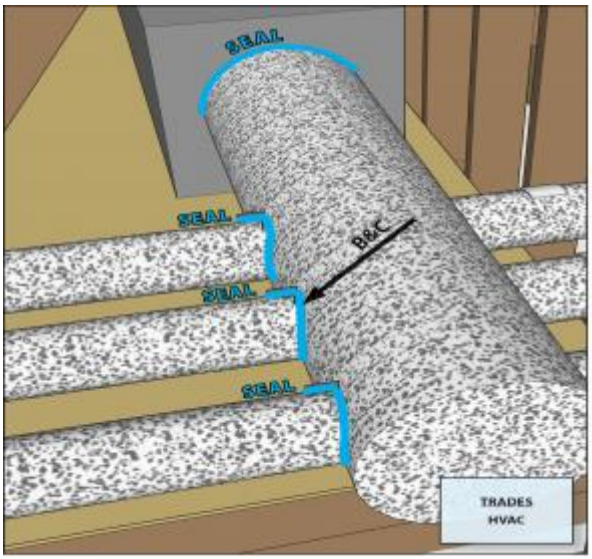
Sealed and Insulated Flex Ducts

Last Updated: 08/15/2013

Scope



Duct Insulation and Air Sealing

All connections to trunk ducts in unconditioned space are insulated

A. Seal all seams, gaps, and holes of all trunk duct connections before installing insulation, preferably with mastic.
B. Install insulation without misalignments, compressions, gaps, or voids around all connections and exposed duct work.
C. Seal duct insulation to boot to prevent accumulation of condensation, preferably with mastic.

Connections to Seal and Inspect

Listed below are common places in a duct system where HVAC contractors must seal in unconditioned spaces, and areas that raters must inspect for properly sealed and insulated connections:

Supply

- Boots
- Duct splicing (two ducts put together)
- Main supply trunk to ductwork

Return

- Return box to ductwork

Pressure Balancing

- Jump duct boxes to ductwork
- Dedicated return boxes to ductwork

Ventilation

- Return box to outside air ductwork
- Exhaust fans to dedicated ductwork
- ERV/HRV to dedicated ductwork

Description

Ideally ducts should be located in conditioned space, such as within a dropped ceiling, between floors, in an insulated basement or crawlspace, or in an unvented attic that is insulated along the roof line. If ducts are located in an unconditioned space, such as a vented attic or vented crawlspace, they should be sealed and insulated to prevent heat loss due to air leaks and conduction and to provide some protection against harsh conditions.

Flex duct consists of a plastic inner liner attached to a metal coil that comes already covered with a layer of fiberglass blanket insulation, which is covered by foil or plastic vapor barrier. It is typically available in R-4, R-6, and R-8. The 2009 IECC (Section 403.2) requires that supply ducts located in unconditioned space be insulated to at least R-8 (return ducts can be insulated to R-6).

Insulation

Whenever ductwork is located in unconditioned spaces, thermal insulation with a vapor barrier is a must to prevent unnecessary heat gain or loss through the duct walls and to prevent condensation from forming on the ducts themselves. For the insulation to work properly, it must be fully aligned and in contact with the walls of the duct system. A typical vented attic with a dark shingle roof can reach summer temperatures of 140ºF. At the same time, the dew point temperature in the attic will be about the same as it is outdoors. In humid climates, "duct sweating" can become a significant problem if the duct's thermal and vapor barriers are not properly aligned along the entire length of the duct. Because the insulation is an integral part of the duct with flex ducts, insulation alignment is not an issue along the duct length but can be a problem at connections, if the insulation layers are not properly connected.

Sealing

Duct leakage is a double hit on the utility bill: 1) duct leaks are an uncontrolled loss of conditioned air to the outdoors and 2) duct leakage drives building infiltration. For example, if a home had a 2.5-ton (30,000 BTU/H) cooling system moving 1,000 CFM (cubic feet per minute) of air and the ducts had 10% leakage (which is typical in code-built homes), the leakage rate would be 100 CFM. Each cubic foot of air carries with it 30 BTUs/H, so 3,000 BTUs of conditioned air would be lost to the outdoors each hour.

Duct leakage is an infiltration driver; it can negatively or positively pressurize the house depending on where the ducts are leaking, pulling outside air in through cracks in the building envelope or pushing conditioned air out. If the duct leakage is in the supply-side ducts, the house will be negatively pressurized compared to outdoors. If all the leakage is on the return side, the building will be positive with respect to outdoors. The field technician should understand this concept to help accurately detect any sources of duct leakage.

Unlike solid sheet metal and ductboard, flex duct is essentially seamless along its length and at bends so, as long as the ducting is not torn or punctured, the only place where air sealing is a concern is at connections. If connected properly, a correctly designed flex duct system can provide efficient air delivery for many years.

While there are several types of connections, all flex duct connections require similar practice to ensure proper air sealing, regardless of whether the flex duct is connected directly to the air handler box, to a trunk line, to a junction box connected to the trunk line, or to a supply register. All connections use a round metal connector called a collar, which is either purchased at a supply house or made in the HVAC contractors' metal shop. A raised metal bead encircles the collar at the end (see Figure 1). The raised bead can be located anywhere from 2 inches to 1/2 inch from the end of the collar. When the flex duct is pulled over this bead and secured with a nylon draw band, the raised bead prevents the duct from slipping off the end of the collar.

Figure 1 shows three types of starting collars and two register boxes (also known as duct boots) with collars attached. Collar A attaches flex duct or round metal duct to a rectangular metal box such as the air handler box or a metal trunk line. Collar B is for attaching a flex duct to a rectangular ductboard box or trunk line. Collar C is for attaching round flex duct or round metal duct to a round trunk line. Images D and E show uninsulated and insulated register boxes that are purchased with the collars pre-attached. If uninsulated boxes are purchased, they can be insulated on site by wrapping them with R-8 blanket insulation. Notice that all five collars have the raised bead. This type of connection (with raised beads on each end) can also be used to splice two pieces of flex duct together, a practice used to save on materials costs rather than throwing away short pieces of duct.

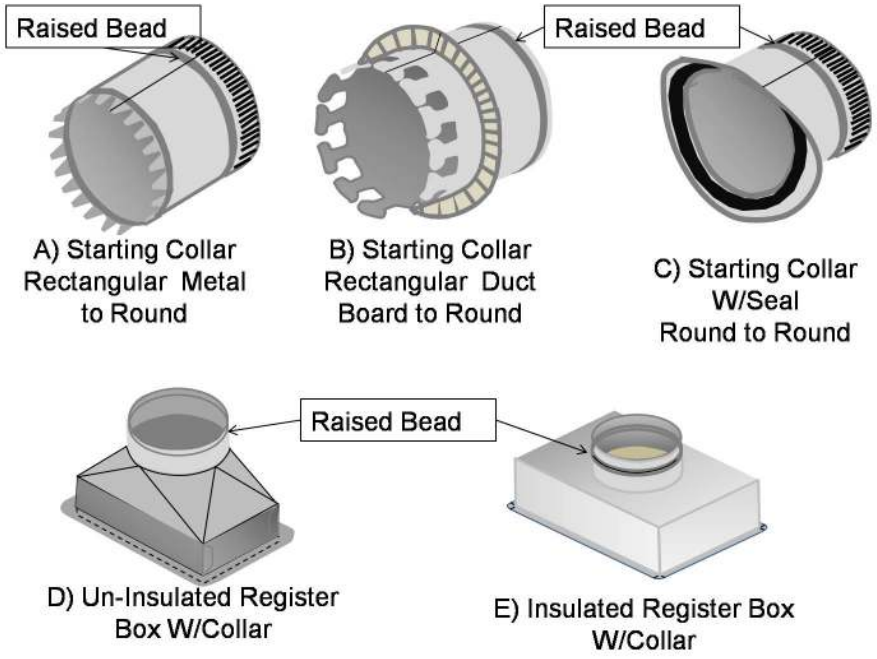


Figure 1 - Collars that are specifically made for flexible duct have a raised bead to prevent the duct from slipping off.

After the inner liner and coil are secured, the insulation and outer liner are secured and the seam is made air tight with metal tape and mastic. The metal tape should meet the requirements of the Underwriters Laboratory UL-181, UL-181A, or 181B (**CEC 2005**). Regular cloth-backed duct tape should not be used because it can dry out and fail quickly. Mastic is a thick, gooey, non-hardening substance that is spread onto the duct seams with a paintbrush or a putty knife.

For more on flex duct installation, see **No Kinks or Sharp Bends in Flex Duct Installation**, **No Excessive Coiled or Looped Flex Ducts**, **Sufficient Cavity Space for Flex Ducts**, **Support at Intervals for Flex Ducts**, **Building Cavities not Used as Supply or Return Ducts**, and **HVAC Ducts Shall Not Be Run in Exterior Walls**.

For more on duct insulation levels see **Insulation Levels for Ducts in Unconditioned Space**. Duct installation standards and installation guidance are also provided in Manual D Residential Duct Systems, 2009 Edition, published by the Air Conditioning Contractors of America (see Appendix 17 for a detailed discussion of duct installation) and The Flexible Duct Performance Standards (Fifth Edition) published by the Air Diffusion Council (ADC).

How to Seal and Insulate Flex Duct at a Collar Connection

1. Pull the end of the flex duct over the end of the collar, pulling the flex duct core at least 2 inches past the raised bead.

2. Push back the outer liner and insulation.

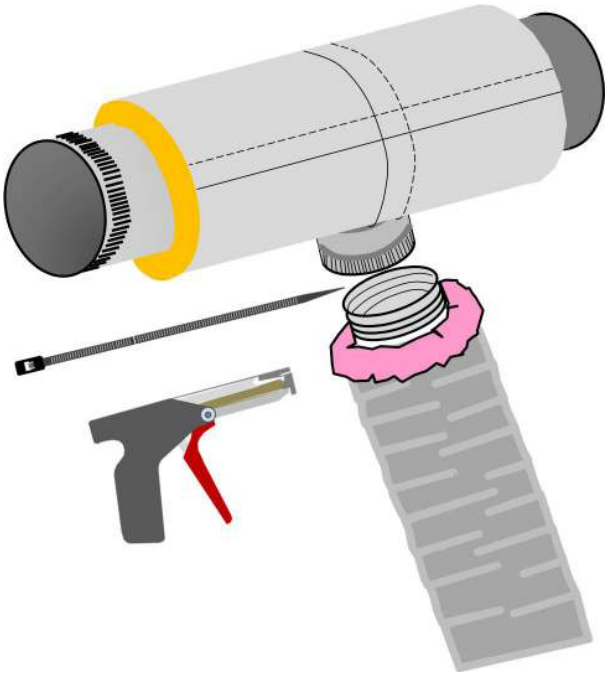


Figure 2 - To attach the flex duct to a main trunk duct or any other connection, the flex duct is pulled over the connecting collar at least 2 inches past the raised bead, then the insulation is pulled back.

3. Wrap the nylon draw band around the duct over the inner liner, above the raised bead.

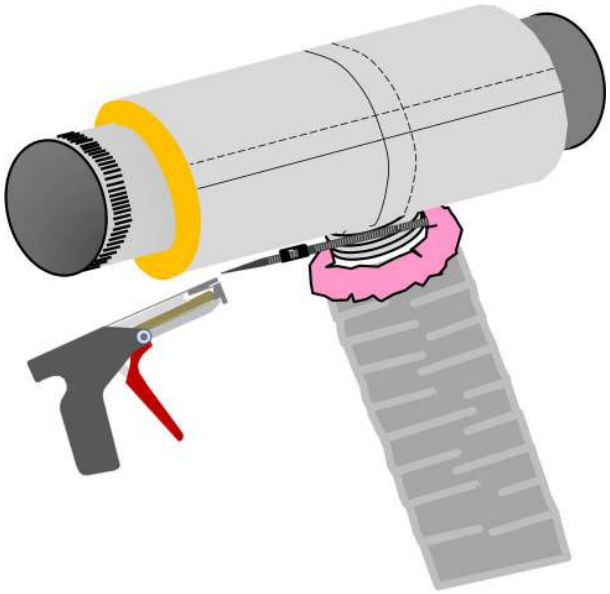


Figure 3 - A nylon draw band and tensioning tool are used to secure the inner coil of the pre-insulated flexible duct.

4. Thread the draw band through its locking system and tighten the nylon draw band with a tool specifically designed for this use, commonly known as a tensioning tool.

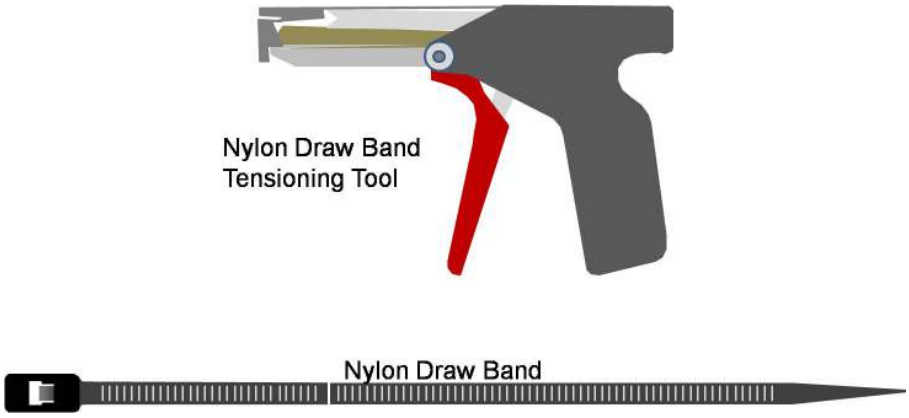


Figure 4 - A nylon draw band and tensioning tool are used to secure the inner liner of the pre-insulated flexible duct.

5. Seal the connection with mastic. Paint the mastic generously over the draw band, bridging from the inner liner to the collar.

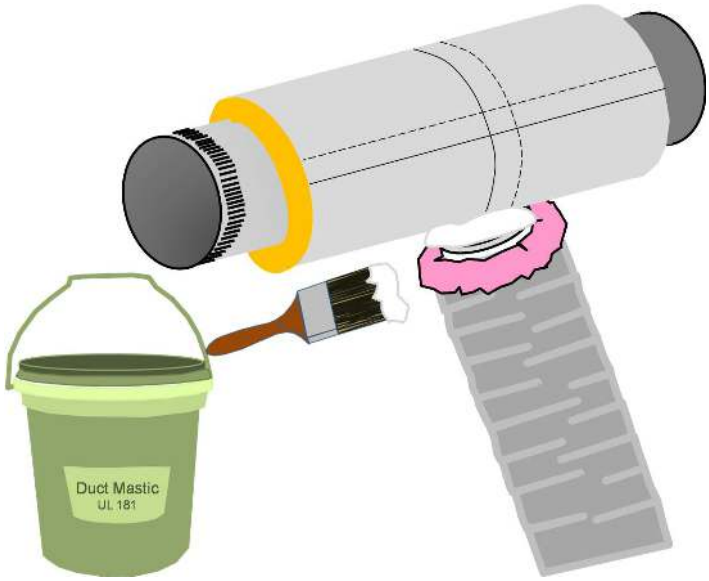


Figure 5 - After securing the inner coil, cover the draw band and the seam with a generous amount of mastic.

6. Pull the insulation and outer liner of the flex duct up over the collar. Make sure the flex duct insulation comes in full contact with the insulation on the trunk line or fitting (such as a duct boot) that it is being attached to. Pull the outer liner of the duct up to the outer liner of the trunk line or fitting.

7. Tape the outer liner in place with UL-181- approved foil tape. Do not use a draw band to secure the flex duct insulation. It will compress the insulation, which could create cold spots along the exterior of the duct and possible condensation issues.

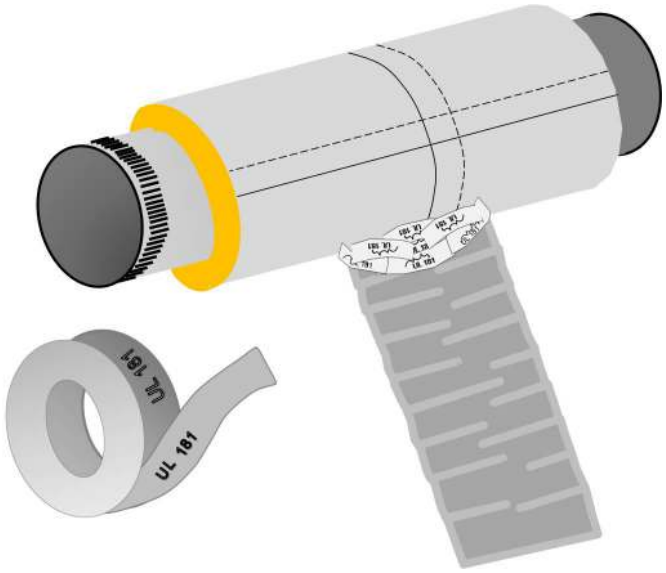


Figure 6 - Pull the insulation and outer liner of the flex duct over the collar to come in full contact with the liner and insulation of the trunk line or fitting and tape in place.

Figure 7 - Use only Underwriters Laboratory UL-181 approved tape.

8. Paint mastic over the foil tape making sure that the mastic bridges across the foil tape from the trunk line or fitting to the duct.

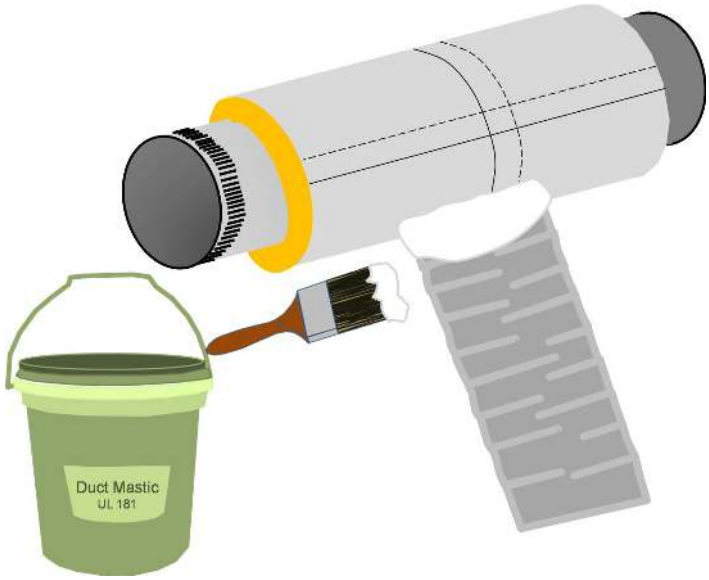


Figure 8 - The tape is covered with mastic to ensure an airtight seal between the duct and the fitting.

How to Seal and Insulate Flex Duct at a Splice

1. Connect each end of the duct to a round sheet metal connecter of the correct diameter that is purchased or fabricated. If fabricated, it should be made with the machined raised bead at each end of the pipe to secure the connections.

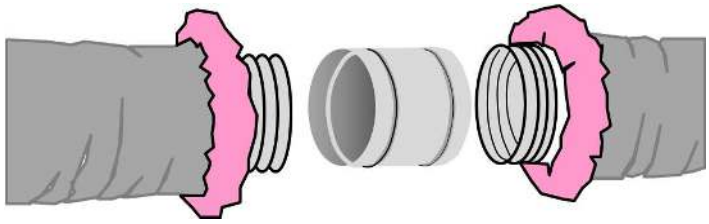


Figure 9 - Two pieces of flex duct can be spliced together with a metal sleeve. Pull the ducts over the raised beads at each end of the connector, fasten the inner coils with nylon draw bands, mastic the seams, then pull together the insulation and outer liners, tape the seams together, and cover the tape with more mastic.

2. Join each piece of flex duct to the connector and secure the inner liner using a draw band, as described in steps 2 through 6 above.
3. Pull the insulation together and ensure that it meets all the way around the pipe.
4. Pull together the exterior liner and attach with foil tape.
5. Seal the connection with mastic.

Ensuring Success

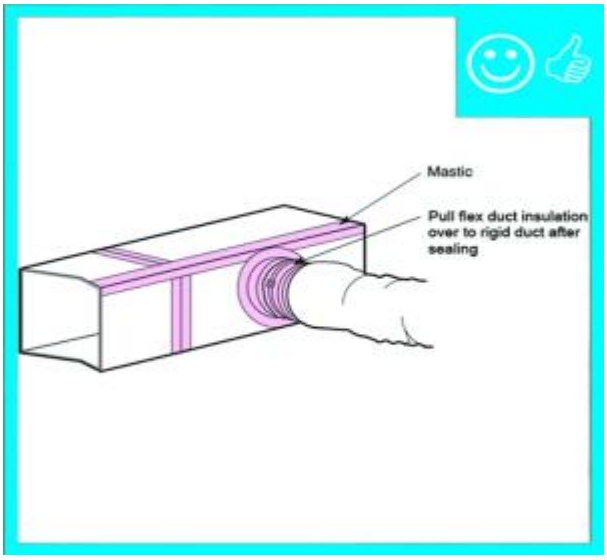
After ducts are installed and before drywall is installed, the duct system should be visually inspected by a HERS rater to ensure that all connections are properly fastened and sealed, preferably with mastic, and completely insulated. The following connections should be inspected: the main supply trunk to the branch duct, the branch duct to the duct boots, duct splices, the return ducts to the return box, jump duct connections, and exhaust fan and ERV/HRV connections. HVAC ducts should be tested for air leakage and proper air flow with a duct blaster test. This test should be done before drywalling when any air leaks can still be accessed and sealed. The ducts should be inspected to confirm that the proper amount of insulation is installed (minimum R-8 for supply ducts and R-6 for all other ducts) and that the insulation is not compressed by tight strapping, by framing members or other obstacles, or by excessive bending.

Climate

No climate specific information applies.

Training

Right and Wrong Images



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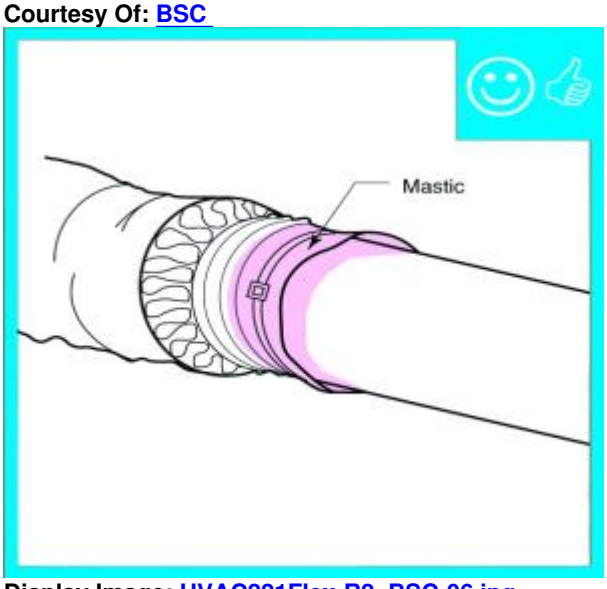

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CAD

None Available

Compliance

ENERGY STAR Version 3, (Rev. 07)

HVAC System Quality Checklist, Duct Insulation. All connections to trunk ducts in unconditioned space are insulated.

DOE Zero Energy Ready Home

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

2009 IECC

Section 403.2.2 Sealing (Mandatory). All joints and seams of air ducts, air handlers, filter boxes, and building cavities used as return ducts are substantially airtight by means of tapes, mastics, liquid sealants, gasketing or other approved closure systems.*

2009 IRC

Section M1401.4.1 Joints and seams. Tapes, mastics, and fasteners are rated UL 181A or UL 181B and are labeled according to the duct construction. Metal duct connections with equipment and/or fittings are mechanically fastened. Crimp joints for round metal ducts have a contact lap of at least 1 1/2 inches and are fastened with a minimum of three equally spaced sheet-metal screws. Exceptions: a) Joint and seams covered with spray polyurethane foam. b) Where a partially inaccessible duct connection exists, mechanical fasteners can be equally spaced on the exposed portion of the joint so as to prevent a hinge effect. c) continuously welded and locking-type longitudinal joints and seams on ducts operating at less than 2 in. w.g. (500 Pa).*

2012 IECC

Section R403.2.2 Sealing (Mandatory). All joints and seams of air ducts, air handlers, and filter boxes are substantially airtight by means of tapes, mastics, liquid sealants, gasketing or other approved closure systems.*

2012 IRC

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*Due to copyright restrictions, exact code text is not provided. For specific code text, refer to the applicable code.

More Info.

Case Studies

None Available

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. **DOE Zero Energy Ready Home National Program Requirements**
   Author(s): DOE
   Organization(s): DOE
   Publication Date: April, 2014
   Standard requirements for DOE's Zero Energy Ready Home national program certification.

3. **ENERGY STAR Certified Homes, Version 3 (Rev. 07) Inspection Checklist for National Program Requirements**
   Author(s): EPA
   Organization(s): EPA
   Publication Date: June, 2013
   Standard document containing the rater checklists and national program requirements for ENERGY STAR Certified Homes, Version 3 (Rev. 7).

4. **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.

*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.
