Air Leakage and Blower Door Basics

New River Center for Energy Research and Training
A Division of Community Housing Partners

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)

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**

Air Leakage Basics

- Direct Leakage = occurs at direct openings to outdoors. Leakage *enters and exits at same location (Examples)*
- Indirect Leakage = *Leakage enters at one location moves through building cavities and exits out in a different location. (Examples)*

Air Leakage Basics

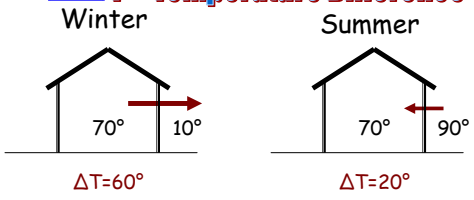
- Infiltration = Air leaking in
- Exfiltration = Air Leaking out
- Ventilation = Controlled Air leakage

Driving Forces

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

•The bigger the ▲T or ▲P the greater the air and heat flow

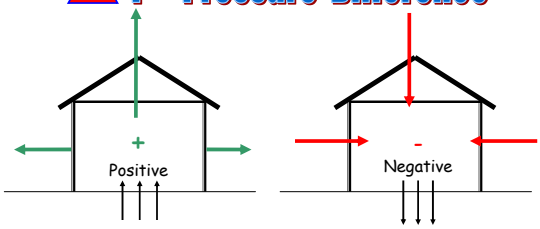
T = Temperature Difference



Flow is from Hot to Cold.

The higher ΔT the (More) heat and air wants to escape or enter the building

P = Pressure Difference



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

For every cfm that Enters one cfm Exits.

Flow takes path of Least resistance.

Driving Force Types

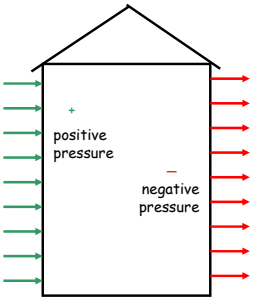
- Wind
- Heat
  - Stack Effect, Combustion
- Fans
  - Exhaust Fans, Duct Leakage, Interior Doors

Driving Forces — Wind Effect

Wind Direction

Wind creates a positive pressure on the windward side of the building…

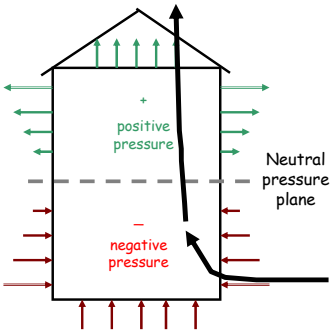
which creates a negative pressure on the other sides of the house

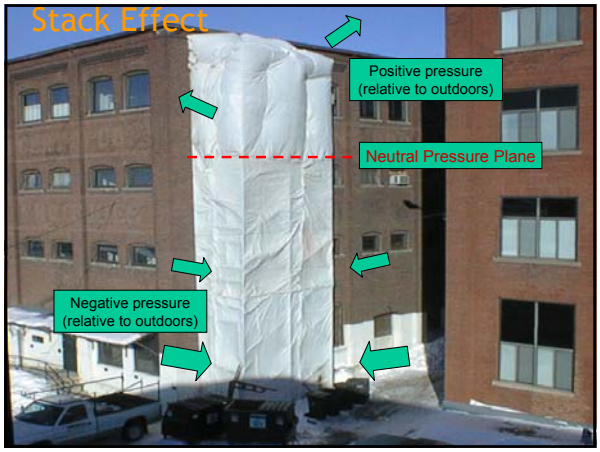


Driving Forces — Stack Effect

Warmer air rises and pushes out at the top….

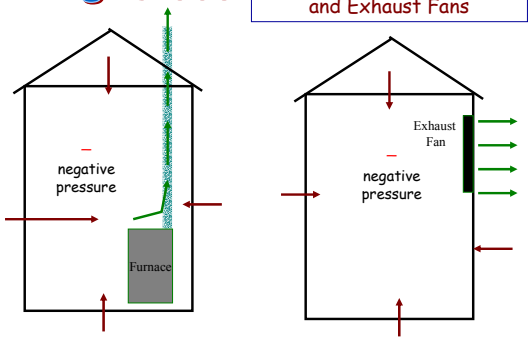
Creating a suction that pulls in cooler air at the bottom





Driving Forces

Combustion Equipment and Exhaust Fans



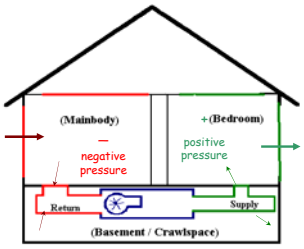
Driving Forces

Duct Leakage

Duct leakage can create positive and negative pressures in different areas of the home.

The pressures associated with duct leaks can be larger and more important because the driving force is bigger.

All holes are not created equal.

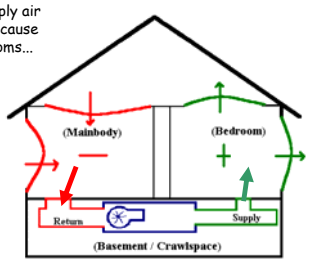


Driving Forces

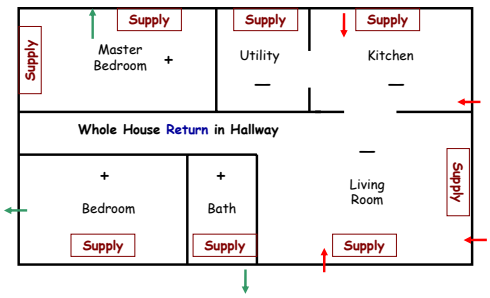
Interior Door Closure

Closed doors that prevent supply air from getting back to a return cause **positive** pressures in those rooms…

Meanwhile starving the return for air, causing **negative** pressures in the zone where the return is located



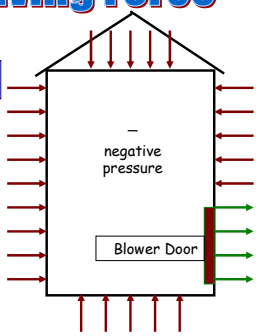
Driving Forces



Controlled Driving Force

"Blower Door" Effect

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



What Do We Measure?

- Not total pressure, but pressure differences between one space and another
- Always one pressure with reference to (WRT) another
- Sometimes we measure pressures under controlled, artificial conditions, sometimes under normal operating conditions

Pressure Difference Between Zones

- One zone will be High Pressure
- One zone will be Low Pressure
- (High Pressure moves to Low Pressure)
- Blower Door Depressurizes home to a standard of -50 pascals

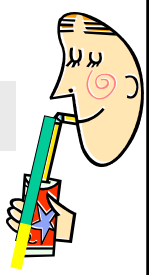
Units for Measuring Pressure

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



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

How Do We Measure

- A calibrated gauge that has pressure channels/ports that are used to measure Pressure and Air Flow

Magnahelic Gauge
Round Gauge with arch-shaped scale

Digital Manometer
Gives readings on digital screen

DG-700 Digital Manometer ™

Automated Performance Testing (APT) System

Uses computer software to take measurements

Blower Door Testing

This test is used to locate and quantify air leakage by using a calibrated fan to depressurize a house.

Measuring Building Air Leakage

- Natural Driving Forces –
  Air leakage not measurable because pressure differences are small and variable

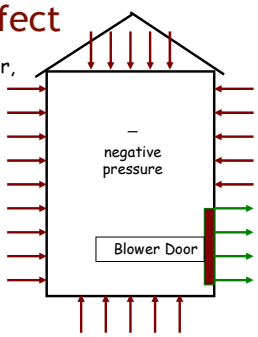
- Blower Door –
  Air leakage is measurable with the Blower Door because the pressure difference is Larger and Steady.

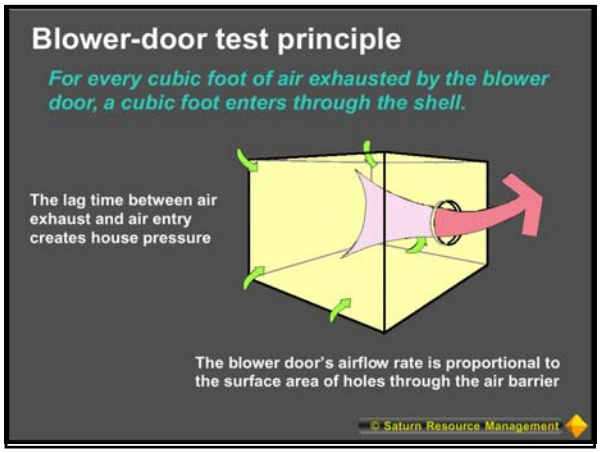
  (Like putting 20mph wind on all sides of House)

"Blower Door" Effect

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





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.

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)

Blower Door, Things to Know

- Low Flow Rings (Measure Air Leakage tighter homes)
- CRF (Can't Reach Fifty)
- Check Flow Sensors
- Outside Reference Hose at least 5 feet away from Fan

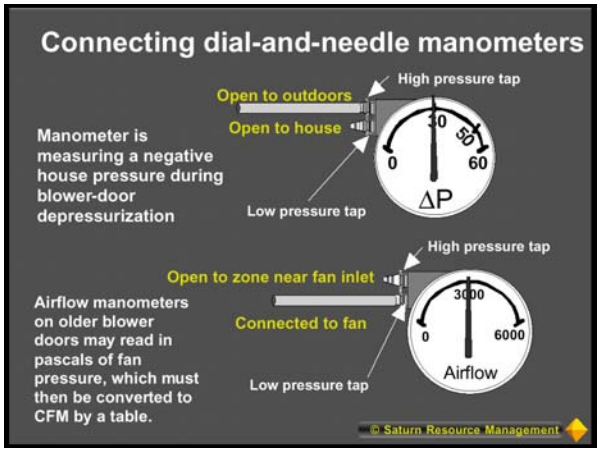
House Pressure
House WRT Outside

MUST Zero Gauge each time use

MUST use in Vertical Position

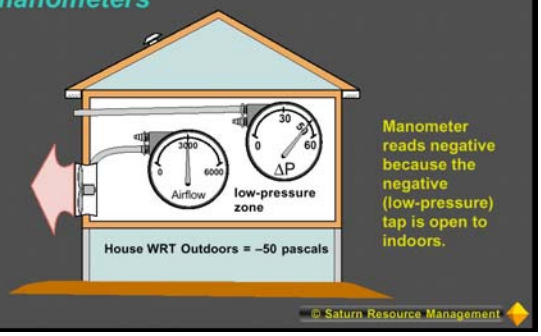
Fan Pressure
Fan WRT House

Connecting dial-and-needle manometers



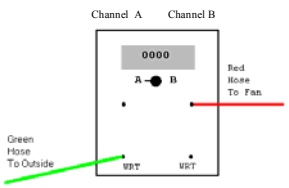
Blower-door depressurization

Connecting dial-and-needle manometers



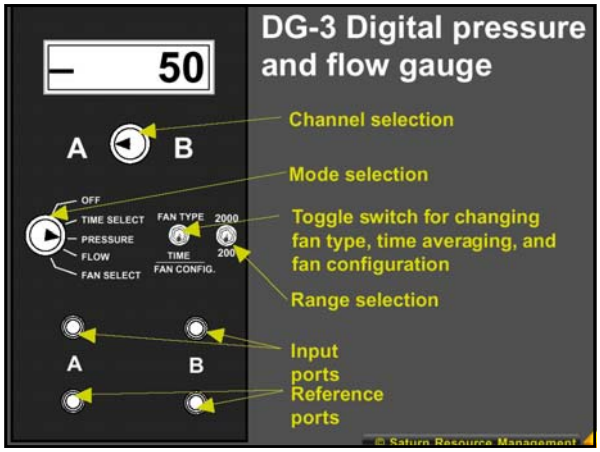
Blower Door Setup w/ Manometer

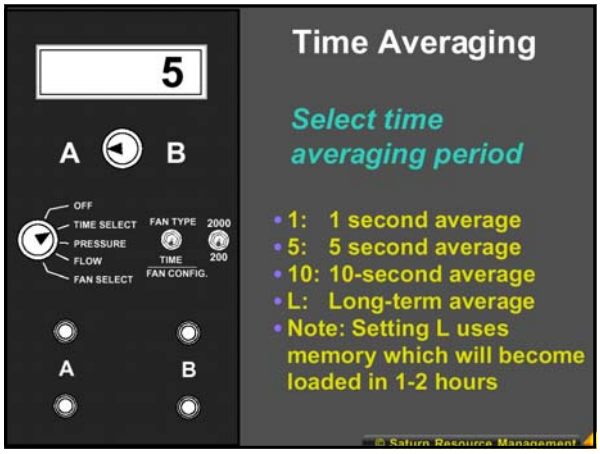
Blower Door Test



(Get **House** up to **-50 PA** on Channel A)
(Then Flip to Channel B to read Fan Flow)

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


– 50
A
B
OFF
TIME SELECT
PRESSURE
FLOW
FAN SELECT
FAN TYPE
2000
TIME
200
FAN CONFIG.
A
B
DG-3 Digital pressure and flow gauge
Channel selection
Mode selection
Toggle switch for changing fan type, time averaging, and fan configuration
Range selection
Input ports
Reference ports
© Saturn Resource Management


5
A
B
OFF
TIME SELECT
PRESSURE
FLOW
FAN SELECT
FAN TYPE
2000
TIME
200
FAN CONFIG.
A
B
Time Averaging
Select time averaging period
• 1: 1 second average
• 5: 5 second average
• 10: 10-second average
• L: Long-term average
• Note: Setting L uses memory which will become loaded in 1-2 hours
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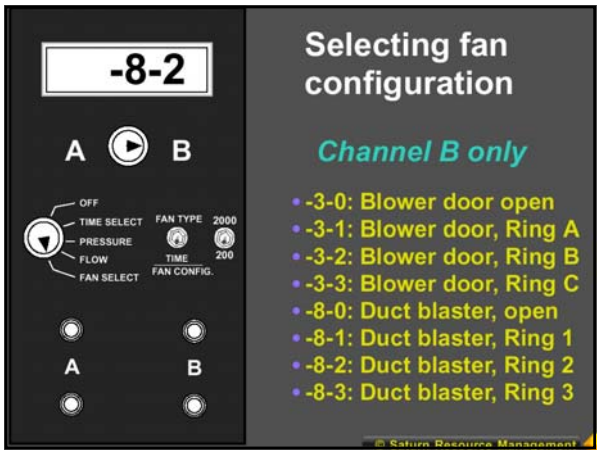
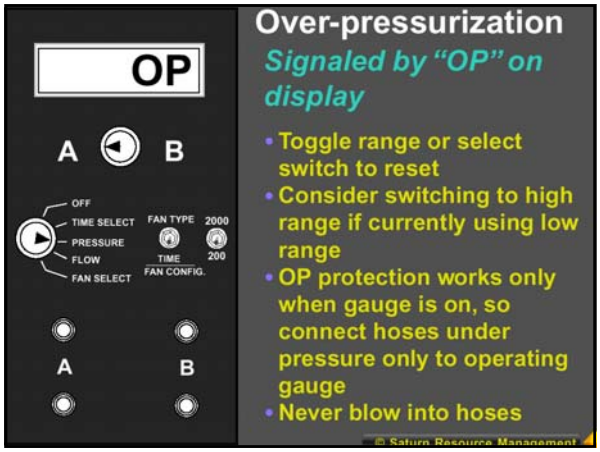

-8-2
A
B
OFF
TIME SELECT
PRESSURE
FLOW
FAN SELECT
FAN TYPE
2000
TIME
200
FAN CONFIG.
A
B
Selecting fan configuration
Channel B only
• -3-0: Blower door open
• -3-1: Blower door, Ring A
• -3-2: Blower door, Ring B
• -3-3: Blower door, Ring C
• -8-0: Duct blaster, open
• -8-1: Duct blaster, Ring 1
• -8-2: Duct blaster, Ring 2
• -8-3: Duct blaster, Ring 3
© Saturn Resource Management



Over-pressurization

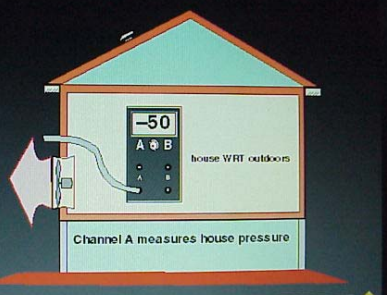
Signaled by "OP" on display

- Toggle range or select switch to reset
- Consider switching to high range if currently using low range
- OP protection works only when gauge is on, so connect hoses under pressure only to operating gauge
- Never blow into hoses

Blower door test

Using a digital manometer

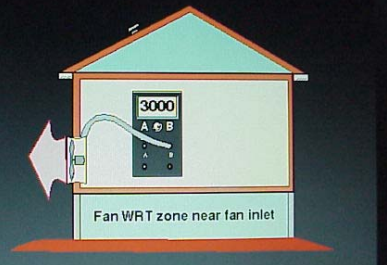
The digital manometer's reference port is always connected to the reference zone which is usually outdoors. The digital manometer tells both quantity and sign (+ or –).



Blower door airflow measurement

Channel B measures airflow

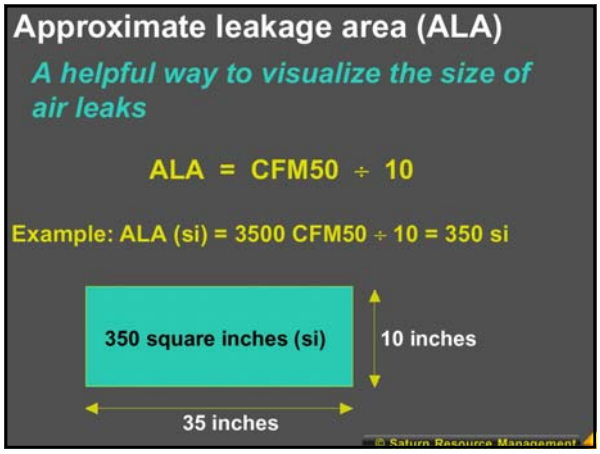
Airflow is measured in cubic feet of air per minute, abbreviated CFM. The blower door's particular airflow reading is often expressed as CFM50 or CFM at 50 pascals of house pressure.



Record Blower Door Readings

BLOWER DOOR TESTING

	CFM	PA	Ring Configuration	Can't Reach 50 Factor	CRF Converted CFM	Location	Wind	Temp IN	Temp OUT
PRE	3450	50	Open A B	None	3450	Kitch	Calm	70	45
POST			Open A B						



Measuring CFM (Tightness of House)

- Fan Pressure is converted from Pascals to Cfm (Cubic Feet pre Minute)
- MVR (Minimum Ventilation Rate) or BTL (Building Tightness Limit)
- Target (Maximum Ventilation Rate)

Target

- Figure Volume of House (L x W X H) (36L x 24W x 8'H)= 6912 cu ft
- Pre Test CFM 50 5432
- Find Volume and Cfm 50 on Target Chart *(Round up)*

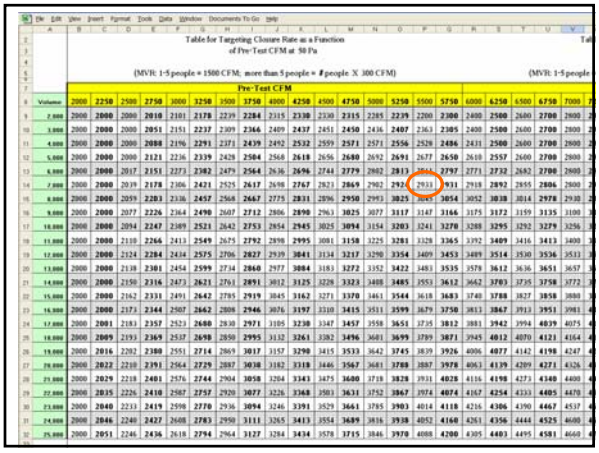


Table for Targeting Closure Rate as a Function of Pre-Test CFM at 50 Pa

(MVR: 1-5 people = 1500 CFM; more than 5 people = # people X 300 CFM)

(MVR: 1-5 people

Volume	Pre-Test CFM																				
	2000	2250	2500	2750	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000	6250	6500	6750	7000
2,000	2000	2000	2000	2010	2101	2178	2239	2284	2315	2330	2330	2315	2285	2239	2200	2300	2400	2500	2600	2700	2800
3,000	2000	2000	2000	2051	2151	2237	2309	2366	2409	2437	2451	2450	2436	2407	2363	2305	2400	2500	2600	2700	2800
4,000	2000	2000	2000	2088	2196	2291	2371	2439	2492	2532	2559	2571	2571	2556	2520	2486	2431	2500	2600	2700	2800
5,000	2000	2000	2000	2121	2236	2339	2428	2504	2568	2618	2656	2680	2692	2691	2677	2650	2610	2557	2600	2700	2800
6,000	2000	2000	2017	2151	2273	2382	2479	2564	2636	2696	2744	2779	2802	2813	2811	2797	2771	2732	2682	2700	2800
7,000	2000	2000	2039	2178	2306	2421	2525	2617	2698	2767	2823	2869	2902	2923	2933	2931	2918	2892	2855	2806	2800
8,000	2000	2000	2059	2203	2336	2457	2566	2667	2775	2831	2896	2950	2993	3025	3045	3054	3052	3038	3014	2978	2930
9,000	2000	2000	2077	2226	2364	2490	2607	2712	2806	2890	2963	3025	3077	3117	3147	3166	3175	3172	3159	3135	3100
10,000	2000	2000	2094	2247	2389	2521	2642	2753	2854	2945	3025	3094	3154	3203	3241	3270	3288	3295	3292	3279	3256
11,000	2000	2000	2110	2266	2413	2549	2675	2792	2898	2995	3081	3158	3225	3281	3328	3365	3392	3409	3416	3413	3400
12,000	2000	2000	2124	2284	2434	2575	2706	2827	2939	3041	3134	3217	3290	3354	3409	3453	3489	3514	3530	3536	3533
13,000	2000	2000	2138	2301	2454	2599	2734	2860	2977	3084	3183	3272	3352	3422	3483	3535	3578	3612	3636	3651	3657
14,000	2000	2000	2150	2316	2473	2621	2761	2891	3012	3125	3228	3323	3408	3485	3553	3612	3662	3703	3735	3758	3772
15,000	2000	2000	2162	2331	2491	2642	2785	2919	3045	3162	3271	3370	3461	3544	3618	3683	3740	3788	3827	3858	3880
16,000	2000	2000	2173	2344	2507	2662	2808	2946	3076	3197	3310	3415	3511	3599	3679	3750	3813	3867	3913	3951	3981
17,000	2000	2001	2183	2357	2523	2680	2830	2971	3105	3230	3347	3457	3558	3651	3735	3812	3881	3942	3994	4039	4075
18,000	2000	2009	2193	2369	2537	2698	2850	2995	3132	3261	3382	3496	3601	3699	3789	3871	3945	4012	4070	4121	4164
19,000	2000	2016	2202	2380	2551	2714	2869	3017	3157	3290	3415	3533	3642	3745	3839	3926	4006	4077	4142	4198	4247
20,000	2000	2022	2210	2391	2564	2729	2887	3038	3182	3318	3446	3567	3681	3788	3887	3978	4063	4139	4209	4271	4326
21,000	2000	2029	2218	2401	2576	2744	2904	3058	3204	3343	3475	3600	3718	3828	3931	4028	4116	4198	4273	4340	4400
22,000	2000	2035	2226	2410	2587	2757	2920	3077	3226	3368	3503	3631	3752	3867	3974	4074	4167	4254	4333	4405	4470
23,000	2000	2040	2233	2419	2598	2770	2936	3094	3246	3391	3529	3661	3785	3903	4014	4118	4216	4306	4390	4467	4537
24,000	2000	2046	2240	2427	2608	2783	2950	3111	3265	3413	3554	3689	3816	3938	4052	4160	4261	4356	4444	4525	4600
25,000	2000	2051	2246	2436	2618	2794	2964	3127	3284	3434	3578	3715	3846	3970	4088	4200	4305	4403	4495	4581	4660

CFM 50 / CFM Natural

CFM 50 = Air Leakage with Blower Door

CFM Natural = Natural Air Leakage

To Convert CFM50

Divide CFM 50 by 20*(n factor)*
(1800 CFM50 / 20 = 90cfm natural)

VA Weatherization MVR

- Virginia uses a standard MVR of 1500cfm 50 (*for up to 5 People*)
- *ASHRAE Standard is 15cfm natural per person*
- *15cfm x 5 people x 20 (n factor) =* ***1500cfm 50***

VA Weatherization MVR *(cont)*

- **For More than 5 people** add 300CFM50 per (15 x 20)= 300cfm 50
- **6 people** *(1500 +300 = 1800)*
- **7 people** *(1500 +600 = 2100)*