Ducts in Conditioned Space...sort of?

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Ducts in Conditioned Space...Sort Of? There is a significant push in the industry/codes to bring ductwork into the conditioned space. There are numerous methods to achieve this, but many require redesigning of the building. What options are available that are simply modifications/additions to typical practice? The Building America program has been researching options to better deal with ducts in vented attics. The history of this research as well as the advantages and disadvantages of these systems compared to alternative strategies will be provided.

In addition, while the practice of burying ducts is not new everywhere, having prescriptive code language is. The 2018 IECC laid out a prescriptive path for the use of buried ducts with fibrous insulation in vented attics, for all climate zones. The code change has the potential to provide a vented attic design that is highly energy efficient but at lower cost than alternatives.
Learning objectives

- An overview of past research done on bringing ductworks into conditioned space.
- A detailed summary of the code changes. There are variants of buried duct approaches with different code, and energy modeling, implications.
- A description of how builders can use this practice today, even if their area is not yet on the 2018 IECC.
- An overview of the energy and cost benefits of this approach compared to traditional or unvented attic design.
- A synopsis of relevant field research proving out this practice by showing how it can be done effectively, and safely, in all climates.
Why Buried Ducts?

- Ductwork thermal losses can range from 10-45%.
- Interior ducts are the current solution, but may be impractical, expensive, or increase envelope loads.

1. Ducts in unvented attic
2. Ducts in dropped ceiling
3. Ducts in modified truss in attic
4. Ducts between floors

Insulation & Air Barrier
Ducts in Unvented Attic

- HVAC design flexibility
- Minimal design integration
- Usually more expensive
- May increase enclosure loads

2015 IRC Sections R806.5 Unvented Attic Assemblies, and R316 FOAM PLASTIC control these assemblies
Ducts in Dropped Soffit

• Low-cost in simple plans

• Longer “throws” may be required based on plan.
• Requires high-level of architectural integration
Floor Truss Integrated Ducts

- Offers simple installation and design flexibility
- Very cost-effective
- Conducive to floor registers which don’t work as well for cooling
- High wall registers increase performance, cost, and complexity
Ducts in Modified Truss

- Works well in narrow plans
- Moderate cost-increase

- Sealing the air-barrier is critical
- Design integration required
Research Timeline

1998

SWA: insulation enhanced ducts
• R-30 attic suspended ducts
• Phoenix, AZ

2000

SWA: buried ducts
• Southern CA
• Beazer Homes

2002

SWA: buried ducts
• Sacramento, CA
• Beazer Homes
• Sought to do drop hallway ceilings, but architect was not interested.
• The science of buried ducts began

2003

SWA: Buried Duct Research
• Finite element analysis model was developed
• SWA ASHRAE paper: effective R-value of buried ducts and defining partial, fully, & deeply buried

2005 revisions to Title 24 Alternative Compliance Path incorporates buried ducts

2007

2009

2011

2013

2015

2017
Research Timeline

SWA: hot/humid climate
- Knew buried duct would condense.
- Modeling suggested it would condense on side of duct @ ~11am. Monitoring confirmed this.
- Melbourne, FL

SWA: new construction
- Outlook Construction
- Working on technique of foamed over, buried ducts
- Cartersville, GA

SWA: retrofit
- Foamed over suspended ducts
- Foamed, buried ducts
- Effective, but required significant oversight during installation.
- Jacksonville, FL

2009 IRC prescriptively allows foamed ducts
Research Timeline

Owens Corning Science & Tech Center
- ASHRAE paper: thermal and moisture performance of buried ducts

HIRL: MD case study
- Double R-8 branch ducts with ~2” insulation mounded over the ducts.

HIRL: NJ case study
- R-8 ducts with R-30 mounded over the ducts

FSEC: hot/humid climate
- Buried ducts
- Condensation during mid-summer
- Cocoa, FL

HIRL: humid climate
- R-8 ducts with R-30 mounded over the ducts
- Effective, but needs quality control
- Lady’s Island, SC

2018 IECC prescriptive language for buried ducts
What Are Buried Ducts?

- Low cost, high-performance duct strategy
- Very high R-values
Buried/Encapsulated Duct Categories

- Buried Ducts
- Buried and Encapsulated Ducts
- Encapsulated Ducts
Buried Duct Classification

Buried Duct Schematic
Buried Duct Classification

Buried & Encapsulated Duct Schematic
Effective R-values

• R-value metrics:
  – Nominal – listed values for duct insulation
  – Effective – heat loss/gain from duct to attic
• Buried duct effective R-values calculated using FEA

Heat flux magnitude through a hung duct, and an encapsulated and fully-buried 8-in diameter duct
### Effective R-values

<table>
<thead>
<tr>
<th>Duct Configuration</th>
<th>R-4.2 Ducts</th>
<th>R-6 Ducts</th>
<th>R-8 Ducts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional hung ducts</td>
<td>4.6</td>
<td>5.9</td>
<td>7.2</td>
</tr>
<tr>
<td>Hung ducts encapsulated in 1.5” of ccSPF</td>
<td>11.3</td>
<td>12.0</td>
<td>12.7</td>
</tr>
<tr>
<td>Partially-buried</td>
<td>8.1</td>
<td>10.2</td>
<td>12.3</td>
</tr>
<tr>
<td>Fully-buried</td>
<td>12.0</td>
<td>14.1</td>
<td>16.2</td>
</tr>
<tr>
<td>Deeply-buried</td>
<td>20.7</td>
<td>22.1</td>
<td>23.5</td>
</tr>
<tr>
<td>Encapsulated in 1.5” of ccSPF and partially-buried</td>
<td>18.4</td>
<td>19.7</td>
<td>21.0</td>
</tr>
<tr>
<td>Encapsulated in 1.5” of ccSPF and fully-buried</td>
<td>22.6</td>
<td>23.8</td>
<td>25.0</td>
</tr>
<tr>
<td>Encapsulated in 1.5” of ccSPF and deeply-buried</td>
<td>29.6</td>
<td>30.3</td>
<td>31.1</td>
</tr>
</tbody>
</table>
Condensation Potential (Before)
BEDs Implementation

- Ducts deeply buried under loose-fill insulation
- Ducts with R-8 insulation encapsulated in 1.5 in of ccSPF running above the truss chords
- Flex duct with R-8 insulation encapsulated in 1.5 in of ccSPF
- Duct-boot connection over ceiling supply register encapsulated in 1.5 in of ccSPF
- Gyp. board ceiling
- Truss lower chords
Install Low-Profile, Compact Design

- Before ceiling drywall
- After ceiling drywall
Mastic seal ducts, and test

- Test total duct leakage to assure performance levels are met (total leakage ≤ 3 cfm25 per 100 ft² of conditioned space)
Apply 1.5” minimum ccSPF

• ccSPF applied prior to ceiling gypsum board
Apply 1.5” minimum ccSPF

- ccSPF applied after ceiling gypsum board
Quality Control Issues - Retrofit

Exposed underside of duct jacket

Well-sealed ductwork
Install Loose-fill insulation

- Insulation must be ASTM classified as “mineral-fiber”, and must cover the ccSPF by a minimum of 1.5” (cellulose doesn’t qualify)
- Some foams are exempt from this requirement (more in a moment)
Code Compliance

• 2015 IRC requires that spray foam insulation applied to the exterior of ductwork (Section M1601.3) in attics (Section R316.5.3) meet several requirements

• Flame spread index less than 25
• Smoke-developed index less than 450
• No attic storage or occupancy
• Spray foam protected by ignition barrier (1.5” mineral fiber)
  – Or meets R316.6 (no ignition barrier required)
Bringing Housing Innovations to Market

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Implementing Buried Ducts

Layout ducts with the understanding that they will need to be buried.
Buried Duct Done Right

Pulled back blown insulation to show that a duct is really there.
Getting it Right... mostly
Buried Ducts?
Thank you!
Any Questions?

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