Ducts in Dropped Ceilings

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Scope

Install ducts in dropped ceilings or “fur-down” duct chases to keep the ducts within the home’s thermal envelope.

- Install drywall at the ceiling plane before the chase is framed to form a continuous air barrier between the top of the chase and the unconditioned attic or floor cavity above.
- Install chase framing.
- Install the sealed, insulated ducts.
- Install drywall on chase sides and bottom when installing drywall in remainder of the house.

Several trades are critical to the success of this technique:

- **HVAC Designers** - Design a compact duct layout that does not cross load bearing walls. Use [ACCA Manual D](#) to determine the duct size needed.
- **Framers** - Construct any non-load bearing walls that will serve as one side of the chase with a gap of 3/4” between the top plate of the wall and the bottom chord of the attic trusses so that drywall can be installed over the top plates to form a continuous ceiling for the duct chase. Construct remaining duct chase after chase ceiling drywall is installed.
- **Drywallers** - Install drywall above duct chase location before framing the chase and before installing the ducting. The remaining drywall in the room will be installed after the duct and chase framing are installed.
- **Plumbers and Electricians** - Do not use the duct chase as a chase for electrical wiring or plumbing, and do not cut holes through the chase walls.
- **All Trades** - Participate in a pre-construction meeting to understand construction sequencing steps for this technique, which is further described in the Description tab of this guide.

See the [Compliance Tab](#) for related codes and standards requirements, and criteria to meet national programs such as DOE’s Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.
Implementing an interior duct system involves bringing the forced air system, including the air handler, within the dwelling’s air and thermal barrier and integrating the new detail into the design and construction process. There are many benefits to bringing the ducts and HVAC equipment within conditioned space – the HVAC equipment is protected from the extreme temperatures of unconditioned attics and crawlspaces, the furnace and air handler are easier to access for maintenance, interior installation requires far fewer holes through the building envelope, and any air losses through duct or cabinet leaks will go to conditioned space rather than being lost to unconditioned space. Installing the ducts in a dropped ceiling chase in a central hallway (with the air handler in a utility closet) is one option for locating ducts in conditioned space. For other options, see the guides Unvented Attic Insulation, Unvented Crawlspace and Conditioned Basements, Raised Ceilings, Ducts Buried in Attic Insulation, Ducts Buried in Attic Insulation and Encapsulated, and Ducts in Interstitial Floor Framing. Another option is to install a heating and cooling system that does not require ducts, such as ductless heat pumps and radiant floor heating.

In a dropped ceiling or “fur-down” duct chase installation, a critical detail is the integrity of the air barrier between the top of the chase and the unconditioned attic or floor cavity above.

The builder must make a clear and consistent commitment to building an interior duct system. Then this commitment must be communicated to all of the relevant trades. All involved parties (trades, designers, architects, etc.) must be dedicated to this task. Four critical trades are the home designer, the HVAC designers and installers, the drywall installers, and the framing carpenters. The best opportunity to minimize costs while ensuring an aesthetically pleasing outcome is during the preliminary schematic design phase of home construction.

- HVAC designers must first determine the needed size of the duct work based on the ACCA Manual D calculation.
- The size and location of the chase can now be planned by the house designer.
- The method and technique of constructing the chase must be clearly planned, documented, and communicated to the drywall contractors, field crews, and carpenters.

U.S. Department of Energy Building America Partners Tommy Williams Homes and Florida H.E.R.O. have developed and implemented an innovative approach to the dropped ceiling or fur-down chase method that addresses the typical failure point of fur-down chases: the integrity of the air sealing between the chase and the attic above. In the common approach to a fur down chase (Figure 1), the air barrier is adhered to the underside of the truss bottom chords and to the face of the studs in the adjacent hallway walls (between the top plates). The intersection of the air barrier material with these framing members creates a complex set of air sealing details, as shown in the circle in Figure 1. The innovative approach described in this guide eliminates the majority of these leakage paths.

![Figure 1](image-url). This typical dropped ceiling hallway chase shows a complicated air sealing scheme where chase ceiling drywall meets sidewall top plates.

By designing the chase’s path to avoid intersecting load-bearing walls, air sealing of the chase’s top plane, or ceiling, is fairly easy. For chases that will use a non-load-bearing interior wall for one or both sides of the chase, the walls can be constructed to leave a gap of \( \frac{3}{4} \)” between the top plate of the wall and the bottom chord of the attic trusses. The \( \frac{3}{4} \)” space allows for the installation of drywall over the top plates of the walls to form a continuous ceiling or top of the duct chase. If the chase walls will not be part of an interior wall, the drywall for the ceiling of the chase is installed first. The chase’s ceiling drywall should be extended beyond the borders of the chase over the top plates of the walls and anticipated framing of the chase sides (Figure 2).
This drywall will be the primary air barrier separating the chase from unconditioned attic space above. It is continuous over the wall framing, thereby eliminating the complex intersections and air sealing details between the ceiling of the chase and the tops of the walls.

The HVAC ducts are hung after the chase ceiling drywall is installed. Then, the framing for the sides and bottom of the chase are installed. These will be drywalled when the interior walls of the home are drywalled.

With information derived from the HVAC designer’s Manual J and D calculations, the designer can finalize plans that consider the size requirements and path of the distribution system. This may require an iterative approach as the vertical dimensions of the required duct sizes, the chase, and the ceiling are refined. Preplanning can help facilitate a compact duct design and reduce the amount of ducting needed.

Ducts brought into the conditioned space should include both the return and supply ducts to provide maximum efficiency for the effort. To reduce the size and amount of chase required and to avoid duct sizing miss-matches between the supplies and returns, one or more central main return registers can be installed in central locations in the home with passive return air pathways consisting of transoms over the interior doors of occupiable rooms (bedrooms). The transoms must be sized to allow adequate return air passage to the main body of the house with the goal of maintaining nearly neutral pressure with respect to the home (<2.5 Pascals) when the mechanical system is operating and the bedroom doors are closed. (See the guides Transfer Grilles and Jump Ducts for more information.) The passive transom returns should be sized at least 1 ½ times larger than the room’s cumulative supply duct areas. The supply ducts should be sized according to ACCA Manual D. By eliminating all ducted returns, labor and material costs are reduced. In addition, the system’s overall operating static pressure can be reduced, allowing for less wear on the air handler’s fan motor. Partner builders implementing transom returns in hundreds of Building America homes have not received any noise or light-related complaints. Pressure mapping during the final commissioning should be performed to confirm that the return air system is working as designed.

How to Build a Dropped Ceiling or Fur-Down Chase

Step 1: Plan ahead and document the location, style, and path of the interior duct chase; show the path on the floor plan with dimensions (Figure 3). Provide a detail of any additional framing necessary to complete the chase after the mechanical rough in.
**Figure 3.** Dropped duct chases are indicated on the plans (in grey highlight) to aid sub-contractors in executing the design.

**Step 2:** Install sheetrock at the top of the chase path as indicated in the design plan (Figure 3).

**Step 3:** Fabricate and install the supply ductwork in the chase (Figure 4). Fabricate the duct system. Construct and air seal as much of the duct system as possible on the ground where it is easier to align the sections and reach the joints to seal them with mastic. The main supply trunk lines and supply ducts are then hung from the drywall using strapping secured to the framing. Care must be taken to avoid damaging the chase’s ceiling. Rigid ducts are used whenever possible because they are easier to manage than flex ducts during the lift from floor to ceiling.
Figure 4. Duct work is strapped to the chase ceiling.

Step 4: Install the framing for the sides and bottom of the chase (Figure 5). Care must be used to not penetrate the chase's ceiling while completing the framing of the chase.

Figure 5. Chase framing is completed and ready for drywall.

Step 5: Install drywall on the sides and bottom of the chase when the rest of the house is drywalled, finishing the chase’s construction (Figure 6).
Step 6: Install return transoms (Figure 7) or other passive return paths to a central return register (jump ducts, etc.).

Figure 7. Transom returns are installed over interior doors to provide a pathway for return air. Louvered transoms are available, providing more privacy and sound deadening.
Ensuring Success

Interior duct implementation requires trade coordination, which is best accomplished by a site meeting after house dry-in (when the building shell has been sufficiently completed to keep out wind, rain, and snow). This meeting should include the designer, sales/marketing professionals, and mechanical, insulation, plumbing, electrical, framing, sheet rockers, and solar contractors. The objective is to minimize the need to alter or redo work because of a lack of knowledge of the design and construction requirements. A meeting provides the opportunity to clearly communicate that the home will be built differently compared to the normal practice of having ducts in the attic/crawlspace. Questions raised in the discussion can be quickly answered by the appropriate trade representative.

Because a dropped ceiling chase is built early in the construction process, it is in danger of subsequent damage by trades people performing later tasks. Diligent inspection and constant oversight by an informed site supervisor are necessary to ensure that all trades people involved with the process (not just the crew bosses) are aware of the interior duct system and its function. The bid documents and scopes of work for plumbing and electrical contractors should include an advisement that the duct chase (drawn on the plans) cannot be used for electrical or plumbing runs. Even after the house is completed, interior duct work is subject to damage when the new homeowners have alarm, cable, and telephone services installed. Therefore, homeowner awareness of the duct system’s function is another important part of successfully implementing an interior duct system.

Advisory notices to cable, security, and telephone installers should be posted in conspicuous locations such as the panel box, attic access hatch, wiring service entrance, etc. Since these notices cannot clearly identify the location of the air boundary, they should advise the installer to seal any penetrations to drywall made from unconditioned spaces. Though it should be standard practice and is often required by code, virtually all services that are installed post-occupancy are never inspected.

Verification of an interior duct system can be executed during house pressure testing. Standardized testing protocols require depressurization of the house and duct system. During this operation, air pressure in the chase can be checked to verify its location, either interior or exterior, or somewhere in between. Testing apparatus include a blower door to depressurize the house and a duct blaster to depressurize the duct system. Typical blower door testing involves depressurizing the house to a standard pressure with respect to the outside, usually 50 Pascals, using a calibrated fan. When the house is subjected to this depressurization, the pressure in the duct chase can be checked with respect to the house. If there is no pressure difference between the house and chase, the chase is truly interior. In other words, it is completely inside the pressure boundary of the house. Depending on the pressure variation, a determination can be made regarding the integrity of the duct chase.

Two tests can be performed with the duct blaster: duct leakage to the outdoors, which measures only that duct leakage outside of the home’s air barrier, for example into an unconditioned attic, and total duct leakage, which measures duct leakage across the entire duct system, both into the home’s interior conditioned space and to the outside. Duct leakage to the outside results in energy lost. If the chase is completely sealed from unconditioned spaces, there should be no duct leakage to the outside. Obviously, if leakage is detected with this test, it indicates that the duct chase or the duct system itself is connected to the outside in some fashion, revealing a breakdown in the air barrier of the chase. See the guides on Duct Leakage Tests for more information.
Climate

No climate specific information applies.
Training

Right and Wrong Images

Display Image: TE63DuctsinDropCeiling-Right1f_BAPIRC_2011.jpg
CAD
None Available
Compliance

The Compliance tab contains both program and code information. Code language is excerpted and summarized below. For exact code language, refer to the applicable code, which may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

ENERGY STAR Certified Homes, Version 3/3.1 (Rev. 09)

National Rater Field Checklist

Thermal Enclosure System.

2. Fully-Aligned Air Barriers. At each insulated location below, a complete air barrier is provided that is fully aligned as follows:

- Ceilings: At interior or exterior horizontal surface of ceiling insulation in Climate Zones 1-3; at interior horizontal surface of ceiling insulation in Climate Zones 4-8. Also, at exterior vertical surface of ceiling insulation in all climate zones (e.g., using a wind baffle that extends to the full height of the insulation in every bay or a tabbed baffle in each bay with a soffit vent that prevents wind washing in adjacent bays).

2.1 Dropped ceilings / soffits below unconditioned attics, and all other ceilings.

Please see the ENERGY STAR Certified Homes Implementation Timeline for the program version and revision currently applicable in your state.

DOE Zero Energy Ready Home (Revision 07)

Exhibit 1 Mandatory Requirements.

Exhibit 1, Item 1) Certified under the ENERGY STAR Qualified Homes Program or the ENERGY STAR Multifamily New Construction Program.

Exhibit 1, Item 3) Duct distribution systems located within the home’s thermal and air barrier boundary or an optimized location to achieve comparable performance.

Footnote 14) Exceptions and alternative compliance paths to locating 100% of forced-air ducts in home’s thermal and air barrier boundary are:

1. Up to 10’ of total duct length is permitted to be outside of the home’s thermal and air barrier boundary.

2. Ducts are located in an unvented attic, regardless of whether this space is conditioned with a supply register.

3. Ducts are located in a vented attic with all of the following characteristics: [Note that in either of these designs the HVAC equipment must still be located within the home’s thermal and air barrier boundary.]

   1. In Moist climates (Zones 1A, 2A, 3A, 4A, 5A, 6A and 7A per 2015 IECC Figure R301.1) and Marine climates (all “C” Zones per 2015 IECC Figure R301.1), minimum R-8 duct insulation with an additional minimum 1.5” of closed-cell spray foam insulation encapsulating the ducts; duct leakage to outdoors ? 3 CFM25 per 100 ft2 of conditioned floor area (in addition to meeting total duct leakage requirements from Section 4.1 of the ENERGY STAR HVAC Rater checklist); and ductwork buried under at least 2” of blown-in insulation.

   2. In Dry climates (all “B” Zones per 2015 IECC Figure R301.1), minimum R-8 duct insulation; duct leakage to outdoors ? 3 CFM25 per 100 ft2 of conditioned floor area (in addition to meeting total duct leakage requirements from Section 4.1 of the ENERGY STAR HVAC Rater checklist); and ductwork buried under at least 3.5” of blown-in insulation.

4. Systems which meet the criteria for “Ducts Located in Conditioned Space” as defined by the 2018 IECC Section R403.3.7

5. Jump ducts which do not directly deliver conditioned air from the HVAC unit may be located in attics if all joints, including boot-to-drywall, are fully air sealed with mastic or foam, and the jump duct is fully buried under the attic insulation.

6. Ducts are located within an unvented crawl space.

7. Ducts are located in a basement which is within the home’s thermal boundary.

8. Ductless HVAC system is used.

2012, 2015, and 2018 IRC

Chapter 16 – Duct Systems, M1601.3 Duct Insulation Materials. Duct insulation materials are required to have a flame spread index of 25 or less and a smoke developed index of 50 or less. There is an exemption for foam, flame spread index of 25 or less and a smoke developed index of 450 or less, and the foam is protected with an ignition barrier.


Section N1101.3 (Section N1107.1.1 in 2015 and 2018 IRC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)

Appendix J regulates the repair, renovation, alteration, and reconstruction of existing buildings and is intended to encourage their continued safe use.
Section R403.2.3 (R403.3.5 in 2015 and 2018 IECC) Building cavities (Mandatory). No building framing cavities should be used as ducts or plenums.


Section R101.4.3 (Section R501.1.1 in 2015 and 2018 IECC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)

**2010 Florida Residential Building Code**

M1601.4.1.8 Cavities of the building structure. No building framing cavities should be used to deliver air from or return to the conditioning system unless they contain an approved, insulated air duct insert. An exception is made for return plenums.
More Info.

Access to some references may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

Case Studies

1. New Whole-House Solutions Case Study: Tommy Williams Homes: Longleaf Village & Belmont, Gainesville, FL
   (916KB)
   Author(s): PNNL
   Organization(s): PNNL
   Publication Date: April, 2012
   Case study about a production builder that achieves HERS scores of 60, compared to 85 for other builders that build new homes to Florida code.

References and Resources*

   Author(s): International Code Council
   Organization(s): ICC
   Publication Date: January, 2009
   Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems and service water heating systems in homes and commercial businesses.

2. 2009 IRC - International Residential Code for One and Two Family Dwellings
   Author(s): International Code Council
   Organization(s): ICC
   Publication Date: January, 2009
   Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

   Author(s): International Code Council
   Organization(s): ICC
   Publication Date: January, 2012
   Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems and service water heating systems in homes and commercial businesses.

4. 2012 IRC - International Residential Code for One and Two Family Dwellings
   Author(s): International Code Council
   Organization(s): ICC
   Publication Date: January, 2012
   Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

5. 2015 IECC - International Energy Conservation Code
   Author(s): International Code Council
   Organization(s): ICC
   Publication Date: May, 2014
   Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems and service water heating systems in homes and commercial businesses.

6.
2015 IRC - International Residential Code for One and Two Family Dwellings
Author(s): International Code Council
Organization(s): ICC
Publication Date: May, 2014
Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

Author(s): International Code Council
Organization(s): ICC
Publication Date: November, 2017
Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems, and service water heating systems in homes and commercial businesses.

8. 2018 IRC - International Residential Code for One and Two Family Dwellings
Author(s): International Code Council
Organization(s): ICC
Publication Date: August, 2017
Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

9. ACCA Manual D - Residential Duct Systems
Author(s): Air Conditioning Contractors of America
Organization(s): Air Conditioning Contractors of America
Publication Date: December, 2013
Standard outlining industry procedure for sizing residential duct systems.

10. DOE Zero Energy Ready Home National Program Requirements (Rev. 07)
Author(s): U.S. Department of Energy
Organization(s): DOE
Publication Date: May, 2019
Standard requirements for DOE’s Zero Energy Ready Home national program certification.

11. Energy Efficient Low-Income Housing Program
Author(s): ADM Associates, Texas A&M University, FSEC, University of Nebraska, LBNL
Organization(s): California Energy Commission
Publication Date: March, 2007
Research project addressing low-cost options that reduce monthly energy costs and improve the quality of life by enhancing comfort levels in low-income homes.

12. Energy Savings and Peak Demand Reduction of a SEER 21 Heat Pump vs. a SEER 13 Heat Pump with Attic and Indoor Duct Systems
Author(s): Cummings, Withers
Organization(s): BA-PIRC, Florida Solar Energy Center, FSEC
Publication Date: December, 2011
Research study describing experiments run in an unoccupied 1600 ft² house to evaluate the delivered performance as well as the relative performance of a SEER 21 variable capacity heat pump versus a SEER 13 heat pump.

13. Low Cost Interior Duct Systems for High Performance Homes in Hot Climates
Author(s): Fonorow, Jenkins, Thomas-Rees, Chandra
Organization(s): FSEC
Publication Date: October, 2010
Document presenting a cost effective method that was used by four builders in the Gainesville, FL area to construct interior ducts in over a dozen site built homes.

Author(s): Beal, McIlvaine, Fonorow, Martin
Organization(s): BA-PIRC, National Renewable Energy Laboratory, Florida Solar Energy Center, FSEC
Publication Date: November, 2011
Document illustrating guidelines for efficient installation of interior duct systems in new housing.

15.
Moving Ducts Inside: Big Builders, Scientists Find Common Ground
Author(s): Lubliner, Kerr, Gordon, Murray
Organization(s): WSU Extension Energy Program
Publication Date: August, 2008
Conference paper making the case that moving ducts to conditioned space saves energy, is practical for production builders (when accompanied by careful pre-planning), and creates significant and marketable energy savings for homebuyers.

16. Research Results from A Few Alternate Methods of Interior Duct Systems in Factory Built Housing Located In the Hot Humid Climate
Author(s): Moyer, Stroer, Hoak, McIlvaine, Chandra
Organization(s): FSEC
Publication Date: December, 2008
Document presenting results from testing HVAC duct system design incorporating a high-side supply register.

*Publication dates are shown for formal documents. Dates are not shown for non-dated media. Access dates for referenced, non-dated media, such as web sites, are shown in the measure guide text.

Contributors to this Guide
The following authors and organizations contributed to the content in this Guide.

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