Ducts in Raised Ceiling Sections

**Scope**

Order roof trusses with a notch along the kingpost that allows a duct to be installed above the ceiling plane to account for a raised ceiling or “fur-up” duct chase.

- Construct an air sealed insulated chase to contain the duct.
- Make the duct out of rigid foam or a solid material like drywall or plywood that is air sealed and insulated with rigid foam, spray foam, or batt insulation.

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 ¾” 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 the remaining duct chase after the chase ceiling drywall is installed.
- **Drywallers** - Install drywall above the 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.
The primary challenge of implementing an interior duct system involves bringing the forced air system, including the air handler, within the dwelling’s air and thermal barrier. This detail must be integrated into the design and construction process. In a raised ceiling or “fur-up” chase installation, a critical detail is the integrity of the air and thermal barriers between the chase and the unconditioned space surrounding it. Also critical for a raised ceiling chase is the truss design. The trusses are typically modified to accommodate the duct chase.

The builder must make a clear and consistent commitment to building an interior duct system. The method and technique of constructing the chase must be clearly documented and communicated to all responsible parties, particularly the drywallers, carpenters, and insulators. The best opportunity to minimize costs while ensuring an aesthetically pleasing outcome is during the preliminary schematic design phase of the home.

The air handler can be located either centrally or at one end of the chase; however, it must be located inside the conditioned space. To avoid long run-out ducts, the chase should trace a path down the center of the house and go to all spaces to be served. Otherwise, small supply runs in unconditioned spaces or excessive chase construction will be required to reach distant rooms.

The chase must be air sealed. This can be done with drywall or an insulating material. If drywall is used, the chase must be insulated, which can prove challenging. The chase presents itself in the attic as two knee walls with a small attic floor above them. Typical blown-in insulation is fairly useless in this application, as it soon falls off the chase. A fur-up chase is an excellent candidate for spray-foam insulation. When properly constructed, the chase should be both air tight and thermally isolated from the attic. There could be a temptation to use the chase itself as the duct for the return air system. This is not a recommended practice. See the Compliance tab for more information.

The case study, **Raised Ceiling Interior Duct Systems**, provides an example of a raised ceiling duct installation.

Instructions for installing a fur-up or raised ceiling duct chase are provided below.

**Design and Install a Raised Ceiling Section or Fur-Up Chase for Ducts**

1. Perform a duct sizing calculation to determine the needed size of the chase to accommodate the duct system.

2. Design and lay out the proposed duct system. With information derived from the HVAC designers’ ACCA Manual J and D calculations, the home designer can finalize plans that consider the size requirements and path of the distribution system.

3. Design the truss package to accommodate a raised ceiling chase. To locate a fur-up chase in a specific design, start by examining the plan for an obvious path. A modified truss package, to allow fur-up chase installation, is only practical when running perpendicular to the truss orientation. In some hip roof situations, the depth of the hip-set can be adjusted to allow for a longer perpendicular run to corner rooms.

![Figure 1. Manual D details show the duct size and chase path. (Source: Florida Solar Energy Center)](image-url)
4. Avoid chase runs that are parallel to the truss orientation. Chases running parallel to the truss orientation will be size-constrained to the width of the truss bay, typically 21 inches when the trusses are set on two-foot centers. With hip roof designs, it may be possible to change the truss orientation, depending on hip orientation, to aid in the lay-out of the fur-up chase and avoid running chases parallel to the truss direction.

5. Commence construction of the chase in the area provided by modified trusses. In this example, the builder decided to use rigid insulation to construct the entire chase due to costs (donated material). The first layer of 2 inch thick rigid insulation is installed and temporarily attached to the trusses, then secured to the truss with a 2 x 4 support at the bottom of the chase with screws. This chase will have a bottom layer of ½ inch rigid insulation installed flush with the bottom chord of the trusses. This detail results in the 2 x 4 support being ½ inch above the bottom chord of the trusses.
6. Seal and secure all seams with the application of a specialty adhesive.

7. Finish sealing the first layer of rigid insulation, and prepare for the installation of the second layer of rigid insulation. Foam adhesive is used to attach the second layer of 2-inch rigid insulation, which will increase the chase R-value to R-20. To ensure a leak-free chase, all joints and seams in the chase are staggered.
8. Install a second layer of rigid insulation. After installing the 2x4 retaining ledge and foam adhesive, the second layer of rigid insulation is installed in the chase, being careful to stagger joints to avoid air leakage.

9. Install the preassembled duct system in the chase. Pre-assemble as much of the duct system as possible on the floor to avoid excessive lifts. After finishing the top and sides of the chase, the main trunk of the pre-assembled duct system is lifted into place.
10. Support the duct system. To hold the duct inside the chase, supports are screwed into the 2x4 ledge in-line with the trusses to facilitate the installation of the ceiling drywall. The bottom of these supports is also located ½ inch above the bottom chord of the trusses to facilitate the later installation of a ½ inch rigid chase bottom.

11. Install run-out ducts to supply air to rooms off the main hallway.
12. Seal run-out ducts and support them. After the duct is supported in the chase, run out ducts are installed to extend to rooms off the chase path. These run-outs need to be supported and well-sealed to the main duct trunk. In this installation, pan stock was used to form boots for register installation.

13. Install pan stock and seal to the chase to make boots for register installation.
14. Prepare to seal the bottom of the chase with ½ inch rigid insulation. The run-out ducts and register drops are sealed with mastic, and boots are formed with pan stock and sealed. Adhesive is installed at the bottom of the chase sides to attach the rigid insulation to the bottom of the chase.

15. Seal the bottom of the chase with rigid insulation. For this installation, the partner decided to seal the bottom of the chase with a layer of ½ inch rigid insulation attached with foam adhesive, then sealed with foil tape, and nailed to the previously installed duct supports.
16. Finish sealing the bottom layer of rigid insulation. After the bottom rigid insulation is installed, the seams are further sealed with foil tape. For more security, the bottom layer of rigid insulation is nailed to the duct supports and the ledge running along the sides of the chase.

17. Install a layer of batt insulation to the top and sides of the chase. As a last step, to bring the chase’s R-value in line with the rest of the attic, the top and sides of the chase are wrapped with R-13 batt insulation.
Figure 16. The finished raised ceiling duct chase is wrapped with batt insulation. (Source: FSEC)

18. The finished chase remains undetectable from the interior of the house.
19. As an alternative, the chase’s sides, top, and bottom can be constructed from drywall. The seams are sealed with drywall mud (Figure 18).
Figure 18. A raised ceiling chase constructed of drywall and sealed with drywall mud. (Source: FSEC)

After the chase is built and air sealed, it needs to be insulated. If the chase is in an unconditioned attic, it should be insulated to a level similar to the attic itself. Spray foam (Figure 19) and batt insulation are good options.

Figure 19. Spray foam insulation is used to insulate a raised ceiling duct chase. (Source: FSEC)
Ensuring Success

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.

A raised ceiling interior duct system requires trade coordination, which is best accomplished by a site meeting after house dry-in. This meeting should include the designer; sales/marketing professionals; and mechanical, insulation, plumbing, electrical, framing, sheet rockers, and solar contractors.

Oversight duties are increased for the site supervisor. Diligent inspection and constant oversight by an informed site supervisor are necessary to ensure that all trades people involved with the process are aware of the chase and its function. The site supervisor must be aware that even if the subcontractors and employees are informed about the chase and its function, the actual workers on the job site may be unaware of this component.

Even after the house is completed, the chase area is subject to damage when the new homeowners have alarm, cable, and telephone services installed. Therefore, homeowner awareness of the chase’s function is another important part of successfully implementing a raised ceiling chase.

Verification

**Blower Door Testing**

During blower door testing, the pressure in the chase can be checked with respect to the house. If there is no pressure difference between the house and chase, the chase area is truly interior. In other words, it is completely inside the air boundary of the house. Depending on the pressure variation between chase and interior, a determination can be made regarding the integrity of the interior duct system.

**Duct Blaster Testing**

Two tests can be performed with the duct blaster, one that measures the leakage of the entire duct system - both into the interior and exterior of the house, and a second test that measures the duct leakage to the exterior of the building only. The results of the second test, leakage to the outside, are important regardless of duct style; leakage to the outside is energy lost. Obviously, any significant leakage results here indicate that the duct system is connected to the outside in some fashion, indicating a breakdown in the air barrier in the chase or in the sealed attic or crawlspace.

See the guides [Duct Leakage to Outdoors](#) and [Total Duct Leakage Tests](#) for more information.
Climate

No climate-specific information applies.
Training

Right and Wrong Images

Display Image: TE64_insulated_raised_chase_right(2)_FSEC_10_8_14.jpg
Native Image: TE64_insulated_raised_chase_right_FSEC_10_8_14.jpg
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).

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.]
   - 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 \(3 \text{ CFM}^2/\text{ft}^2\) 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.
   - In Dry climates (all “B” Zones per 2015 IECC Figure R301.1), minimum R-8 duct insulation; duct leakage to outdoors \(3 \text{ CFM}^2/\text{ft}^2\) 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.
2012, 2015, and 2018 IECC

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.
Case Studies

1. Technology Solutions Case Study: Raised Ceiling Interior Duct System
   Author(s): FSEC
   Organization(s): FSEC
   Publication Date: October, 2014
   Case study describes raised ceiling duct strategy in New Smyrna, Florida.

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.
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. Design and Construction of Interior Duct System
Author(s): McIlvaine, Beal, Fairey
Organization(s): FSEC
Publication Date: October, 2014
This study focuses on the design, construction, and performance of the interior chase approach as implemented by five different builders in Texas, North Carolina, and Florida.

11. 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.

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**

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