Auto-Sealing New Home Leaks with Aerosols

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Presentation Overview

» Air Sealing Benefits
» Basic Concept
» Building America Project
» Path Forward
Energy Benefits of Air Sealing

› Heating and cooling is responsible for large fraction of energy use
  • 48% in residential
  • 35% in commercial

› Infiltration is responsible for 30% of the heating and cooling load

› Better insulated envelopes increase fraction of heating & cooling associated with infiltration/ventilation

› Envelope tightness standards were fairly recently included in U.S. codes

› Cost-effective approaches to sealing envelope leakage would improve and simplify adherence to code
Basic Concept

Blower door setup for pressurization

Seal formed between gap in foam
Building America Project Goals

Integrate aerosol sealing into building process
» Determine appropriate time for applying
» Measure performance relative to conventional methods
» Determine existing sealing efforts that could be avoided
» Determine cost-effectiveness
Building America Project Approach

**House Leakage Assessment**
- Review existing sealing practices
- Aerosol sealing demonstration

**Develop Two Sealing Options**
- Meet with builder to go over options
- Pick two promising approaches

**Perform Aerosol Sealing**
- Seal at least two homes under each option
- Evaluate impact relative to baseline

**Refine Sealing Options**
- Refine most promising option

**Perform Aerosol Sealing**
- Seal 3-4 homes under refined option
Building America Interim Results (CA)

» California Builder #1
» Homes designed with sealed attics
» Using open-cell spray foam
  • Under roof deck
  • At rim joist and other mechanical penetrations
» Fiberglass/mineral wool in wall cavity
» HRV integrated into central air handler
» Target leakage of 800 CFM50 (2.1-2.4 ACH50)
Conventional Sealing

Can foam at seams where wood is joined

Can foam and gasket at sill plate

Foam gasket to seal drywall to top plate
Sealing Options

» Sealing options
  • Option 1: After open-cell spray foam
  • Option 2: Before spray foam insulation

» Advantage of sealing before drywall
  • Addresses outer wall surface
  • Seals less prone to damage in wall cavity
  • Easier aerosol distribution
Option 1: After Foam

Foam at roof deck

Foam at rim joist
# Results Sealing After Foam

<table>
<thead>
<tr>
<th>Stage/Option</th>
<th>Lot</th>
<th>Plan</th>
<th>Floor Area (ft²)</th>
<th>Volume (ft³)</th>
<th>Pre-Seal CFM50</th>
<th>Pre-Seal ACH50</th>
<th>Post-Seal CFM50</th>
<th>Post-Seal ACH50</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demo 1</td>
<td>7</td>
<td>3</td>
<td>2569</td>
<td>23121</td>
<td>1690</td>
<td>4.39</td>
<td>429</td>
<td>1.11</td>
<td>75%</td>
</tr>
<tr>
<td>Demo 2</td>
<td>8</td>
<td>1</td>
<td>2032</td>
<td>22215</td>
<td>1286</td>
<td>3.47</td>
<td>351</td>
<td>0.95</td>
<td>73%</td>
</tr>
</tbody>
</table>

![Graph showing Leakage (cfm at 50 Pa) vs. Elapsed Minutes](attachment:image.png)

- Demo 1
- Demo 2
Example Seals After Foam

Seals formed under trusses

Seal formed at corner of wall assembly
Option 2: Before Foam

Exposed roof deck

Rim joist penetrations
Option 2 Pre sealing work

» Large penetrations needed to be sealed prior to aerosol sealing
» Time/materials for pre-sealing was tracked
Prepare for unexpected!
# Pre-Sealing Time/Materials

<table>
<thead>
<tr>
<th>Stage/Option</th>
<th>Sealing Penetrations</th>
<th>Sealing Gap at Eaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Foam</td>
<td>1.5</td>
<td>3</td>
</tr>
<tr>
<td>Before Foam</td>
<td>4.5</td>
<td>6</td>
</tr>
</tbody>
</table>

*Note: Pre-sealing work performed by inexperienced staff*
## Option 2 Results

<table>
<thead>
<tr>
<th>Stage/Option</th>
<th>Lot</th>
<th>Plan</th>
<th>Floor Area (ft²)</th>
<th>Volume (ft³)</th>
<th>Pre-Seal</th>
<th>Post-Seal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demo 1</td>
<td>23</td>
<td>3</td>
<td>2569</td>
<td>23121</td>
<td>CFM50</td>
<td>ACH50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5836</td>
<td>15.14</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>828</td>
<td>2.15</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>% Reduction</td>
<td>86%</td>
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<tr>
<td>Demo 2</td>
<td>24</td>
<td>2</td>
<td>2223</td>
<td>20007</td>
<td>CFM50</td>
<td>ACH50</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>3005</td>
<td>9.01</td>
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<td>477</td>
<td>1.43</td>
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<td></td>
<td></td>
<td>% Reduction</td>
<td>84%</td>
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</tbody>
</table>

### Leakage at 50 Pa

<table>
<thead>
<tr>
<th>Leakage (cfm at 50 Pa)</th>
<th>Demo 1</th>
<th>Demo 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFM50</td>
<td>483</td>
<td>352</td>
</tr>
<tr>
<td>ACH50</td>
<td>1.25</td>
<td>1.06</td>
</tr>
<tr>
<td>% Reduction</td>
<td>6%</td>
<td>4%</td>
</tr>
</tbody>
</table>
Option 2 Example Seals
CA Builder #1 Results Summary

- 39% tighter than two control houses
- 55% tighter than Zero Energy Ready requirement of 2.5 ACH50

Diagram showing ACH50 values for Demo 1 and Demo 2 before and after foam, with Avg. 1.1 ACH50 and Avg. 1.8 ACH50.
Building America Interim Results (MN)

» Minnesota Builder #1
» Homes designed with ventilated attics
» Closed-cell spray foam at rim joist
» Interior poly wrap
» Fiberglass/mineral wool in wall cavity
» ERV integrated into central air handler
Conventional Sealing

Caulk at seams where wood is joined

Can foam at wire penetrations

Caulk at sill plate
Proposed Sealing Options

» Option 1:
  • Seal home after spray foam at rim joist
  • Reinforced poly at ceiling-attic interface
  • Maintain conventional sealing

» Option 2 (Ultimately not implemented):
  • Seal home after spray foam at rim joist
  • Reinforced poly at ceiling-attic interface
  • Do not install:
    ▪ Airtight electrical boxes
    ▪ Interior poly
Sealing Results

![Graph showing sealing results with leakage (cfm at 50 Pa) on the y-axis and elapsed minutes on the x-axis. The reinforced poly failed at certain points.](image-url)

- Reinforced poly failed
Example Seals

Seal formed between studs

Seals formed at wire penetrations

Seal formed at electrical box

Seals formed at plumbing penetrations
MN Builder #1 Results Summary

» 41% tighter than two control houses

» 56% tighter than Zero Energy Ready requirement of 2.0 ACH50
Project Path Forward

California Homes
» Test performance with blown insulation at roof deck
  • Sealing completed late July
» Develop and test strategies for vented attics
  • Likely after drywall

Minnesota Homes
» Phase two testing with first builder – eliminate interior poly
» Begin sealing work with second builder
  • First homes sealed below 0.6 ACH50

» Gather cost data from builders to determine cost effectiveness
Research Path Forward

» Application in commercial buildings
  • Completed a project for DoD on non-res retrofits
  • Commercial buildings present challenges
    ▪ Roof-to-wall connection
    ▪ Supplemental manual sealing sometimes required

» Application in existing homes
  • Existing homes are leakier
  • Apply at time of tenant change
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