High Performance Diagnostics
Blower Doors and Infrared Cameras
SPFA Conference
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PV Burns

- “Attic Rat”- House Doctor, Insulator, Radon Mitigation
- Indoor Air Quality Technician on the Metropolitan Airport Commission Sound Insulation Project
  - Performed over 1000 blower door and worst case depressurization tests
- Supervised Insulation, Lead & Mold Abatement Crews
- PV Burns Consulting
  - Performed forensic investigations for clients involved in moisture and performance related building failures.
  - Building Science Trainer for Midwest Environmental Consulting, Quantum Business Group.

Currently working as a

- Technical Sales Rep for the Energy Conservatory
  - Manufacturer of the Minneapolis Blower Door System
Agenda

- Codes
- Blower Door
- Infrared Scanning
- Duct Blasting
- Q&A
Status of Code Adoption: Residential
Overview of the currently adopted residential energy code in each state.
402.4.1 Building thermal envelope.
The building thermal envelope shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. The following shall be caulked, gasketed, weatherstripped or otherwise sealed with an air barrier material, suitable film or solid material:
402.4.2 Air sealing and insulation. Building envelope air

Tightness and insulation installation shall be demonstrated to comply with one of the following options given by Section 402.4.2.1 or 402.4.2.2:
Two options to demonstrate compliance

Option 1

- Whole-house pressure test (Blower Door)
  - Air leakage <7 ACH when tested at pressure differential of 0.2 inches w.c. (50 pa)
  - Testing may occur any time after rough in and installation of building envelope penetrations
Visual inspection option.

Building envelope tightness and insulation installation shall be considered acceptable when the items listed in Table 402.4.2, applicable to the method of construction, are field verified.
## Table 402.4.2
Air Barrier and Insulation Inspection Component Criteria

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>COMPONENT</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Air barrier and thermal barrier</td>
<td>Exterior thermal envelope insulation for framed walls is installed in substantial contact and continuous alignment with building envelope air barrier. Breaks or joints in the air barrier are filled or repaired. Air-permeable insulation is not used as a sealing material. Air-permeable insulation is inside of an air barrier.</td>
</tr>
<tr>
<td>2</td>
<td>Ceiling/attic</td>
<td>Air barrier in any dropped ceiling/soffit is substantially aligned with insulation and any gaps are sealed. Attic access (except unvented attic), knee wall door, or drop down stair is sealed.</td>
</tr>
<tr>
<td>3</td>
<td>Walls</td>
<td>Corners and headers are insulated. Junction of foundation and sill plate is sealed.</td>
</tr>
<tr>
<td>4</td>
<td>Windows and doors</td>
<td>Space between window/door jambs and framing is sealed.</td>
</tr>
<tr>
<td>5</td>
<td>Rim joists</td>
<td>Rim joists are insulated and include an air barrier.</td>
</tr>
<tr>
<td>6</td>
<td>Floors (including above-garage and cantilevered floors)</td>
<td>Insulation is installed to maintain permanent contact with underside of subfloor decking. Air barrier is installed at any exposed edge of insulation.</td>
</tr>
<tr>
<td>7</td>
<td>Crawl space walls</td>
<td>Insulation is permanently attached to walls. Exposed earth in unvented crawl spaces is covered with Class I vapor retarder with overlapping joints taped.</td>
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<tr>
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</tr>
<tr>
<td>8</td>
<td>Shafts, penetrations</td>
<td>Duct shafts, utility penetrations, knee walls and flue shafts opening to exterior or unconditioned space are sealed.</td>
</tr>
<tr>
<td>9</td>
<td>Narrow cavities</td>
<td>Batts in narrow cavities are cut to fit, or narrow cavities are filled by sprayed/blown insulation.</td>
</tr>
<tr>
<td>10</td>
<td>Garage separation</td>
<td>Air sealing is provided between the garage and conditioned spaces.</td>
</tr>
<tr>
<td>11</td>
<td>Recessed lighting</td>
<td>Recessed light fixtures are air tight, IC rated, and sealed to drywall. Exception—fixtures in conditioned space.</td>
</tr>
<tr>
<td>12</td>
<td>Plumbing and wiring</td>
<td>Insulation is placed between outside and pipes. Batt insulation is cut to fit around wiring and plumbing, or sprayed/blown insulation extends behind piping and wiring.</td>
</tr>
<tr>
<td>13</td>
<td>Shower/tub on exterior wall</td>
<td>Showers and tubs on exterior walls have insulation and an air barrier separating them from the exterior wall.</td>
</tr>
<tr>
<td>14</td>
<td>Electrical/phone box on exterior walls</td>
<td>Air barrier extends behind boxes or air sealed-type boxes are installed.</td>
</tr>
<tr>
<td>15</td>
<td>Common wall</td>
<td>Air barrier is installed in common wall between dwelling units.</td>
</tr>
<tr>
<td>16</td>
<td>HVAC register boots</td>
<td>HVAC register boots that penetrate building envelope are sealed to subfloor or drywall.</td>
</tr>
<tr>
<td>17</td>
<td>Fireplace</td>
<td>Fireplace walls include an air barrier.</td>
</tr>
</tbody>
</table>
IRC N1102.4.1.2
IECC R402.4.1.2

Testing.

The building or dwelling unit **shall be tested** and verified as having an air leakage rate not exceeding

5 air changes per hour in Zones 1 and 2,

3 air changes per hour in Zones 3 -8.

Testing with a blower door at a pressure of 50 Pascals.
5 air changes per hour in Zones 1 and 2.
3 air changes per hour in Zones 3 - 8.

See TABLE N1101.10 IRC or R301.1 IECC for CLIMATE ZONES BY STATE & COUNTY
Where required by the code official, an approved party independent from the installer of the insulation shall inspect the air barrier and insulation.

**ACH50 = CFM50 x 60 ÷ House volume**

Get volume from builder/designer
Blower Door Equipment

Anatomy of the Minneapolis Blower Door

Lightweight, Durable Door Frame and Panel
- The innovative design is the result of years of refinements based on the experience of thousands of users. There is no easier way to pull a Blower Door fan into a door opening.
- Snap-together aluminum frame comes in a compact case and sets up in seconds.
- Precision cam lever mechanism securely clamps the nylon panel into the door opening.

DG-700 Pressure and Flow Gauge
- Specifically designed for blower testing with specialized measurement functions.
- One of the most accurate pressure measuring gauges on the market.
- Channel A measures the change in building pressure.
- Channel B measures air flow from the Blower Door fan.
- DG-700 can be connected to a laptop computer for automated testing.

Fan Speed Controller
- Precision control of fan speed throughout the entire range.
- Compatible with Guide Control feature and automated testing.

Powerful, Calibrated Fan
- The Minneapolis Blower Door comes with Ring A and B to measure a wide range of air pressure differential. Optional Ring C, D, and E extend the low range of the Blower Door fan.
- Flow sensor at the entrance to the fan assures precision readings from 11 CFM to 2300 CFM.
Purposes of a Blower Door Test

- Allows you to measure envelope tightness
  - To show compliance with a code or program standard
- Diagnostic tool to find and document air leakage sites
  - Blower door with IR Scan
- Document the effectiveness of weatherization activities
  - Pre and post WX measurements
- Investigate duct leakage problems
  - Pressure pan test
Purposes of a Blower Door Test

- Measure and record the relative air tightness of buildings
  - (are they leaky - tight - or somewhere in between).
- Help find air leaks by inducing air to move through all leaks at the same time (chemical smoke, IR camera, feeling with you hand, zonal pressures).
Purposes of a Blower Door Test

- Determine the effectiveness of the air barrier
- Determine the effectiveness of air sealing activities
  - compare before and after measurements.
- Find air leaks
- Investigate duct leakage problems.
- Help estimate the need for mechanical ventilation.
Blower Door Test

- Blower Door fan is used to blow air out of (or into) the house.
- Adjust fan until the house pressure is changed by 50 Pa. (Approx. pressure of 20 mph wind)
- Flow through the fan needed to create a 50 Pa change is the house air tightness – CFM50.
Blower Door Test

- ACH50 is used to adjust for house size-
  - <1.5 - very tight (requires mechanical ventilation)
  - 1.5 to 3 – tight (requires mechanical ventilation)
  - 3 to 6 - typical pretty good new construction or retrofit (may require mechanical ventilation)
  - 6 to 10 - leaky
  - 10 to 20 - very leaky

- ACH50 = CFM50 x 60 ÷ House volume
- 2009 IECC- 7ACH50
Zone Pressure Diagnostics (ZPD)

- ZPD is a tool used since 1990
- Used to identify and measure series leaks
- Depressurize house to 50 pa and measure zone pressures
- Pressures are a ratio of leakage areas
Blower Door with IR

- Air Leakage Path investigation
  - Blower Door with an Infrared Camera
  - View wall before Blower Door Test
  - View wall with Blower Door running
• 120x120 IR Resolution

• Thermal Sensitivity of < 0.1°C @ 25°C
More Useful Information

- Visit our website
  www.energyconservatory.com
- 2009 Air Sealing Check list
- Information on the 2009 IECC
- Information on the 2012 IECC

Thanks!
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