

# Designing and Building Interior Duct Systems

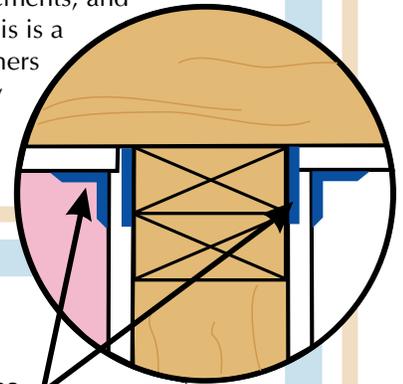
*An Introduction for Design, Construction, and Energy Research Professionals*

Over the past 15 years, duct related energy use has emerged as one of the most extreme and pervasive energy wastes in American homes, accounting for as much as 40% of annual heating and cooling bills. Duct leakage and conductive heat transfer also degrade building durability, comfort, and indoor air quality by altering surface temperatures and moving air through walls cavities and vented unconditioned spaces.

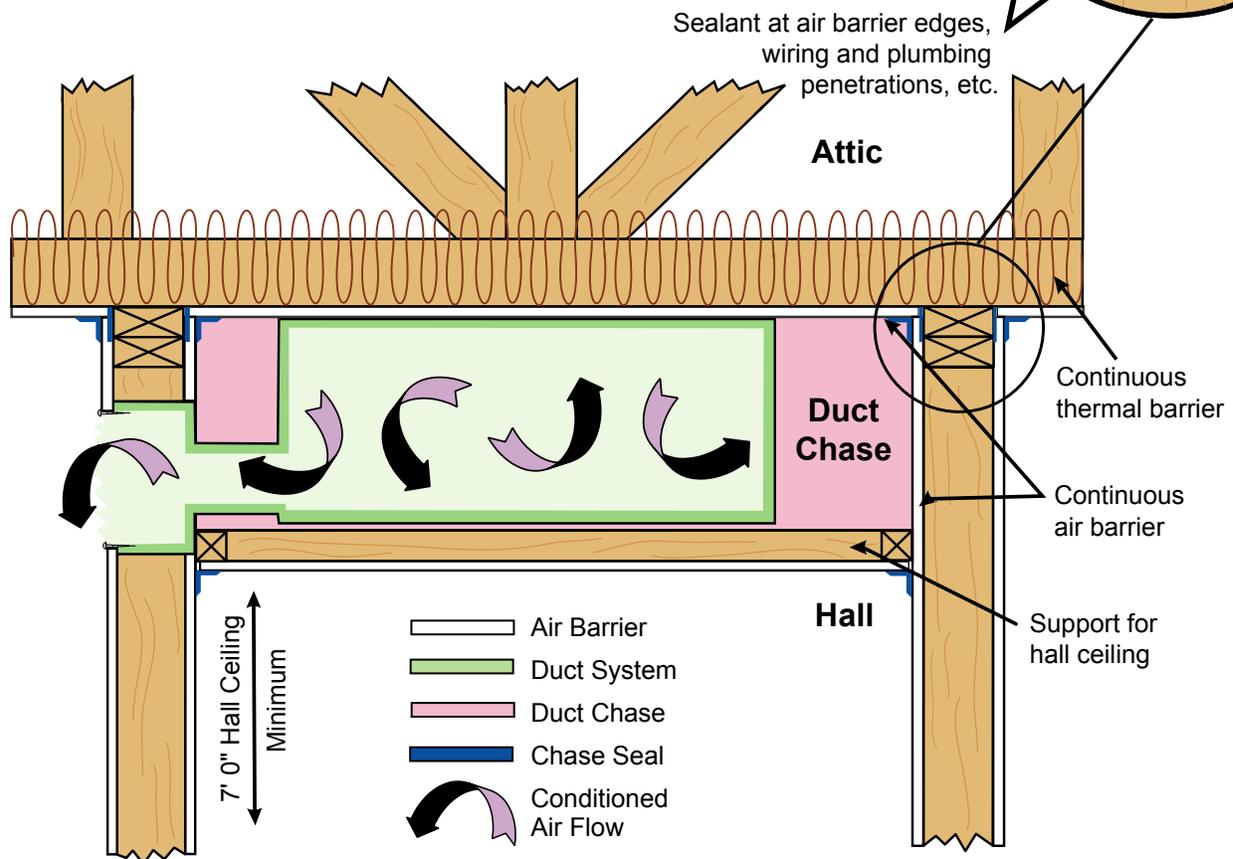
Experts often recommend installing ducts and

conditioning equipment inside the conditional space. To be effective, an interior duct chase and air handler closet must be separated from unconditioned, vented spaces by both a continuous air barrier and continuous thermal barrier (see illustration below).

Scheduling conflicts, code requirements, and tight tolerances converge to make this a challenging task. Four Building Partners (see back page) volunteered to show FSEC how they handle these challenges.



## Interior Duct System — Fur Down in Hallway



## Challenges and Solutions

Each Builder Partner constructs furred down chases which house the duct system (duct chases) and an interior air handler closet (AHU closet). The chases and closet are separated from the attic by:

- a continuous air barrier, typically drywall taped and mudded at the edges and seams, installed *prior* to the installation of the mechanical system.
- a continuous thermal barrier, typically ceiling insulation.

While the thermal barrier (ceiling insulation) is installed as usual, the air barrier (drywall) installation requires a change in scheduling. Though drywall commonly forms the ceiling air barrier, it isn't usually at the site until after the mechanical system is installed. The Builder Partners bring in a few sheets to make the top and sides of the chase and AHU closet.

All joints and edges are sealed with code approved sealant. Essentially, they are putting up a portion of the ceiling and wall finish early, so that when the ducts and air handler are installed, they will be on the conditioned side of the house's air barrier. If the ducts and/or air handler have some leakage, there will be minimal involvement of unconditioned air. This is similar to the practice of sealing top plate penetrations. The foamed top plate and the sealed air barrier both block air flow between the attic and the conditioned space.

Building the chase in a fur down creates an area with a lowered ceiling height. Many codes set a minimum ceiling height requirement at 7' 0". For homes with 8' 0" finished ceilings this leaves only a foot for the duct chase, including framing and finish. The three challenging aspects of this are:

- Fitting the ducts inside the shallow chase. *Consult with the mechanical contractor in advance to ensure that the ducts are sized for the space provided.*
- Minimizing the vertical dimension of framing that supports the bottom of the chase. *Researchers observed use of light gauge metal framing, 2 x 2s, and 4 x 4s broad side down.*
- If the 7' 0" minimum ceiling height is not achieved, door framing must be trimmed. *(see Key Construction Steps for tips)*

## Design Concepts

In homes with a central hall, the Building Partners usually run the duct chase the length of the hall and locate an air handler closet at the end or middle. In the main living area, the chase extends out into the living space above kitchen cabinets, closets, or alcoves. The change in ceiling height provides architectural value by visually dividing the open living area and creating niches for entertainment equipment, books cases, curios or decorative cabinets.

Without exception, the Partner Builders aligned elements of the house (closets, cabinets, halls, etc.) specifically to ease construction of the chase. Installing and sealing the air barrier and duct system around wall and ceiling framing significantly increases complexity and cost of the job. It's smart to frame a rough opening in any interior walls the chase will be running through. In general, keep the chase as simple as possible and invite input from key sub-contractors (ie, mechanical, drywall, framing, etc.) on the layout and design of the chase.

## The Results

Researchers tested 23 Partner houses. Five had conventional duct systems in vented crawl spaces and 18 had interior duct systems in furred-down chases. All had significantly lower supply duct leakage than their conventional counterparts. Several air handler closets were found to have holes in their air barriers resulting in unacceptably high return leakage. Repairs involved patching the air barriers and replacing insulation.

The design and construction of an interior duct system should be detailed prior to construction and should involve sub-contractors. With attention to the challenges outlined here, interior ducts can become part of a regular strategy for reducing duct leakage and conductive heat exchange resulting in improved durability, comfort, indoor air quality, and energy efficiency.

The key construction steps (*right*) offer guidance for implementing this strategy. For more information, request the complete paper from the Florida Solar Energy Center (*see back*).



*Fur-down duct chase under construction. Note that chase side extends below framing for the chase bottom.*



*In hallway fur-down chases, the air barrier is installed and sealed on both sides and the top of the chase first.*



*Code required 7' 0" ceiling height creates tight tolerance for door trim under fur-down chases.*



The effect of the lower ceiling height can be offset by increasing the hall width (right).

## Key Construction Steps

The successful completion of an interior duct chase depends largely on careful planning in the design phase and coordination of trades on site. Builders use special energy crews or work with the framing and drywall crews to accomplish the following seven steps:

### Step 1: Layout the Chase and Prepare to Install the Air Barrier

- Mark the chase path on the top or bottom plate using a construction marker or spray paint after rough framing is complete.
- Apply a continuous bead of caulk or staple a strip of closed cell foam to the top plate of all walls being used to form the chase sides. This will block airflow between the drywall and rough framing, a common leakage path. If possible, this should also be done on the opposite side of the top plate when the rest of the

house is dry walled (see yellow highlights on illustration).

### Step 2: Install the Air Barrier

- Being careful not to disturb the caulk or sill seal, install a code-approved air barrier (e.g. drywall, rigid insulation, OSB, plywood, etc.) to form the top and side(s) of the chase and air handler closet.
- If using drywall, extending it down to interior door rough openings eliminates the need to fill in small pieces of drywall over the doorways later. **Make sure the chase sides extend below the bottom of the chase.**

### Step 3: Seal The Air Barrier

- Working from the conditioned side of the air barrier, fill all seams in the air barrier with a code-approved sealant (e.g. dry-wall mud, mastic and fiberglass mesh, etc). Include corners and air handler closet walls and floor (see illustration on page 1).

### Step 4: Locate the Minimum Ceiling Height

- Measure from the floor up the interior walls to locate the minimum ceiling height. REMEMBER, doors and door trim MUST fit below this line.
- Snap a chalk line throughout the chase to mark the bottom of the chase finish.

### Step 5: Install the Ducts and Remaining Chase Framing

- Ducts may be strapped into place prior to framing the bottom or slid into place afterwards.
- Framing for the chase bottom can be assembled (like a ladder) on the floor and installed in sections.
- After the duct system is in place, fill the opening in the air barrier around each run out duct, another common leakage path, with code approved sealant (see illustration, page 1).

### Step 6: After the House is Dry walled

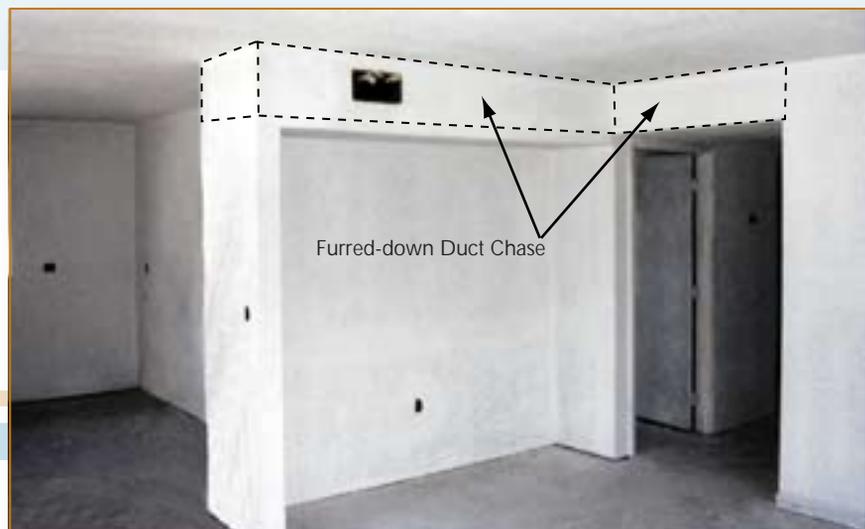
- After drywall is installed in the rest of the house, but before the registers are installed, seal the space between the boot and the drywall. Ceiling insulation should cover the chase during normal installation.

### Step 7: Protect the Air Barrier

- It's important to avoid leaving holes, for wiring and plumbing unsealed. The site supervisor should review the purpose of the chase detail with affected crews and check their work before they leave the site. Consider requiring each installer to fill holes and penetrations they create with code approved sealant or having one person take care of this detail after all of the sub-contractors have completed their work.



The air handler, the heart of the duct system, is housed in a sealed closet with a central return.



A hallway fur-down extends duct chase into the main living area over an



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### **Designing and Building Interior Duct Systems**

Based on field studies conducted by the  
Florida Solar Energy Center, Buildings Research Division  
A Research Institute of the University of Central Florida

#### **In Collaboration With**

Bentweed Custom Homes, Waxahachie, Texas  
Durham County Habitat for Humanity, Durham, North Carolina  
Broward County Habitat for Humanity, Ft. Lauderdale, Florida  
Builders affiliated with Ken Fonorow, Florida Home Energy  
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reducing residential energy use.*

#### **For More Information:**

Request the document,  
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