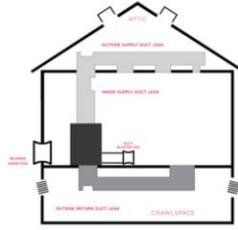




Advanced Duct Leakage Testing



Paul Morin

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Performance Testing Tools

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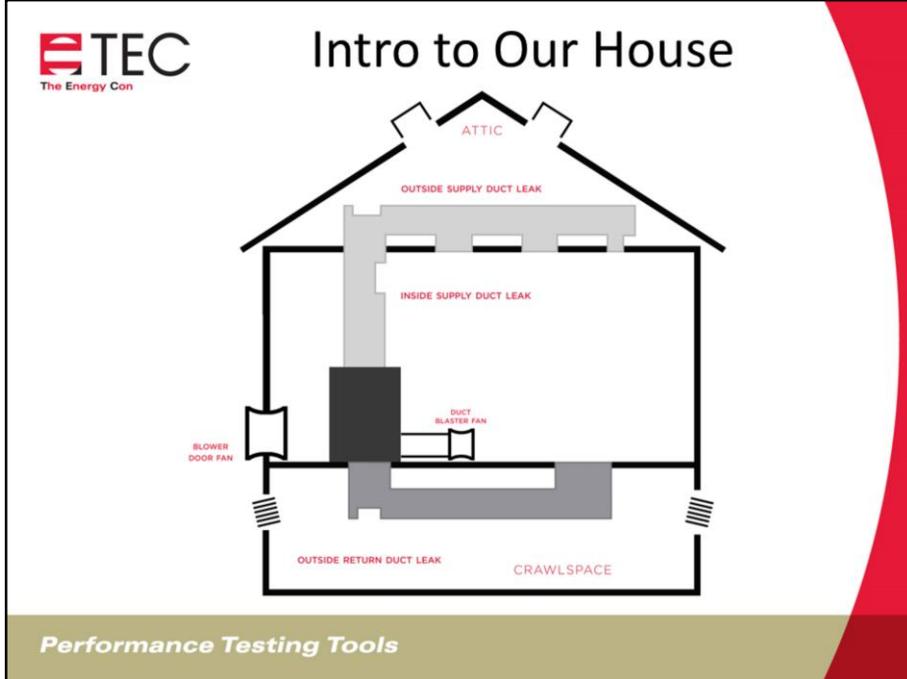
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Agenda

- Choosing a Location to Measure Duct Pressure
- Choosing a Location to Attach to the Ductwork
- Basic Pressure Concepts
- Duct Leakage to Outside Concepts
- Testing Options

The goal of this presentation is to give you a better understanding of why the tests are done the way they and what is going on with the pressures in unconditioned spaces during a duct leakage test. This information should help you diagnose issues when you are not getting the number you were expecting



Well vented attic and crawlspace. Terminology: Furnace (air handler), supply plenum, trunk, branches, registers, grills, return in crawlspace. Supply air leaks into attic and house, return air leaks into crawlspace. Blower door and Duct Blaster.

Choosing a Location to Measure Duct Pressure

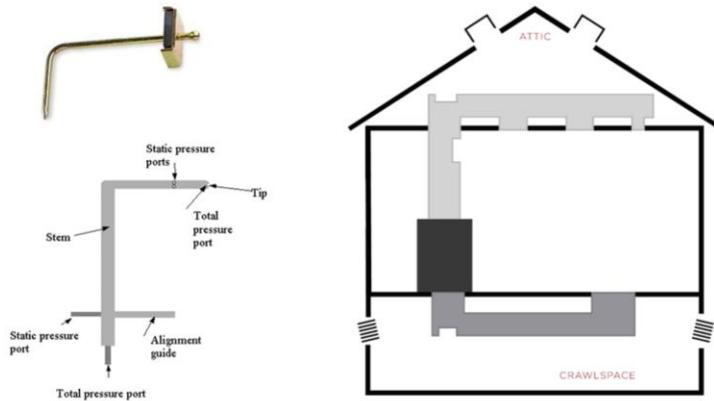
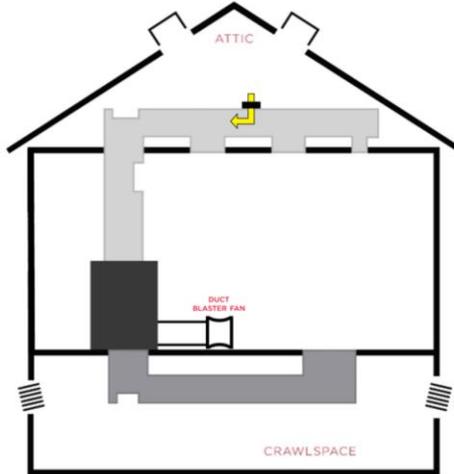


Fig. 1 Generic Pitot Static tube configuration.

Static pressure probe: Bursting pressure, Bullet shaped end with 4 tiny holes, Pointed into airflow, If measuring at a supply register where there is very little airflow, a tube is an option. Not the same as a pitot tube

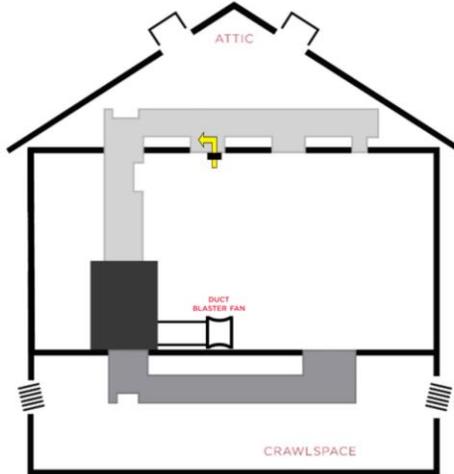
In Supply Trunkline



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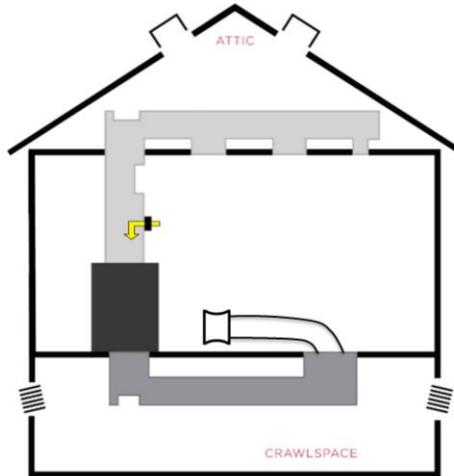
3 options for where you can measure duct pressure

In Supply Register



In Supply Plenum

If duct blaster fan is installed at a central return



Performance Testing Tools

Pressure is more stable in plenum when the duct blaster fan is further away

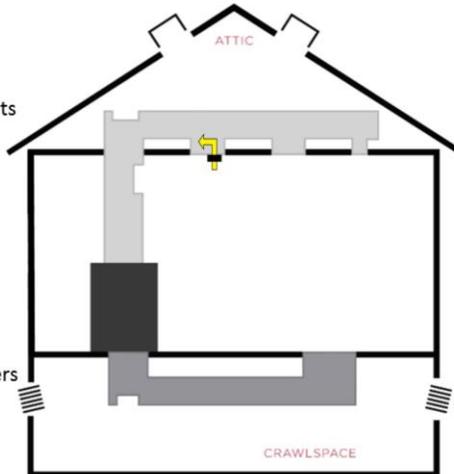
Testing Leaky Ducts

For tight ducts, any of those 3 locations will provide consistent results

For leaky ducts, first test with pressure at closest supply

Next test with pressure at furthest supply

Average the two numbers



If ducts are relatively tight (< 200 CFM) pressure will tend to be pretty uniform and any of the 3 locations will provide consistent results. If the duct system is leaky (>500 CFM), there may be large pressure differences between from one part of the duct system and another. In this case the choice of probe locations may affect the results. For leaky duct systems you may want to do 2 tests, one with a pressure at closest supply and one with pressure at furthest supply, and average the results.

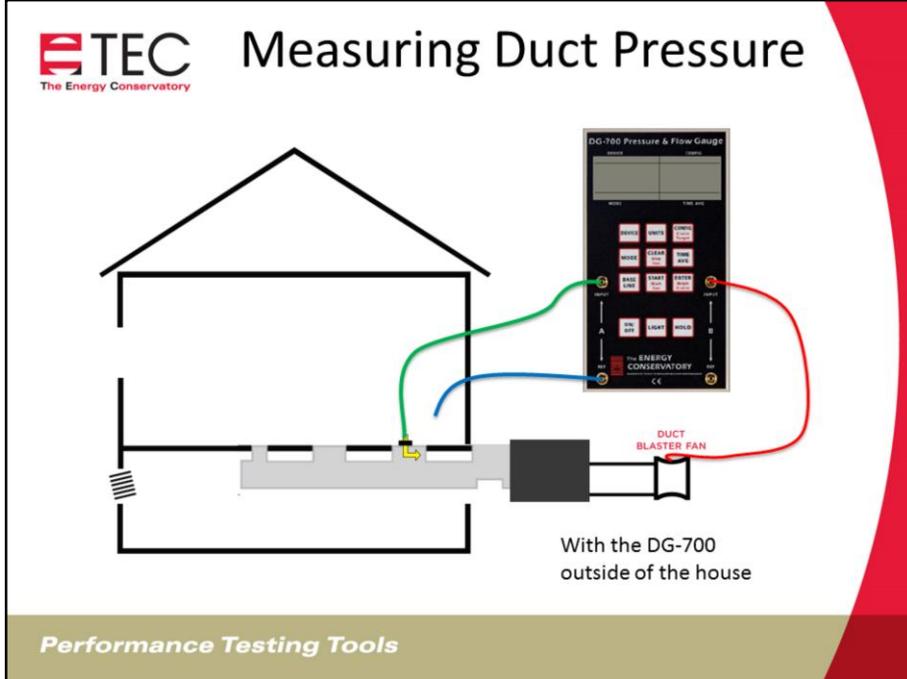


Static Probe not necessary at Supply Register



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Static probe not necessary at a supply register, but can be used



If the DG-700 is outside the house, such as connecting to an air handler in a garage, attic or a package unit in the yard, remember to reference the duct pressure to the house



Duct Pressure Location Review

- Supply trunkline, Supply register, or Supply plenum if connecting to a central return
- If ducts are fairly tight (<200 cfm) any of 3 locations will give you consistent results
- If ducts are leaky (> 500 cfm) there may be large pressure differences
- Do two tests (near and far register) and average the results

Performance Testing Tools

With most code testing, the ducts should be fairly tight.



Choosing a Location to Attach to the Ductwork

- At central return
 - In 1, 2 or 3 return systems the largest and closest one to the AH is best



Performance Testing Tools

Small return can result in high back pressure

Choosing a Location to Attach to the Ductwork

- Connecting to a small return



Performance Testing Tools

Left gauge show 302 Pa of backpressure (small return WRT room). Right gauge has 22.1 Pa at supply register in that room with open fan cranked. Back pressure must be < 100 Pa for calibration to be correct.



Choosing a Location to Attach to the Ductwork

- Connecting directly to the AH cabinet



Performance Testing Tools

Some AH cabinets may have electrical boards or other obstructions that create a high Back pressure. Back pressure is the ΔPa AH cabinet / room

How to Measure Backpressure

- Measure backpressure if you suspect it might be an issue
- Measure pressure with Duct Blaster fan running
 - Backpressure should be less than 100 Pa



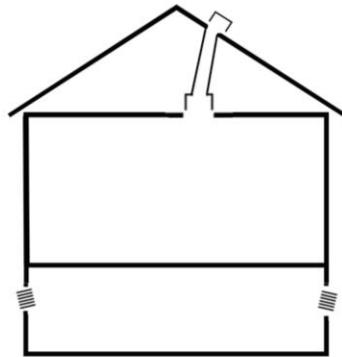
Performance Testing Tools

In this case, we are connected at the AH cabinet. So we are measuring the AH cabinet with respect to the room pressure.

Location to Attach to the Ductwork - Review

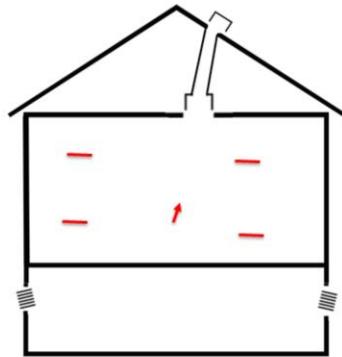
- At Central Return Grille
- 1, 2 or 3 Return Systems
 - Connect at largest grille closest to DB fan
- At Air Handler
- If you suspect backpressure over 100 Pa – measure it
- Build out from air handler with cardboard if backpressure is high

- Exhaust fan depressurizes house

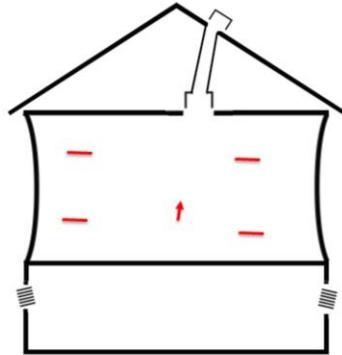


The goal of this section is to give you a better understanding of pressures you are measuring

- Exhaust fan depressurizes house

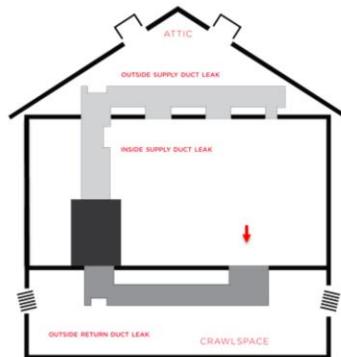


- Exhaust fan depressurizes house



- Supply leaks to outside can do the same

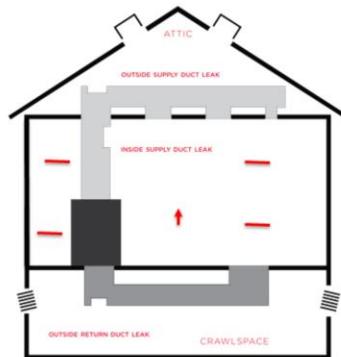
No duct leaks =
no change in
house pressure



We are not talking about during the duct tightness test, but under normal operating conditions

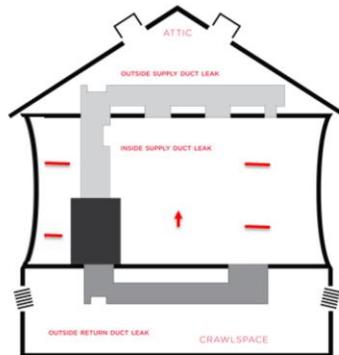
Basic Pressure Concepts

- Supply leaks to outside act like an exhaust fan



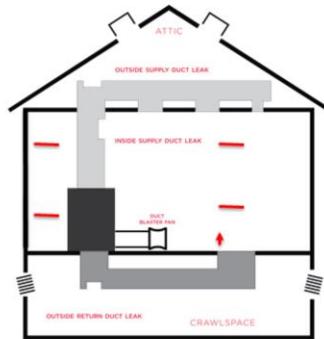
Basic Pressure Concepts

- Supply leaks act like an exhaust fan



Basic Pressure Concepts

- Total Leakage Pressurization does the same
 - Important to open a window or door



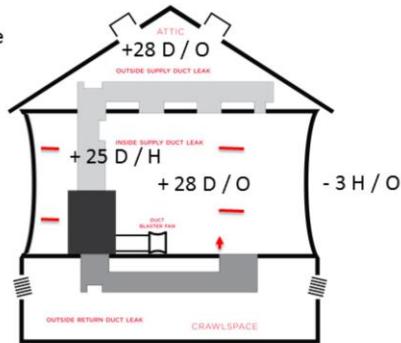
Performance Testing Tools

Now we have added the duct blaster fan and sealed the registers and grills and the house is closed up.

Basic Pressure Concepts

- Total Leakage Pressurization does the same
 - Important to open a window or door

200 CFM of duct leakage
in a 1500 CFM50 house
will change the house
pressure by -3 Pa.



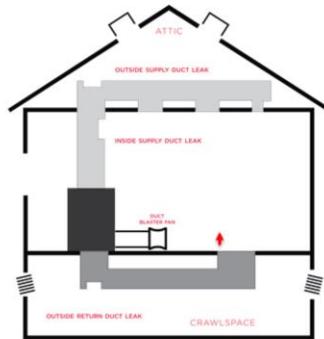
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Ducts in well vented unconditioned spaces are seeing a higher pressure.

Basic Pressure Concepts

- Total Leakage Pressurization does the same
 - Important to open a window or door

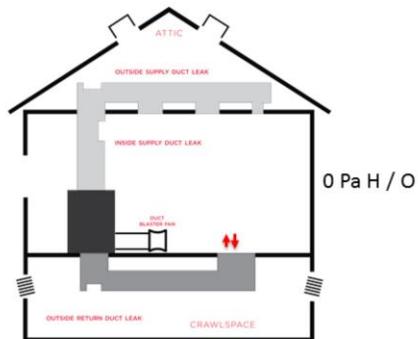
Opening a window
relieves the pressure



Basic Pressure Concepts

- Important that crawlspace and attic are open to outside

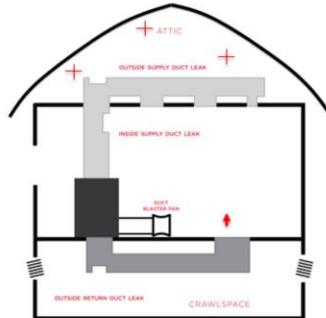
Attic and crawlspace are well vented:
leakage does not change pressures in those spaces



Basic Pressure Concepts

- Important that crawlspace and attic are open to outside

Attic venting
closed =
pressurized attic



Performance Testing Tools

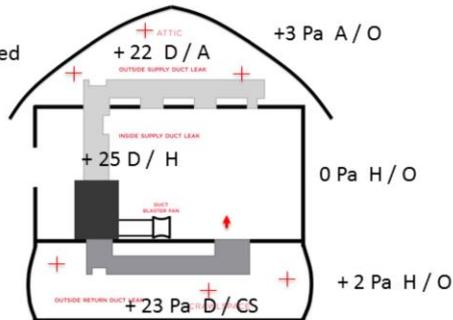
If attic is not well vented, the attic spaced will be pressurized by duct leaks. The ducts in those spaces will not see the full 25 Pa of pressure

Basic Pressure Concepts

- Important that crawlspace and attic are open to outside

Crawl space venting closed
= pressurized space

Our manual and other standards say to open vents, access panels, or doors in unconditioned spaces containing ducts to the outside



Performance Testing Tools

Same with crawlspaces. The leaks are not seeing the full 25 Pa of pressure. If you don't open unconditioned spaces to the outside, you are cheating the system. It has a similar affect if you were to seal vents closed during the test.

Basic Pressure Concepts Review

- Leaky ducts change pressures in the house
need to open a window during test
- Leaky ducts change pressures in unconditioned spaces
need to open those spaces to the outside
- The most accurate measurement will be with 25 Pa at all
locations, including unconditioned spaces.
- Standards say unconditioned spaces containing ducts shall
be opened to the outside
- This is not always possible or practical.
- To get repeatable numbers you need to document how the
house was set up.
- Understanding pressures in adjoining spaces may help you
understand and explain the numbers you are getting

Duct Leakage to Outside Concepts

- Airflow requires both a driving force and a hole
- $\Delta Pa + \text{hole} = \text{airflow through the hole}$
- If the house and the ducts are at the same pressure, air will not flow through the leaks

The goal is to get the house and the ducts to the same pressure

Duct Leakage to Outside Concepts

- To tape or not to tape
- If entire duct is not at exactly 25 Pa, you can have large flow across open registers
- Standards and manuals say to tape

Leaky duct systems will likely not all be at the same pressure. Even tight duct systems may have a different pressure near a large leak. You can go around and measure the pressure at the taped registers during the test and see if you get exactly zero in all cases.

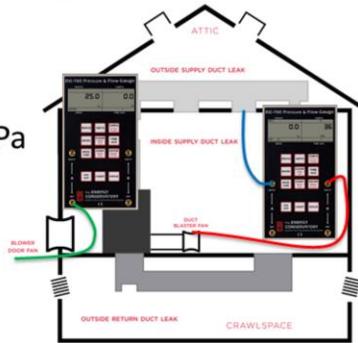
Duct Leakage to Outside Concepts

- Two methods taught of measuring duct pressure
 - Duct / House
 - Duct / Outside

There are two methods being taught.

Duct Leakage to Outside Concepts

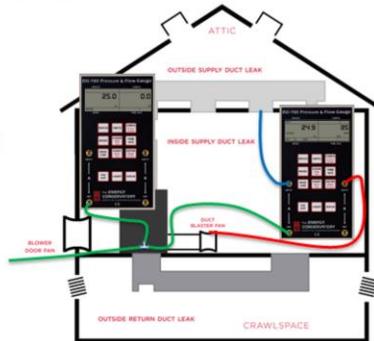
- Measuring duct pressure
 - Duct / House
 - PR/ FL Mode
 - Bring duct to zero Pa



Talk about what Duct / House means – talk about tubing connections on the gauge on A and B channels. Talk about what PR / FL mode means

Duct Leakage to Outside Concepts

- Measuring duct pressure
 - Duct / Outside
 - PR/ FL@25 MODE
 - Bring duct to 25 Pa



Outside pressure tube has tee connection to house and duct reference

Duct Leakage to Outside Concepts

- Bring duct to zero
 - Method in Duct Blaster manual and quick guides
 - Method in RESNET Chapter 8 Standard

But if the pressure gauge you are using has trouble reading zero without any tubing connected, you will probably be better off shooting for 25 Pa

Duct Leakage to Outside Concepts

- Can't Reach Zero
- Try to pressurize without flex duct
 - Depressurize requires a ring, so maximum flow is less
 - Maximum pressurization flow without flex is about 1350 cfm
- Lower house pressure
- Apply Can't Reach Pressure Factor



Can't reach zero with the duct blaster or can't reach 25 with the blower door.

Can't Reach Pressure Factor

Chapter 6 Conducting a Total Leakage Pressurization Test

Table 2: Can't Reach Pressure Factors (25 Pa Target)

Duct Pressure (Pa)	CRP Factor	Duct Pressure (Pa)	CRP Factor
24	1.02	14	1.42
23	1.05	13	1.48
22	1.08	12	1.55
21	1.11	11	1.64
20	1.14	10	1.73
19	1.18	9	1.85
18	1.22	8	1.98
17	1.26	7	2.15
16	1.31	6	2.35
15	1.36	5	2.63

Example: With no Flow Ring installed and the fan running full speed, you are able to achieve a duct system test pressure of 14 Pascals with a measured fan flow of 1,200 cfm. The corresponding CRP Factor for a duct pressure of 14 Pascals is 1.42. The estimated total duct leakage at a test pressure of 25 Pascals is $1,200 \times 1.42 = 1,704$ cfm.

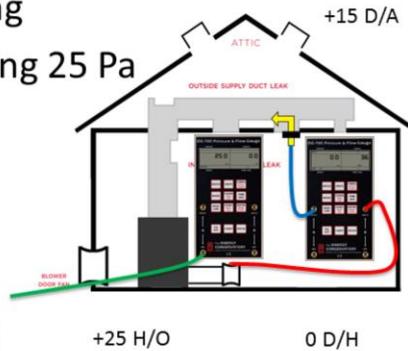
$$\text{Can't Reach Pressure Factor} = \left\{ \frac{25}{\text{Current Test Pressure (Pa) (Channel A)}} \right\}^{0.60}$$

Note: The TECBLAST program automatically applies the CRP Factors to One-Point Test data.

Use chart or formula

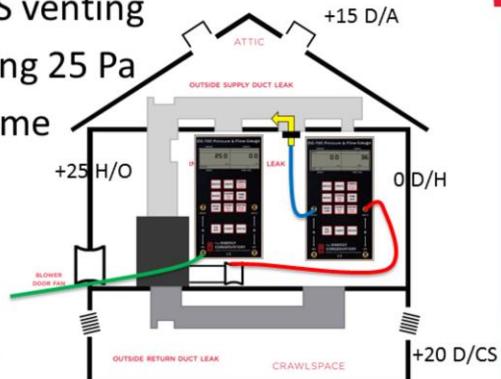
Duct Leakage to Outside Concepts

- One unconditioned space containing most of ductwork
- Minimal attic venting
- Most ducts not seeing 25 Pa



Duct Leakage to Outside Concepts

- Two unconditioned space containing most of ductwork
- Minimal attic and CS venting
- Most ducts not seeing 25 Pa
- Attic & Crawl not same
- It gets complicated

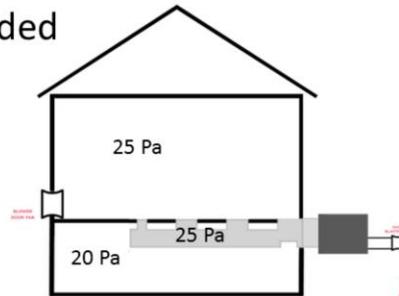


Performance Testing Tools

If you had a 3rd fan to keep the crawl space and attic at the same pressure, it would be possible to have all the ducts seeing 25 Pa, but this is beyond what can be expected of a tester.

Duct Leakage to Outside Concepts

- Conditioned crawl without an access to house
- CS does not see 25 Pa
- Some leaks to CS included

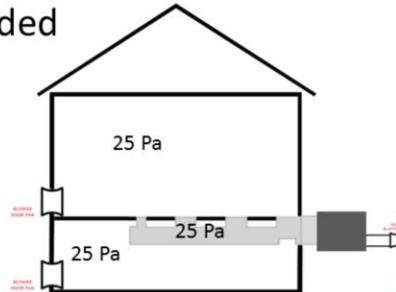


Performance Testing Tools

Air flows from high pressure to low pressure. Leaks to conditioned crawlspace show up as leaks to the outside.

Duct Leakage to Outside Concepts

- Conditioned crawl without direct access
- CS does not see 25 Pa
- Some leaks to CS included
- Use 3rd fan



Finally getting builders to do crawlspaces right but it makes your job harder



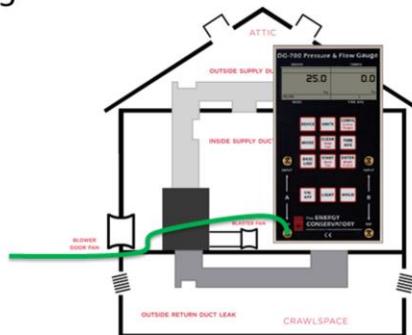
Duct Leakage to Outside Concepts - Review

- To tape or not to tape
- Duct / House or Duct / Outside
- Can't reach zero or Can't reach 25
- One unconditioned space containing most of the ducts
- Conditioned crawl without access to house
- Pressures in unconditioned spaces can be changed during the duct test and this will effect your readings
- If unconditioned crawlspaces or attic spaces are not well connected to the outside, it will effect readings



Duct Leakage to Outside

- Testing options – One DG-700
 - Bring house to 25

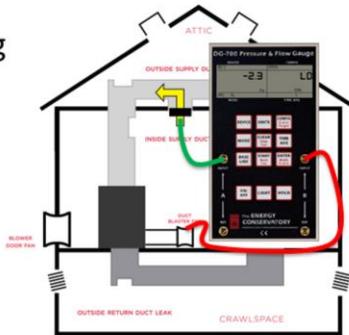


Performance Testing Tools

Duct leakage to outside test with one gauge. Some customers only buy one gauge at first. If you send one in for calibration, you can still do the test.

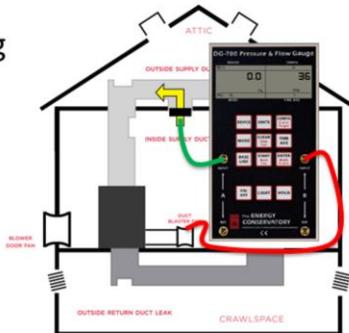
Duct Leakage to Outside

- Testing options – One DG-700
 - Bring house to 25
 - Disconnect BD tubing
 - Connect DB tubing



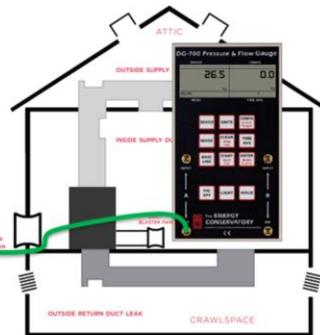
Duct Leakage to Outside

- Testing options – One DG-700
 - Bring house to 25
 - Disconnect BD tubing
 - Connect DB tubing
 - Bring ducts to zero



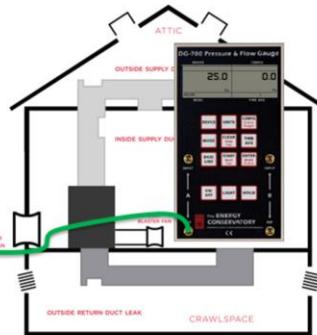
Duct Leakage to Outside

- Testing options – One DG-700
 - Bring house to 25
 - Disconnect BD tubing
 - Connect DB tubing
 - Bring ducts to zero
 - Disconnect DB tubing
 - Reconnect BD tube



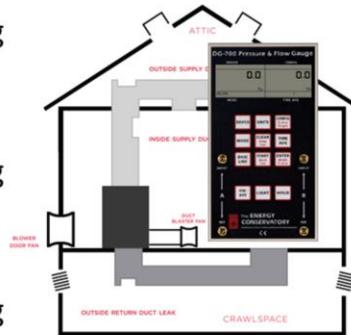
Duct Leakage to Outside

- Testing options – One DG-700
 - Bring house to 25
 - Disconnect BD tubing
 - Connect DB tubing
 - Bring ducts to zero
 - Disconnect DB tubing
 - Reconnect BD tube
 - Adjust back to 25



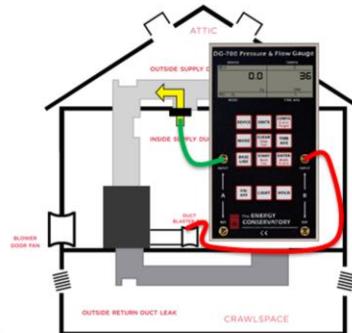
Duct Leakage to Outside

- Testing options – One DG-700
 - Bring house to 25
 - Disconnect BD tubing
 - Connect DB tubing
 - Bring ducts to zero
 - Disconnect DB tubing
 - Reconnect BD tube
 - Adjust back to 25
 - Disconnect BD tubing



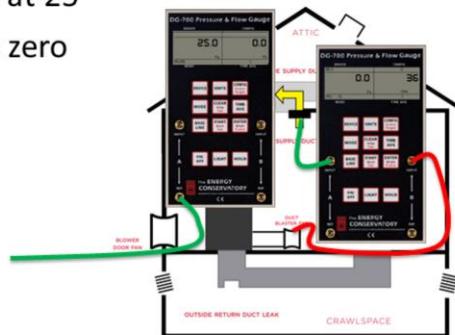
Duct Leakage to Outside

- Testing options – One DG-700
 - Bring house to 25
 - Disconnect BD tubing
 - Connect DB tubing
 - Bring ducts to zero
 - Disconnect DB tubing
 - Reconnect BD tube
 - Adjust back to 25
 - Disconnect BD tubing
 - Reconnect DB and adj.



Duct Leakage to Outside

- Testing options – Two DG-700's
 - Cruise house at 25
 - Bring duct to zero



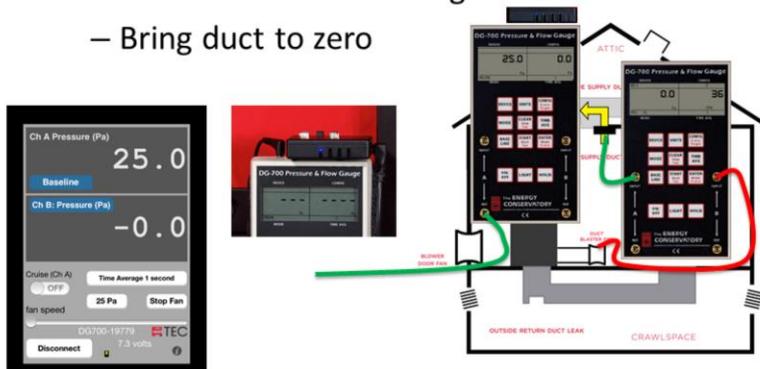
Performance Testing Tools

Inducted pressure of 25 Pa – need to do a baseline on blower door pressure. Some standards (RESNET) require a duct pressure baseline also.



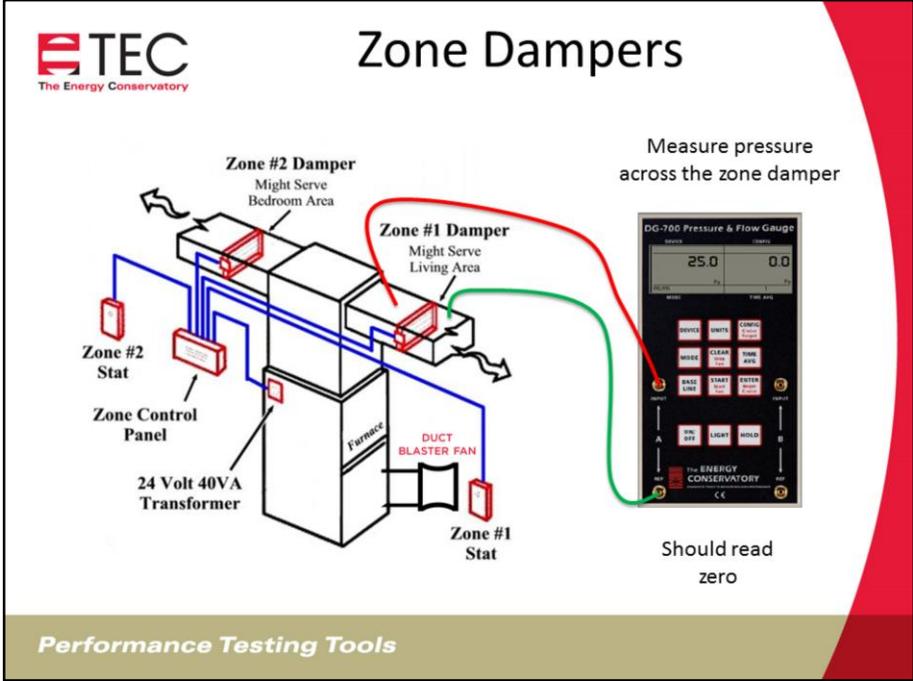
Duct Leakage to Outside

- Testing options – Two DG-700's + WiFi Link
 - Cruise house at 25 using iTEC-700
 - Bring duct to zero



Performance Testing Tools

Blower door will run less time during extreme conditions - in MN anytime between thanksgiving and Easter



Default should be open, but before power is connected it is hard to say. Always good practice to verify. One tube might be where DB fan is connected at return and the other at a supply register



Thank You

Questions?

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