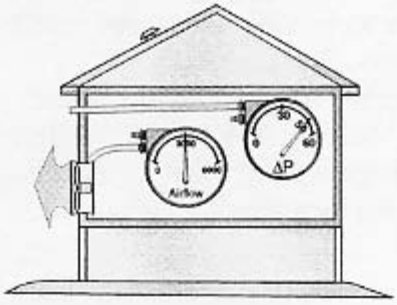
Blower-door testing

The blower door creates a 50-pascal pressure difference across the building shell and measures airflow in cubic feet per minute at 50 Pascals (CFM_{50}), in order to compare the leakiness of homes. PAWAP requires that dwelling units shall have a blower door test performed both before and after building shell weatherization retrofit. It's purpose is to help locate air leakage and to monitor the level of air tightening resulting from sealing and insulating the building shell.

The minimum blower door generated value to be obtained and documented in the client file is air flow in cubic feet of air per minute at a house pressure difference of 50 pascals (CFM_{50}).

While blower door tests based on the traditional 5 point readings are still allowable, a one point reading at 50 pascals is the minimum requirement for estimating CFM_{50}. A one point test is achieved by the interpretation of one data set, which includes one house and one fan pressure reading from the blower door gauges (Minneapolis Model 3) or the from the calibration charts provided by the Blower Door manufacturer.

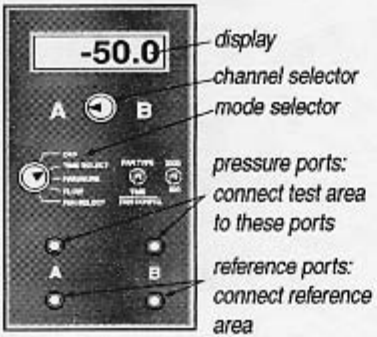
Technicians may perform as many blower door tests as they wish to monitor the progress of their air sealing work. This is encouraged. However, a minimum of one "Pre Test" and one "Post Test" must be documented in the client file.



Standard blower door test: The house is depressurized to –50 pascals and the airflow through the fan is measured.

The blower door also creates pressure differences between rooms in the house and intermediate zones like attics and crawl spaces that can give clues about the location and size of a home's air leaks. For more information on air-leak location, see *"Sealing bypasses" on page 129.*

Measuring pressure and airflow



Digital manometers: Diagnose zone pressures and duct pressures conveniently and accurately.

Connecting the manometer's hoses correctly is essential for accurate testing. A widely accepted method for communicating correct hose connection helps avoid confusion. This method uses the phrase "with reference to", "WRT", to discriminate between the input zone and reference zone for a particular measurement. The outdoors is the most commonly used reference zone for blower door testing. The reference zone is considered to be the zero point on the pressure scale. For example, *house WRT outdoors* = –50 pascals means that the house (input) is 50 pascals negative compared to the outdoors (reference or zero-point). The pressure reading in the last example is called the house-to-outdoors pressure difference.

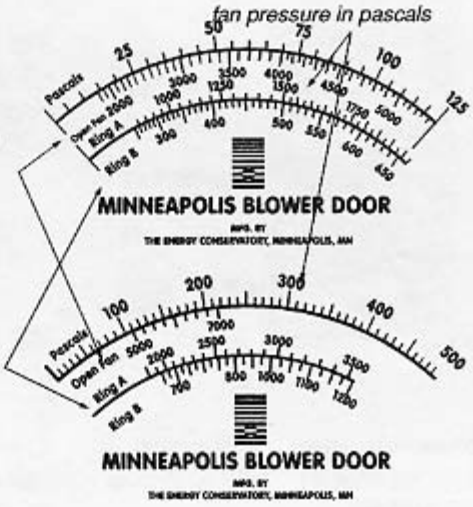
During the blower door test, the airflow is measured through the fan. This airflow is directly proportional to the surface area of the home's air leaks. For the blower door to measure airflow accurately, the air must be flowing at an adequate speed. Tighter buildings don't have enough air leakage to create an adequate airspeed. This necessitates using one of three low-flow plates provided with the blower door to reduce the fan's opening and increase air speed through the fan.

When using one of these low-flow plates, you must read the correct scale on the analog gauges, shown below. When using a digital gauge, follow the manufacturer's instructions for select-

ing the proper fan configuration corresponding to the correct low-flow plate.

Read from either of these scales when operating the blower door with the rings removed. This orientation is called "open fan."

Read from the correct scale depending on which low-flow plate, Ring A or Ring B, is installed.



Blower door analog gauges: Blower door airflow gauges provide ranges for accurate measurement of homes with a wide variety of airtightness.

Some homes are so leaky that the blower door isn't powerful enough to depressurize them to –50 pascals. In these cases, you must apply a factor to the airflow you measure at a lower pressure. Those factors are listed in *Table on page 171*. Use these factors only when absolutely necessary because they may result in inaccurate air leakage estimates.

Preparing for a blower door test

Preparing the house for a blower door test involves putting the house in its heating or cooling operating condition with all conditioned zones open to the blower door. Anticipate safety problems that the blower door could cause, particularly with combustion appliances. Understand how you will use the measurements you take during the blower door test.

- ✔ Identify location of the thermal boundary and which house zones are conditioned.

- ✔ Identify and repair large air leaks that could prevent the blower door from achieving adequate house pressure.
- ✔ Survey pollutants that may pollute the air during a blower door test—wood-stove or fireplace ashes for example.
- ✔ Put the house in its heating and/or cooling mode with windows, doors, and vents closed and air registers open.
- ✔ Turn off combustion appliances temporarily.
- ✔ Open interior doors so that all indoor areas inside the thermal boundary are connected to the blower door.
- ✔ Measure house volume if you plan to use ACH_{50} (air changes per hour at 50 pascals) or ACH_n (air changes per hour—natural).
- ✔ Ensure children and pets are at a safe distance from fan blades.

Zeroing blower door manometers

To obtain accurate blower door measurements, you must zero the manometers. The procedure for zeroing a manometer is different for analog manometers versus digital manometers. Consider these specifications for zeroing these two types of manometers.

- *Analog manometer:* Block the blower door's opening to prevent ambient airflow through the fan. Make sure that the house-pressure hose is connected to outdoors and that the fan hose is disconnected. Tap each gauge face with your finger to make sure that the needle isn't stuck. Use the adjustment screw on the face of the dial to set the needle at exactly zero.
- *Digital manometer:* Block the blower door's opening to prevent ambient airflow through the fan. Make sure that the house-pressure hose is connected to outdoors and that the fan hose is disconnected. Measure the house pressure with the blower door off. If you read a positive house pressure of a few pascals with reference to outdoors, add those pascals to 50 pascals and set the house pressure at 50+ pascals to get your accurate airflow (CFM50). If you read a nega-

tive house pressure with reference to outdoors, subtract those pascals from 50 pascals, and then set the blower door to produce 50 pascals to get your accurate airflow.

Blower door test procedures

Follow these general instructions when performing a blower-door test.

1. Install blower door frame, panel, and fan in an exterior doorway with a clear path to outdoors.
2. Follow manufacturer's instructions for fan orientation and manometer setup for either pressurization or depressurization.
3. Connect the house-pressure manometer to measure house WRT outdoors.
4. Connect the airflow manometer to measure fan WRT zone near fan inlet. The zone near the fan inlet is indoors for depressurization and outdoors for pressurization.
5. Make pretest adjustments to manometers following manufacturer's instructions. Zero manometers as described previously.
6. Turn on the fan and increase its speed until you read 50 pascals of pressure difference between indoors and outdoors.
7. Read the CFM_{50} from the airflow manometer or from the second channel of a two-channel digital manometer.
8. If the house cannot be depressurized to –50 pascals, depressurize to highest multiple of 5 and multiply your measured airflow by the "can't reach 50" (CRF) factors in the conversion table shown here.

'Can't Reach Fifty' Factors

House Pressure	15	20	25	30	35	40	45
Can't Reach 50 Factor	2.2	1.8	1.6	1.4	1.3	1.2	1.1

Thanks to The Energy Conservatory

Note: See sections 1.1.3 and 1.1.4 of the Pennsylvania Weatherization Field Standards if this is confusing to you.

Post blower-door test essentials

Be sure to return all temporary measures, taken to facilitate the blower door test, to their original condition.

- ✔ Inspect all pilot lights of combustion appliances to ensure that blower door testing did not extinguish them.
- ✔ Reset thermostats of heaters and water heaters that were turned down for testing.
- ✔ Remove temporary plugs, installed to increase house pressure, and make air seals permanent.

Fan Pressure and Airflow for MN Blower Door Model 3

Fan Pressure	Open fan	Ring A	Ring B	Fan Pressure	Open fan	Ring A	Ring B	Fan Pressure	Ring A	Ring B
20	2130	790	260	135	5620	2030	680	250	2750	930
25	2390	880	290	140	5730	2060	690	255	2770	940
30	2620	970	320	145	5930	2100	710	260	2800	950
35	2830	1040	350	150	5930	2140	720	265	2830	960
40	3030	1110	370	155	6030	2170	730	270	2850	960
45	3220	1180	390	160	6130	2200	740	275	2880	970
50	3390	1240	410	165	6220	2240	750	280	2900	980
55	3560	1300	430	170	6320	2270	760	285	2930	990
60	3720	1360	450	175		2300	780	290	2950	1000
65	3880	1420	470	180		2340	790	295	2980	1010
70	4030	1470	490	185		2370	800	300	3000	1020
75	4170	1520	510	190		2400	810	305	3030	1030
80	4310	1570	420	195		2430	820	310	3050	1030
85	4440	1620	540	200		2460	830	315	3080	1040
90	4580	1660	560	205		2249	840	320	3100	1050
95	4700	1710	570	210		2520	850	325	3120	1060
100	4830	1750	590	215		2550	860	330		1070
105	4950	1790	600	220		2580	870	335		1070
110	5070	1830	610	225		2610	880	340		1080
115	5180	1870	630	230		2640	890	345		1090
120	5290	1910	640	235		2660	900	350		1100
125	5410	1950	650	240		2690	910	360		1110
130	5510	1990	670	245		2720	920	370		1130

Building tightness limits (BTL)

Air leakage must provide fresh outdoor air when no mechanical ventilation system exists because the air leaks are the home's only means of fresh air intake and pollutant removal. Follow one of these two procedures to determine the building tightness limit (BTL).

BTL from table

Use this table to determine building tightness limits.

Building tightness limits (CFM_{50})

Wind shielding	Number of stories				
	1	1.5	2	2.5	3
5 Occupants					
Shielded	1670	1500	1340	1230	1160
Normal	1390	1250	1110	1030	980
Exposed	1250	1130	1000	920	880
6 Occupants					
Shielded	2000	1800	1600	1480	1400
Normal	1670	1500	1330	1230	1170
Exposed	1500	1350	1200	1110	1050
7 Occupants					
Shielded	2330	2100	1870	1720	1630
Normal	1940	1750	1550	1440	1370
Exposed	1750	1580	1400	1290	1230
8 Occupants					
Shielded	2660	2400	2140	1970	1860
Normal	2220	2000	1780	1640	1560
Exposed	2000	1800	1600	1480	1400

BTL from house volume

Or, use the following simple formula to determine the building tightness limit (BTL).

$$\text{BTL CFM}_{50} = \frac{0.35 \times \text{volume} \times \text{NCF}}{60}$$

Refer to the following table for the Natural Conversion Factor (NCF) to use in these formulas. The NCF value is a calculated correction factor to convert between airflow at 50 pascals and airflow at natural conditions.

NCF-Values According to Height and Shielding

Wind Shielding	Number of Stories				
	1	1.5	2	2.5	3
Shielded	22.2	20.0	17.8	16.4	15.5
Normal	18.5	16.7	14.8	13.7	13.0
Exposed	16.7	15.0	13.3	12.3	11.7

If the existing CFM_{50} is near or below the BTL, air sealing is not an energy-conservation priority. Air sealing, however, may still be important to prevent the flow of pollutants and humid air.

Pollution control

Pollution control and ventilation also may be priorities for homes testing below the BTL. The importance of pollution control and ventilation depend on answers to the following questions.

- Are sources of moisture like ground water, humidifier, water leaks, unvented clothes dryer, or unvented space heater causing indoor air pollution, high relative humidity,

or moisture damage? See *"Solutions to moisture problems" on page 40.*

- Do occupants complain or show symptoms of building-related illnesses?

Pollutant sources combined with tight houses produce poor indoor air quality. Educate residents about removing pollution sources and ventilating their homes. Take appropriate steps during weatherization to reduce pollutants and to install mechanical ventilation if needed. See *"Mechanical ventilation" on page 42* for more information.