Home Innovation
RESEARCH LABS

Building America Webinar
Topic 9: High Performance Space Conditioning Systems, Part II
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# Compact Buried Ducts

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Finding Innovation a Home

# Presentation Overview

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

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# 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)

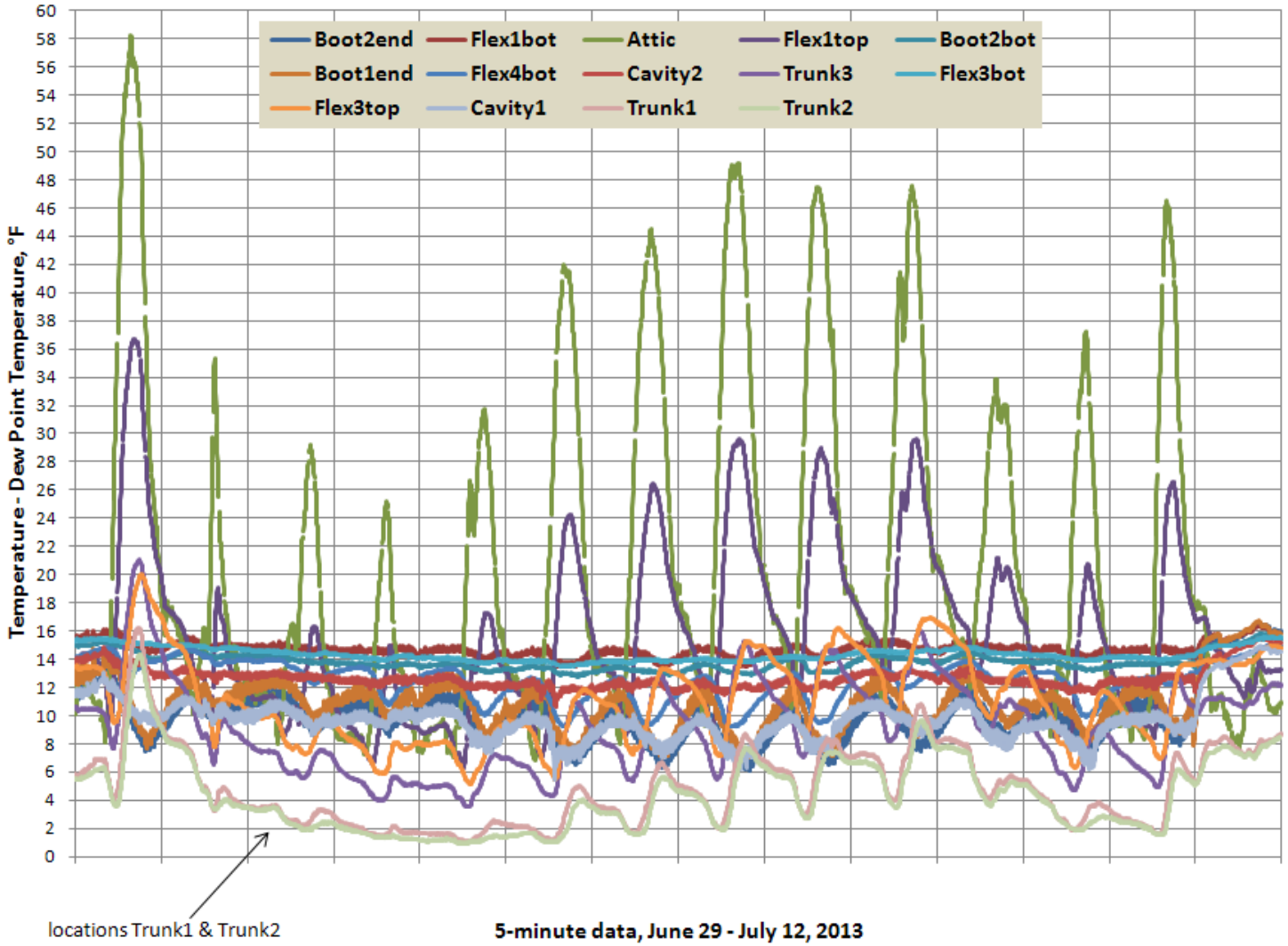
## Duct Results –

- 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.



# 2014-2015 Hot-Humid Project
# South Carolina Test House

## 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.

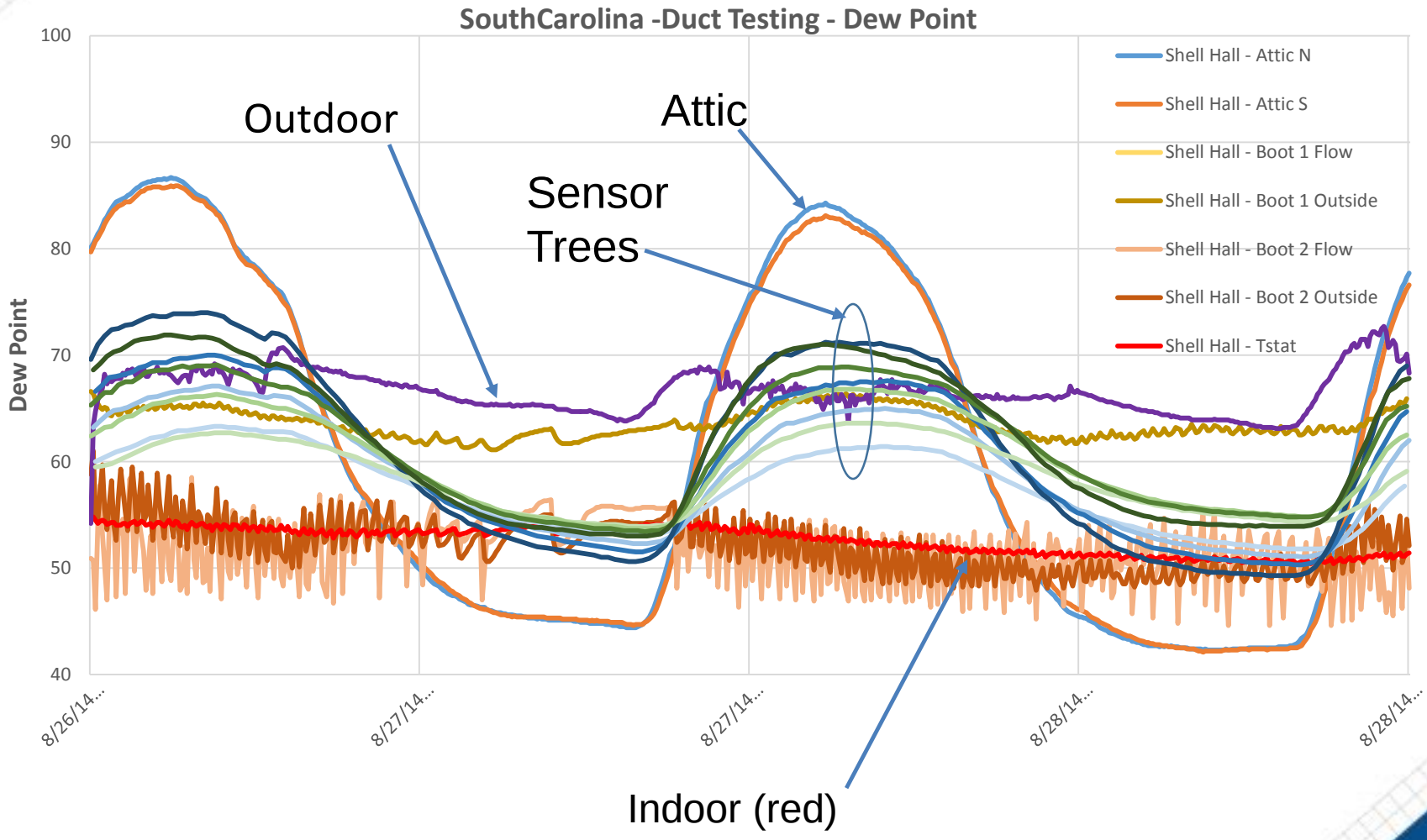
# Moisture Dynamics in Vented Attics

- **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

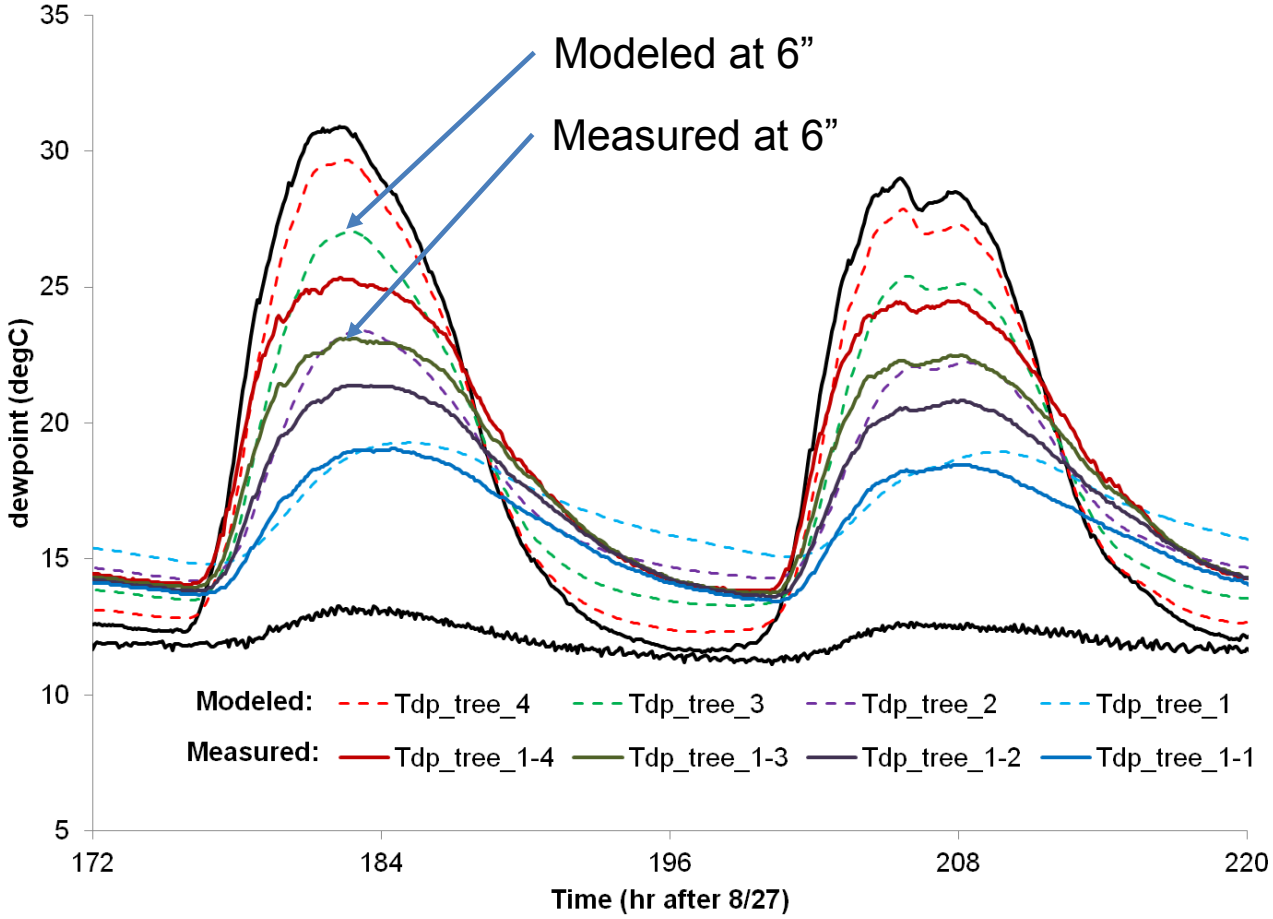
## Takeaway: dew points within the attic are dynamic!



# Preliminary Modeling Results

Plots sensor dew points – modeled & measured

Takeaway: Lower measured DPs during the day



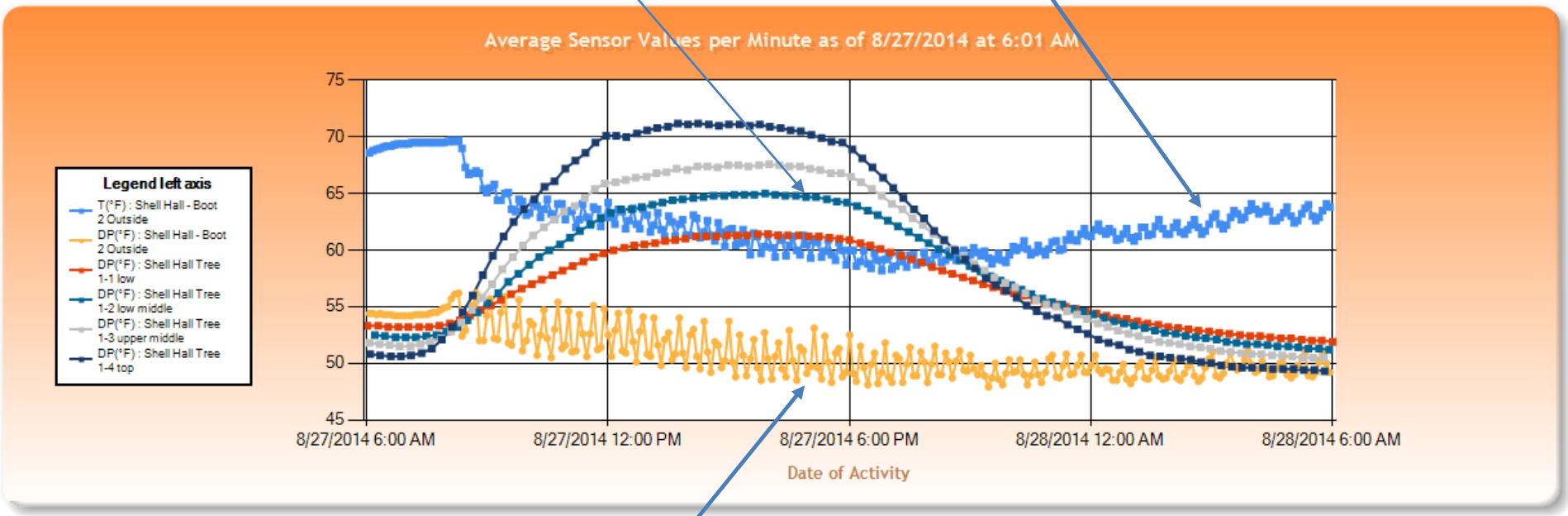
# Monitored Data

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

Sensor Tree DP

Duct surface T




Duct 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

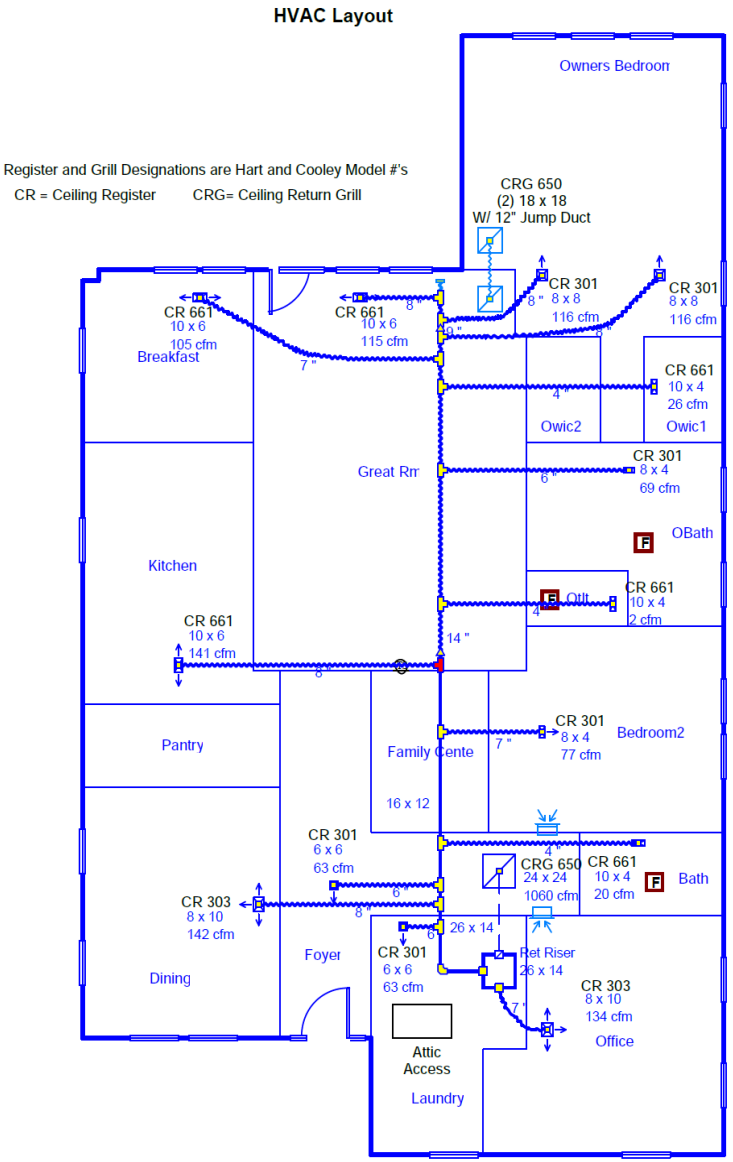
- Total target: 3 CFM25/100SFcfa
- Rough-in target: 1 CFM25/100SFcfa
- Seal using mastic and zip ties

## 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

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# THANK YOU!

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