

## Energy Out West 2008 Conference

Scottsdale, Arizona  
June 2 – 6, 2008

## Pressure Balancing

Presenter: Tom Brodbeck

## Pressure Webster's Definition

1. The action of force against an opposing force
2. The force per unit of area exerted upon a surface
3. The pressure exerted in every direction by the weight of the atmosphere
4. Pressurize – To keep nearly normal atmospheric pressure inside (an airplane, etc) at high altitude
5. Pressure in a space is increased

## Units of Pressure Measurement

1 pound per square inch = 6,893 pascals  
1 inch of mercury = 3,385.5 pascals  
1 inch of water column = 249.1 pascals

Pressure differentials are measured in different units, depending upon the amount of pressure and/or type of application.

## Examples of Pressure Measurements

Pounds per square inch (psi) for measuring pressure in inflatables.

Millimeters of mercury (mmHg) used in measurement of blood pressure.

Inches of water column (inWG) commonly used by the HVAC industry to measure pressures in furnaces and air conditioners.

Weatherization Programs typically uses Pascals.

## Pressure Principles

Hole + Driving Force = Air Flow  
Wind and Stack Affect / Air Handlers  
Equipment that Exhausts Air

High Pressure Always Flows to Low  
Test with Manometer / Magnehelic / Smoke

One CFM In = One CFM Out  
A driving force may cause pressure in a building but the flow is always equal entering existing the building

## Balancing

To arrange so that one set of elements exactly equals another (mathematical equation)

To complete so that the same number of atoms and electrical charges of each kind appears on each sides (chemical equation)

Webster's Dictionary

## Pressure Balancing

The process of neutralizing pressure differentials in the home. It involves changing building and/or mechanical system characteristics so that strong pressure differences are eliminated or at least reduced.

Florida Solar Energy Center

## Why Do Pressure Balancing

- 1 Ensure safe draft of combustion Appliances.
- 2 Produce efficient air flows.
- 3 Maintain durability of the the building and the air handler after duct tightening.
- 4 Increase comfort of the residents.

## Pressure Differential

The driving force for air. Air flows from high pressure to low pressure. Pressure differential is commonly measured in units of inches of water column (inWG) or pascals. 249.1 pascals equals 1.0 inWG. A pressure measurement is always pressure differential measurement. That is, it is the difference in the pressure between one location and another.

Florida Solar Energy Center

## Diagnosis

The process of identifying problems, recognizing the source of the problem, and finding solutions to those problems. Diagnosis involves finding the facts, analyzing the facts and prescribing a solution.

Florida Solar Energy Center

Investigation or analysis of the cause or nature of a condition from such analysis

Webster's Dictionary

## Pressure Measuring Tools Blower Door



## Duct Blaster at Furnace and Cold Air Return



## Pressure Pan



## Flow Hoods



## Digital Manometers



## Magnehelic Gauges



## CO & Combustion Testing



## Smoke



## Natural Draft of Combustion Appliances Under Worst Case.

- Minimum Draft

Appliance	Outdoor Temperature (Degrees F)				
	<20	21-40	41-60	61-80	>80
Gas-fired furnace, boiler, or water heater	-5 Pa.	-4 Pa.	-3 Pa.	-2 Pa.	-1 Pa.
with atmospheric chimney	-0.02	-0.016	-0.012	-0.008	-0.004
	IWC	IWC	IWC	IWC	IWC

Saturn Resource

## Worst Case Zone Depressurization Test Limits.

### House Depressurization Limits (HDL's)

Fireplace (wood or gas) AND Non-Airtight Wood stoves

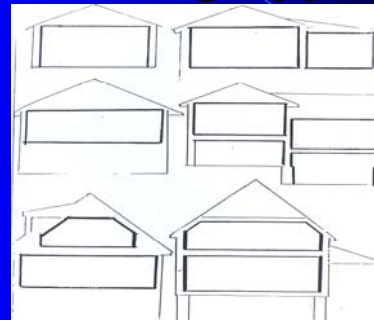
Unlined chimneys on exterior walls -3 pa

Metal-lined, Insulated or interior chimneys -4 pa

## Room Pressure Limits.

- 1 No rooms should be pressurized more than 3pa
- 2 Very important to measure Room pressures after duct sealing
- 3 Bedrooms with an attached bathroom, must be tested with the bathroom door open to the bedroom

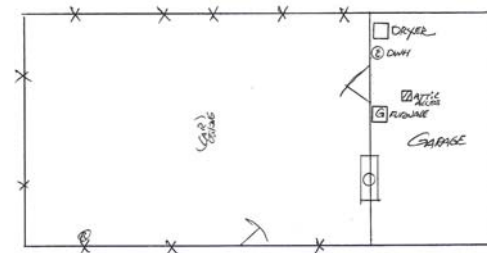
## Housing Types



## Single Story w/Converted Garage & Crawl Space



## Housing Floor Plan



**Worst Case FP -7.3pa & Room Pressures +4.5pa - +6.4pa.**



**After Registers Installed in all Bedrooms Doors W/C @ FP -2.4pascal All Room Pressures at +3pa or Less**



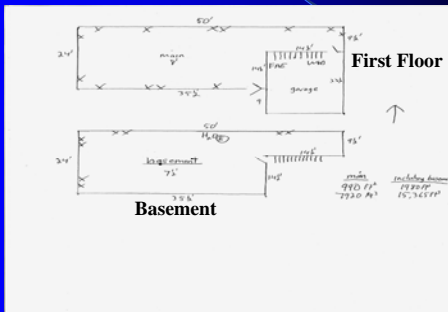
**Calculating Amount of Net Free Air Area Needed to Relieve Room Pressure**

- Height of door x Amount of Opening to Relieve Pressure x .75 equals gross grill size.

**Single Story with Basement & Attached Garage**



**Housing Floor Plan**



**Worst Case @ FP Main Floor -14.0pa / Basement FP -4.0pa**



**Room Pressures were  
+20.5pa to +22.0**



**Sheet Metal Box Installed on  
Top of an Old CAR**



**Sheet Metal Box in the Attic  
Sealed and Insulated**



**Sheet Metal Box in the Attic  
for Jumper Ducts**



**Ducts are Sealed With  
Mastic from Inside the Box**



**Register Installed over  
Sheet Metal Box**



### Ducts Installed from Metal Box to Each Bed Room



### Registers Installed In Each Room Connected to Ducts



### After Restricting Kitchen Fan Ducting

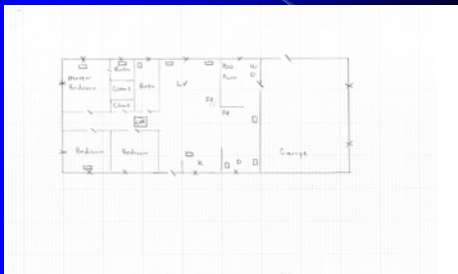


Worst Case at 1<sup>st</sup> Floor FP  
-2.8pa & Base FP -1.5 Room  
Pressures are +2.0pa - +3.2pa

### Single Story House w/Crawl Space & Attached Garage



### Housing Floor Plan



### Gas Furnace & H2O Heater Inside Heated Area Pre/Post Draft



**Measuring Draft Under Worst Case Depressurization**



**House with Kitchen, 2 Bath Exhaust Fans & Dryer in Combustion Zone**



**House Has Two Fireplaces**



**Measuring Worst Case at Each Fireplace @ -8.3pa**



**Room Pressures +14.2pa - +6.8pa**



**Installing Returns in Bedrooms to Correct Worst Case**



## Return Ducts Installed From the Main CAR Trunk



## Return Ducts to the Bedrooms



## Registers Connected to the New Cold Air Returns



## Results of Worst Case After Returns Installed in Bedrooms

1. Room Pressures average +2pa
2. Master Bedroom w/Bath +3.1pa
3. Worst Case at Fireplaces -2.8pa
4. Draft in Gas Water Heater only under Worst Case -4.1pa
5. Draft in Gas Furnace only under Worst Case -6.4pa
5. Draft in Gas Furnace and Water Heater under Worst Case -8.5pa
- Worst Case at Fireplaces -2.2

## Pressure Balancing Summary

Complete Air Sealing & Duct Sealing before attempting to Pressure Balance a house

Pre Testing can give indications that Pressure Balancing will be needed at work is completed

Health & Safety issues are a major concern for conducting Pressure Balancing

Testing & Repairs are intended to product a Healthy, Safe, Durable, Comfortable & Energy Efficient Structure