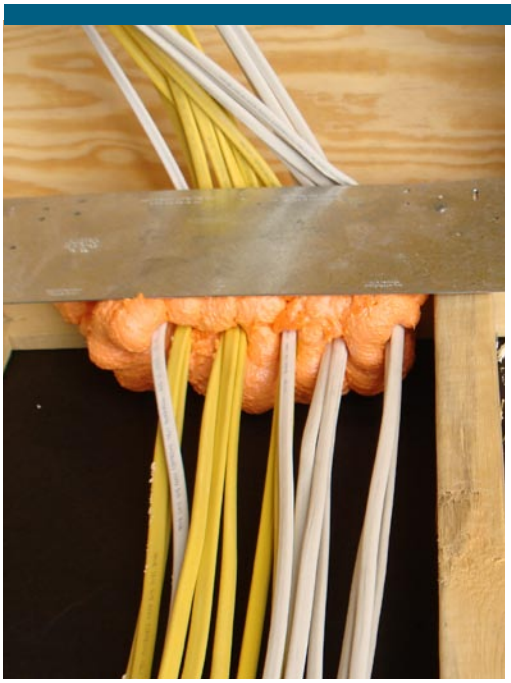


The holes in the sill plate were properly air sealed during construction of this house.

New Code Air Sealing Requirements

The 2009 International Energy Conservation Code (IECC) and the 2009 International Residential Code (IRC) have several new mandatory requirements for air sealing in new construction and additions. These codes apply to new construction where adopted by local jurisdictions. In general, these requirements do not apply to retrofit projects unless the project adds living space to the building or changes the building's energy load. The existing, unaltered portions of the structure are not required to comply with all of the requirements of the 2009 IECC or IRC. However, Building America recommends implementing these requirements in existing portions of your home wherever they are applicable and your budget allows or health and safety concerns make them necessary.

The requirements regarding new buildings can be summarized in this section excerpted from IECC, Chapter 4, Section 402.4, Air Leakage (mandatory) (quoted verbatim). Builders can see IECC 2009, Chapter 4 "Residential," and IRC 2009, Chapter 11 "Energy Efficiency," for more details:

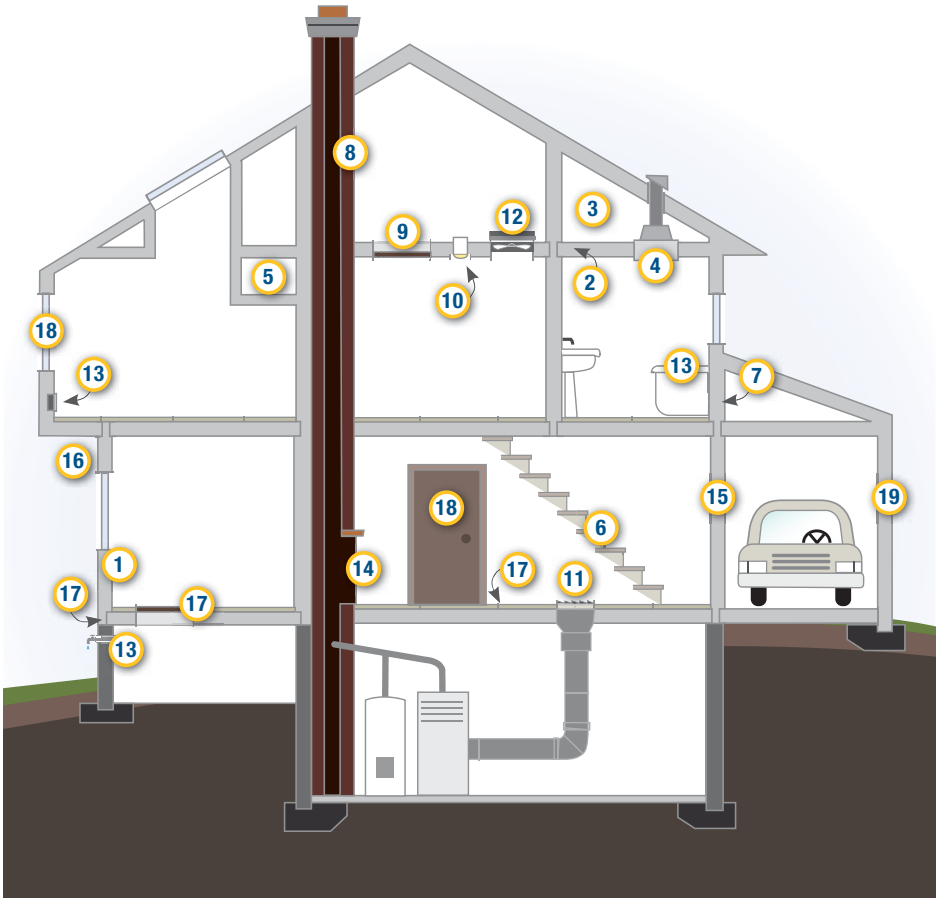
> "The building thermal envelope shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. The following shall be caulked, gasketed, weather stripped or otherwise sealed with an air barrier material, suitable film, or solid material:
>
> 1. all joints, seams and penetrations,
> 2. site-built windows, doors, and skylights,
> 3. openings between window and door assemblies and their respective jambs and framing,
> 4. utility penetrations,
> 5. dropped ceilings or chases adjacent to the thermal envelope,
> 6. knee walls,
> 7. walls and ceilings separating a garage from conditioned spaces,
> 8. behind tubs and showers on exterior walls,
> 9. common walls between dwelling units,
> 10. attic access openings,
> 11. rim joists junction,
> 12. other sources of infiltration."

ICC Docket No. 13-0550
CUB-City Exhibit 1.2

An Air Sealing Checklist

This section provides descriptions of the areas of the home most likely to have air leakage, when to address those problems, durability and health concerns related to the problems, and references for more information. Additional information on how to identify and fix these problems and other building science information can be found in the Building America Best Practices guides produced by DOE and available for free download at www.buildingamerica.gov. Work with your contractor to determine which of these measures are most needed and most cost-effective.

Common air sealing trouble spots are shown on the graphic below and listed on the following page. Each of these trouble spots is described further in the pages that follow.



Building America research identifies 19 key areas where air sealing can improve a home's energy efficiency, comfort, and building durability. The information in this guide can help you find a certified home performance contractor and work with your contractor to identify problem areas, prioritize projects with safety in mind, and start sealing the air leaks in your home for cost-effective energy savings.

Get the Details

Contractors, see the references in the sections below for detailed descriptions of air sealing techniques and technologies.

Air Sealing Trouble Spots

1. Air Barrier and Thermal Barrier Alignment
2. Attic Air Sealing
3. Attic Kneewalls
4. Shaft for Piping or Ducts
5. Dropped Ceiling/Soffit
6. Staircase Framing at Exterior Wall
7. Porch Roof
8. Flue or Chimney Shaft
9. Attic Access
10. Recessed Lighting
11. Ducts
12. Whole-House Fan
13. Exterior Wall Penetrations
14. Fireplace Wall
15. Garage/Living Space Walls
16. Cantilevered Floor
17. Rim Joists, Sill Plate, Foundation, Floor
18. Windows & Doors
19. Common Walls Between Attached Dwelling Units

ICC Docket No. 13-0550
CUB-City Exhibit 1.2

Air Sealing List

Each of these items is addressed on the following pages.

Air Barrier	Completion Guidelines
1. Air Barrier and Thermal Barrier Alignment	Air barrier is in alignment with the thermal barrier (insulation).
2. Attic Air Sealing	Top plates and wall-to-ceiling connections are sealed.
3. Attic Kneewalls	Air barrier is installed at the insulated boundary (kneewall transition or roof, as appropriate).
4. Duct Shaft/Piping Shaft and Penetrations	Openings from attic to conditioned space are sealed.
5. Dropped Ceiling/Soffit	Air barrier is fully aligned with insulation; all gaps are fully sealed.
6. Staircase Framing at Exterior Wall/Attic	Air barrier is fully aligned with insulation; all gaps are fully sealed.
7. Porch Roof	Air barrier is installed at the intersection of the porch roof and exterior wall.
8. Flue or Chimney Shaft	Opening around flue is closed with flashing, and any remaining gaps are sealed with fire-rated caulk or sealant.
9. Attic Access/Pull-Down Stair	Attic access panel or drop-down stair is fully gasketed for an air-tight fit.
10. Recessed Lighting	Fixtures are provided with air-tight assembly or covering.
11. Ducts	All ducts should be sealed, especially in attics, vented crawlspaces, and rim areas.
12. Whole-House Fan Penetration at Attic	An insulated cover is provided that is gasketed or sealed to the opening from either the attic side or ceiling side of the fan.
13. Exterior Walls	Service penetrations are sealed and air sealing is in place behind or around shower/tub enclosures, electrical boxes, switches, and outlets on exterior walls.
14. Fireplace Wall	Air sealing is completed in framed shaft behind the fireplace or at fireplace surround.
15. Garage/Living Space Walls	Air sealing is completed between garage and living space. Pass-through door is weather stripped.
16. Cantilevered Floor	Cantilevered floors are air sealed and insulated at perimeter or joist transition.
17. Rim Joists, Sill Plate, Foundation, and Floor	Rim joists are insulated and include an air barrier. Junction of foundation and sill plate is sealed. Penetrations through the bottom plate are sealed. All leaks at foundations, floor joists, and floor penetrations are sealed. Exposed earth in crawlspace is covered with Class I vapor retarder overlapped and taped at seams.
18. Windows and Doors	Space between window/door jambs and framing is sealed.
19. Common Walls Between Attached Dwelling Units	The gap between a gypsum shaft wall (i.e., common wall) and the structural framing between units is sealed.

ICC Docket No. 13-0550
CUB-City Exhibit 1.2

1. Air Barrier and Thermal Barrier Alignment

The air barrier is in alignment with (touching) the thermal barrier (insulation).

Convective loops can form in wall cavities if there are gaps between the insulation and the air barrier. Convective loops (air movement within the wall cavities caused by temperature differences) will get cold air falling and hot air rising. This air movement reduces the effectiveness of the insulation and can pull in outside air and cause moisture problems. Arches, soffits, chases, and other design features create an uneven air barrier (drywall plane) that is difficult to insulate thoroughly. Expect the contractor to inspect these areas visually or with an infrared camera to make sure batts or blown insulation completely fill wall cavities.

Thermal and air barrier alignment is not an issue with insulation materials like spray foam or rigid foam that form an air barrier as well as thermal barrier, as long as they form a continuous air barrier from top to bottom and side to side. Spray foams should be sprayed to a consistent minimum depth across the area to be sealed and insulated. Rigid foam board that is serving as the air and thermal barrier should be taped at the seams with housewrap tape and glued with caulk at the edges to the wall framing, sill plate, or top plate. Blown cellulose and blown or batt fiberglass insulation will not stop air flow.

Figure 1.1. *(left)* Cut fiberglass batt insulation to fit around electrical boxes and wiring or pipes that run through the walls. Compressions like these ruin the batt's thermal alignment with walls and lessen its effectiveness.

Figure 1.2. *(right)* Install batts to fit smoothly and to completely fill wall and ceiling cavities. Here fiberglass batts completely fill joists of basement ceiling.

When To Do This

When replacing dry wall, replacing siding, adding an addition, adding insulation to attic or crawlspace or any time access is available.

Durability & Health

Convective loops in walls can pull in pollen, dust, and moisture. Walls that are not well insulated can provide a cold surface in wall cavities where warm indoor air can condense in winter and warm outdoor air can condense in the summer, encouraging mold growth in walls.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Air barrier and thermal barrier

- Exterior thermal envelope insulation for framed walls is installed in substantial contact and continuous alignment with building envelope air barrier.
- Breaks or joints in the air barrier are filled or repaired.
- Air-permeable insulation is not used as a sealing material.
- Air-permeable insulation is inside of an air barrier.

More Information

- Building America Best Practices
- U.S. Department of Energy 2009b
- U.S. Environmental Protection Agency 2008b

ICC Docket No. 13-0550
CUB-City Exhibit 1.2

2. Attic Air Sealing

Top plates and wall-to-ceiling connections are sealed.

When To Do This

When replacing dry wall, replacing siding, adding an addition, adding insulation to attic, anytime you see cracks at the inside seam of the wall and ceiling. In vaulted ceilings, the ceiling-to-wall intersection can be accessed and sealed from the inside or from the outside when reroofing occurs.

Durability & Health

Heat moves from high-temperature regions to low-temperature regions. The warmer the air, the more water vapor it can carry with it. If warm, moist air gets into a cold attic through leaks in the home's thermal envelope, it can condense on rafters and other solid surfaces, which may lead to water damage and mold growth.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Ceiling/attic

Air barrier in any dropped ceiling/soffit is substantially aligned with insulation and any gaps are sealed.

More Information

- Building America Best Practices
- Lstiburek 2010
- U.S. Environmental Protection Agency 2008a
- U.S. Environmental Protection Agency 2008c

Good air-sealing and a continuous air barrier between the attic and the home's conditioned (living) space are important not only to save energy and reduce fuel bills, but also to prevent moisture problems in the attic. Sealing holes in the attic makes chimneys and flues work better because a leaky attic ceiling acts like a chimney and will compete with the real chimney for air. Air sealing the leaky attic ceiling also reduces the house's "suction" (or stack effect) so less contaminants are drawn up into the house from the ground such as radon and other soil gases (Lstiburek 2010).

On the inside of the home, the ceiling drywall can serve as an air barrier. Visible cracks at the seam of the wall and ceiling can be taped, mudded, and painted or filled with paintable caulk, such as silicon latex. Your contractor can determine where leaks are with an infrared camera, by feeling for air flow, or by inspecting the attic insulation. Dirty insulation is an indication that air is flowing through the insulation and pulling dust with it.

Your contractor may pull back or scoop out the insulation to apply caulk, spray foam, or other sealant where the walls meet the attic floor. Other places in the attic that often are big sources of air leaks are soffits (dropped-ceiling areas, duct chases, plumbing chase), behind or under attic kneewalls, around recessed can lights, around flue pipes, around ducts, and at attic hatches (see strategy #3, #4, #5, #8, #9, #10, and #11).

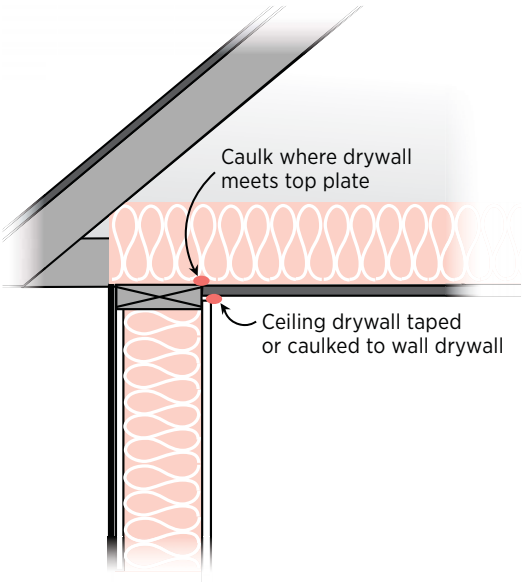


Figure 2.1. Seal the wall drywall to the top plate and ceiling drywall.

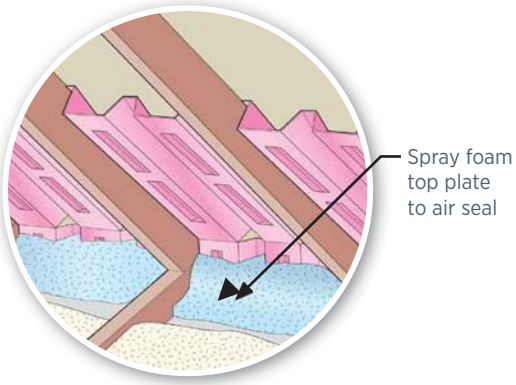


Figure 2.2. Pull back insulation to seal drywall to top plate with spray foam, caulk, or other sealer (Lstiburek 2010).

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3. Attic Kneewalls

Air barrier is installed at the insulated boundary (kneewall transition or roof, as appropriate).

Kneewalls, the sidewalls of finished rooms in attics, are often leaky and uninsulated. Your contractor can insulate and air seal these walls in one step by covering them from the attic side with sealed rigid foam insulation. Your contractor can plug the open cavities between joists beneath the kneewall with plastic bags filled with insulation or with pieces of rigid foam. Another option is to apply rigid foam to the underside of the rafters along the sloped roof line and air seal at the top of the kneewall and the top of the sidewall, which provides the benefit of both insulating the kneewall and providing insulated attic storage space.

Doors cut into kneewalls should also be insulated and airsealed by attaching rigid foam to the attic side of the door, and using a latch that pulls the door tightly to a weather-stripped frame.

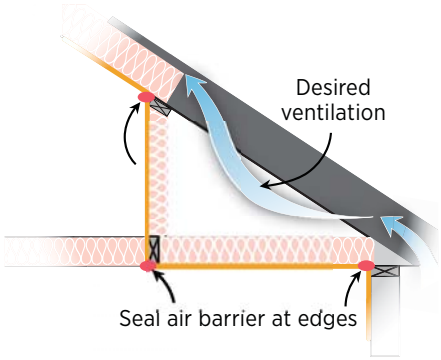

Figure 3.1. Insulate and air seal the kneewall itself, as shown, or along the roof line (Source: DOE 2000a).

Figure 3.2. Air seal floor joist cavities under kneewalls by filling cavities with fiberglass batts that are rolled and stuffed in plastic bags (as shown here) or use rigid foam, OSB, or other air barrier board cut to fit and sealed at edges with caulk.

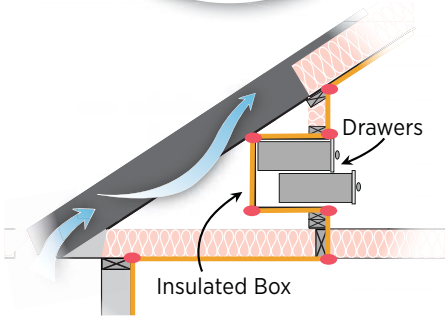

Figure 3.3. Build an airtight, insulated box around any drawers or closets built into attic knee walls that extend into uninsulated attic space. Insulate along air barrier (shown in yellow on drawing) or along roof line with rigid foam (Source: Iowa Energy Center 2008).

When To Do This

Any time you have access to kneewalls.

Durability & Health

If warm moist air gets into a cold attic through leaks in the home's thermal envelope, it can condense on rafters and other solid surfaces, which may lead to water damage and mold growth.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Ceiling/attic

Attic access (except unvented attic), kneewall door, or drop down stair is sealed.

More Information

- Building America Best Practices
- Iowa Energy Center 2008
- Lstiburek 2010
- U.S. Department of Energy 2000a
- U.S. Environmental Protection Agency 2008a
- U.S. Environmental Protection Agency 2008b
- U.S. Environmental Protection Agency 2008c

4. Duct Shaft/Piping Shaft and Penetrations

Openings from attic to conditioned space are sealed.

Any chases, shafts, or building cavities that contain piping or wiring can serve as links between conditioned and unconditioned space. Your contractor can inspect these areas and close the gaps with caulk, spray foam, and blocking material (pieces of rigid foam, plywood, or oriented strand board cut to fit and sealed in place with spray foam). Furnace flues require high-temperature-rated sealing materials.

When To Do This

Any time you have access.

Durability & Health

HVAC, plumbing, and wiring chases can bring conditioned air into attics, leading to condensation and mold problems. They can also connect crawlspaces and living spaces bringing soil gases into the home.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Shafts, penetrations

Duct shafts, utility penetrations, knee walls and flue shafts opening to exterior or unconditioned space are sealed.

More Information

- Building America Best Practices
- Iowa Energy Center 2008
- U.S. Environmental Protection Agency 2008a
- U.S. Environmental Protection Agency 2008c
- House Energy 2009

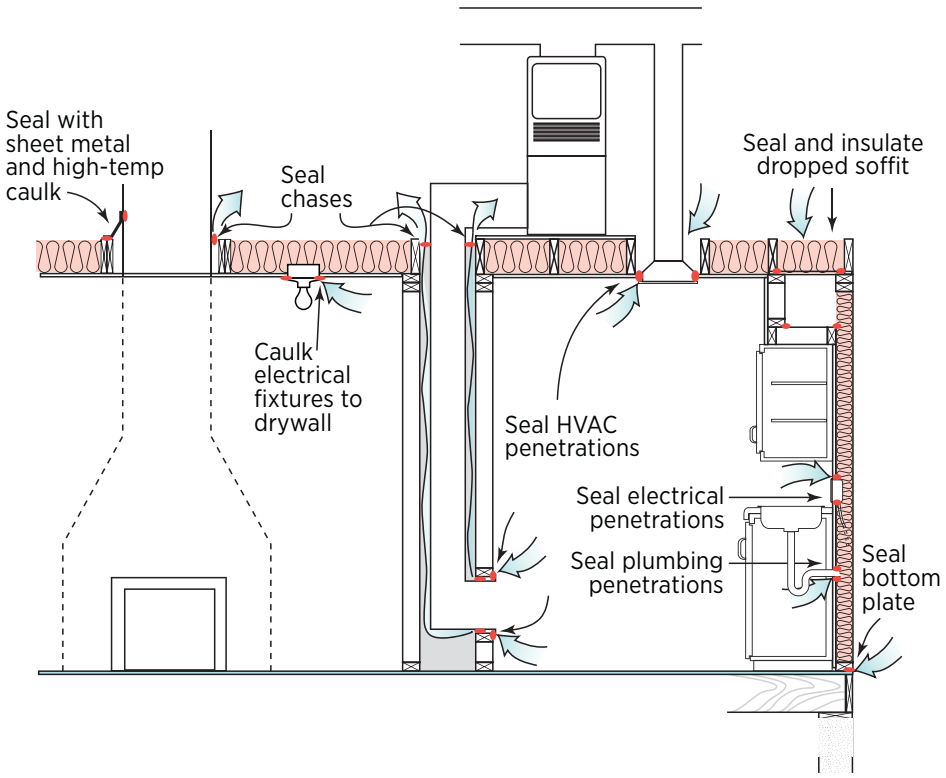

Figure 4.1. Seal attic and wall penetrations associated with mechanical ventilation systems, electrical chase openings, and dropped soffits (Source: DOE 2000a).

5. Dropped Ceiling/Soffit

Air barrier is fully aligned with insulation; all gaps are fully sealed.

Soffits (dropped ceilings) found over kitchen cabinets or sometimes running along hallways or room ceilings as duct or piping chases are often culprits for air leakage. Your contractor will push aside the attic insulation to see if an air barrier is in place over the dropped area. If none exists, the contractor will cover the area with a piece of rigid foam board, sheet goods, or reflective foil insulation that is glued in place and sealed along all edges with caulk or spray foam, then covered with attic insulation. If the soffit is on an exterior wall, sheet goods or rigid foam board should be sealed along the exterior wall as well. If the soffit contains recessed can lights, they should be rated for insulation contact and airtight (ICAT) or a dam should be built around them to prevent insulation contact.

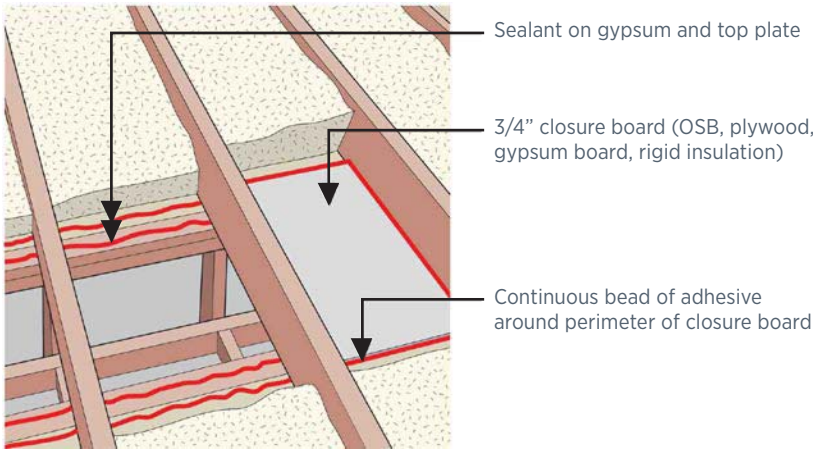

Figure 5.1. Place a solid air barrier over soffits as follows: pull back existing insulation; cover area with air barrier material (gypsum, plywood, OSB, rigid foam, etc.); seal edges with caulk; cover with insulation (Lstiburek 2010).

When To Do This

Any time, if attic construction allows access to area above soffits.

Durability & Health

If warm moist air gets into a cold attic through leaks in the home's thermal envelope, it can condense on solid surfaces, which may lead to water damage and mold growth.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Ceiling/attic

Air barrier in any dropped ceiling/soffit is substantially aligned with insulation and any gaps are sealed.

More Information

- Building America Best Practices
- Iowa Energy Center 2008
- Lstiburek 2010
- U.S. Environmental Protection Agency 2008a
- U.S. Environmental Protection Agency 2008b
- U.S. Environmental Protection Agency 2008c

6. Staircase Framing at Exterior Wall/Attic

Air barrier is fully aligned with insulation; all gaps are fully sealed.

When To Do This

Any time.

Durability & Health

Uninsulated exterior walls with no air barriers present a cold surface where condensation and mold can form.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Air barrier and thermal barrier

- Exterior thermal envelope insulation for framed walls is installed in substantial contact and continuous alignment with building envelope air barrier.
- Air-permeable insulation is inside of an air barrier.

More Information

- Building America Best Practices
- U.S. Environmental Protection Agency 2008c
- House Energy 2009

If the area under the stairs is accessible, look to see if the inside wall is finished. If not, have your contractor insulate it, if needed, and cover it with a solid sheet product like drywall, plywood, oriented strand board, or rigid foam insulation. Then, your contractor can caulk the edges and tape the seams to form an air-tight barrier. Stairs should be caulked where they meet the wall.

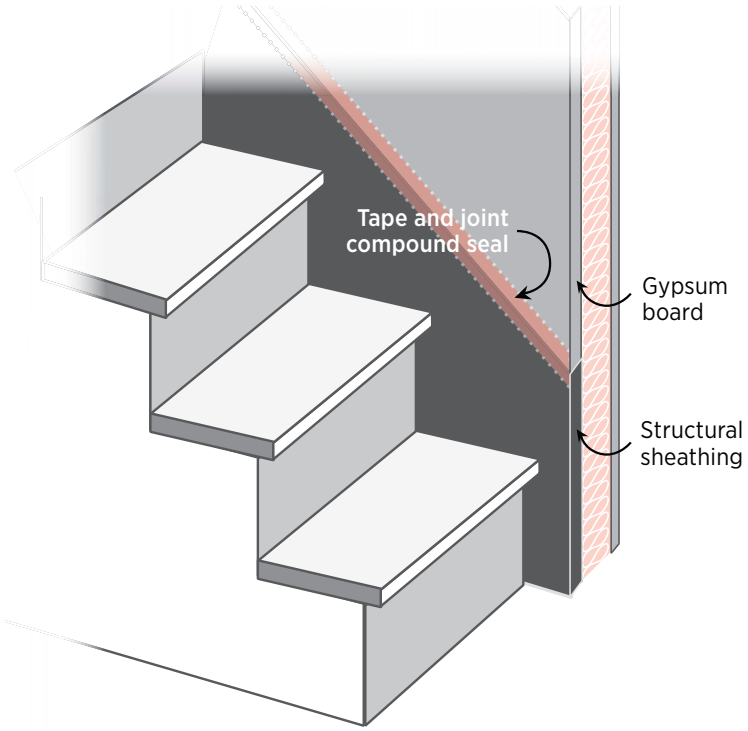

Figure 6.1. Install an air barrier and air sealing on exterior walls behind stairs. If the area behind the stairs is inaccessible, caulk stairs where they meet the wall. Use caulk if the area is already painted; use tape and joint compound if area will be painted.

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7. Porch Roof

Air barrier is installed at the intersection of the porch roof and exterior wall.

If a test-in inspection identifies air leakage at the wall separating the porch from the living space, the contractor will investigate to see if the wall board is missing or unsealed. If this is the case, the contractor will install some type of wall sheathing (oriented strand board, plywood, rigid foam board) cut to fit and sealed at the edges with spray foam. Your contractor will also make sure this wall separating the attic from the porch is fully insulated.

Studies Show

Steven Winter Associates, a Building America research team lead, used a blower door test and infrared cameras to investigate high-energy bill complaints at a 360-unit affordable housing development and found nearly twice the expected air leakage. Infrared scanning revealed an air leakage path on an exterior second-story wall above a front porch. Steven Winter Associates found that, while the wall between the porch and the attic had been insulated with unfaced fiberglass batts, wall board had never been installed. The insulation was dirty from years of windwashing as wind carried dust up through the perforated porch ceiling, through the insulation, into the attic and into the wall above. Crews used rigid foam cut to fit and glued in place with expandable spray foam to seal each area. Blower door tests showed the change reduced overall envelope leakage by 200 CFM_{50}. At a cost of $267 per unit, this fix resulted in savings of $200 per year per unit, for a payback of less than two years.

Figure 7.1. When researchers pulled back the porch ceiling, they found the wall board was missing so nothing was covering the insulation on this exterior wall. An air barrier of rigid foam board was put in place with spray foam (Source: Moriarta 2008).

When To Do This

Any time, if porch wall is accessible, either from the attic or from the porch.

Durability & Health

Cold surfaces in the exterior wall encourage condensation and mold. If the air barrier is missing, wind can carry dust and pollen into the living space.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Air barrier and thermal barrier

- Exterior thermal envelope insulation for framed walls is installed in substantial contact and continuous alignment with building envelope air barrier.
- Breaks or joints in the air barrier are filled or repaired.
- Air-permeable insulation is inside of an air barrier.

More Information

- Building America Best Practices
- Moriarta 2008
- U.S. Environmental Protection Agency 2008b

8. Flue or Chimney Shaft

Opening around flue is closed with flashing, and any remaining gaps are sealed with fire-rated caulk or sealant.

When To Do This

Any time the flue pipe is accessible in the attic.

Durability & Health

Use the right sealing products and techniques to keep flammable materials from touching hot flues.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Shafts, penetrations

Duct shafts, utility penetrations, knee walls and flue shafts opening to exterior or unconditioned space are sealed.

More Information

- Building America Best Practices
- U.S. Environmental Protection Agency 2008a
- U.S. Environmental Protection Agency 2008c

There are often gaps around chimneys, furnaces, and water heater flues that allow conditioned air to flow up into the attic. Your contractor can seal this gap with lightweight aluminum flashing (sheet metal) and special high-temperature (heat-resistant) caulk. A metal dam should be used to keep insulation away from the flue. The same technique is used for masonry chimneys.

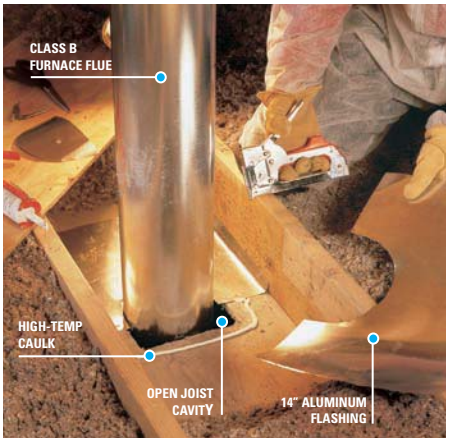

Figure 8.1.

Step 1: Cut aluminum flashing to fit around flue.

Figure 8.2.

Step 2: Seal flashing to pipe with high-temperature caulk.

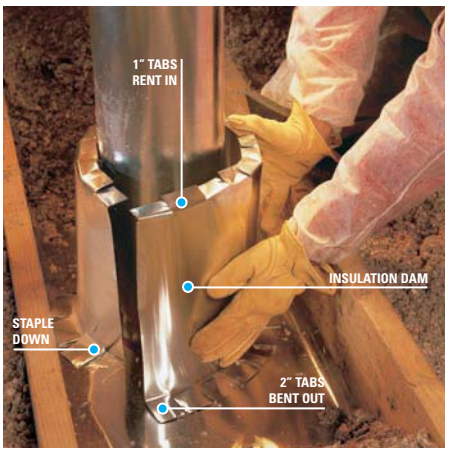

Figure 8.3.

Step 3: Form an insulation dam to keep the insulation from coming into contact with the flue pipe.

(Source: EPA 2008a)

ICC Docket No. 13-0550
CUB-City Exhibit 1.2

9. Attic Access/Pull-Down Stair

Attic access panel or drop-down stair is fully gasketed for an air-tight fit.

A home's attic access, which could be an attic hatch, pull-down stairs, or a kneewall door, can leak a lot of heated or cooled air into the attic if it is not sealed properly.

Your contractor can add weather stripping either to the frame or panel of the attic access and may install latch bolts to ensure a tighter seal. The hatch lid, stairs, or door should be insulated too.

If you are planning to add an attic access, consider the location. An access hatch or pull-down stairs that is located in an unconditioned part of the house, such as a garage, covered patio, or porch, does not necessarily need to be air sealed or insulated. If your hatch connects conditioned space like a bedroom, hallway, or closet to an unconditioned attic, your contractor will check for air leakage.

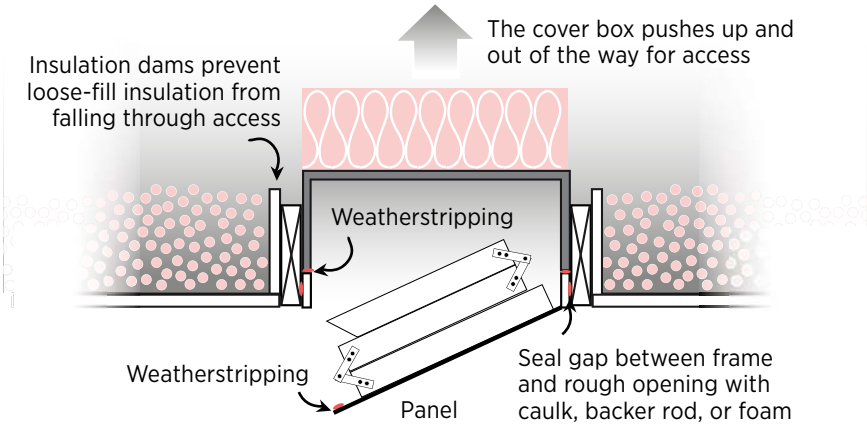

Figure 9.1. Insulate and air seal the attic access hatch cover.

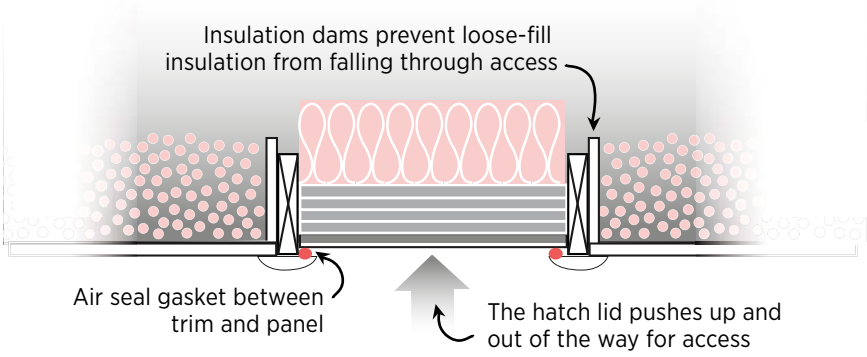

Figure 9.2. Insulate and air seal the pull-down attic stair.

When To Do This

Any time.

Durability & Health

Air sealing the attic access will minimize the amount of moisture-laden air that escapes into the attic reducing the risk of mold in the attic.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Ceiling/attic

Attic access (except unvented attic), knee wall door, or drop down stair is sealed.

More Information

- Building America Best Practices
- U.S. Department of Energy 2000b
- U.S. Department of Energy 2009a
- U.S. Environmental Protection Agency 2008a

ICC Docket No. 13-0550
CUB-City Exhibit 1.2

10. Recessed Lighting

Fixtures are provided with air-tight assembly or covering.

When To Do This

Replace old uninsulated can fixtures when changing lighting fixtures; can caulk any time.

Durability & Health

Non-airtight recessed can fixtures can allow heated air to escape to attic during winter, carrying moisture that can condense in a cool attic. They can also draw hot attic air into the home in summer, pulling dust and insulation particles into the home.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

Recessed lighting

Recessed light fixtures are airtight, IC rated, and sealed to drywall. Exception: fixtures in conditioned space.

More Information

- Building America Best Practices
- ASTM 1991
- McCullough and Gordon 2002

Recessed downlights are the most popular home lighting fixture in the United States. Older model recessed can fixtures are energy intensive in three ways—they are not approved for insulation contact so insulation has to be kept at least 3 inches away all the way around, leaving about 1 square foot of uninsulated ceiling space. Most are using incandescent bulbs that use 3 to 5 times the power of fluorescents and add to air-conditioning loads. Third, the cans are not airtight, so they allow conditioned air to escape from the living area into unconditioned spaces such as attics.

If your home has non-airtight fixtures, you can have a contractor replace the whole fixture with insulation contact-rated, air-tight (ICAT) fixtures, or caulk around the fixture, under the trim ring if caulking from inside the home. Other alternatives are to install the recessed cans in an air-sealed dropped soffit or to use surface-mounted fixtures instead. After air sealing, replace any incandescent lights in the recessed lighting fixture with low-wattage CFL or LED lamps.

Studies Show

Old, leaky recessed cans are like a hole in the ceiling, only worse. Old recessed cans with incandescent bulbs can pull 3 to 5 times as much air as a hole the same size, thanks to the "stack effect"—the heat inside the can pulls air from the house up into the attic. Replacing a leaky can with an ICAT (insulation contact-rated, air-tight) recessed downlight would save a Phoenix, AZ, homeowner $1.56 per year in cooling costs or a Minneapolis, MN, homeowner $3.57 per year in heating costs (these savings don't even include the possible energy savings of CFL bulbs over incandescent bulbs) (McCullough and Gordon 2002).

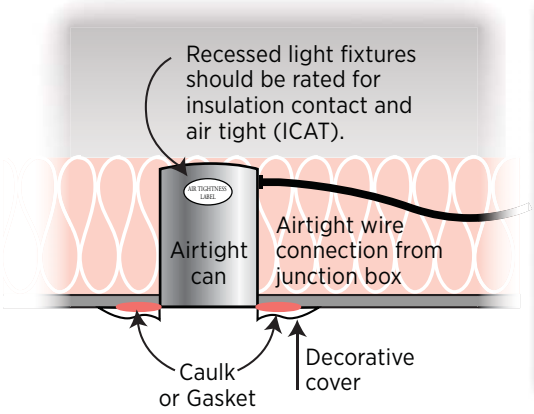

Figure 10.1. *(left)* Replace old, leaky can fixtures with insulated, airtight recessed light fixtures and caulk them where the housing meets the drywall.

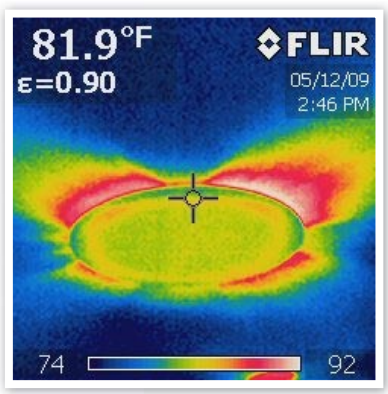

Figure 10.2. *(right)* Seal cans to prevent heated and cooled air from leaking into attics as shown in this infrared camera image.

ICC Docket No. 13-0550
CUB-City Exhibit 1.2

11. Ducts

All ducts should be sealed, especially in attics, vented crawlspaces, and rim areas.

Repairing leaking ducts can yield big energy improvements. Duct sealing contractors often find more than just a few leaks: duct tape dries and falls away; ducts may have been torn or crumpled by other trades during installation; and poorly hung ducts can have bends and kinks that prevent air from flowing through them. It is not uncommon to find one or more ducts completely disconnected from their register.

If return ducts in the heating and air-conditioning system have holes, they can draw in hot attic air or cold outside air. As a result, the system must work harder and use more energy to heat and cool the inside of the house. In older homes, wall cavities and floor joist cavities are sometimes used as return "ducts" to bring air from the return registers back to the air handler unit, but these building cavities are rarely air sealed.

A heating and cooling equipment contractor may

- Inspect the duct system, including the attic and crawlspace.
- Evaluate the system's supply and return air flow.
- Repair damaged and disconnected ducts.
- Seal all leaks and connections with mastic (a thick sealant painted on duct joints).
- Seal all registers and grills to the ducts.
- Insulate ducts in unconditioned areas (like attics, crawlspaces, and garages) with duct insulation that has an R-value of 6 or higher.
- Replace the filter as part of any duct system improvement.
- Retest air flow after repairs are completed.
- Ensure there is no backdrafting of gas or oil-burning appliances, and conduct a combustion safety test after ducts are sealed.

When To Do This

Whenever and wherever ducts are accessible.

Durability & Health

Unsealed ducts can draw in dust, moisture, and contamination from unconditioned spaces in the home. Broken ducts can be a pathway for pests.

2009 IECC/2009 IRC Code

Requirement for New Construction and Additions

HVAC register boots

HVAC register boots that penetrate building envelope are sealed to subfloor or drywall.

More Information

- Building America Best Practices
- Building Science Corporation 2006
- Building Science Corporation 2009d
- Cummings et al. 1990
- Granade et al. 2009
- Jump and Modera 1994
- Karins et al. 1997
- ORNL
- Sherman et al. 2000
- U.S. Environmental Protection Agency 2008a
- U.S. Environmental Protection Agency 2009a

Figure 11.1. Paint mastic (a thick, gooey substance) on to the duct seams and joints. (Photo source: Habitat for Humanity Lakeland FL).

Studies Show

In a study of energy-efficient measures, DOE's Energy Information Administration reported that sealing the ducts yielded by far the greatest energy savings of the 12 measures studied, at the lowest cost (Granade et al. 2009). In a DOE study of 100 homes in Phoenix, Arizona, sealing ducts cut leakage by 30%, saving homeowners $80 per year. A study of 24 Florida homes found air-conditioning energy use was reduced by 18% after duct repairs were made (Cummings et al. 1990). A study of a retrofit project involving 25 apartments in New York found that sealing the HVAC ducts cut airflow leakage by 92 CFM for supply ducts and 223 CFM for return ducts with a simple payback of 3 to 4 years (Karins et al. 1997). Research on six homes in the southwest indicated that 30% to 40% of the thermal energy delivered to the ducts passing through unconditioned spaces is lost through air leakage and conduction through the duct walls. Sealing and insulating the ducts cut overall duct leakage approximately 64% (Jump and Modera 1994).

DOE studies show duct tape fails within months (Sherman et al. 2000).

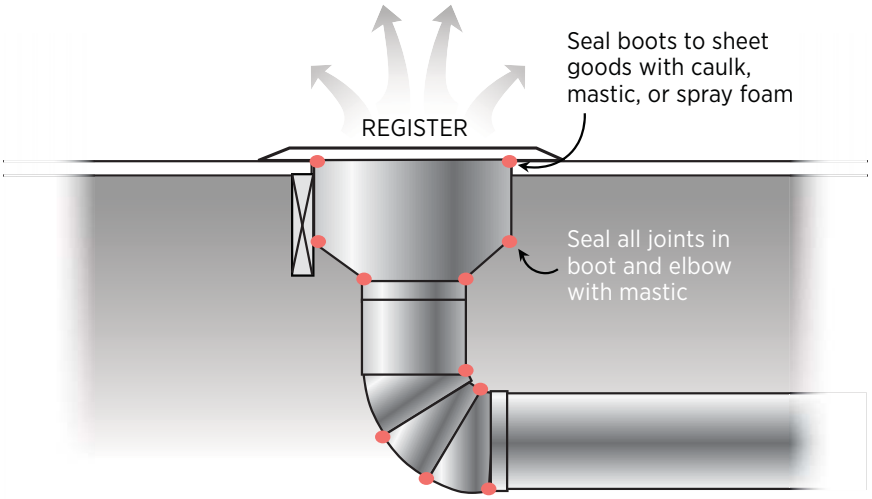

Figure 11.2. Mastic seal all supply and return air ducts.