Building America Case Study

Compact Buried Ducts in a Hot-Humid Climate House

Lady's Island, South Carolina

PROJECT INFORMATION

Construction: New home

Type: Single-family

Partners:

Home Innovation Research Labs, *homeinnovation.com*

K. Hovnanian Homes

Size: 2,222 ft^2 conditioned area

Price: $300,000

Date Completed: August 2015

Climate Zone: Hot-humid (International Energy Conservation Code warm-humid climate zone 3A)

PERFORMANCE DATA

Home energy rating system index: Not available

Projected annual energy cost savings: $281 based on all ducts being buried

Incremental cost of energy-efficiency measures: $732

Incremental annual mortgage: $42

Annual cash flow: $239

Billing data: Not available

A new home was recently completed that features a compact buried-duct system. The term "buried ducts" describes heating and cooling air-distribution ducts that are insulated, installed close to the ceiling in a vented attic, and covered with attic insulation to minimize energy loss. The term "compact ducts" describes a duct layout that minimizes the overall duct length and duct area to reduce energy losses caused by conduction, leakage, and duct pressure drop.

This technology is an alternative to installing ducts inside conditioned space (inside the air barrier), which often presents a challenge for many house configurations—including this single-story slab-on-grade design.

The primary research issue with buried ducts is potential condensation at the outer jacket of the duct insulation in humid climates during the cooling season. Current best practices for buried ducts rely on encapsulating the ducts with closed-cell spray polyurethane foam insulation to control condensation and improve air sealing.

With U.S. Department of Energy Building America Program support, Home Innovation Research Labs partnered with K. Hovnanian Homes to demonstrate a new buried-duct design that is durable, energy efficient, and cost-effective in a hot-humid climate. There were three project goals to support this purpose:

- Develop design criteria for buried ducts that use common materials and do not rely on encapsulation or disrupt traditional work sequences.
- Establish design criteria for compact ducts and incorporate those with the buried-duct criteria to further reduce energy losses and control installed costs.
- Develop heating, ventilating, and air-conditioning design guidance for performing accurate heating and cooling load calculations for compact buried ducts.

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Key Features

COMPACT BURIED DUCTS

- Heat-pump air handling unit installed in mechanical closet (in conditioned space)
- Single central-return duct located near the air handling unit
- Bedroom transfer grilles provide the return air path to the central return
- Supply-air registers primarily located in the ceiling near interior walls
- Ducts sealed using mastic
- R-38 insulation in vented attic, plus R-30 insulation mounded over the buried ducts (R-8 duct insulation).

The insulated ducts were installed close to the ceiling and were well sealed.

After attic insulation was installed (shown), additional R-30 insulation was mounded above the ducts.

Data in the report was taken at one house in a hot humid climate during August of 2015 under the conditions, construction quality, and construction details for that house. Conditions, construction quality, and details that vary from those monitored in this report should be evaluated based on engineering principles and methods or empirical data.

For more information read the Building America report *Compact Buried Ducts in a Hot-Humid Climate House* at *buildingamerica.gov*.

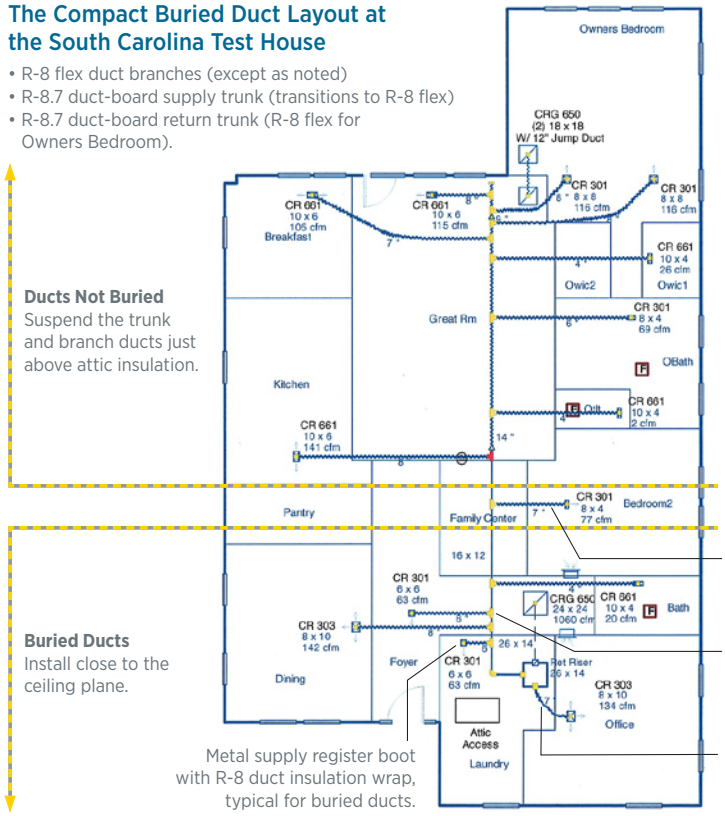
Image credit: All images were created by the Home Innovation Research Labs team.

The Compact Buried Duct Layout at the South Carolina Test House

- R-8 flex duct branches (except as noted)
- R-8.7 duct-board supply trunk (transitions to R-8 flex)
- R-8.7 duct-board return trunk (R-8 flex for Owners Bedroom).

Ducts Not Buried
Suspend the trunk and branch ducts just above attic insulation.

Buried Ducts
Install close to the ceiling plane.



Insulation Partner
- Install R-38 attic insulation
- Mound R-30 insulation above buried ducts
- Install buried duct markers with depth gauges every 10 feet and at take-offs and boots.

Note: the following supply registers were substituted: Dining 12×6 (303); Office 12×6 (303); Foyer 10×6 (301); Laundry 10×6 (301); Bedroom2 10×6 (301); OBath 10×6 (301); OBedroom (2) 10×6 (301).

Partially buried branch duct.

Add supplemental R-8 duct wrap over flex duct at this take-off.

R-12 branch duct (R-8+R-4) and metal boot with R-12 wrap.

Metal supply register boot with R-8 duct insulation wrap, typical for buried ducts.

Lessons Learned

- Based on readings from numerous sensors installed to monitor duct surface and attic conditions, no condensation was observed at the buried ducts.
- Conventional duct-sealing methods resulted in an acceptable measured leakage rate for the ducts in the attic.
- The buried ducts delivered colder air during cooling than the ducts that were not buried (7°F colder on average), which resulted in increased energy savings and improved occupant comfort.
- The compact buried-duct layout was practical to install, although effective quality control is required to ensure uniform insulation coverage above the buried ducts and to meet duct leakage goals.
- Using a compact-duct layout for this project reduced attic duct surface area by 32% for supply ducts and by 75% for return ducts compared to builder standard practice.
- This project outlined a cost-effective energy-savings solution for a hot-humid climate with a predicted annual cash flow of $239, a simple payback of 3.1 years, and a simple return on investment of 32%.
- Simulations predicted 21% annual heating/cooling site energy savings compared to conventional attic ducts; roughly 13% of those savings were attributed to compact-duct layout and 8% to buried-duct application.

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buildingamerica.gov

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