building science.com

The Snapshot—A Quick Description

Building America Report – 0413a

2004
Building Science Corporation

Abstract:

SNAPSHOT stands for Short, Non-destructive Approach to Provide Significant House Operation Thresholds. It is a test form used in the Building America program to ascertain house performance and specifications.

Building Science Corporation
Architecture and Building Science
70 Main Street
Westford, MA 01886
P: 978.589.5100
F: 978.589.5103
www.buildingscience.com

The Snapshot: A Quick Description

SNAPSHOT stands for Short, Non-destructive Approach to Provide Significant House Operation Thresholds. It is the test form that we use in the Building America program to ascertain house performance and specifications.

This technique incorporates the field characterization of critical parameters, (thresholds of operation) for indoor environment, thermal comfort, air delivery and distribution systems as well as their interaction with the building envelope. The data collected will then be used as direct inputs to energy prediction tools, such as REM/Design or DOE-2. The major parts of the testing include building envelope leakage (aka blower door test), duct leakage test (Duct Blaster®), and differential pressurization of zones. Also, the form provides a place to collect information on mechanical equipment and ventilation systems.

Using the Snapshot Form (Instructions and Hints)

The Snapshot is done in order to have an effective and concise record of house performance and specifications for the Building America program.

The top includes information on the location (lot #, address, subdivision), model type, and date & time.

Initialization

- Square feet (as measured by real estate numbers)
- Surface area: this is used to obtain our envelope infiltration goal (2.5 square inches of leakage area per 100 sf of envelope); it includes the foundation, such as slab and/or basement walls.
- Volume: volume of house in cubic feet; provides air change information
- Windspeed: estimated (5, 10, 15 mph); tests in high wind conditions are often suspect
- Outside temperature: to provide order of magnitude of stack effects; also used in TECTite
- Check all registers and bedroom doors (equalize into one zone)

- Measure static pressure in return between fan & filter (used for supply-only AirCycler™ systems)
- Static pressure in Supply and Return (estimates airflow through AHU; useful as an indication of restrictive duct systems. Measure across AHU cabinet, not including add-on coils or pleated media filters, if possible).

- Is there a ventilation system (yes/no)
- Type of ventilation system (e.g., exhaust-only, HRV or ERV, AirCycler™ supply-only system)
- If there is an AirCycler™, enter the off / on times (in minutes)
- Enter outside air duct pressure (carefully make hole for pressure probe through duct wall; see Addendum II for a table relating duct pressure to airflow)
- Type of outside air duct (type—flex/sheet metal, and diameter)
- Is there an adjustable outside air damper (yes/no)
- Is there a fireplace or wood stove (yes/no)
- Duct location (approximate fraction in attic, conditioned space, basement, etc.)

Pressure Testing

- The next group of tests can be run at the front door, measuring house main space pressure with respect to (WRT) outside. You should be able to read it off one of the pressure taps that you have set up already to perform the blower door test.
- Stack Pressure (take a baseline measurement with blower door installed; covers on)
- Dominant Duct Leak Effect (baseline with HVAC system running)
- Master Bedroom Door Closure Effect (with HVAC running, what is main space WRT outside when master bedroom door is closed; i.e., shuts off some of the supply flow to the main space)
- All Doors Closed Effect (with HVAC running, what is main space WRT outside when all doors are closed)
- Fireplace/Wood Stove Zone HVAC Test (what is the worst negative pressurization WRT outside in the zone that contains the fireplace or wood stove? Turn on exhaust fans, dryer, and open and close doors for worst case. Should not be greater than 5 Pa.)

- Pressure In Each Closed Room (what is the pressure in a bedroom WRT the main space when the door is closed? Often a problem due to lack of transfer grilles or returns; room becomes pressurized, increasing infiltration, and decreasing supply flow). 3 Pa is used as the Building America threshold.

Blower Door Testing (BDT)

- Blower Door Location (front door, garage door, etc)
- Total CFM 50 (cubic feet per minute at 50 Pa)
- Add C & n values if available on multipoint test: provided in results of TECTite computerized blower door test; adds further information about leakage characteristics, and is statistically better data due to multipoint testing.
- If there is a conditioned space that is typically sealed from the main space (i.e., sealed conditioned attic, sealed conditioned crawl space, conditioned kneewall sections), please run the test with the access to that space open. It provides information on how well sealed the total conditioned space is. This is the number that should be reported for pass/fail criteria.

Duct Airtightness Testing (DAT)

- CFM 25 total: if a first submission to BSC, provide information on how ducts were sealed (to inside of boot, at face of register, etc), type of test (pressurize or depressurize), and location of pressure tap.
- CFM 25 outside (requires both blower door and duct blaster setup; leak to the outside is more significant than total system leakage for energy calculations).

Mechanicals

- Furnace or air handler (if heat pump or fan coil unit) (Make and model)
- Air Conditioner (Make and model of outdoor unit); include indoor coil model, if an add-on part on air handler.
- Domestic hot water (Make and model)
- If there are multiple units, please use the back of the form, or customize an electronic copy to your own specifications.
- If there is other equipment of interest (HRV/ERV, humidifiers, electrostatic filters) please note that here as well.

Further questions can be referred to Kohta Ueno at the number above.

Addendum I: Duct Leakage to Outside

Here is the protocol that we typically use to measure duct leakage to outside. The test is based on the fact that in order to have airflow, you need a hole and a pressure difference. Total duct leakage measures all of the holes in the duct system. In a leak to outside test, we bring the house to -25 Pa with respect to the outside, then we use the Duct Blaster® to make the ductwork 0 Pa with respect to the inside of the house (or -25 WRT outside). Zero pressure difference between ducts and inside, means zero leakage between the two, therefore the only remaining leak is to the outside.

- Blower door test: set up and run conventional house infiltration test/blower door test (set on depressurization). Leave setup in doorway.

- Duct Blaster®: run conventional duct depressurization test to measure total duct leakage. Leave setup intact (blaster, masked ducts) at end of test.

- Turn the blower door on so house reaches -25 Pa WRT outside. Check the duct pressure WRT inside; it should be slightly positive (i.e., air is coming out of it into the house). Turn on the Duct Blaster® while watching the duct pressure; when it reaches zero, go back to the blower door, make sure it is still reading -25 Pa WRT outside. Readjust duct Blaster® to give zero pressure difference between the ducts and the inside. Then switch to B channel and measure airflow. That is duct leakage to the outside.

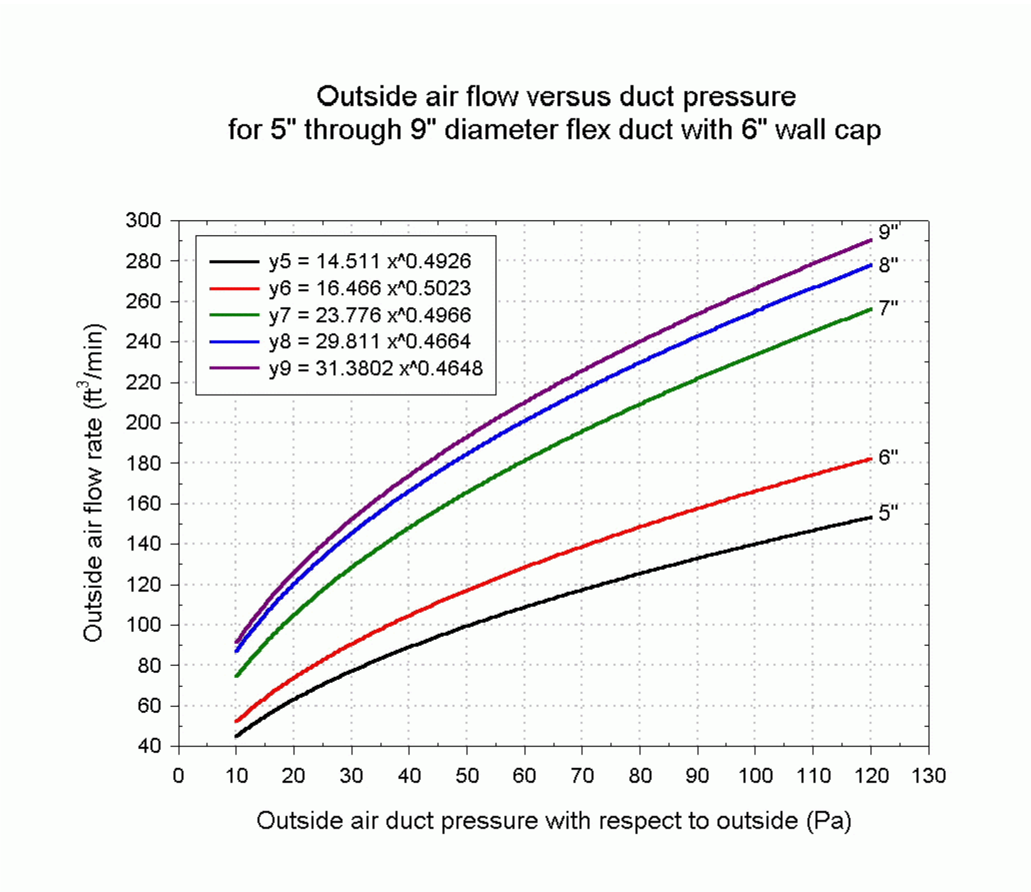
It is very helpful to have either two manometers (one for the Duct Blaster®, the other for the blower door), or even better, an APT setup with TECTITE. You can set the house to 'cruise' at -25 Pa WRT outside; it will automatically compensate for pressure changes caused by running the Duct Blaster®.

Odds are that the duct leakage to outside will be relatively small, so you will probably need to use Ring 3.

Addendum II: Outside Air Duct Pressure and Flows

The graph below is used for estimating the airflow in a supply-only integrated ventilation system. It relates outside ventilation air duct pressure (in Pa) to flow (in CFM), given various sizes of flex duct. This graph is also available in WIC (inches water column), upon request. Obviously, if you increase the duct pressure, or increase the duct size, it increases the amount of airflow.

However, remember that you can measure pressure, but not have any flow. If the duct is blocked, the return will be pulling from that fresh air duct line, but not moving any air. Therefore, you should at least do a quick visual inspection of the fresh air duct condition, and occasionally verify flows by other methods. The chart below lets you estimate flow, assuming that you have a 6" wall cap, and ~25 feet of duct, maximum.



Duct static pressure should be measured in the duct, outboard (i.e., on the outdoors side) of the filter and damper (if installed). Also, although the graph uses "outside air duct pressure with respect to outside," the indoor-outdoor pressure difference should not be large in our Building America houses (~1-2 Pa, at most). Therefore, measuring the outside air duct pressure WRT indoors should work. Of course, if you are working in a vented attic, it is essentially at outside pressure.

Remember that the AirCycler™ or Carrier Totaline thermostat (with air handler cycling feature) operates the air handler for a set duty cycle (e.g., 10 minutes on, 20 minutes off, is a 33% duty cycle). Also, there is natural infiltration occurring as well, even when the ventilation system is not in operation (~0.1 natural air change per hour, in these houses). Therefore, the airflow through the fresh air duct should time-average out to the goal, based on the cycling and infiltration.

The design ventilation rate is input according to Equation (1). For three bedroom houses, using a 33% fan duty cycle, the intermittent outside air flow usually falls in a range of 60 to 85 CFM. We often specify 80 CFM for the design outside airflow. For large houses with high ceilings and relatively few bedrooms, the result of Equation (1) can be small or even less than zero, however, the minimum design ventilation rate should be 40 CFM for a three bedroom house.

The ventilation airflow rate is calculated according to the following equation, but limited to a minimum equal to $\dot{Q}_{cont}$:

$$\dot{Q}_{cfan} = \frac{(\dot{Q}_{cont}) - (\frac{I}{60}V(1-f))}{f} \qquad (1)$$

where:

$\dot{Q}_{cfan}$ = intermittent outside air flow rate through the central fan (CFM)

$\dot{Q}_{cont}$ = continuous outside air flow rate required (CFM)
I = estimate of natural air change when central fan is not operating (h^{-1})
V = volume of conditioned space (ft^3)
f = fan duty cycle fraction

As an example, take a three bedroom house with a volume of 16,000 cubic ft (single-floor slab on grade example). The continuous outside air flow rate required (Q_{cont}) is 40 CFM (based on the number of bedrooms), and we will assume a 33% duty cycle on the AirCycler® and 0.1 nACH. When all these numbers are plugged in, Q_{cfan} (the intermittent outside air flow rate) is 67 CFM.

The basement or unvented conditioned attic should not be included in the volume used in this computation. Also, in some houses with large volumes, the computed Q_{cfan} may be greater than the specified average flow Q_{cont}. In this case, use Q_{cfan}= Q_{cont}.

Addendum III: Building Envelope Testing Protocol

(i.e., What to seal off and what to leave as found)

1. Outside Air For Ventilation

Central-fan-integrated supply ventilation

Our standard Building America ventilation design involves an outside air duct routed to the return side of the central air handling system. The outside air duct is an intentional, active (fan-powered) opening in the building envelope; therefore, it should be temporarily sealed off for testing. If the outside air duct has a normally closed motorized damper in place (FR-V system), then temporarily remove control voltage from the damper so that it remains in its normally closed position during testing. If the outside air duct does not have a motorized damper (FR system), then temporarily seal the duct opening either at the outside or inside.

Other active supply or balanced HRV/ERV ventilation systems

For other active supply or balanced HRV/ERV ventilation systems, temporarily seal off any intentional ducts leading to outside. For HRV/ERV systems, this includes the fan-powered supply inlet and the fan-powered exhaust outlet.

Passive openings to outside

Any systems that utilize passive (non fan-powered) ducts or openings to outside should not be sealed other than through means available with the installed original equipment. For example, adjustable window trickle ventilators, adjustable through-wall vents, like Fresh-80's, can be closed via the original equipment mechanism, but not taped. A passive stack duct should not be sealed for testing.

2. Outside Air For Combustion And Dilution Air

The Building America Performance Specification for combustion appliances is as follows:

> *All combustion appliances in the conditioned space must be sealed combustion or power vented. Specifically, any furnace inside conditioned space will be a sealed-combustion 90%+ unit. Any water heater inside conditioned space will be power vented or direct-power vented unit.*

For non-sealed combustion appliances, combustion air and dilution air ducts may be required by the building code. These ducts should not be sealed when testing for building air leakage. Where combustion air and dilution air ducts are required inside conditioned space, it is best that the combustion appliance be enclosed and sealed within a framed structure such that it has little or no air exchange with the conditioned space. If this is not done, these ducts can contribute greatly to building air leakage, and make it hard to meet low building leakage targets, such as for Building America.

3. Dryer Vents

When the dryer is not installed at the time of testing, the open vent duct should be temporarily sealed for building air leakage testing. When the dryer is installed, closing the dryer door is all that should be done.

4. Kitchen And Bath Exhaust Fans

Kitchen range hoods should exhaust to outdoors. Range hoods should have a built-in back-draft damper, therefore, no temporary sealing of range hoods should be done. If the range hood is not installed at the time of testing, the open exhaust duct should be sealed.

Bathroom exhaust fans should have a built-in back-draft damper, therefore, no temporary sealing of bathroom exhaust fans should be done.

5. Fireplaces

Fireplace chimney dampers should be closed, and glass doors should be closed. No additional temporary sealing of the fireplace should be done.

6. Plumbing Drains

Plumbing drains that have not been used (making it likely that the P-traps are not full of water) should be temporarily sealed by closing the drain stopper, or by running water, or by taping.

7. Windows

All windows should be closed and latched.

8. Doors

All doors to unconditioned space should be closed; all other doors should be open. Doors to unconditioned space should have weather stripping installed and thresholds should be adjusted to properly seal against the bottom of the door. If at the time of testing, in new construction, weather stripping and/or locksets have not yet been installed, or thresholds have not yet been adjusted, temporarily seal the door with tape.

9. Attic And Crawl Space Access Hatches

For attic and crawl space access hatches that cross between conditioned and unconditioned space, these should have been fitted with permanent seals before the time of testing. It is unlikely that they will ever be sealed if they aren't sealed at the time of testing, therefore, no additional temporary sealing should be done.

About this Report

This report was produced in cooperation with the US Departments of Energy's Building America Program.

Direct all correspondence to: Building Science Corporation, 30 Forest Street, Somerville, MA 02143.

Limits of Liability and Disclaimer of Warranty: