Slide 1

The Blower Door and Duct Leakage Basics

AIRTIGHTNESS VERIFIED

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Overview

- Blower Door and Building Code
- Blower Door Basics
- Duct Leakage Testing and Building Code
- Duct Leakage Testing Basics

Things we will be discussing: Blower door testing and code, The building set up, Equipment set up, Duct Leakage testing

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2015 IECC

- R402.4.1.2 Testing
  - 3 air changes per hour (ACH50) in CZ 3 - 8.
  - Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascal's).
  - Code Official determines if third party is required to conduct test, and who is qualified to conduct the test
  - A written report of the results signed by the party conducting the test and provided to the code official.
  - Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*.

Blower door testing limits according to 2015 IECC. 3 ACH50, Following ASTM protocols, with a written report

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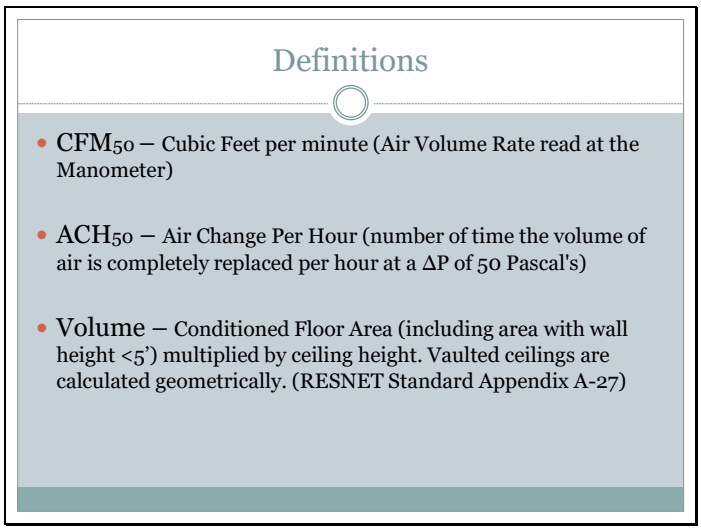

CFM50 – Blower door Test Result
ACH50 – Accounting for Building Volume
Volume – Fill the house with water

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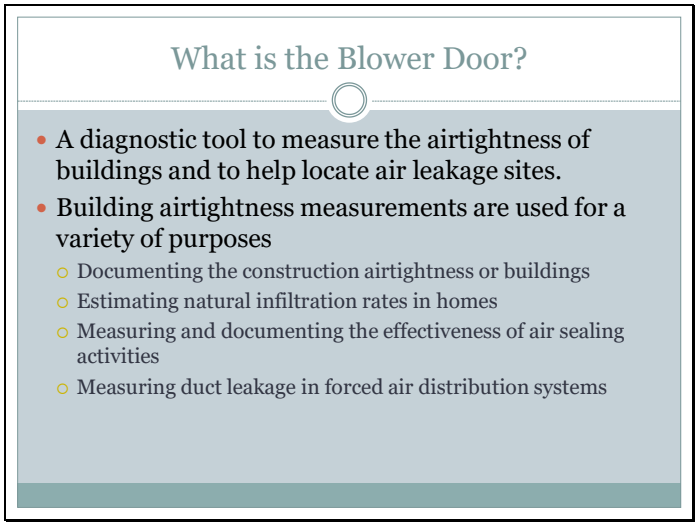

Variable speed fan and Manometer system that quantifies building envelope leakage by creating a differential pressure. It results in forced infiltration / exfiltration.
A diagnostic tool to measure the airtightness of buildings and to help locate air leakage sites.
Building airtightness measurements are used for a variety of purposes

- Documenting the construction airtightness or buildings
- Estimating natural infiltration rates in homes
- Measuring and documenting the effectiveness of air sealing activities
- Measuring duct leakage in forced air distribution systems

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Formula

$$ACH_{50} = \frac{CFM_{50} \times 60^{min}/_{hour}}{\text{Conditioned Volume}}$$

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Preparing the Building

E1827 – 11

TABLE 1 Recommended Test Envelope Conditions

Building Component	Envelope Conditions	
	Occupied (Default)	Closed
Vented combustion appliance	Off	Off
Pilot light	As found	As found
Flue to nonwood combustion appliance	Sealed	No preparation
Flues for fireplaces and wood stoves with dampers	Closed	Closed
Flues for fireplaces and wood stoves without dampers	Ashes removed	Ashes removed
Fireplace and wood stove doors and air inlet dampers	Closed	Closed
Fireplace without firebox doors	No preparation	No preparation
Furnace room door for furnace outside test zone	Closed	Closed
Combustion air intake damper for wood stove or fireplace	Closed	Closed
Make up air intake damper for furnace inside test zone	Sealed	Closed
Make up air intake for furnace inside test zone without damper	Sealed	No preparation
Exhaust and supply fans	Off	Off
Fan inlet grills with motorized damper	Closed	Closed
Fan inlet grills without motorized damper	Sealed	No preparation
Ventilators designed for continuous use	Sealed	Sealed
Supply and exhaust ventilator dampers	Sealed	Held closed
Clothes dryer	Off	Off
Clothes dryer vent	No preparation	No preparation
Ventilation to other zones	Sealed	Sealed
Windows and exterior doors	Latched	Latched
Window air conditioners	Sealed	No preparation
Openings leading to outside the test zone	Closed	Closed
Openings within the test zone	Open	Open
Floor drains and plumbing traps	Filled	Filled

Put house in wintertime conditions. Only thing you are allowed to completely seal off is an HRV/ERV system supply and exhaust.

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Items to check before testing




Photo 1 – Rough in Blower Door test – plumbing traps
Photo 2 – All windows are locked. Put hands on every window as they can appear closed but the latch is pushing apart the sashes.
Photo 3 – Fireplace condition – extinguished, no ashes, flue closed
Photo 4 – Air handlers are off, and will not come on during test
Not pictured – Water Heater – Check pilot after test

Slide 9

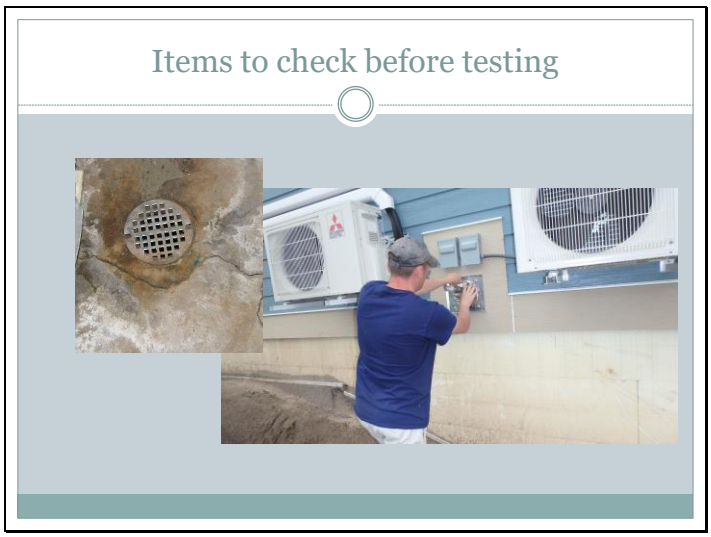

Photo 1 – Floor Drain – may be dried out, fill before test
Photo 2 – Continuously operating HRV/ERV supply and exhaust

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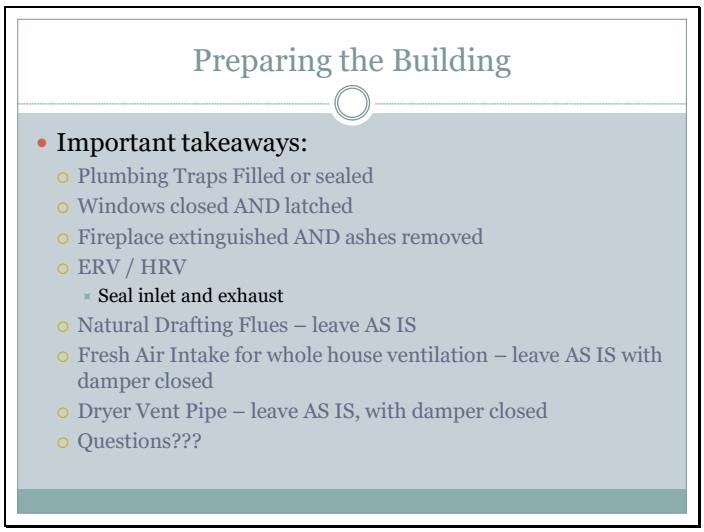

Spirit of the test – Test the house for air leaks the occur naturally when mechanical systems are not running

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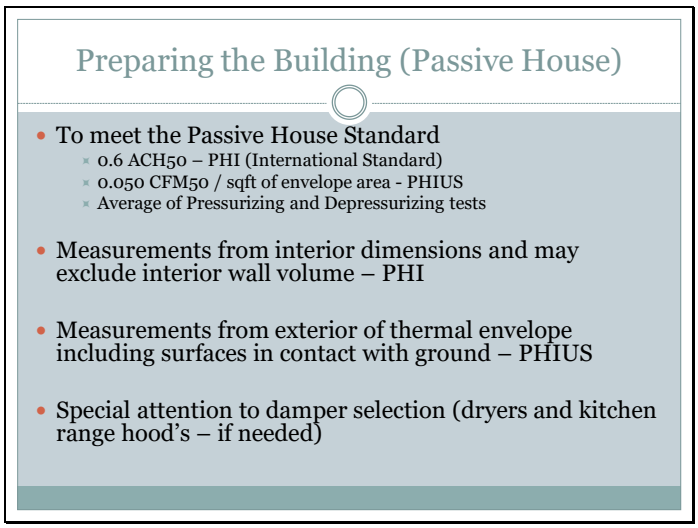

What you may see in the near future – Passive House Blower Door results, more stringent testing requirements than ASTM requirements

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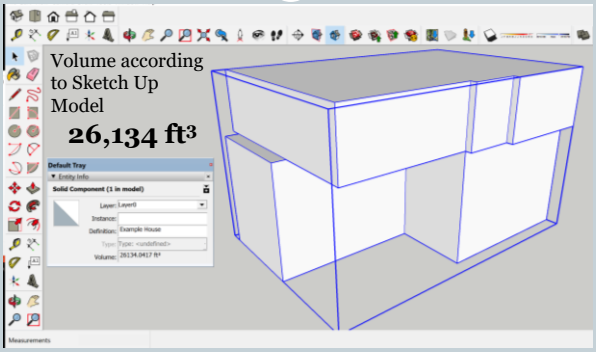
Example House



Run through an example house – 2 story colonial with a full basement. The 2nd floor is built out over the garage.

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Blower Door Test Walk Though

- Before arriving for test:
  - Calculate the volume from Prints or verify in field prior to starting test – 26,134 ft3

$$ACH_{50} = \frac{CFM_{50} \times 60\ {}^{feet}/_{hour}}{\text{Conditioned Volume}} \qquad CFM_{50} = \frac{ACH_{50} \times \text{Volume}}{60}$$

3 ACH50	0.6 ACH50
NYS Code	Passive House
1307 CFM_{50}	261 CFM_{50}

Calculating the volume before arrival will ensure "fudging the volume numbers" before test is prevented.

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Ring Selection

Blower Door Rings

Fan Configuration	Flow Range (cfm) for Model 3 Fan	Flow Range (cfm) for Model 4 Fan
Open (no Flow Ring)	5,100 - 3,435	4,850 - 2,090
Ring A	2,800 - 915	2,500 - 790
Ring B	1,100 - 300	900 - 215
Ring C	330 - 85	260 - 45
Ring D	115 - 30	125 - 30
Ring E	45 - 11	50 - 11

Duct Blaster Rings

Flow Ring Configuration	Flow Range (CFM)	Minimum Fan Pressure (Pa)
Open (no Flow Ring) *	1,500 – 600	25 Pa
Ring 1	800 – 225	25 Pa
Ring 2	300 – 90	25 Pa
Ring 3	125 – 10	3 Pa

Just be aware that different systems from different manufacturers have different ring limits

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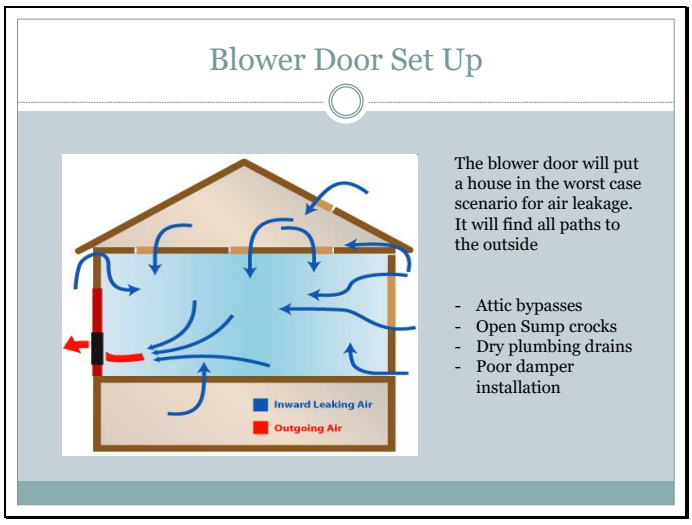

Just be aware that different systems from different manufacturers have different ring limits

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Choose a door out of the wind, that goes directly outside (garage doors can be used but are not ideal)

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Open Door, open storm door

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Assemble Frame, rough size frame into door opening, outdoor pressure hose is placed away from fan (around a corner)

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Install canvas door over frame

Slide 20

Install door and lock cam's to tighten the fit

Slide 21

Bring in pressure hose

Slide 22

Install fan into canvas opening

Slide 23

Install frame cross bar to support fan

Slide 24

Manometer board installed onto frame (optional)

Slide 25

Connect pressure hose to blower door fan pressure port

Slide 26

Connect hoses outdoor hose and fan hose to manometer (Outside hose to the reference port on left side, and fan hose to input port on right side)

Slide 27

Connect power cord and controller

Slide 28

Turn on manometer and set Manometer to “PR/ FL@50” then hit “baseline”
The 50 Pa pressure difference is 50 Pa greater than normal – not 50 Pa as is
In this case we will be depressurizing to -52.2 Pa

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Adjusted Pressure is 0
Select appropriate Device (Blower Door 3 is standard, Blower Door 4 is a 220V version, Duct Blaster Fans can be used as well)
Select appropriate Configuraton (Ring size)

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Outdoor view of fan

Slide 31

Outdoor hose is moved away from fan

Slide 32

Remove appropriate ring (to match manometer configuration)

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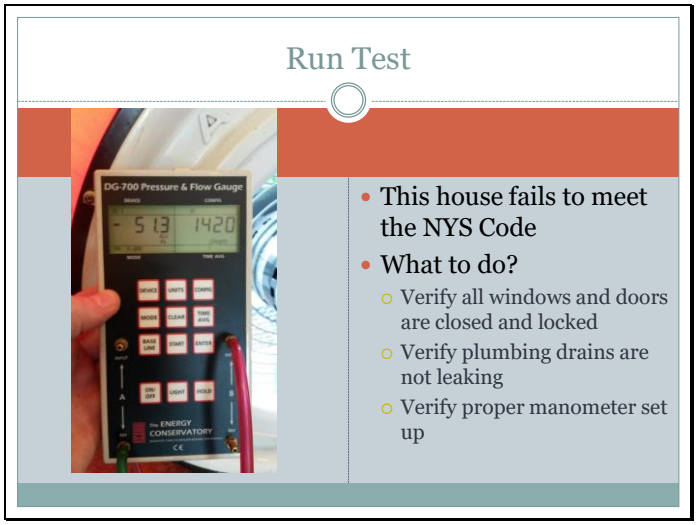

Run Test (since wind pressure is constantly changing the pressure will jump from -45.0 Pa to -55.0 Pa or more)
Our calculated limit was 1307 cfm50 – this test doesn't meet code
Tour house for inappropriate set up or simple fixes

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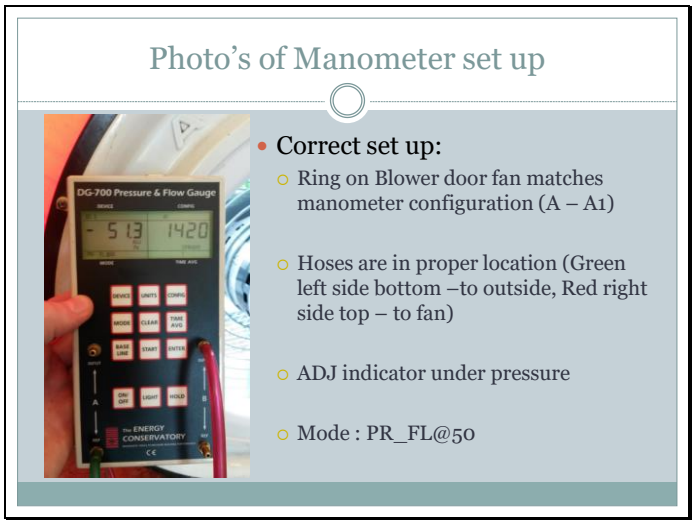

Check Manometer set up – Fan ring matches configuration ring, Hoses are in proper location, we are using the ADJ pressure, we are in the proper mode "PR_Fl@50"

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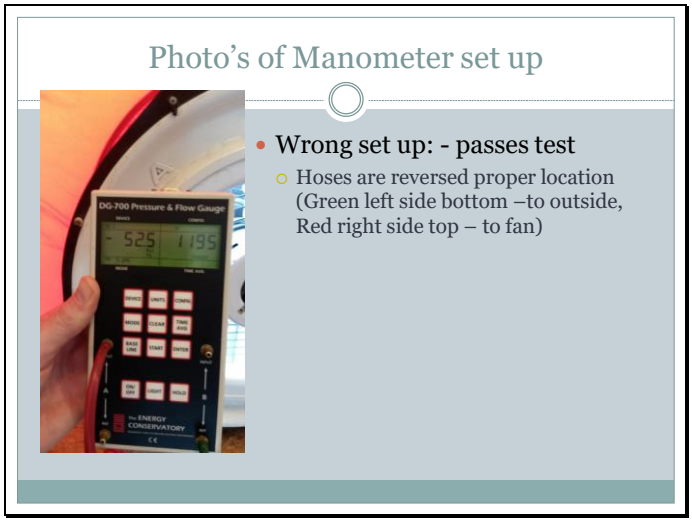

Things to watch out for: Operator Error – Switching ports significantly changes the results

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Photo's of Manometer set up

- Wrong set up: - passes test
  - Ring on Blower door fan doesn't matches manometer configuration (A – B2)

Things to watch out for: Operator Error – Incorrect configuration on Manometer – changes results significantly

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Fixing a Failing Test

- Infrared Scans
- Zonal Pressure Diagnostics
- Pressure Pan Testing

Regardless some more air sealing needs to be done

Things to watch out for: Operator Error – Incorrect configuration on Manometer – changes results significantly

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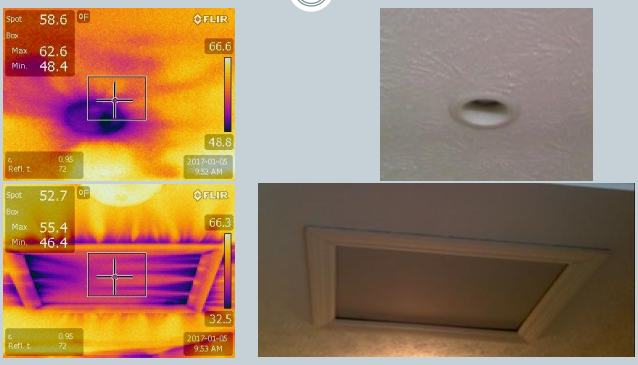
Infrared Scans



Top Photo Set – Recessed light not sealed
Bottom Photo Set – This attic hatch has a gasket. Caulk trim to ceiling, add weight to the hatch

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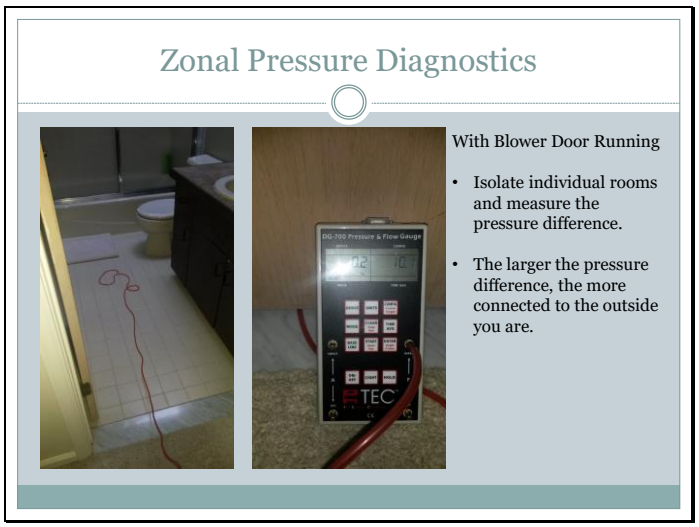

With Blower Door Running

- Isolate individual rooms and measure the pressure difference.
- The larger the pressure difference, the more connected to the outside you are.

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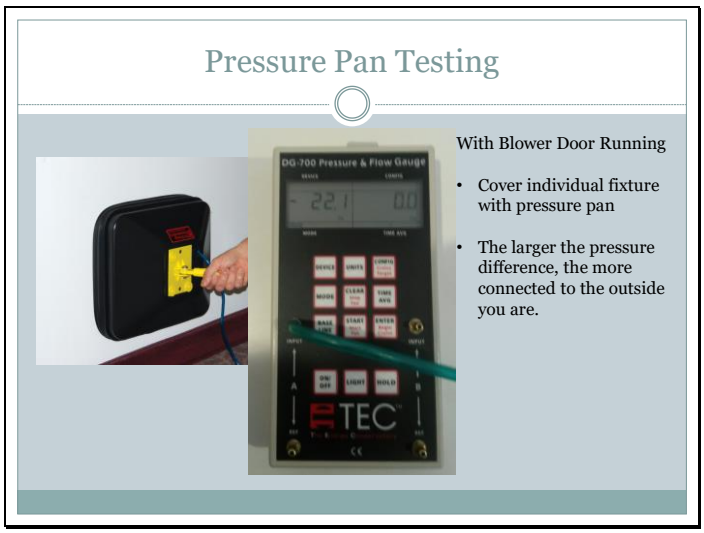

With Blower Door Running

- Cover individual fixture with pressure pan
- The larger the pressure difference, the more connected to the outside you are.

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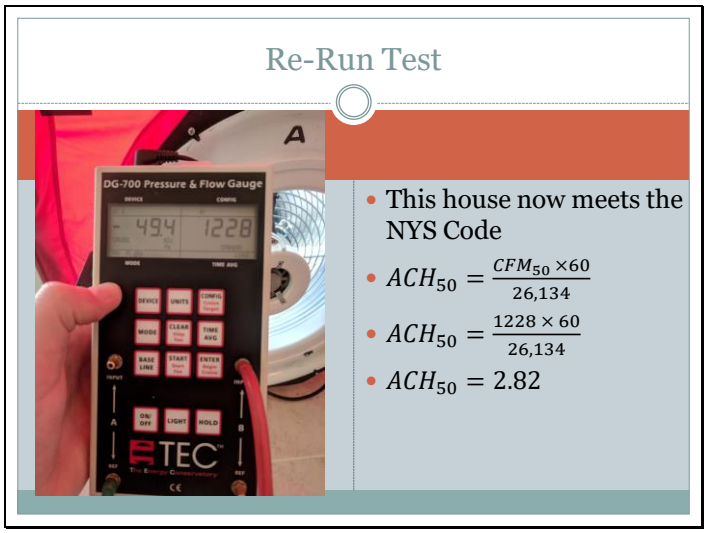

Re-Run Test after the necessary air sealing has been done
Our calculated limit was 1307 cfm50 – We have now met the code minimum.

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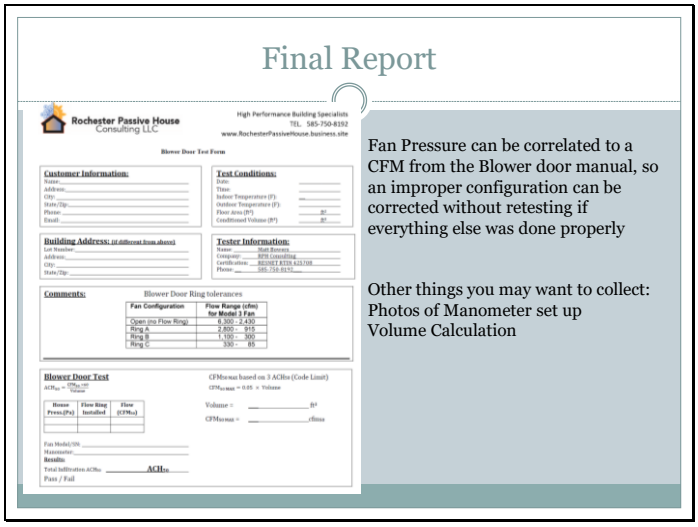

Fan Pressure can be correlated to a CFM from the Blower door manual, so an improper configuration can be corrected without retesting if everything else was done properly
Other things you may want to collect:
Photos of Manometer set up,
Volume Calculation

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Duct Leakage Testing – "Duct Blaster"
1st Photo – "smoking the system" for leaks
2nd Photo – Standard test set up

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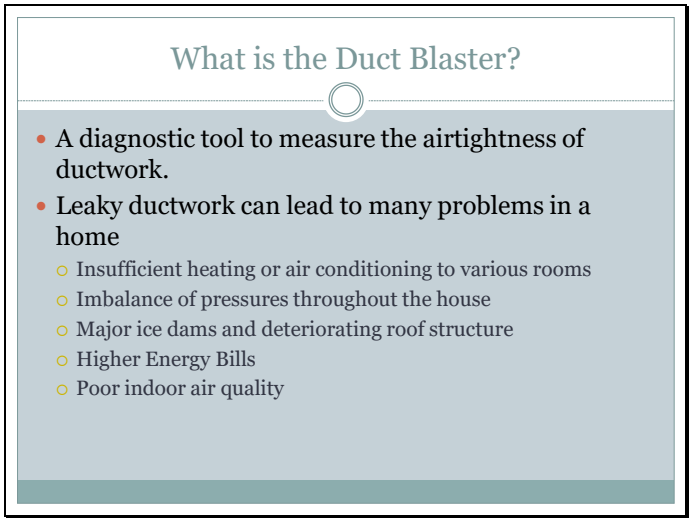
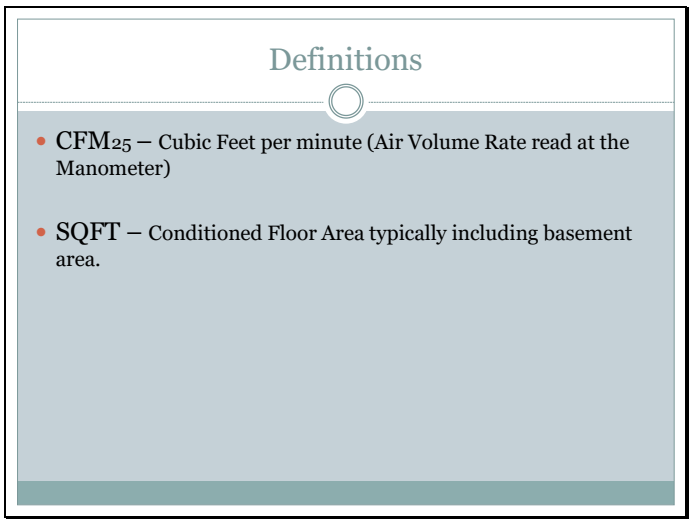


A diagnostic tool to measure the airtightness of ductwork.
Leaky ductwork can lead to many problems in a home

- Insufficient heating or air conditioning to various rooms
- Imbalance of pressures throughout the house
- Major ice dams and deteriorating roof structure
- Higher Energy Bills
- Poor indoor air quality

Slide 45



CFM25 – Duct Leakage Test Result
SQFT – conditioned area of house, typically includes the basement but excludes any floor area with walls less than 5' tall (ie: Next to a knee wall)

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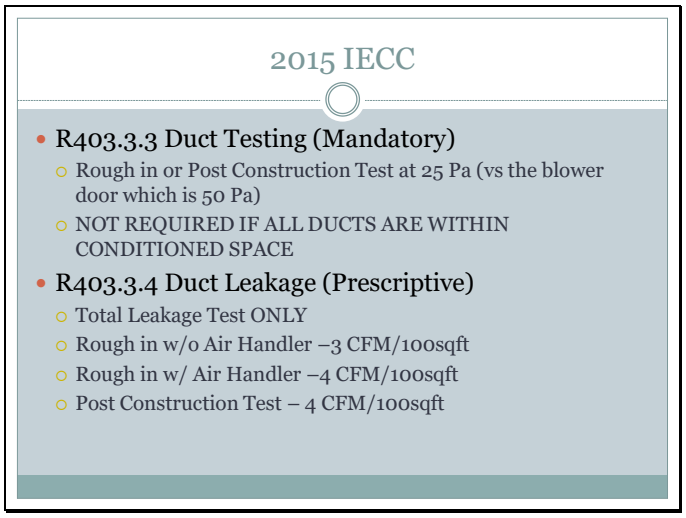

R403.3.3 Duct Testing (Mandatory)

- Rough in or Post Construction Test at 25 Pa (vs the blower door which is 50 Pa)
- NOT REQUIRED IF ALL DUCTS ARE WITHIN CONDITIONED SPACE

R403.3.4 Duct Leakage (Prescriptive)

- Total Leakage Test ONLY
- Rough in w/o Air Handler –3 CFM/100sqft
- Rough in w/ Air Handler – 4 CFM/100sqft
- Post Construction Test – 4 CFM/100sqft

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Avoiding the testing limits

- R401.2 Compliance
  - Section 405 and Mandatory items
  - An Energy Rating Index (ERI) Approach in Section R406
- When ducts are outside the conditioned space the test is required regardless, however they do not need to meet the 4 CFM/100 sqft limit.
- The test results will be part of a much larger energy model that will take offsets from more efficient parts of the house

The test will be “extremely difficult” to pass. It may be in the builder best interest to use an alternate path to compliance.

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Test Set Up

- Total Leakage Test only
  - Leakage to the outside test is not accepted for NYS Code Compliance
  - Basically a blower door test for the ductwork
- For Rough-in test without the air handler, individual tests must be done for supply and return ductwork

Total Leakage Test only

Leakage to the outside test is not accepted for NYS Code

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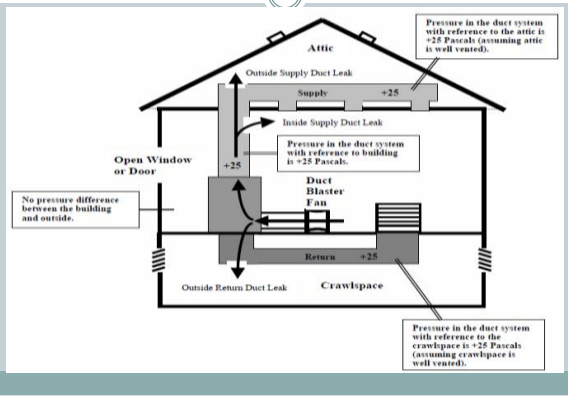
Test Set Up



Total Leakage Test only – Blower Door test for the ductwork

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Example House

1500 ft²
Slab on Grade

To meet code the Total Leakage Test must be under:

60 CFM25 (With Air Handler – 4%)

45 CFM25 (W/O Air Handler – 3%)

Run through an example house – This is a slab on grade version – if it had a basement it probably wouldn't need a test

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Test Set Up

- Turn off Air Handler
- Seal off all supply and return registers
  - For a post construction test it is best to have boots sealed to subfloor or to drywall with mastic or caulk
  - Carpeted floors present a problem getting a good seal, extra time and attention to detail is needed to seal the boot from the inside

Turn off Air Handler
Seal off all supply and return registers

For a post construction test it is best to have boots sealed to subfloor or to drywall with mastic or caulk
Carpeted floors present a problem getting a good seal, extra time and attention to detail is needed to seal the boot from the inside

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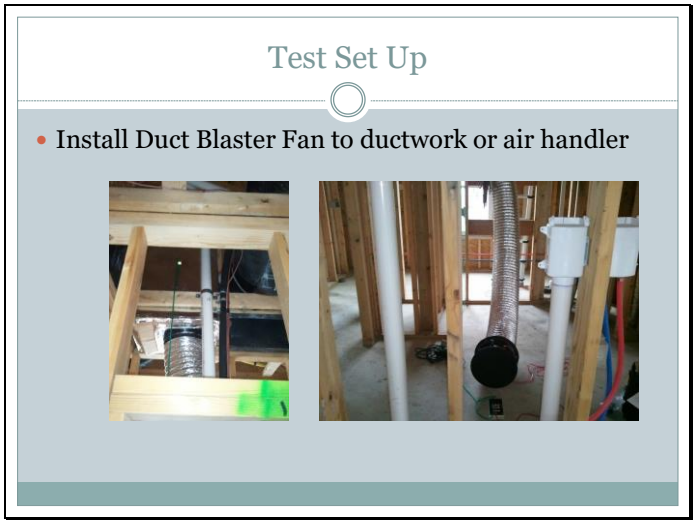

Photo 1 – Duct blaster connected to main trunk line before the air handler is installed
Photo 2 – Duct blaster fan on the floor for set up

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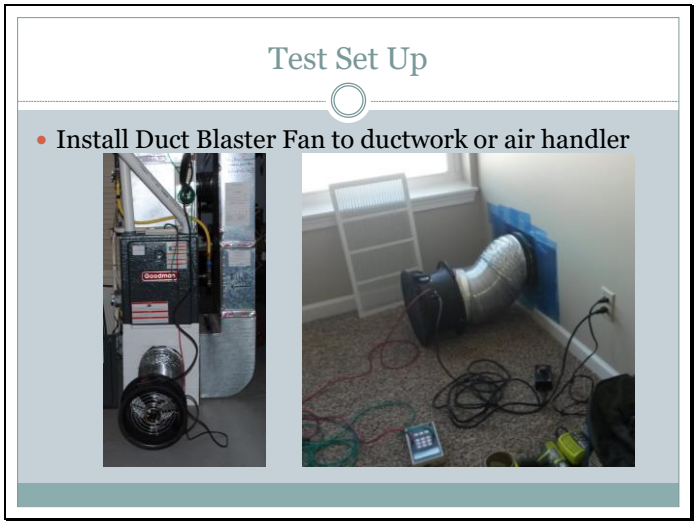

Photo 1 – Duct blaster connected to air handler
Photo 2 – Duct blaster connected to central return

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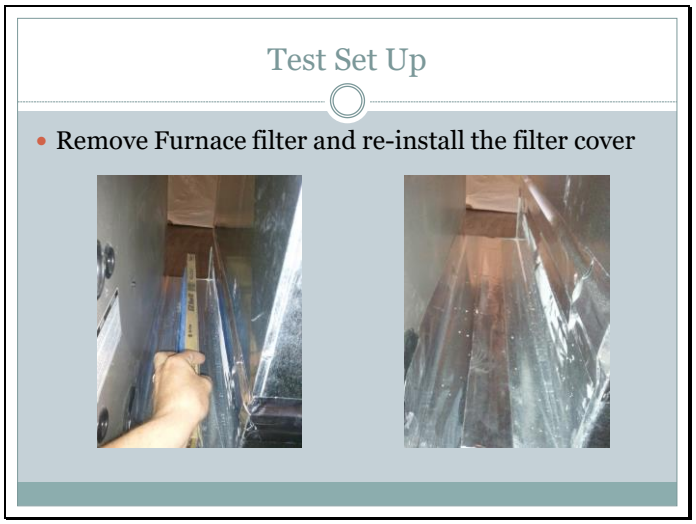

Photo 1 – filter removal
Photo 2 – Taped over filter slot – should have a removable cover that seals

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Test Set Up

- Install the pressure probe into the ductwork
  - Actual location isn't too important, but should be out of the stream of air from the fan
  - Usual locations include:
    - Trunk
    - Nearest supply outlet
    - Filter slot

Install the pressure probe into the ductwork

Actual location isn't too important, but should be out of the stream of air from the fan

Usual locations include:

Trunk

Nearest supply outlet

Filter slot

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Test Set Up

- Set up manometer and pressurize the ductwork

25 Pa is the pressure of the ductwork

204 is the CFM25 (The total duct leakage of the system is 204 CFM25)

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How to fix a failed test

- Pressure diagnostics
  - Probe each of the supplies and returns to identify the lowest pressure – lowest pressure is the leakiest
  - Put filter in a garbage bag, and reinstall it
    - This isolates the supply and returns
- Smoke test
- Inspect the furnace cabinet for leaks

Pressure diagnostics

Probe each of the supplies and returns to identify the lowest pressure – lowest pressure is the leakiest

Put filter in a garbage bag, and reinstall it

This isolates the supply and returns

Smoke test

Inspect the furnace cabinet for leaks

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Photo 1 – Furnace cabinet (for multiple position cabinets there is a removable plate – that plate is not sealed)
Photo 2 – Toe Kick supply – it is very common to see this register damaged and just pointing toward the toe kick, not sealed in any way – the register is fastened to the cabinet
Photo 3 – Ductwork Penetrations – Should be far less common now – but you never know

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If you are going to require a duct leakage test, it is best to have this test done in the rough so leaks can be fixed before they are covered up with drywall. This can be a very painful and impossible task if drywall is up

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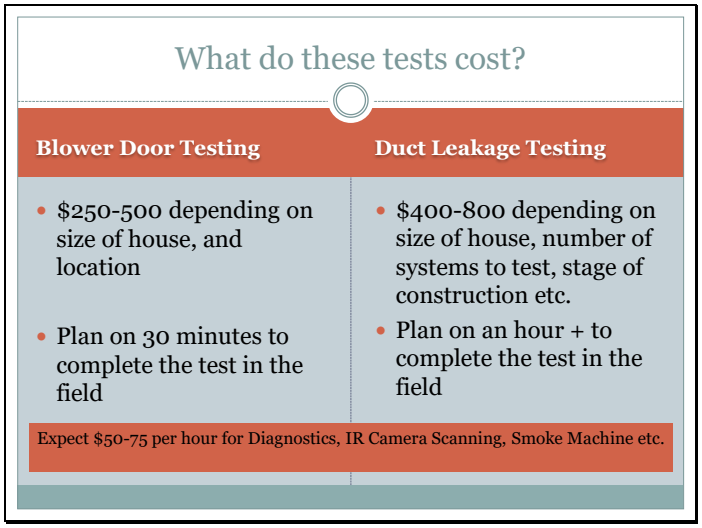

Blower Door Tests cost $250-500 depending on size of house, location, etc.
Duct Leakage Tests cost $400-800 depending on size of systems, number of systems, stage of construction, etc.
An Energy Rating Index Score (ERI) includes the cost of both of these tests and costs $650-1000 depending on a variety of items.

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