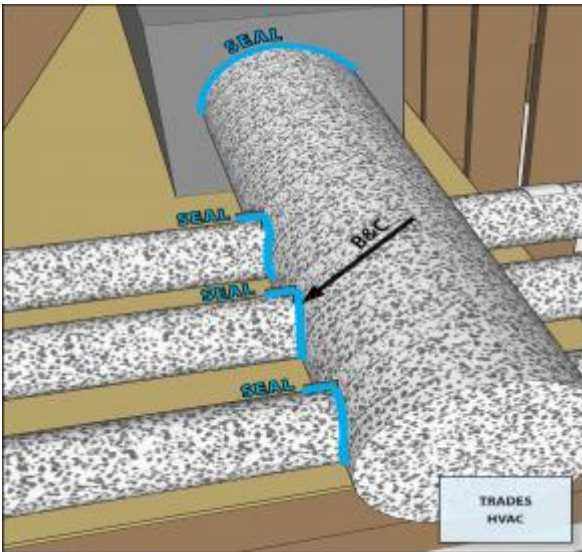


Sealed and Insulated Metal Ducts

Last Updated: 08/15/2013

Scope



Duct Insulation

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.

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 diagnose the dominant sources of duct leakage.

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 140°F. 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 ducts' thermal and vapor barriers are not properly aligned along the entire length of the ducts.

Metal ductwork is constructed using sheets of galvanized steel. Metal ducts are either rectangular or round in shape. Metal ducting consists of straight lengths, elbows, connectors, junction boxes, and register boots that are purchased or fabricated in the HVAC contractor's shop and fitted together at the job site. A compact duct layout design with short, straight runs and minimal bends provides the best performance from an air flow standpoint and also reduces the number of lengths and seams that need to be sealed and insulated.

For more on duct layout, see [No Kinks or Sharp Bends in Flex Duct Installation](#).

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.

Metal ducts for residential HVAC systems are typically insulated on the exterior using a "duct wrap," such as fiberglass blanket insulation with a foil-faced vapor barrier. Duct wrap comes in four-foot-wide rolls 50 to 100 feet long and in R-values that range from R-4 through R-8. Before applying duct wrap, sheet metal duct should be clean, dry, and tightly sealed at all joints and seams. 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). For more on duct insulation levels, see [Insulation Levels for Ducts in Unconditioned Space](#).

Ducts should be sealed with duct mastic and/or metal tape that meets 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, goeey, non-hardening substance that is spread onto the duct seams with a paintbrush or a putty knife. For additional strength with seams that are wider than 1/8 inch, cover the gap with fiberglass mesh tape then apply the mastic.

How to Seal and Insulate Metal Duct

1. Install the metal ducts. Fit pieces together at joints by sliding the wider pipe over the narrower connecting collars. Use screws to secure connections. Wipe ducts with a dry cloth to ensure they are clean and dry especially at all joints and seams.
2. Use mastic to seal the seams along the lengths of the pipes, the seams in the elbows, the joints where the elbow and straight pieces are joined, where ducting is joined to the air handler, junctions between trunk ducts and branch ducts, and at duct boots.

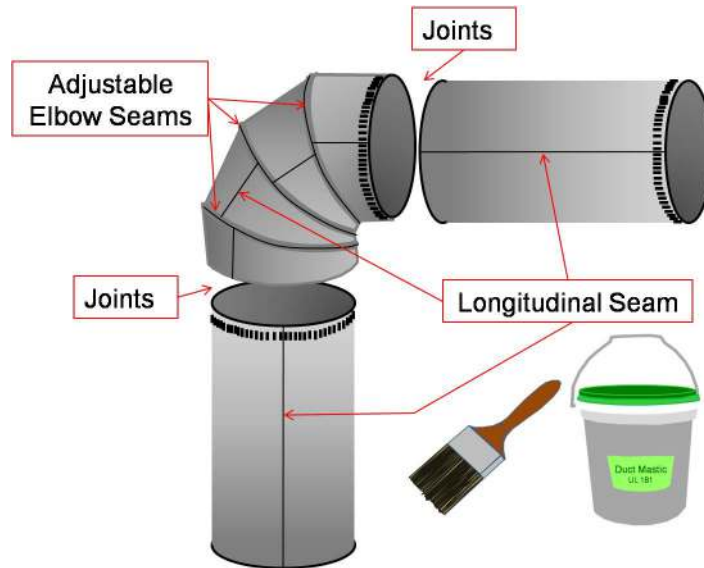



Figure 1 - Seal all joints and seams in the metal ductwork with mastic, including all joints and seams in elbows, before installing insulation. 

3. Measure foil-faced blanket insulation to fit around the circumference of the pipe with two inches of overlap. Wrap the insulation around the duct with the facing to the outside so the 2-inch flap completely overlaps the facing and insulation at the other edge of the insulation. Insulation should be snugly butted but not wrapped too tightly, which would compress the insulation and reduce its R value. Follow the manufacturer's "stretch-out" guidelines, which specify how much insulation to use, based on the pipe circumference, to ensure that the insulation thickness is maintained to achieve the rated R-value (see Table 1). The insulation should be a minimum of R-8 for all supply ducts and at least R-6 for all return ducts.

Table 1 - Duct Insulation Stretch-Out Measurements

Labeled Thickness (in.)	Installed Compressed Thickness (in.)	Round	Square	Rectangular
1.0	0.75	P + 7.0"	P + 6.0"	P + 5.0"
1.5	1.125	P + 9.5"	P + 8.0"	P + 7.0"
2.0	1.5	P + 12.0"	P + 10.0"	P + 8.0"
2.3	1.75	P + 13.0"	P + 11.0"	P + 8.5"
2.0	2.25	P + 17.0"	P + 14.5"	P + 11.5"

Stretch-outs include 2 inches (51 mm) for overlap.
P = Perimeter of duct to be insulated

4. Overlap the insulation and staple along the seam every 6 inches at the "tape flap" using outward-clinching staples.
5. Wrap another piece of insulation around the next section of duct, overlapping two inches at the end of the first piece of insulation. Staple along the lengthwise seam and at the overlap. Continue overlapping and stapling until the entire length of duct is covered. After stapling, cover and seal all tape flaps and overlaps with UL-181 metal tape or mastic (mastic is recommended).
6. Make sure insulation covers all pipe connections to trunk duct, junction boxes, and boots.

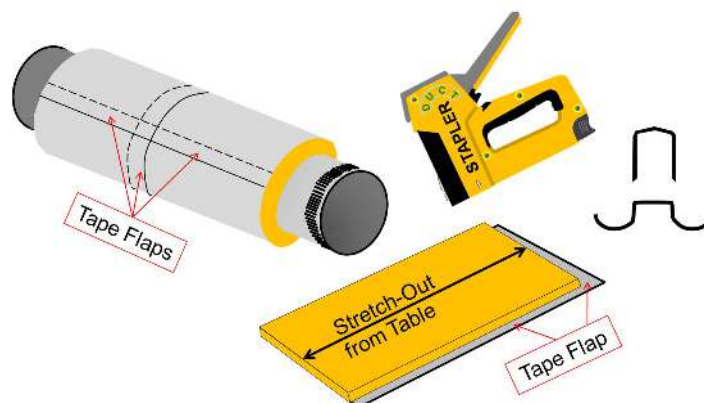



Figure 2 - When wrapping metal pipes with insulation, allow two inches of overlap and staple along the seam with outward clinching staples. Follow the insulation manufacturer's guidelines for "stretch-out" to avoid pulling the insulation too tightly. 

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. Locations to inspect include the main supply trunk to branch connections, at the duct boots, duct splices, the return box to the return ducts, 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. Ducts should be insulated along the length including at connections and the insulation should not be compressed by tight strapping, by framing members, or by excessive bending. The insulation should be a minimum of R-8 for all supply ducts and at least R-6 for all return ducts.

Climate

No climate specific information applies.

Training

Right and Wrong Images



Display Image: [ES HVAC QIRC 3.1 PG44 58b 102811.jpg](#)

Reference:



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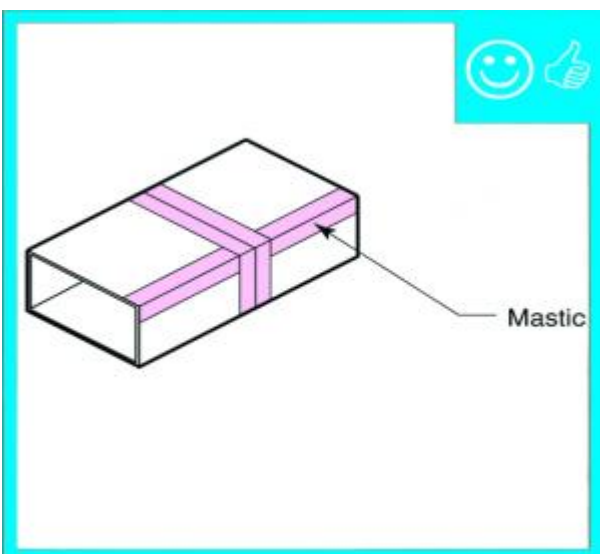
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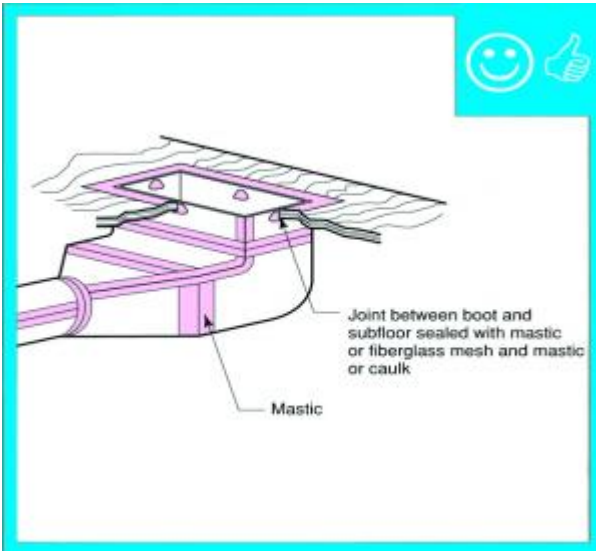
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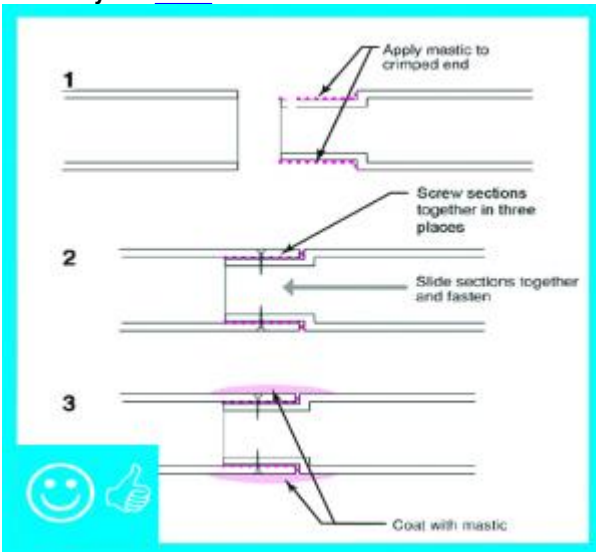


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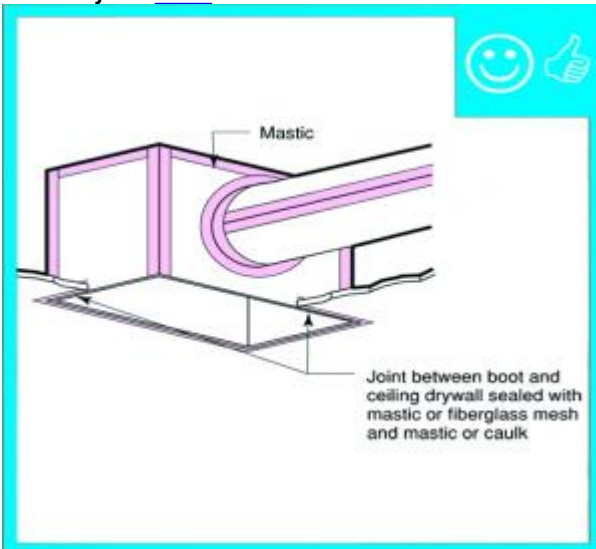
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CAD

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](#)

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).*

*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).

*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.

Source URL (retrieved on 2014-10-21 09:59): <https://basc.pnnl.gov/resource-guides/sealed-and-insulated-metal-ducts>