Presentation Overview

• What are compact buried ducts?
• Field data from the mixed-humid climate
• Test house in the hot-humid climate
Background

- **Installing ducts in conditioned space:**
  - Heating & cooling energy savings
  - A challenge for some house designs

- **Constructing an unvented attic:**
  - A viable approach
  - May not be cost-effective

- **Installing conventional attic ducts:**
  - Convenient
  - Not energy efficient
Buried Ducts

- **Buried ducts:**
  - Insulated ducts in a vented attic
  - Installed close to the ceiling
  - Covered with attic insulation

- **Benefits:**
  - Design flexibility
  - Can be an energy efficient alternative

- **Issues:**
  - Condensation in humid climates
  - Duct leakage

- **Current best practices:**
  - Encapsulate ducts (closed-cell spray foam)
  - Building America ZERH program exception
Compact Ducts

- **Compact duct layout:**
  - Minimizes duct surface area
  - Reduces duct pressure losses
  - May reduce installed cost
  - Further reduces energy losses where combined with buried ducts

- **Design considerations:**
  - Central returns
  - Transfer grilles
  - Supply registers
  - Noise control
2009 Mixed-Humid Project

Duct Design –
- Compact central return in conditioned space
- Bedroom transfer grilles
- Insulated R-8 attic supply ducts
- Encapsulated trunk and boots (not branches)

Duct Results –
- Rough-in: 1.0 CFM25/100SFcfa (25CFM25) attic ducts only before spray foam.
- Final: 85 CFM25 total, 0 outdoors.
- Monitoring: no condensation measured
- Reduced duct area: 70% less return, 28% less supply, 40% less overall
2012 Mixed-Humid Project

Duct Design –
- Compact central return chase
- Compact supply duct layout in attic
- Double R-8 branches, R-8 register boots
- Encapsulated trunk (not branches or boots)

Duct Results –
- Rough-in: 1.9 CFM25/100SFcfa (43 CFM25) (same after encapsulation)
- Final: 98 CFM25 outdoors (downstairs system 84 CFM25 outdoors)
- Monitoring: No condensation measured
Worst Case Condensation Potential
Plots the difference between the temperature and dew point.

**Takeaway**: no condensation observed at these 15 sensors.
Research Purpose

- Develop a buried duct system that performs effectively as ducts in conditioned space in mixed-humid and hot-humid climates.

Research Goals

- Develop a buried duct design that does not rely on encapsulation.
- Incorporate a compact duct layout for best performance.
- Develop HVAC design guidance for performing accurate heating and cooling load calculations.
Moisture Dynamics in Vented Attics

- **Research Objective:**
  - Determine minimum duct R-value to prevent condensation

- **Methods:**
  - Hygrothermal Modeling
  - Monitor moisture conditions at an existing house
  - Install and monitor a modified duct design at a test house
Monitored Data
Plots Attic Dew Point Temperatures
Takeaway: dew points within the attic are dynamic!
Preliminary Modeling Results
Plots sensor dew points – modeled & measured
Takeaway: Lower measured DPs during the day
Monitored Data
Plots sensor & duct dew points and duct temperature

**Takeaway:** the duct surface $T$ is below the corresponding height sensor $DP$, but above the duct surface $DP$.
SC Test House Duct Design

Compact duct layout
- Central return jump duct/transfer grilles
- Most supply registers near interior walls

Buried duct insulation
- R-8.7 duct-board trunk
- R-8 branches and boots (one R-12)
- Supplemental at flex connections

Duct tightness
- Total target: 3 CFM25/100SFcfa
- Rough-in target: 1 CFM25/100SFcfa
- Seal using mastic and zip ties

Attic insulation (R-38)
- Mound R-30 over buried ducts

Monitoring
- Sensors to monitor condensation
Summary

The compact buried duct approach can be a practical alternative to ducts in conditioned space:

- Can be insulated to prevent condensation
- Can be sealed to within acceptable standards
- Can provide energy savings and comfort
- A compact duct layout can benefit any duct system
- Next Steps: monitor & evaluate the test house
THANK YOU!

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