A new look at duct leakage: DeltaQ

lain Walker Lawrence Berkeley National Laboratory Home Energy Magazine



What is DeltaQ?

- Test for duct leaks to outside conditioned space
- Gives air flows at operating conditions
- Based on blower door testing with air handler on and off



Difference between Blower Door tests



DeltaQ Illustration



DeltaQ Procedure

- 1. Connect blower door to the building envelope
- 2. Install envelope pressure difference sensor
- 3. With air handler fan off:
 - Adjust blower door until there is 5 Pa (0.02 inches of water) envelope pressure difference
 - Record the envelope pressure difference and flow
 - Repeat with the pressure difference increased by 5 Pa each time until the envelope pressure difference is 50 Pa.
- 4. Repeat with air handler fan on
- 5. Repeat steps 3 and 4 with the house depressurized

DeltaQ Calculations

- Adjust the flows to exactly match pressures using fan off results.
- Calculate the flow difference (ΔQ) at each pressure station (ΔP).
- Fit the ΔP and ΔQ pairs from each pressure station to determine supply leakage (Qs) and return leakage (Qr), and the characteristic pressures (ΔPs and ΔPr).

$$\Delta Q\left(\Delta P\right) = Q_{s} \left[\left(1 + \frac{\Delta P}{\Delta P_{s}}\right)^{0.6} - \left(\frac{\Delta P}{\Delta P_{s}}\right)^{0.6} \right] - Q_{r} \left[\left(1 - \frac{\Delta P}{\Delta P_{r}}\right)^{0.6} + \left(\frac{\Delta P}{\Delta P_{r}}\right)^{0.6} \right]$$

ducts.lbl.gov

DeltaQ Benefits - Technical

- Air flows to outside
- At operating conditions
- Supply and return separate
- Envelope leakage for "free"

Comparison to Pressurization



Comparison to Pressurization



DeltaQ Benefits - Operation

- Ease of use
 - Standard & existing equipment
 - Familiar techniques
 - Non-intrusive
- Faster
 - No duct or air handler access required
 - No register covering
 - Half of test is envelope leakage
- BUT Need a computer & a complete building

LBNL Research: Laboratory Testing



All leaks measured – reference Leaks at many locations (pressures)

Test Facility Schematic



Controlled Pressure Exponent Leaks

End

cap



Pressure taps and sample tubes to measure pressure difference across PVC plug

Prototype for Lab



Laboratory DeltaQ Evaluation

- Duct Leakage: zero to 60% of air handler flow
- Envelope Leakage: 500 to 5000 cfm50
- Three air handler speeds
- Leakage distribution: plenum (high pressure), register boot (low pressure) & intermediate
- Over 70 combinations
- Leakage uncertainty ±0.5% to 2% of leakage flow

Test Results – Fraction of Air Handler Flow Average over many systems: Bias = -1.1%Typical for a single test: **RMS = 3.2%**

Differences concentrated in tests where leaks pressures significantly different from plenum pressures

Field Evaluation

>200 Homes in several studies
No leakage reference

< 30 minutes

Limits to testing:

- Ring swapping
- High wind speeds
- Very leaky envelopes

Use variability in measured pressures to generate uncertainty estimate

Current Status

- Procedure in ASTM E1554
 - I recommend taking more data points
- Spreadsheet to do calculations at ducts.lbl.gov
- Equipment manufacturers developing automated versions
- Increasing user base including EPA & Weatherization

Next Steps

Pressure Correction (Bias <1%, RMS (<2%))

- 1. Leakage Imbalance flows:
 - Typically < 10% of leakage flow: scales with leakage imbalance and house leakage
- 2. Duct Flow Resistance:
 - Up to 25% correction at high leakage (50%) flows
- Ramping
 - Continuously change blower door
 - Sample about once a second
 - Ten times more data (more at low pressure)
 - Less time < 1 minute (no pressure matching)
 - New analysis programs

Next Steps: Ramping

