Princeton University in 1979 to research air infiltration in buildings and homes.

The fan was originally mounted in a window, instead of a doorway.

In the early days, there were 13 blower door manufacturers, now there are only three prominent manufacturers: The Energy Conservatory, Infiltec, and Retrotec.

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## Anatomy of the Minneapolis Blower Door



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## DG-700 Manometer



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## Features of the DG-700



Two independent channels that will measure separately and simultaneously in different or like units.



Versatility allows it to be used in several applications and in conjunction with other Energy Conservatory products.



Built-in compensation for "can't reach fifty" and baseline measurements.

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## Calibrated Fan with Sensor and Flow Rings with Adjustable Aluminum Doorway Frame



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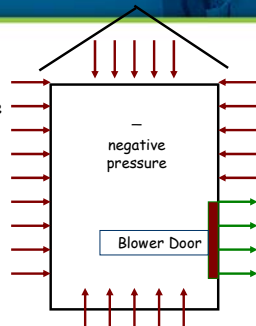
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When using the blower door, air is drawn in through all holes of the building.  
**DEPRESSURIZATION**

Combustion appliances, Air Handlers, exhaust fans, Duct Leakage, and Door Closure cause this same effect to a lesser degree during the normal operation of the building



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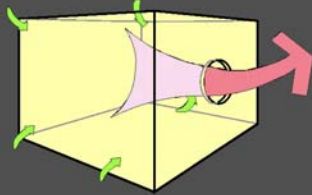
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## Blower-door test principle

*For every cubic foot of air exhausted by the blower door, a cubic foot enters through the shell.*

The lag time between air exhaust and air entry creates house pressure



The blower door's airflow rate is proportional to the surface area of holes through the air barrier

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### Units for Measuring Air Flow

**Cubic Feet per Minute (CFM)**  
This is the rate of air flow

Based on the size of a home and the number of occupants, a home should have a certain amount of fresh air when the home is closed up

**CFM 50 (standard for blower door)**  
*The Blower Door measures the air flow rate in CFM at House pressure of -50 pascals*

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### Units for Measuring Pressure

**Pascal (Metric Standard)**  
1 Pascal = *weight of 1 Post-it Note.*  
248 Pascals = 1" w.c (American Standard)

*1" water column = pressure required to suck 1" of water up a straw*

A cartoon illustration of a person's head in profile, sucking water up a yellow straw. The straw is inserted into a glass of water. An arrow points from the text '1" water column = pressure required to suck 1" of water up a straw' to the straw.

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### Measuring Building Air Leakage

- Natural Driving Forces –  
 Air leakage not measurable because pressure differences are small and variable
- Blower Door –  
 Air leakage is measurable with the Blower Door because the pressure difference is Larger and Steady.

(Like putting 20mph wind on all sides of House)

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## Blower Door Testing

- Allows us to Estimate total air leakage of all the holes in the building
- Can do Pre and Post Blower Door readings to compare before and after.
- Can also compare to other houses of same building type.
- The blower door is your ultimate quality control device!

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## AIR LEAKAGE

Air Leakage Requires All of the Following:

- Air
- Hole
- Pressure Difference (Driving Force)

*The Bigger the Hole or Pressure Difference the more air flow*

*(Can reduce hole or driving force to reduce air flow)*

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## Air Leakage Basics

• 1 cfm in = 1 cfm out

➔

• Takes path of least resistance

➔

• Air Moves from High to Low Pressure Areas

➔

• Air Moves from High to Low Temperature Areas

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## Driving Forces

• Driving Forces are Temperature and Pressure differences usually between inside the house and outside.

• The bigger the  $\Delta T$  or  $\Delta P$  the greater the air and heat flow

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### T = Temperature Difference

**Winter**

$\Delta T = 60^\circ$

**Summer**

$\Delta T = 20^\circ$

Flow is from **Hot** to **Cold**.

The higher  $\Delta T$  the **More** heat and air wants to escape or enter the building

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### P = Pressure Difference

**Positive**

**Negative**

Flow is from **+ Positive (High)** to **- Negative (Low)**.

For every cfm that **Enters**, one cfm **Exits**.

Flow takes path of **Least** resistance.

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### Driving Force Types

Wind

Heat

Stack Effect,  
Combustion

Fans

Exhaust  
Fans,  
Duct  
Leakage,  
Interior  
Doors

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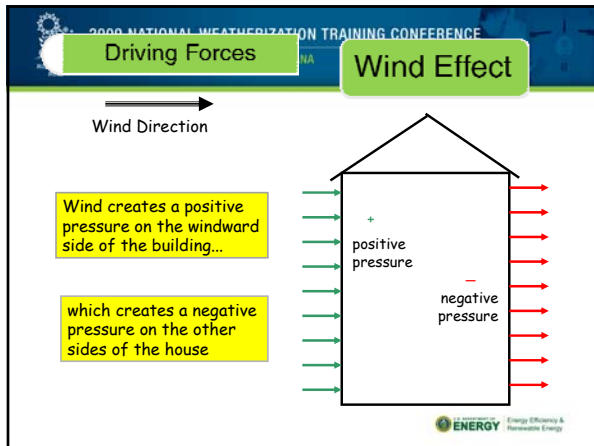
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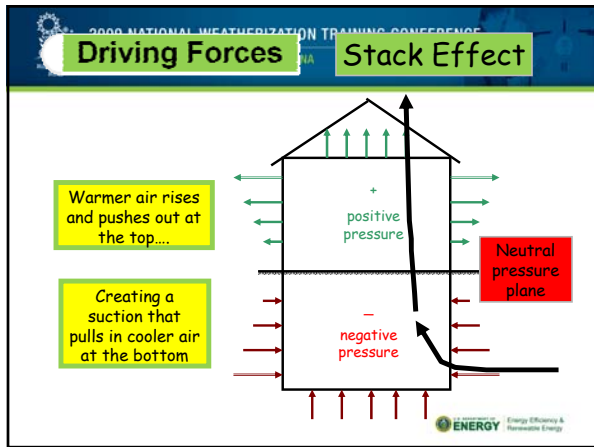
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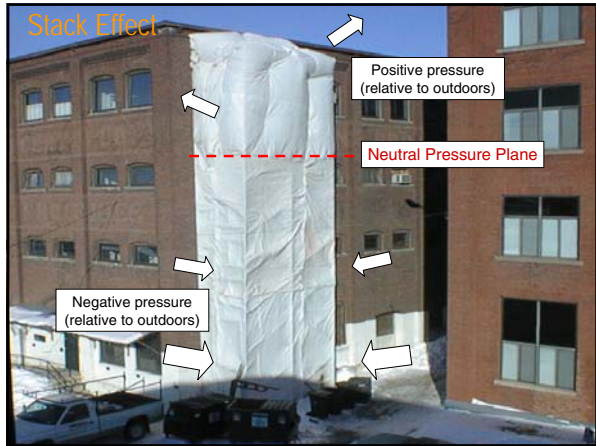
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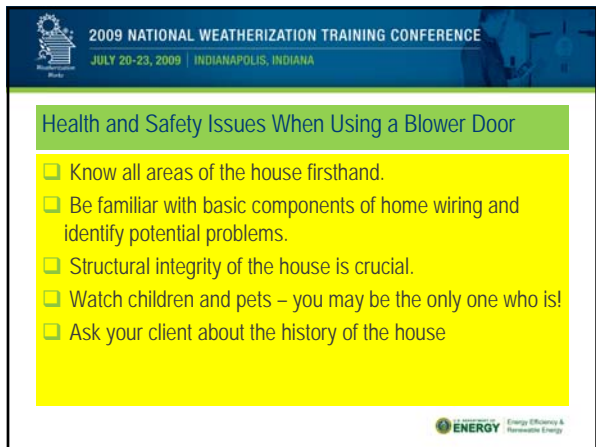
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Condensation and Mold in the Crawlspace



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Mold in the Attic in the same house



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**Health and Safety**

**Heating System Safety**

- Draft
- Carbon Monoxide
- Fuel Leaks
- Clearance to Combustibles



**Moisture-Related Health Hazards**

- Mold
- Mildew
- Fungi



**Ventilation/Fresh Air Exchange Issues**



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### Knob and Tube Wiring



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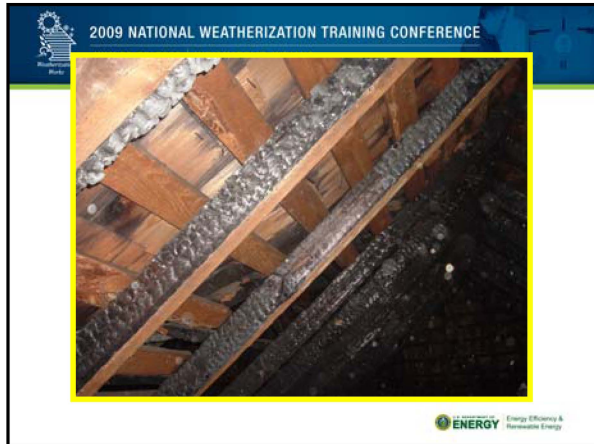
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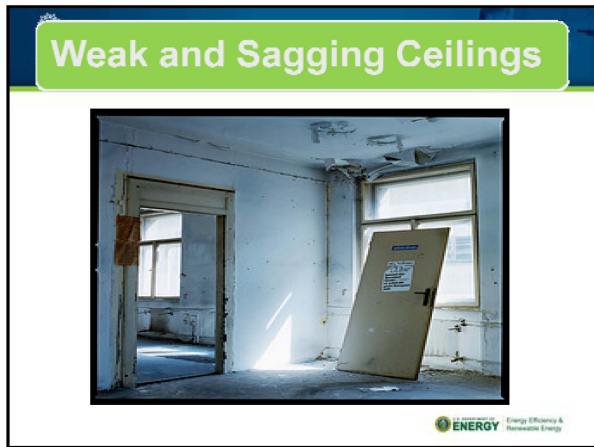
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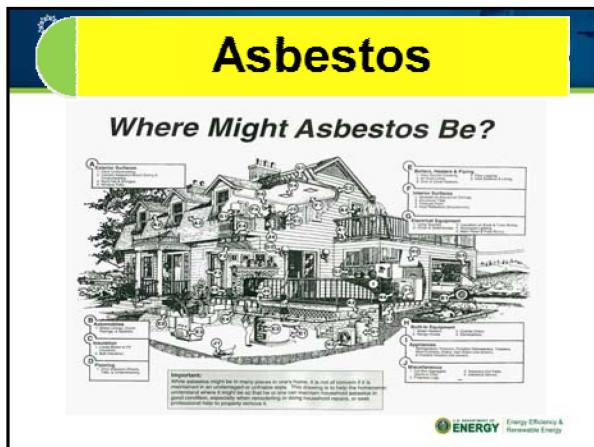
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# Fireplaces

Blower door tests should never be conducted if there is even the slightest chance of fire or smoldering embers escaping and causing a housefire. Fireplaces should be blocked with dampers closed and woodstoves should be opened and inspected prior to testing and the drafts should be closed tightly.



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Please watch children and pets carefully when running the blower door!



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## Pressure and Thermal Boundaries

The *Pressure Boundary* is the air block between Conditioned indoor air and Unconditioned outdoor air

The *Thermal Boundary* is the insulation between Conditioned indoor air and Unconditioned outdoor air

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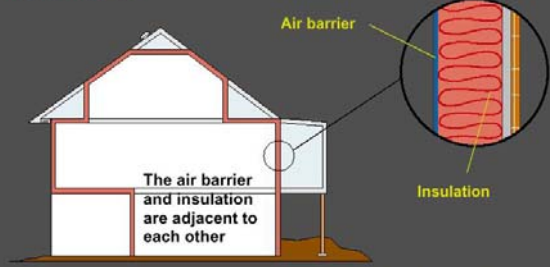
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### The ideal thermal boundary

An ideal thermal boundary consists of an effective air barrier and an optimal level of insulation



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### Pressure and Thermal Boundaries

- The Pressure Boundary and Thermal Boundary must be together and continuous.

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### Pressure and Thermal Boundaries

- If the boundaries are misaligned or If there are holes, voids or gaps this will make the building difficult to heat and cool.

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## Blower Door Setup

- Set up Blower Door in Exterior Door
- Set up house in winter mode  
(Exterior doors & windows closed, interiors doors open)
- Turn off Heating Systems
- Close Fireplace Dampers
- No Wood Stoves in Use  
(Remove Ashes or cover with wet paper)

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## DG-700 Digital Manometer™

### BLOWER DOOR TEST SETUP

**Channel A**  
House  
WRT  
Outside

**Channel B**  
Fan WRT  
Fan Location

Green Hose to Outdoors



Red hose pressure tap on top of fan

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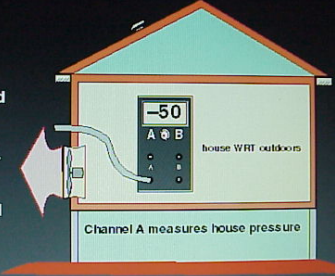
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## Blower door test

### Using a digital manometer

The digital manometer's reference port is always connected to the reference zone which is usually outdoors. The digital manometer tells both quantity and sign (+ or -).



house WRT outdoors

Channel A measures house pressure

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## Blower door airflow measurement

*Channel B measures airflow*

Airflow is measured in cubic feet of air per minute, abbreviated CFM. The blower door's particular airflow reading is often expressed as CFM50 or CFM at 50 pascals of house pressure.

Fan WRT zone near fan inlet

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### Understanding Your Blower Door Reading

- 4000cfm @ 50Pa

Measured rate of airflow

Pressure Reference Point

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### Approximate Leakage Area (ALA)

- Blower Door Reading ÷ 10 = ALA
- For example: 4000cfm@50Pa if all leakage areas were combined would be:

40" 10"

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# Zonal Pressure Diagnostics

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## Zonal Pressure Diagnostic Definitions

A Zone is a space that has 2 surface types

- One surface between the House and the Zone
- One surface between the Zone and Outdoors

Zone Pressure Diagnostics (ZPD) can be performed on any zone to determine which surface is the tightest. (Pressure Boundary)

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## Benefits of Zonal Testing

- Provides an idea of how well connected two spaces are
- Can be a good check for air sealing work
- Most of the time, a general indication of tightness is enough for good decision-making

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## Zonal Pressure Basics

With Blower at -50 Pascals (stick hose outside) and Measure Pressure on Manometer (Reading is 50)

With Blower at -50 Pascals (stick hose inside) and Measure Pressure on Manometer (Reading is 0)

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## Measuring Zonal Pressures

With the Blower Door at -50 Pascals we can measure the pressure Difference between to Different Zones.

*Zone (Area that can be closed off)*

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## Outside Zones and Inside Zones

We want Zones Outside the House (Unheated Areas) to be closer to 50

We want Zones inside the House (Heated Areas) be closer to 0

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## Manometer Setup for Zonal Testing

Channel A      Channel B

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A      Hose to Zone

Reference taps are left open to the zone that is being referenced from.

(This test is done with the house depressurized to -50 PA)

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## Examples of Outside & Inside Zones

**Outside Zones**  
(Unheated)

- Attics
- Garage
- Porches
- Crawlspace
- Basement

**Inside Zones**  
(Heated)

- Interior Walls
- Floors Between Stories
- Crawlspace
- Basement

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## Are the zones where they are supposed to be??

If the zones are **NOT** where they are supposed to be, we need to seal holes between Inside and Outside. (*wasting money and Energy*)

By sealing the holes we stop Air Leakage by making a **PRESSURE BOUNDARY**

**Pressure Boundary (Air Block between Inside and Outside)**

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## Using Pressure Pan to do Zonal Test



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## Test Key Areas

- Attics, Side attics, Porch roofs
- Garages, Basements, Crawlspace
- Chases (plumb, elec, duct, chimney)
- Plumbing Access, Duct Location, Soffits

## Keep It Simple

- Record basic pressure measurements
- Explain bad pressure readings (ex 10 attic)
- Should take very little time (blower door is all ready up)

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## Bypass in attic covered by insulation



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Large chase in furnace closet. Chase is large enough for attic insulation to fall down into closet



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Large chimney chase between two interior walls. Zonal testing is way quicker than trying to find it on your own.



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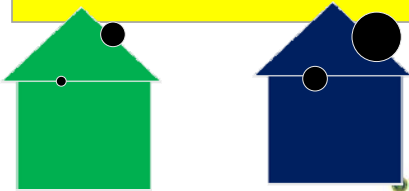
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### Pressures and Leakage

**Attic Zonal Reading of 48pa**

Means hole between Attic and House is 1/8<sup>th</sup> size of Hole Between Attic and Outdoors



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### Pressures and Leakage

**Attic Zonal Reading of 25pa**  
 Means hole between Attic and House is  
 Same size as Hole Between Attic and Outdoors

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### What is Ductwork?

Ductwork circulates heated or cooled air inside the home.

Ductwork should be sealed so that there are no leaks.

(Basement / Crawlspace)

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### Why Do Pressure Pan Testing?

If there are Duct Leaks you are losing **heated** or **cooled** air to the outside.

(Basement / Crawlspace)

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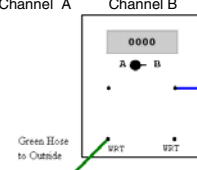
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## Manometer Setup for Pressure Pan



Pressure Pan Testing

Channel A



Channel B

Green Hose to Outside

Hose to Duct (Pressure Pan)

Pressure Pan

Channel A: is House WRT Outside  
Channel B: is Duct WRT House

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## 2009 NATIONAL WEATHERIZATION TRAINING CONFERENCE Duct Leakage With the Pressure Pan

Since ductwork circulates inside air we should get a pressure pan reading near 0.

The higher the reading, the leakier the duct in than vicinity.

If we get a reading higher than 1.0 we want to seal the duct with Mastic (not duct tape)

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## 2009 NATIONAL WEATHERIZATION TRAINING CONFERENCE Things to Know When Using Pressure Pan

- Remove Furnace Filters
- Make sure registers in conditioned areas are **open**
- Make sure registers in semi and unconditioned areas are **sealed off** (*garages, shop, etc.*)
- Temporarily seal outside combustion air inlets or ventilation system connections which are hard ducted into the duct system

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## Dominant Duct Leak Readings

0 Zero	NO Leaks / Equal Leaks / House to Leaky
- Negative Pressure	Dominant Supply Leak
+ Positive Pressure	Dominant Return Leak

- **Negative Pressure:** Can cause Backdrafting and Flame Roll out  
 Pulls in unconditioned air, Pollutants and Soil Gases
- **Positive Pressure:** Pushes out  
 (Pollutants, Flue Gases, Conditioned Air and Moisture)
- (-Negative Pressure) Can cause backdrafting (-12.5) Can cause Flame Roll out

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## Dominant Duct Leakage Setup With Manometer

Channel A: is House WRT Outside

(Turn Air Handler on and off several times)  
 (Notice the immediate pressure change on channel A)

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## More Stuff to Know

Take Zonal Pressure readings in duct locations

- If zone reading only 12pa then highest reading possible even if duct is disconnected would be 12pa
  - Can either adjust or open zone to outdoors so that zone will be near 50pa
- If basement is considered outside the conditioned living space, close the basement door to the house, open a window or door in the basement, and seal all basement supply and return registers
- In crawlspace houses, open crawlspace door or vents

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### Inspect Exhaust Fans

- Do they work?
- Are they noisy?
- Do the occupants use them?
- Are they vented all the way outdoors?

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### Inspect Exhaust Fans (cont.)

- Are vent runs as short and straight as possible?
- Is the proper material used for venting?
- Inspect Lint traps on dryers
- Are clothes blocking intake air for dryer?

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It runs, but does it move much air?



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Two Ventilation Strategies for Indoor Air Quality

- Dilution – **example**: fresh air intakes, heat and energy recovery ventilators
- Source control – **example**: exhaust fans

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Room Pressure Testing

- This test is used to measure room pressures created by the air handler and to determine if there are any problems associated with the pressures.

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Room Pressure Testing

(Room WRT Main body) Channel B

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### Need to Get Return Air From Behind Closed Doors (to Equalize Pressures)

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### Pressure Relief Needed

- Rooms are Pressurized
- Main body is Depressurized to an unsafe condition

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### Pressure Relief Solution

- Pressure Relief has equalized pressure in rooms
- Main body is now in a safe condition
- Fixed Health & Safety, Comfort, Durability problems and increased Energy Efficiency by doing Pressure Relief

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## How Much Sq” Relief is needed

- Open door wide enough to relieve Pressure
- Use Door Gauge or Tape to measure width of door opening
- Look up door size on chart & multiply by measured door opening to get sq” needed for Pressure Relief

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## Test in and Test Out

- Because when changes are made to a house, we are going to affect what???
- Health and Safety
- Durability of the Building
- Comfort
- Energy Efficiency

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## Combustion Appliance Zone

### CAZ Testing

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### Intentional Depressurization

- Blowers Doors intentionally Depressurize a home to measure air leakage at -50 Pascals.
- When we do a Blower Door test we turn off all the heating and cooling equipment, (including gas water heaters), so we do not cause **Backdrafting**.

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### Backdrafting

Spillage of flue gases from combustion equipment into the home.

These gases can be harmful and even Deadly, especially Carbon Monoxide which is odorless, colorless, and tasteless.

Backdrafting is caused by Depressurization (Negative Pressure)

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### Unintentional Depressurization

- Depressurization (Negative Pressure) can also be caused by duct leakage, exhaust fans, and even door closure.
- We want to be able to use or Heating and Cooling equipment without causing Backdrafting.
- We also want to avoid positive pressures.

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## Combustion Appliance Zone

- This test is done to determine if there is a possibility of a Combustion Appliance backdrafting because of.....
- Duct Leakage
- Door Closure
- Exhaust Fans or Equipment

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## "Worst-Case" Scenario

- We use the existing fans (air handler, exhaust fans, clothes dryer, etc) to create the largest possible negative pressure in the area of the appliance. Then we check.....
- How strong is that negative pressure?
- Will the appliance draft under that condition?
- If so, how strong is the chimney draft?

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## COMBUSTION APPLIANCE ZONE TESTING

(CAZ With Reference To Outside)  
Channel A

(CAZ With Reference To Outside)  
Channel B

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### Inspect and Test Gas Cook Stove

- Fuel Leaks?
- Type of supply line, replace if old brass flexible
- Exhaust fan Vented to OUTDOORS?
- Measure CO at Burners Less than 25ppm each?
  - Recommend clean and tune if more than 25ppm

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### Gas Oven

- Aluminum foil blocking oven combustion air?
- Measure Undiluted CO Reading for Oven
  - Set oven to bake at 400–500 degrees for 10 min.
  - Less than 100ppm as measured
  - Less than 800ppm AIR FREE

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# The End

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