Sealing Duct Boots to Floor or Drywall

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Scope

Caulk air seals the boot to the ceiling

- Air seal around all duct shafts and flues installed through ceilings, walls, and flooring to keep conditioned air from leaking into unconditioned space.

  - To air seal around duct boots, use caulk, canned foam, or rigid air barrier material cut to fit and caulked or foamed in place around the duct shafts.

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.
**Description**

Connections between grilles, registers and ducts at ceilings, floors or knee walls typically leak where the boot does not seal tightly to the grille or gypsum board. Air from the attic, basement, or crawlspace can leak in or out where the ducts connect to the boot.

If the gap between boots and gypsum board opening or subfloor openings is kept to less than \( \frac{3}{8} \)-inch, a bead of sealant or mastic may be used to seal the gap. Where gaps are larger than \( \frac{3}{8} \)-inch, fiberglass mesh tape and mastic should both be used. The optimum approach is to keep the gaps to less than \( \frac{3}{8} \)-inch and use a bead of sealant. This requires careful coordination with the drywall contractor to make sure that the rough openings for the boots are cut no more than \( \frac{3}{8} \)-inch bigger than the actual boot size on all sides.

Air barrier effectiveness is measured at the whole-house level. High-performance branding programs and the IECC code require that builders meet specified infiltration rates at the whole-house level. See the “Compliance” tab for links to these programs.

For more about sealing ducts, see the guides [Sealed and Insulated Flex Ducts](#), [Metal Ducts](#), and [Fiberboard Ducts](#).

**How to Seal a Duct Boot to the Ceiling**

1. Seal all sides of the duct boot to the gypsum board with spray foam or caulk (Figures 1, 2, and 3). Apply mastic or metal tape to all duct seams and joints.
2. Cover boot with insulation.
3. Add insulation to the specified attic insulation depth.

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**Figure 1.** Spray foam air seals the boot to the ceiling (Figure Source: BSC [Attic Air Sealing Guide and Details](#))
How to Seal the Duct Boot to the Floor

1. Mechanically attach the boot to framing around the hole in the flooring. Caulk, spray foam, or mastic seal between floor opening and boot with caulk or fiberglass mesh and mastic.

2. Cover boot with insulation.
Ensuring Success

Blower door testing, which is conducted as part of the whole-house energy performance test-out, may help indicate whether duct openings to unconditioned space (such as an attic) have been successfully sealed. Duct blaster testing may also help to indicate leaks. An infrared camera can be used in conjunction with the blower door testing to detect air leakage and heat loss at the duct and flue shaft openings, if a sufficient temperature difference exists between the unconditioned and the conditioned space of the house. An experienced technician can also check for air leaks around registers with a smoke pencil or by feeling with the back of the hand.
Climate

See the Compliance tab for climate-specific air leakage requirements for IECC codes and for the ENERGY STAR program. The climate zones are shown on the map below, which is taken from Figure C301.1 of the 2012 IECC.

IECC climate zone map

All of Alaska is in Zone 7 except for the following boroughs in Zone 8: Bethel, Northwest Arctic, Dillingham, Southeast Fairbanks, Fairbanks N. Star, Wade Hampton, Nome, Yukon-Koyukuk, North Slope.

Zone 1 includes Hawaii, Guam, Puerto Rico, and the Virgin Islands.
Training

Right and Wrong Images

Display Image: ES_HVAC_QIRC_3.1_PG44_63g_102811.jpg
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, Rev. 08)

ENERGY STAR Certified Homes (Version 3/3.1, Revision 08), Rater Field Checklist

Thermal Enclosure System:

4. Air Sealing (Unless otherwise noted below, "sealed" indicates the use of caulk, foam, or equivalent material):

4.1 Ducts, flues, shafts, plumbing, piping, wiring, exhaust fans, & other penetrations to unconditioned space sealed, with blocking / flashing as needed.

DOE Zero Energy Ready Home

Exhibit 1: Mandatory Requirements. Certified under ENERGY STAR Qualified Homes Version 3.

2009, 2012, 2015, and 2018 IECC

Table R402.1.2 Lists insulation requirements by climate zone for ceilings, crawlspaces and other building components.  (Table 402.1.1 in 2009 IECC).

Section R402.2 specifies insulation requirements for ceilings, floors, and other building components.

Section R402.4 specifies air sealing guidelines for ceilings, floors and other building components.

Section R403.3 specifies duct sealing and duct leakage testing. (Section 403.2 in 2009 and 2012 IECC.)

Section R402.4.1 Building thermal envelope. Joints (including rim joist junctions), attic access openings, penetrations, and all other such openings in the building envelope that are sources of air leakage are sealed with caulk, gasketed, weather stripped or otherwise sealed with an air barrier material, suitable film or solid material.


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.)


Section N1102.4.1 Shafts, Penetrations: Air Barrier and Insulation Installation, Shafts/penetrations: Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space are air sealed. General Requirements: Air barrier and thermal barrier: A continuous air barrier is installed in the building envelope including rim joists and exposed edges of insulation. Breaks or joints in the air barrier are sealed. Air permeable insulation is not used as a sealing material.  (Table N1102.4.2 in IRC 2009.)

Section N1102.3 specifies duct sealing and duct leakage testing.  (N1103.2 in 2009 and 2012 IRC.)


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.

ACCA Standard 9

Overview:

The intent of this brief is to provide code-related information about properly sealing heating, ventilating, and air conditioning (HVAC) register boots to help ensure that the measure will be accepted as being in compliance with the code. Providing consistent information to document compliance with codes and standards to all relevant parties responsible for verifying with those codes and standards (e.g., code officials, builders, contractors, designers, etc.) is expected to result in increased compliance and more timely, less challenging and more uniform plan review and field inspections.

Heating, ventilating, and air conditioning register boots are products located at the beginning and end of an HVAC duct run to transfer the air moving within the ducts to and from the conditioned space; these products are commonly known as “supply and return register boots.” If HVAC register boots are not properly sealed and insulated, the following problems can arise:

- Proper air sealing leading to leaks around boot into interstitial cavities possible failure of blower door test required by code
- Duct leakage and possible failure of the mandatory duct leakage test required by code
- Condensation forming around the HVAC supply and return register boots
- Water damage from condensation occurring where the HVAC supply and/or return register boot is attached to the structure (e.g., subfloor, ceiling, or wall covering).

Applicable code requirements and details helpful for conducting Plan Reviews are discussed in the next section of this Code Compliance Brief. The Field Inspection section provides details of inspecting HVAC supply and return register boots. Finally, resources for technical validation, best practices, and measure guidelines are provided in the Technical Validation/Reference Materials section.

Plan Review:

This section lists current code sections in the 2018/2015 International Residential Code (IRC) and International Energy Conservation Code (IECC).

**2018/2015 IRC, Section R104 Duties and Powers of the Building Official**

Section R104.1, General. The building official has authority to render interpretations of this code and to adopt policies, and procedures in order to clarify the application of its provisions. Such interpretations, policies, and procedures shall be in conformance with the intent and purpose of this code.

Section R102.1/R104.11, Alternative Materials, Design and Method of Construction and Equipment. The provisions of this code are not intended to prevent the installation of any material or prohibit any design or method of construction not specifically prescribed in the 2015 IECC/IRC, provided that any such alternative has been approved. The building official is permitted to approve an alternative material, design, or method of construction where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and the material, method, or work offered is for the purpose intended, not less than the equivalent of that prescribed in the code. Compliance with the specific performance-based provisions of the International Codes is an alternative to the specific requirements of this code.

**2018/2015 IECC/IRC, Section R103.3/R106.3, Examination of Documents.** The code official/building official must examine or cause to be examined construction documents for code compliance.

Construction Documentation. Review the construction documents for details describing the location, insulation, and sealing material specifications for the HVAC supply and return register boots.

- **2018/2015 IECC/IRC, Section R103.2/N1101.5, Information on Construction Documents.** Construction documents should include:
  - Location of each HVAC supply and return register boot
  - Specified R-value of insulation and sealant materials.

Air Sealing/Air Leakage Control

- **2018/2015 IECC/IRC, R402.4./N1102.4, Air Leakage Section R402, Building Thermal Envelope[1].**
- **Section R402.4.1/N1102.4.1, Building Thermal Envelope.** The sealing methods between dissimilar materials should allow for differential expansion and contraction.
Section R402.4.1.1/N1102.4.1.1, Installation. Components listed in the Air Barrier and Insulation Installation Table should be installed in accordance with the manufacturer’s instructions and the criteria listed as the applicable method of construction. Below are the General Requirements and components from the table that are applicable to sealing HVAC supply and return register boots.

Excerpts from Table R402.4.1.1/N1102.4.1.1, Air Barrier and Insulation Installation
- HVAC register boots. HVAC supply and return register boots that penetrate the building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot. (The 2018 IECC/IRC fixed this provision to include sealing the “supply and return” register boots.)

2018/2015 IECC/IRC, Section R403.3/N1103.3 Ducts. Ducts and air handlers shall be in accordance with Sections R403.3.1/N1103.3.1 through R403.3.5/N1103.3.5. (Sections R403.3.6/N1103.3.6 through R403.3.8/N1103.3.8 are new provisions in the 2018 IECC/IRC regarding ducts buried within ceiling insulation[2].

Section R403.3.1/N1103.3.1 Insulation (prescriptive). Supply and return ducts in attics should be insulated to a minimum of R-8 where 3 inches (76 millimeters) in diameter and greater and R-6 where less than 3 inches (76 millimeters) in diameter. Supply and return ducts in other portions of the building shall be insulated to a minimum of R-6 where 3 inches (76 millimeters) in diameter or greater and R-4.2 where less than 3 inches (76 millimeters) in diameter. (Per the Building America research, a minimum R-8 duct insulation would be required on all buried ducts.)

Exception:
Ducts or portions thereof located completely inside the building thermal envelope. (Buried ducts will be installed outside the building thermal envelope so this exception would not apply.)

Section R403.3.2/N1103.3.2 Sealing (mandatory). Ducts, air handlers, and filter boxes shall be sealed. Joints and seams shall comply with either the International Mechanical Code or IRC, as applicable.

Exceptions:
1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.
2. For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams, and locking-type joints and seams of other than the snap-lock and button-lock types.

Existing Buildings

2018/2015 IECC/IRC, Section R501.1.1/N1107.1.1 Additions, alterations, or repairs: - General. Additions, alterations, or repairs to an existing building, building system or portion thereof should comply with Section R502/N1108, R503/N1109 or R504/N1110. Unaltered portions of the existing building are not required to comply.

- Section R503.1/N1109.1, General. Alterations to any building or structure should comply with the requirements of the code for new construction. Alterations should be such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the alteration. Alterations should not create an unsafe or hazardous condition or overload existing building systems. Alterations should be such that the existing building or structure uses no more energy than the existing building or structure prior to the alteration.

- Section R503.2/N1109.2 Change in space conditioning. Any non-conditioned or low-energy space that is altered to become conditioned space should be required to be in full compliance with this code. (This means not only the altered assembly is brought into compliance but the entire space or building would need to be brought into compliance.)

Exception
Where the simulated performance option in Section R405/N1105 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110% of the annual energy cost otherwise allowed by Section R405.3/N1105.3.

- Section R503.1.2/N1109.1.2, Heating and Cooling Systems. New heating, cooling, and duct systems that are part of the alteration shall comply with Sections R403/N1103.

Section R502/N1108, Additions

- Section R502.1.1.2/N1108.1.1.2, Heating and Cooling Systems. New heating, cooling, and duct systems that are part of the addition shall comply with Sections R403/N1103.
The building thermal envelope is defined as the basement walls, exterior walls, floor, roof, and any other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.


Field Inspection:

Per the 2018/2015 IECC, Section R104, Inspections, construction or work for which a permit is required is subject to inspection. Construction or work is to remain accessible and exposed for inspection purposes until approved. Required inspections include footings and the foundation, framing and rough-in work, plumbing rough-in, mechanical rough-in, and final inspection.

- Section R104.2.4, Mechanical Rough-In Inspection. Inspections at mechanical rough-in shall verify compliance as required by the code and approved plans and specifications as to installed HVAC equipment type and size, required controls, system insulation and corresponding R-value, system air leakage control, programmable thermostats, dampers, whole-house ventilation, and minimum fan efficiency.

Per the 2018/2015 IRC, Section R109, Inspections, the wording is somewhat different in that for onsite construction, from time to time the building official, upon notification from the permit holder or his agent, can make or cause to be made any necessary inspections. Further details are provided for inspections regarding foundation, plumbing, mechanical, gas and electrical, floodplain, frame and masonry, and final inspection. Any additional inspections are at the discretion of the building official.

This section provides details for inspecting to the specific provisions for HVAC supply and return register boots where one or more specific type of inspection per the IECC or IRC may be necessary to confirm compliance. Verifying code compliance for HVAC register boots would typically be at the mechanical rough-in and final inspection. Inspections should provide verification in the following areas:

- Verify that HVAC supply and return register boots are sealed and insulated properly.
- Verify that joints and seams in ductwork are properly sealed, and the duct tightness report is complete and has been submitted per jurisdictional requirements. If ducts are employed, verify that duct insulation is installed in accordance with manufacturer’s installation instructions and that the manufacturer’s R-value mark is readily available and meets the approved R-value specified in construction documents.
- Verify that joints, seams, holes, and penetrations are caulked, gasketed, weather-stripped, or otherwise sealed.

Technical Validation(s):

This section provides additional related information and references to materials that are applicable to the provision.

  
  Author(s): ICC
  
  Organization(s): ICC
  
  Publication Date: May 2014
  
  This code establishes 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.

- 2018/2015 IRC—International Residential Code for One- and Two-Family Dwellings
  
  Author(s): ICC
  
  Organization(s): ICC
  
  Publication Date: May 2014
  
  This code for residential buildings 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.


Related BASC Guides:

- **Whole Building Delivered Ventilation**
- **Duct Leakage to the Outdoors**
- **Ducted Returns**
References and Resources*

1. **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.

2. **Duct Sealing**
   - **Author(s):** Building Science Corporation
   - **Organization(s):** Building Science Corporation
   - **Publication Date:** May, 2009
   - Brochure with details on HVAC duct air sealing.

3. **Flexible Duct Performance and Installation Standards**
   - **Author(s):** Air Diffusion Council
   - **Organization(s):** Air Diffusion Council
   - **Publication Date:** January, 2010
   - Standard providing a comprehensive approach to evaluating, selecting, specifying and installing flexible duct in HVAC systems.

4. **Measure Guideline: Sealing and Insulating Ducts in Existing Homes**
   - **Author(s):** Aldrich, Puttagunta
   - **Organization(s):** CARB, National Renewable Energy Laboratory, Steven Winter Associates, SWA
   - **Publication Date:** December, 2011
   - Report describing the sealing and insulating of HVAC duct systems in new and existing homes.

*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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