MATERIAL AND INSTALLATION (M&I) STANDARDS

Your guide to quality, comfort, and energy savings.

INSULATION & AIR SEALING

Updated November 2023

focus on energy®
Partnering with Wisconsin utilities

OVERVIEW

AIR SEALING

INSULATION

WORKING TOGETHER TO IMPROVE HOME PERFORMANCE

Thank you for your participation in FOCUS ON ENERGY®. This guidebook presents rules and requirements for materials and installation of qualified energy efficiency measures in existing homes.

The goal is for participants (Trade Ally contractors, sponsors, field staff, and management) to share a common understanding of how specified energy-saving measures should be implemented for various residential applications. This includes selecting the right approved materials and understanding what it takes for completed installations to meet Focus on Energy requirements.

We created these requirements for instances where national standards have yet to be developed through an American National Standards Institute (ANSI) accredited organization following ANSI procedures. Where such ANSI standards do exist, bring them to the attention of the Program team for resolution.

OVERVIEW

ORGANIZATION

ORGANIZATION

This set of guidelines is organized into two basic sections. The first section covers items that apply to all types of work performed by participating Trade Ally contractors and Program staff, and the second details the means and methods for residential energy improvement construction work.

WORK-RELATED STANDARDS & REGULATIONS

GENERAL

All Trade Ally contractors are required to perform their work in compliance with all applicable codes, regulations, laws, and standards.

All Trade Ally contractors are required to comply with their company's health and safety specifications. Trade Ally contractors will comply with all applicable Occupational Safety and Health Administration (OSHA) and State of Wisconsin worker safety regulations. Trade Ally contractors will maintain a copy of their Company Health and Safety Plan at the work site. Trade Ally contractors will make available Safety Data Sheets (SDS, previously MSDS) for products and materials used by their crews.

PERSONAL PROTECTION & WORK SITE AIR QUALITY

Employee Safety

Trade Ally contractors will maintain a copy of their Health and Safety Policy and train all employees accordingly. The Health and Safety Policy will include a written air quality management plan. All jobs conducted by Trade Ally contractors or those working under contract to the Trade Ally contractors must adhere to worker health and safety and applicable OSHA standards.

Trade Ally contractors will perform all work in a safe manner and utilize appropriate personal protection measures where required.

Occupant Safety

Consider potential impacts an installation may have on the occupants and the structural integrity of the building before commencing work. The Trade Ally contractor and/or its subcontractors will evaluate existing conditions and communicate potential problems with the customer so that problems are resolved before beginning work. This includes the identification of possible indoor air contaminants, severe moisture problems, and potential backdrafting of combustion appliances. The Trade Ally contractor will prepare a plan to minimize, reduce, or eliminate these potential impacts. Trade Ally contractors will communicate the plan to occupants and agree on its implementation in advance. The plan will also comply with all local, state, and federal regulations governing potentially hazardous materials or situations.

ASBESTOS-LIKE MATERIALS

Vermiculite.

Definition

Asbestos is a mineral that was used in thousands of building products until 1973. This mineral, when broken down, forms microscopic razor-sharp particles that, when disturbed, can float in the air and be inhaled. These razor-sharp asbestos fibers can cause debilitating and sometimes fatal lung diseases.

Requirements

The presence of suspected non-rigid asbestos in the home disqualifies the home for air sealing or insulation that could introduce asbestos particles into the living space. Non-rigid asbestos materials can be a source of airborne asbestos if the material can be disturbed by movement or air currents. Examples of non-rigid or friable asbestos include but are not limited to: vermiculite, boiler and pipe insulation, and ceiling coatings. Examples of non-friable asbestos include but are not limited to: floor tiles, house siding, shingles, firestop boards, pipes, and chimneys. Do not conduct blower door tests if non-rigid or friable asbestos is present or suspected. Presume that vermiculite used as loose-fill insulation contains asbestos. Do not do work that will disturb vermiculite. Testing vermiculite for asbestos is not recommended as only a small portion is sampled and other areas may contain asbestos.

See **epa.gov/asbestos/overview-asbestos-national-emission-standards-hazardous-air-pollutants-neshap** for the Environmental Protection Agency (EPA) guidelines on the treatment of vermiculite.

Suspected rigid or fixed asbestos materials do not automatically disqualify a home from all weatherization work unless work causes the asbestos particles to become airborne by activities such as sawing, drilling, etc. Under no circumstances is the Trade Ally contractor permitted to saw, cut, break, tear, sand, or drill materials containing suspected asbestos in the performance of work.

Follow EPA guidelines, which say not to disturb the material. Visit **epa.gov/asbestos** to learn more.

It is possible to remediate asbestos and vermiculate to allow for retrofit work to proceed. To satisfy the remediation requirement, a certified asbestos abatement professional must remediate the asbestos and/or vermiculite and attest to its remediation in writing. Do not perform a post blower door test unless the certified abatement professional provides an air clearance report.

Trade Ally contractors may use the Zonolite trust in conjunction with Focus on Energy rebates. Visit **zaitrust.com** to learn more. To calculate the correct amount, deduct Focus on Energy rebates from the total amount first, then calculate the trust payment. The trust is retroactive for homeowners that had vermiculite professionally removed in the past.

KNOB & TUBE WIRING

Knob and tube wiring.

Definition

This pre-1950 style of wiring is characterized by two separated strands of insulated wire. The wire runs through ceramic tubes when passing through framing members and ceramic knobs when being attached to a framing member. When electricity flows through the wires, there is resistance to the passage of the electrons. This resistance builds up heat that is dissipated to the surrounding space.

Requirements

When knob and tube wiring is present in a home, do not install insulation or perform air sealing work where the knob and tube is present until one of these two conditions is met:

1. The knob and tube wiring is completely removed by a licensed electrician from the area to be insulated or air sealed.
2. A licensed electrician confirms in writing that the knob and tube wiring in the area to be insulated or air sealed was permanently deactivated.

Please make documentation available to inspectors upon completing either option one or two.

MOLD

Mold on walls.

Definition

Mold is an organic substance that can cause adverse health effects in some individuals.

Requirements

When a mold-like substance is present in an area of the home and it exceeds an area greater than 10 sq. ft., do not perform air sealing work or install insulation until one of the following conditions is met:

1. A certified mold abatement professional remediates the mold and attests to its remediation in writing.
2. A certified mold abatement professional determines that the substance is not mold and does not need to be remediated and attests to this determination in writing.

If the area of suspected mold-like substance is less than 10 sq. ft., inform the homeowner and direct them to consult the EPA's "Mold Cleanup in Your Home." Visit **epa.gov/mold/mold-cleanup-your-home** to learn more.

LEAD PAINT

Lead paint.

Definition

Lead was a common ingredient in many paints until its use was banned in 1978. Lead ingestion or inhalation can cause damage to the central nervous system. Children in particular are at high risk for nervous system damage due to lead exposure.

Requirements

In any home built before 1978, it is possible that lead paint was applied to some or all surfaces. If specified work in the home requires cutting into areas that are potentially covered with lead paint, follow the procedure below:

1. First, test the areas that will be disturbed with field test kits to determine if lead paint is present. Test kits must conform to guidelines spelled out in the State of Wisconsin Lead Safe document Department of Health Services (DHS) 163, Section 163.16. Visit **docs.legis.wisconsin.gov/code/admin_code/dhs/110/163/II/16/3** to learn more.
2. If lead paint is present at a site, calculate the area of lead paint that will be disturbed and compare it to the maximum amount of lead paint area that is allowed to be disturbed before lead safe practices are required.
3. If the area to be disturbed exceeds the maximum allowable area permitted by the State of Wisconsin Lead Safe regulations, then follow all lead safe practices as outlined in the State of Wisconsin Lead Safe document DHS 163.

RECESSED LIGHTS

Recessed lighting.

Definition

Recessed lights are fixtures that project through the thermal boundary into the attic space or cathedral roof slope. The holes in the thermal boundary created by these fixtures are a source of air leakage and degrade the overall thermal performance of the attic insulation or roof plane.

It is important to take great care when sealing and insulating these fixtures.

Requirements

If a home has recessed lighting fixtures that penetrate the thermal envelope, use the following criteria and method to air seal and insulate them:

1. First, determine if the fixture is a non-Insulation Contact (IC) rated fixture, an IC rated fixture, or an airtight IC rated Insulation Contact Air Tight (ICAT) fixture. If you cannot determine what type of fixture it is, then you should assume that it is a non-IC rated fixture.
2. If the fixture is non-IC rated, then you must install an airtight enclosure over it. This enclosure must maintain a minimum clearance of 3 inches to any part of the fixture, per section SPS 322.37(4) of the Wisconsin Uniform (1-2 Family) Dwelling Code. The enclosure must be made of cement board, drywall or any rigid material that has a smoke development index of less than 10 when tested in accordance with ASTM International (ASTM) E84. The top of the enclosure for a fixture that is not IC rated cannot be covered with insulation.
3. You may use an airtight ENERGY STAR® certified LED recessed light insert on a non-IC rated recessed light. In this situation, it is not necessary to build a cement board box around the recessed light for air sealing purposes. You still cannot install insulation within 3 inches of the light, and cannot blow insulation over the top. It is still considered a non-IC recessed light.
4. If the fixture is IC rated but not airtight, then you must install an airtight enclosure over it with a minimum clearance of 3 inches to any part of the fixture using an air barrier material such as wallboard or rigid foam insulation. You can use rigid foam insulation or other impermeable material for the enclosure sides, but the top of the enclosure must be a non-insulating material with a high vapor permeability like wallboard. You may insulate over this box.
5. You may use an airtight ENERGY STAR certified LED recessed light insert in IC rated recessed lights. This should properly air seal the IC rated recessed light, and you do not need to build a box over the recessed light for air sealing purposes in this case. You can blow over the IC rated recessed light with air permeable insulation. You may not dense pack insulation around or foam over the light, even if there is an airtight ENERGY STAR certified LED insert.
6. If the fixture is an airtight IC rated can, you can bury it in insulation without it being treated.

HEAT SOURCES

Flashed chimney with 3-inch spacing.

Definition

A heat source is any penetration through the pressure boundary that has the potential to ignite combustible sealing materials. Examples of heat sources include metal flue pipes (furnaces, boilers, water heaters, and dryer vents), masonry chimneys, cooking stove/range hood exhaust vents, and exhaust fans with heat lamps/electric heaters. You should always use special non-combustible materials to air seal heat sources.

A range hood over the stove is a heat source. A fan in the kitchen ceiling that is not directly over the range/stove is not a heat source, so you can treat it like any non-heat-source bath fan duct.

To determine if a kitchen fan is a heat source, strike a 45-degree line from the center of the oven/stove in a circle toward the ceiling. If the fan falls within the resulting cone circle on the ceiling, it is a heat source.

Requirements

Locations such as chimneys and flue pipes that have the potential to combust typical air sealing materials (such as foam, silicone caulk, or cardboard) must be air sealed with fireproof materials. The only approved materials for this application are sheet metal and high-temperature sealants (ASTM E136 for oil or wood flues, 500°F room-temperature-vulcanizing (RTV) silicone for gas flues).

Apply the sheet metal over any openings that cannot be bridged by the sealants and mechanically fastened in place with nails, screws, or staples for a minimum distance of 3 inches from the heat source. You should then seal gaps and leakage points around the sheet metal using the appropriate high-temperature sealant for a minimum distance of 3 inches from the heat source. Mineral wool may be used as the damming material.

IGNITION BARRIER VS. THERMAL BARRIER

The difference in requirements of thermal barrier vs. ignition barrier is clearly defined along the lines of occupant safety. If there is any chance that a space will be occupied for any reason, even for short periods of time, the space must have the 15-minute protection that a thermal barrier affords. This should allow safe evacuation of the space. If a space is clearly not going to be occupied for any reason except maintenance, a step down to an ignition barrier is permitted. In the event of a fire, an ignition barrier should afford sufficient time for a technician to exit the space. If a space will never be occupied because there is no permanent access and this space does not communicate with any other spaces in the building, either by obvious means or by thermal bypasses, then no protection is required.

WHAT QUALIFIES AS AN IGNITION BARRIER?

1. 1 1/2-inch mineral fiber insulation.
2. 1/4-inch wood structural panels.
3. 3/8-inch particle board.
4. 1/4-inch hardboard.
5. 3/8-inch gypsum board.
6. 0.016-inch-thick corrosion-resistant steel.

WHAT QUALIFIES AS A THERMAL BARRIER?

1. Prescriptive thermal barrier: The International Building Code (IBC) and International Residential Code (IRC) specifically name 1/2-inch gypsum wallboard as an “approved” thermal barrier.
2. Equivalent thermal barriers: Materials equivalent to 1/2-inch gypsum wallboard can be used as thermal barriers provided they have been tested in accordance with the IBC or IRC to limit temperature rise and remain in place for 15 minutes. Typical equivalent thermal barriers include:
   - Spray-applied cementitious materials.
   - Spray-applied cellulose materials.
   - Portland cement plaster.
   - Intumescent coatings.
3. Other various proprietary materials: Look for the test report and/or International Code Council Evaluation Service (ICC-ES) report to document equivalence for a particular product and thickness.
4. Other various proprietary materials generally fall into two categories: rigid foam board insulation or two-part spray foam. At present, Thermax and Hunter Panels Xci 286 are the only rigid foam board manufacturers that have a rigid board insulation that meets the requirements to be a thermal barrier. Hunter Panels Xci 286 may be used vertically or horizontally, up to 4 inches thick. They may not be used both vertically and horizontally.

COMBUSTION APPLIANCE ZONE SAFETY

Combustion Appliance Zone (CAZ) safety screening and/or testing is required before and after air sealing or insulation work. This includes dense packing of exterior walls.

Test all projects using the current Building Performance Institute (BPI) Building Analyst procedure related to the visual inspection of the CAZ (ANSI/BPI-1200-S-2017 section 7.7), visual inspection of the combustion appliance/s and venting system/s (ANSI/BPI-1200-S-2017 section 7.8), and a spillage assessment (ANSI/BPI-1200-S-2017 section 7.9). Testing for ENERGY STAR projects must also follow the carbon monoxide and gas leak detection protocols (ANSI/BPI-1200-S-2017 section 7). Visit **bpi.org/standards/current-standards** for more information.

Record all test results in a data collection sheet. Homeowners must receive and sign a notification form and you will need to submit a signed copy to Focus on Energy. You must address CAZ failures before work can start.

RADON

Radon chemical element.

Definition

Radon is a colorless, odorless gas that, in high enough concentrations, has been shown to cause lung cancer. Visit **epa.gov/radon/index.html** to find more information on health risks associated with radon.

INDOOR AIR QUALITY

Bath fan.

In the classic sense, maintaining an acceptable level of indoor air quality involves ensuring that there is enough fresh air supplied to a home by some method to meet the needs of occupants and replace the air exhausted to remove indoor air pollutants (see **Combustion Safety**). The quantity of fresh air required is generally calculated based on some combination of house volume and/or occupancy. In some cases, maintaining good indoor air quality requires addressing other issues such as asbestos, mold, lead paint, or radon and then adding mechanical ventilation at the calculated rate once these issues have been successfully remediated.

When assessing existing homes for energy improvements, apply the BPI interpretation of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 62.2-2013. As standards change, the Focus on Energy Trade Ally contractor reference web page will add technical bulletins regarding the new requirements for indoor air quality. Trade Ally contractors may use the built-in ASHRAE calculator in a modeling software, the most recent version available at **residentialenergydynamics.com**, or the table below.

Install continuous or intermittent mechanical ventilation when required by these standards or notification provided in writing to the homeowner.

Homes found to have an unmet ASHRAE 62.2 need during inspections will be resolved at cost to the Trade Ally with the installation of a compliant bath fan or switch.

Homeowners must receive and sign a notification form.

Mechanical Ventilation Requirements, Cubic Feet per Minute (CFM)					
Floor Area, sq. ft.	Bedrooms				
	1	2	3	4	5
<500	30	38	45	53	60
501–1,000	45	53	60	68	75
1,001–1,500	60	68	75	83	90
1,501–2,000	75	83	90	98	105
2,001–2,500	90	98	105	113	120
2,501–3,000	105	113	120	128	135
3,001–3,500	120	128	135	143	150

CARBON MONOXIDE

Replace batteries in carbon monoxide testers.

Detectors

Ensure a carbon monoxide (CO) detector is present on all conditioned floors before submitting an insulation/air sealing project as complete. Visit **docs.legis.wisconsin.gov/statutes/statutes/101/I/149** for more information.

In addition, projects that are not tested following the carbon monoxide and gas leak detection protocols (ANSI/BPI-1200-S-2017 section 7) must have an Underwriters Laboratory (UL)-listed combustible gas alarm installed on the floor of the home with the greatest total length of gas line. This is usually the basement. You may combine the gas alarm with a CO alarm.

All common walls in garages must have all gaps, cracks, and holes air sealed to prevent migration of auto exhaust CO into the living space of the home.

Homes found to have an unmet CO or gas leak detector compliance during inspection will be resolved at cost to the Trade Ally.

MOISTURE

Properly controlling moisture will improve the effectiveness of air sealing and insulation efforts, and prevent certain occupant health and home durability issues.

Bath fans, dryer fans, and other appliances must be properly vented to outside the building envelope. Vent all bathroom fans through the roof with insulated ductwork. If roof penetrations are prohibited, find an alternative route. For new installations, Y connectors in the ductwork are not allowed. Existing bathroom fans must be vented outside to a dedicated exhaust port. Do not vent into attic venting (soffit/roof). (See **Bathroom Fan Under Attic** and **Roof Slope Insulation**.) Dryer vents cannot have heat traps and dryer vents must be treated as a heat source regardless of fuel type. (See **Dryer Vents Under Conditioned Basement Air Sealing**.)

Always install a vapor barrier on exposed dirt floors any time the house is tightened by air sealing and/or insulation. (See **Ground Cover Under Basement** and **Crawlspace Wall Insulation**.)

Homes found to be air sealed with an exposed dirt floor in a conditioned or semi-conditioned space within the home during an inspection will have a vapor barrier installed at cost to the Trade Ally.

Do not install air sealing and insulation work until you have investigated and corrected moisture problems.

AIR SEALING

ALL AIR SEALING

GENERAL

It is widely recognized that air leakage links both directly and indirectly to the most prevalent building envelope performance and durability issues. The best way to ensure adequate thermal performance and comfort, as well as to avoid moisture problems, is to prevent air from uncontrollably flowing into and out of the occupied space through the building envelope.

Clean up spray foam air sealing around doors.

Intent

This section defines the quantitative and qualitative requirements for the products, materials, and workmanship for the air barrier "system" of the thermal envelope for buildings receiving energy improvements. The goal of the air sealing work is to provide a continuous, structurally supported plane of materials to contain the indoor air (reduce exfiltration) and to reduce the amount of outdoor air entering the building (reduce infiltration).

REQUIREMENTS

1. Select and install air sealing materials in a manner that will accommodate normal building movements and wind and stack pressures.
2. Ensure air sealing addresses all building assembly transitions, changes in substrate, perimeter, and transition conditions, mechanical penetrations, and mechanical system components that are extensions of the building envelope into unconditioned spaces.

Objective

To obstruct airflow through leaks, penetrations, and bypasses found in the attic, basement, living space, and exterior pressure boundaries as indicated by the air sealing guidelines, and to cost-effectively and safely control air leakage.

REQUIREMENTS

1. The building envelope must incorporate a continuous air barrier system, per the 2009 International Energy Conservation Code.
2. Install the air barrier in a manner that meets the Energy Conservation section of Wisconsin's Uniform Dwelling Code.

Implementation

Maintain continuity of the air barrier system at all intersections of the building assemblies. Seal each component of the air barrier system to the adjoining air barrier system component. Terminate all air sealing work with a sealed connection to the adjoining air barrier system component.

Trade Ally contractors may use an instrumented blower door and pressure diagnostics to locate air leakage paths and seal leaks in a dwelling. Use a fully instrumented blower door in accordance with manufacturer's instructions and Focus on Energy specifications.

If the home is under construction and has large bypasses open, or if asbestos is present or suspected in the home, do not conduct a blower door test, neither pressurization nor depressurization. Air sealing may still continue. Contact your regional manager for guidance on estimating reduction amounts.

The air sealing technician will seal leaks in the following areas, in the following order of priority:

1. Attic areas. Seal the attic plane as thoroughly as possible. Attic areas must be air sealed before adding insulation.
2. Penetrations and gaps in mechanical system components where they pass outside of the conditioned space.
3. Basement, crawlspace, or other low leaks in the building.
4. Other significant leaks in the sidewalls or framing transitions.

LOCATIONS & USE

General

The following are generic requirements that apply to all air sealing material choices:

1. Match the proper caulk to the location where it is applied. Consider the durability, paint compatibility, adherence, color, toxicity, flammability, etc.
2. In general, only use siliconized acrylics in interior locations or where paint compatibility is important. When used in visible areas, customers must approve the application and see a sample before continuing. Due to their shiny appearance, only use clear acrylics where appropriate, and make sure to have customer approval prior to use in visible areas. Avoid the use of clear acrylics due to greater shrinkage of this material.
3. You will typically use pure silicone in exterior applications, unless they require paint compatibility. You can use pure silicone anywhere that needs sealants between wood and metal, wood and concrete, or other materials that expand and contract at different rates as moisture and temperature vary, or where you need greater flexibility.
4. Perform caulking on the interior of the dwelling for general air leakage and to prevent moisture penetration into wall cavities.
5. Perform caulking on the exterior of the dwelling to prevent bulk moisture from entering the envelope of the building and to seal areas of air leakage.
6. Dimensional limits:
   a. Do not use siliconized acrylic in openings or cracks over 3/16 inch without a backer, and generally do not use in openings or cracks more than 3/8 inch.
   b. Do not use pure silicone in openings or cracks over 3/8 inch without a backer, and generally do not use in openings or cracks more than 1/2 inch.
7. One-part and two-part foam:
   a. Do not use foam to span gaps or openings more than 1 1/2 inches without a backer material.
   b. Do not use foam sealant in locations where exposure to sunlight or other ultraviolet sources can occur. Do not use near any heat-producing device.

SEALANT & BLOCKING

General

The selected sealant and blocking materials must be suitable for the working surfaces to which they are applied and able to maintain a durable seal.

Material Requirements

CAULK

All caulking materials must be rated for a minimum 20-year life.

1. Caulking used around chimneys must be rated for use against heat sources.
2. Caulk used against gas flues or chimneys must meet ASTM C290.
3. Caulk used against solid fuel or oil appliance vent flues or chimneys must meet ASTM E136.
4. Siliconized acrylic caulks must be paintable ("silicone" refers to 100% silicone caulk, clear, or pigmented—not acrylic).

ONE-PART POLYURETHANE FOAM SEALANTS

Approved zero-chlorofluorocarbons (CFCs) products include the following:

1. PurFil.
2. Insta-Foam or equivalent.
3. AirKrete (allowed at R3.9 per inch).

"RCD #6" MASTIC FIBROUS ADHESIVE SEALANT OR EQUIVALENT

BLOCKERS & BACKERS

1. Plywood.
2. Foam board.
3. Foil bubble wrap or similar (to block large bypasses).
4. Flashing materials (required for damming and to bridge gaps at chimneys and flues).
5. Wallboard.
6. Glass or mineral fiber insulation as a backer for other sealants.
7. Backer rod (foam rope) as a backer for other sealants.
8. 6-mil (0.l50 mm) polyethylene sheet.
9. Cellulose or fiber glass insulation in dense-pack application.
10. House wrap such as "Tyvek" or similar.

Installation Requirements

CAULKS

Before applying caulking, remove any loose dust, dirt, or debris from the area to be sealed. Ensure that the application area is dry. Read and follow any additional instructions cited in the manufacturer's specifications, including temperature restrictions.

ONE-PART FOAM

Review the manufacturer's installation instructions before applying one-part foams. Usually there are surface preparation requirements to ensure best adhesion.

WATER-BASED DUCT MASTIC

You can apply duct mastic as an air sealant, using either a glove or a paint brush to apply. Whichever method you choose, it is important to apply a thick coat of the mastic to avoid cracking and failure. Be sure to clean application surfaces to remove loose dust, dirt, and debris.

BACKER MATERIALS

Backer materials will fall into two general categories: rigid and non-rigid. Rigid backers inserted into joist or stud bays may be held in place by friction and permanently secured by the adhesion of one-part foam or caulk. For rigid insulation that seals drop soffits, large mechanical chases, etc., you will need to fasten in place using either nails or screws. Metal flashing can be held in place with box nails or screws. You can secure non-rigid barriers (foil-faced bubble wrap, polyethylene, etc.) using 1/2-inch staples every 4–6 inches. When using rolled batts or mineral wool, stuff tightly into openings to ensure they stay where intended.

Applying caulk around window frame.

ATTIC AIR SEALING

Attics are enclosed spaces outside of the intentionally conditioned living space. Air sealing measures for conditioned attic spaces are covered in the sections on walls and roof slopes.

GENERAL

To ensure that attic air sealing measures form an effective and durable seal, use the following installation guidelines. The materials used in each descriptive application (see **Locations and Use**) will be chosen from the list of approved materials. You may use alternate materials in each application when the substituted material has the same performance criteria (i.e., fireproof for fireproof). All applications must be able to support the weight of existing and proposed insulation and will need to be supported appropriately. Ensure no backer material exceeds an unsupported distance of 24 inches. It is the responsibility of the installer to decide if additional support (less than 24-inches span) is required to keep the backer and insulation in place.

Infrared camera.

LOCATIONS & USE

Seal the attic plane as thoroughly as possible. Typical openings, cracks, gaps, and penetrations to air seal in attics include—but are not necessarily limited to—the following:

1. Interior partitions and exterior wall top plates.
2. Along both sides of the plates, at butt joints, and at intersections.
3. At wiring and plumbing penetrations.
4. Dropped ceilings and soffits.
5. Junction boxes and wiring penetrations.
6. Open joist bays in knee wall attics.
7. Hatches and pull-down stairs.
8. Wet walls and plumbing chases/penetrations.
9. Mechanical system components.
10. Chimneys and flues.
11. Duct penetrations.
12. Whole-house fan enclosures.
13. Bathroom fans and recessed light fixtures.

MATERIAL REQUIREMENTS

Approved Backers

Backers are any material used to bridge openings that cannot be closed by a sealant. The following backers are approved for use in attics.

1. Fireproof backers:
   a. Metal flashing.
   b. Mineral wool.
2. Fire-resistant backers:
   a. Thermax.
   b. Wallboard.
   c. Foil-scrim-kraft (FSK) rigid board.
3. Moisture-resistant backers:
   a. At least 6 mil polyethylene.
   b. Rigid foam board insulation (extruded polystyrene).
   c. Foam backer rod.
   d. Foil-faced polyisocyanurate.
4. Other backers (may be used when fire and/or moisture resistance is not applicable):
   a. House wrap.
   b. Radiant bubble wrap.
   c. Plywood.
   d. Insulated structural sheathing.

INSTALLATION REQUIREMENTS

Approved Sealants

Sealants are any material applied to attic surfaces or backers to form an airtight seal. The following is a list of sealants that are approved for use in attics.

1. Fireproof sealants:
   a. Non-combustible fire-rated caulk meeting ASTM E136.
   b. Silicone high-temperature RTV sealant on gas vents to 500°F, meeting ASTM C920.
2. Non-fireproof sealants:
   a. One-part urethane foam.
   b. One-part urethane fire block foam rated for sealing gaps in wood framing.
   c. Two-part urethane foam kits.
   d. Siliconized latex sealants meeting ASTM C834.
   e. Silicone urethane and other elastomeric sealants meeting ASTM C920.
   f. Water-based duct sealant meeting UL181A-M, UL181B-M.

Top plates sealed with one-part foam.

Attic Top Plates

Where exterior and interior walls terminate in the attic, there is a junction between the wallboard and the framing. This long thin gap allows conditioned house air and attic air to exchange. To seal this gap, remove any existing insulation or debris from either side of the top plate where it meets the wallboard. Apply a continuous bead of one-part urethane foam between the wooden top plate of the wall and the wallboard. You can also use two-part foam for this location.

Dropped soffit sealed with extruded polystyrene insulation (XPS) and one-part foam.

Dropped Ceiling & Soffits

This attic detail most commonly occurs above bathrooms and kitchens. Wallboard is often excluded from areas above cabinets, bathtubs, and/or showers, which results in open spaces that are open to wall cavities. Seal these open spaces from the attic using a rigid supported material, installing and sealing in line with the attic plane. If the dropped soffit or ceiling is above a bathroom or kitchen, use a moisture-resistant backer. The backer should bridge the span, leaving enough overlap at all edges to mechanically attach the backer to the surrounding attic air barrier. Seal the edges and seams with foam.

Junction Boxes & Wire Penetrations

There are two different materials you should use to deal with these two common details. For junction boxes, seal using siliconized or silicone caulk. To ensure that the caulk bonds to the junction box, brush off dust and debris. You can seal the openings in the box with the caulk but be careful not to inject the caulk into the junction box. For wire penetrations, seal with foam. Insert the nozzle of the foam gun into the wire hole and inject the foam until it backs out into the attic space.

Open Joist Bays in Knee Wall Attics

This area, sometimes referred to as the knee wall transition, is the space where the floor joists of an unconditioned knee wall attic pass under the knee wall and transition from unconditioned space to what should be conditioned space. To close this space, cut rigid foam board to the dimensions of the floor bays and rigid fit the foam board into the joist bay. The foam board should be inserted under the shoe plate of the knee wall's inner (toward conditioned space) side. The inner face of the rigid board should align with the vertical plane of the wallboard. Seal any gaps or seams with either silicone caulk or one-part urethane foam.

Knee wall transition sealed with XPS and one-part foam.

Attic hatch weatherstripped.

Pull-down stair cover.

Hatches/Attic Access Panels

Hatches need to be made as airtight as possible. You should weatherstrip hatches on all four sides with Q-Lon weatherstripping, when possible, and miter the corners to fit together. Use a siliconized caulk to caulk the seams between the weatherstripping and the finish, and to seal all seams in the finish. Seal any gap between the finish and the rough framing and the surrounding wallboard with one-part urethane foam. If necessary, install eye hooks on opposite sides with sufficient tension to compress the weatherstripping. Do not seal attic hatches shut using any method. This is against fire code in the state of Wisconsin and prohibits the Program from doing an inspection on your work. Access panels may not be insulated with pink or blue expanded polystyrene insulation (EPS) board for the same reason. An approved Thermax/foil-covered rigid insulation must be used with an R-value matching that of the surrounding insulation (as room allows), and have all exposed foam edges covered with metal tape. The insulation should be mechanically affixed to the panel. Box should always be insulated to R50 or that of the surrounding attic insulation. An R38 batt may be affixed to the underside of thermo pan type product to ensure this.

Pull-Down Staircases

Ensure pull-down staircases are airtight by constructing an airtight enclosure that fits over the top of the stairs. This enclosure must be large enough to allow the pull-down staircase to close without interference. Seal all seams of this enclosure with construction glue and foil tape. The existing surrounding framing of the attic deck must be complete and level enough to allow weatherstripping on the bottom of the enclosure or attached to the deck to engage all the way around the enclosure. There must be some type of fastening mechanism (eye hooks, Velcro, brackets, etc.) with sufficient tension to engage the weatherstripping on all four sides. Construct this box with materials light enough to be easily moved aside by the homeowner.

Chimney in attic sealed with high-temp caulk and metal flashing.

Bath fan sealed with one-part foam.

Chimney Flues & Vents

Closing the gap between heat sources and combustible materials requires the use of non-combustible materials. Maintain a clearance of 3 inches between masonry chimneys or double wall metal vents and combustible materials, and 6 inches between single wall vents and combustible materials. The only approved material to span this gap is metal flashing. The metal flashing must be a minimum of 26 gauge. Cut the metal flashing so that it spans the gap and leaves enough overlap to attach with fasteners to surrounding framing. Measure and cut the flashing so that, when fastened in place, the remaining gaps between the flashing and the venting and the flashing and the framing are 1/4 inch or less and can be sealed using fireproof caulk. You can use other sealants on the side of the sheet metal that is fastened to the framing.

Bath Fans

The housings of most bath fans have many perforations and knock-outs. In addition to the openings in the housing, it is not uncommon for there to be sizable openings between the housing and the attic plane material (wallboard, plaster, paneling, etc.). If the bath fan is a fan-light combination unit, you must treat it as a non-IC rated recessed light. Exceptions can be made if it is a fixture designed to use only LED or compact fluorescent lamp (CFL) lighting. Contact your regional manager prior to treating this type of fixture.

If the fan does not have a light, seal the openings and perforations with silicone caulk. You can seal the gap between the attic plane and the fan housing with caulk if the gap is small enough or foam if the gap exceeds the maximum bead width of silicone caulk.

IC & Non-IC Rated Recessed Light Fixtures

Recessed light fixtures can be a significant source of air leakage between conditioned space and unconditioned attic spaces. To seal recessed lights, build an airtight enclosure that maintains a clearance of at least 3 inches to any part of the fixture. This 3-inch clearance requirement includes the application of any sealant that makes the enclosure airtight. For IC rated lights, the sides of the box can be made of any type of rigid material. If the recessed light fixture is IC rated, you can insulate over the enclosure. In cold climates the top of the enclosure should be vapor permeable. If the fixture is non-IC rated, construct the box with noncombustible material that does not readily conduct heat.

Note: Wisconsin Uniform (1–2 Family) Dwelling Code SPS322.37(4) will accept cement board, drywall, and other materials that exhibit flame spread and smoke developed indices of 10 or less when tested in accordance with ASTM E84. If a fixture is not IC rated, you cannot cover the top of it with insulation. Do not seal or plug holes, gaps, and openings on the recessed light housing with any material.

Open attic chase sealed with sheet metal, duct mastic, and acoustical sealant.

Open Chases

Material selection is the most critical aspect of sealing open attic chases. Backer materials that seal chases must have sufficient rigidity to span the opening and to support any insulation. For any span greater than 24 inches, framing members must provide support regardless of the material chosen. Choose a moisture-resistant backer when persistent exposure to moisture-laden air is likely. Whatever material you choose, you should cut it in a section large enough to span the chase and have enough overlap to securely fasten it to the surrounding framing. Use foam to seal any remaining gaps between the rigid material and the surrounding air barrier. Follow applicable fire codes that apply to either ignition barriers or thermal protection if the backer will not be covered by insulation.

Plumbing wet wall sealed with fiberglass batt backer and one-part foam.

Plumbing Penetrations (Wet Walls)

A wet wall is a wall that has plumbing pipes running vertically through it to unconditioned space. These walls are often framed using higher-dimension framing (e.g., 2x6s) or a double 2x4 stud wall. From the attic, this wall is easy to locate. It is the one that the waste vent comes through. Usually, the top plate(s) of this wall have large openings that you need to bridge with a rigid, moisture-resistant material and then seal with foam.

Ceiling height transition wall sealed with two-part foam.

Ceiling Height Level Changes

When ceilings change from one height to another, a short wall is created with wall studs that run from conditioned space into the unconditioned space of the attic. In the case of pre-platform framing, this transition area in the wall stud bay will normally not have an air barrier installed at all. If the house was built with platform framing, there may be a wood blocker with unsealed edges. If there is no backer in the wall stud bay at the transition from conditioned to unconditioned space, you should install one. This backer can be rigid foam insulation or a rolled insulation batt. Once you install the backer, it should either have the edges sealed with foam (in the case of rigid board) or be entirely covered with foam (in the case of the insulation batt backer).

COMPATIBLE ATTIC AIR SEALING MATERIALS

(Note: This table lists combinations of backers, fasteners, and blockers that, when used together, will satisfy the standard. Other combinations are possible but must be approved by Focus on Energy staff before use.)

Attic Locations	Backer	Fastener	Sealant	Notes
Attic top plates	N/A	N/A	1- or 2-part foam	Platform construction.
Attic top plates	Fiberglass	Friction fit	2-part foam	
Attic top plates	XPS	Friction fit	1- or 2-part foam	
Attic top plates	Foil-faced wrap	1/2" staples	1- or 2-part foam or caulk	
Dropped soffit	1/2" drywall	1" drywall screws	1- or 2-part foam	Openings over spans larger than 24" should be supported.
Dropped soffit	1 1/2" XPS	2" drywall screws	1- or 2-part foam	Openings over spans larger than 24" should be supported.
Dropped soffit	1" foil scrim kraft (FSK)	1" drywall screws	1- or 2-part foam	Openings over spans larger than 24" should be supported.
Dropped soffit	Foil-faced wrap	1/2" staples	1- or 2-part foam	Openings over spans larger than 24" should be supported.
Junction boxes	N/A	N/A	Silicone caulk	No foam in electrical boxes.
Wire penetration	N/A	N/A	1-part foam	
Knee wall transition	Fiberglass	Friction fit	2-part foam	
Knee wall transition	XPS	Friction fit	1-part foam or caulk	If exposed needs fire barrier based on space location and use.
Knee wall transition	1' FSK	Friction fit	1-part foam or caulk	
Knee wall transition	Foil-faced wrap	1/2" staples	1-part foam or caulk	
Chimney/Flue	Metal flashing	4d box nails	High-temp caulk	High-temp sealant must be compatible with fuel type.
Chimney/Flue	Mineral wool	Friction fit	High-temp caulk	If gaps are very small they can be stuffed and caulked.
Recessed lights	Cement board	Tape	1-part foam or caulk	
Open chases	Drywall	1" drywall screws	1- or 2-part foam	Openings over spans larger than 24" should be supported.
Open chases	1 1/2" XPS	2" drywall screws	1- or 2-part foam	Openings over spans larger than 24" should be supported.
Open chases	1" FSK	1" drywall screws	1- or 2-part foam	Openings over spans larger than 24" should be supported.
Open chases	Foil-faced wrap	1/2" staples	1- or 2-part foam	Openings over spans larger than 24" should be supported.
Wet wall top plates	XPS	Friction fit	1- or 2-part foam or caulk	Backer must be moisture resistant.
Wet wall top plates	1" FSK	Friction fit	1- or 2-part foam or caulk	Backer must be moisture resistant.
Wet wall top plates	Foil-faced wrap	1/2" staples	1- or 2-part foam or caulk	Backer must be moisture resistant.

WALL AIR SEALING

GENERAL

The following are general requirements for wall air sealing:

1. Sealant materials must be compatible with the wall assembly materials and should allow normal movement due to changes in temperature, humidity, and air pressure variations.
2. Sealant materials should be a matching color to the substrate or be paintable.
3. Install sealants in a manner that continues the function of the drainage plane. Do not install sealants in a manner that will hold water in the wall assembly.
4. When insulation is part of the air barrier system, the installation must be an airtight material or meet the minimum density requirements for the material (see **Wall Insulation – Dense-Pack Insulation**).
5. When membranes or films are components of the air barrier system, the entire perimeter of the material must be air sealed.
6. Integrate windows, doors, and skylights into the wall air barrier system. Seal the portion of the window, door, or skylight that is the air barrier component of the opening assembly to the air barrier component of the wall assembly, not the exterior siding or trim.
7. Seal mechanical penetrations to the air barrier component of the wall assembly, not the exterior siding or trim.

LOCATIONS & USE

Air seal all structural and mechanical penetrations. As appropriate, you should caulk windows along the full perimeter of the interior or exterior, including sill area, side stops, apron, and casings. As appropriate, caulk doors along the interior or exterior casings and door jambs/stops.

MATERIAL REQUIREMENTS

Wall air sealing materials can be broken into three different types: backers, sealants, and dense-pack insulations.

Approved Backers

Backers are materials you can use to bridge openings that sealants cannot close. Following is the list of approved backers for use when air sealing walls.

1. Fireproof backers:
   a. Metal flashing.
   b. Mineral wool.
2. Fire-resistant backers:
   a. Wallboard.
3. Moisture-resistant backers:
   a. Wallboard (unpainted).
   b. Building wrap.
4. Other backers:
   a. 6-mil polyethylene.
   b. Radiant bubble wrap.
   c. Plywood/Oriented strand board (OSB).
   d. Thermo-ply.
   e. Structural insulated sheathing.
   f. Foam backer rod.

Approved Sealants

Sealants are any material applied to the existing wall air barrier or the installed backer that forms an airtight seal. Following is the list of approved sealants for use when air sealing walls.

1. Fireproof sealants:
   a. Non-combustible fire-rated caulk meeting ASTM E136.
   b. Silicone high-temperature RTV sealant on gas vents to 500°F, meeting ASTM C920.
2. Non-fireproof sealants:
   a. One-part urethane foam.
   b. One-part urethane fire block foam rated for sealing gaps in wood framing.
   c. Two-part urethane foam kits.
   d. Siliconized latex sealants meeting ASTM C834.
   e. Silicone urethane or other elastomeric sealants meeting ASTM C920.

Dense-Pack Insulations

Fibrous insulations blown into an enclosed cavity at a specified density can greatly reduce air flow through the cavity and are a form of air sealing. The two most widely used materials for this application are cellulose and glass wool (fiberglass). Other materials that can be dense packed are mineral wool and rock wool. A Trade Ally contractor can assess and approve these materials and their required density upon request.

INSTALLATION REQUIREMENTS

Air sealing the exterior walls can be broken into distinct parts:

1. The combination of air sealing and insulation embodied in dense packing.
2. Heat sources that must be dealt with using fireproof materials and methods.
3. Seals made in areas that must resist moisture intrusion or allow vapor to escape when necessary.
4. Penetrations through the walls that can be dealt with using other backers and non-specialized sealants.

Dense-Pack Insulations

If walls have no existing insulation and empty cavities, you can effectively air seal them by filling the wall cavity with densely packed fibrous insulations. (See **Wall Insulation – Dense-Pack Insulation**.)

Heat Sources

You must use fireproof materials to seal any penetrations through exterior walls that are considered heat sources (stove pipes, range hoods, dryer vents, etc.). If you cannot bridge the gap between the existing wall air barrier and the venting system with sealants alone, you may bridge the gap with metal flashing and seal with furnace cement meeting ASTM E136. An alternative method is to stuff the gap with mineral wool as a backer (and insulation) and seal the mineral wool with a fire-rated furnace cement meeting ASTM E136. If the gap is small enough to bridge with sealant alone, you should seal it with a fire-rated furnace cement meeting ASTM E136.

Moisture-Resistant Seals

Air sealing of exterior walls in some locations may require the use of a material that is a Class I vapor retarder. Such locations could be bathrooms, kitchens, or other areas of high moisture concentration. When sealing out moisture is a consideration and the opening in the air barrier is too large to close with sealant, seal the opening with one of the following:

1. For interior sealing that is meant to retard vapor diffusion, XPS, wallboard painted with two layers of latex paint, and polyethylene are acceptable materials.
2. For exterior sealing meant to stop bulk moisture intrusion, metal flashing, building wrap, polyethylene, and XPS are acceptable materials.

Once the backer is selected based on location, suitability, and appearance, you must match a compatible sealant to the location and the finished appearance requirements. Acceptable interior sealants are siliconized latex sealants meeting ASTM C384, silicone caulk meeting ASTM C920, one-part urethane foam, and duct mastic. Suitable exterior sealants are siliconized latex sealants meeting C384 or silicone caulk meeting ASTM C920.

Other Wall Penetrations

When sealing interior wall penetrations that are not heat sources or areas of high moisture concentration, you should choose the backer on large openings based on two criteria: compatibility with the surrounding finish and fire resistance.

Where visible or exposed to the living space, wallboard is the material of choice as a backer due to its classification as a thermal barrier and its ease for finishing. Limit sealants in visible areas to either low-sheen clear caulks or paintable caulks where applicable. You can use one-part foam if you will then cover it with insulation or some form of thermal barrier.

Seal Baseboards

If a room is not carpeted, you can seal the baseboard by caulking the seam between the baseboard molding and the floor and the baseboard molding and the drywall.

Window & Door Trim Sealed

You can seal the trim around windows and doors using caulk at the seam between the window trim and the window frame and the seam between the window trim and the drywall.

Plumbing Penetrations Sealed

You can seal the area where plumbing pipes pass through walls with caulk if the gap is less than 1/4 inch, with one-part foam if the gap is less than 1 inch, or with an approved backer and one-part foam or caulk if the gap is greater than 1 inch.

Heating, Ventilation, and Air Conditioning (HVAC) Boot to Subfloor/Drywall Sealed

The area where an HVAC supply or return boot penetrates the subfloor or drywall on a wall or ceiling can be sealed with duct mastic or caulk if the gap is less than 1/4 inch. If the gap is greater than 1/4 inch, you must use a backer and then seal with mastic.

Interior Sheathing Voids Repaired

Repair holes and gaps in the interior sheathing with a material similar to the surrounding materials. Discuss these repairs with the homeowner prior to beginning the repair to get approval of material and sealing methods.

Garage Door Weatherstripped & Swept

The door that separates occupied space from an attached garage is always weatherstripped. See **Door Weatherstripping** for approved methods and materials.

Exterior Doors Weatherstripped & Swept

You may weatherstrip doors between conditioned space and unconditioned space and install a door sweep if the customer requests specifically. See **Door Weatherstripping** for approved methods and materials.

Compatible Wall Air Sealing Materials

(Note: This table lists combinations of backers, fasteners, and blockers that, when used together, will satisfy the standard. Other combinations are possible but must be approved by Focus on Energy staff before use.)

Attic Top Plates	Backer	Fastener	Sealant	Notes
Wall cavities	N/A	N/A	Cellulose	Dense-pack cellulose to 3.5+ lbs./cu. ft.
Wall cavities	N/A	N/A	Fiberglass	Dense-pack fiberglass to 2.2+ lbs./cu. ft.
Wall cavities	N/A	N/A	Spray foam	See spray-applied polyurethane foam insulation on page 89.
Heat sources	Metal flashing	4d box nails	High-temp caulk	Use compatible caulk and fuel combination.
Moisture-resistant interior	Drywall/Paint (2 layers of latex)	1" drywall screws	See notes	If finished look use joint compound; if not use 1-part foam.
Moisture-resistant interior	1 1/2" XPS	2" drywall screws	1-part foam or caulk	Not for finished areas.
Moisture-resistant interior	6 mil polyethylene	1/2" staples	1-part foam or caulk	Not for finished areas. “Tu-Tuff” or similar thinner sheeting may be substituted.
Moisture-resistant exterior	Foil-faced wrap	1/2" staples	1-part foam or caulk	Not for finished areas.
Moisture-resistant exterior	Metal flashing	4d box nails	Silicone caulk	
Moisture-resistant exterior	Building wrap	1/2" staples	Sheathing tape	Sealant must be protected from exterior exposure immediately.
Moisture-resistant exterior	Rigid insulation	Screws	Sheathing tape	Sealant must be protected from exterior exposure immediately.
Moisture-resistant exterior	Polyethylene	1/2" staples	Sheathing tape	Sealant must be protected from exterior exposure immediately.
Other openings	1/2" drywall	1" drywall screws	See notes	If finished look, use joint compound; if not, use 1-part foam. First choice finish and fire rating.

WINDOW WEATHERSTRIPPING

LOCATIONS & USE

Only install window weatherstripping where it does not have the potential to affect window performance and where normal operation of the window will not cause the weatherstripping to be torn out. Note that the use of weatherstripping on windows and doors is governed by the air sealing installation standards above. The weatherstripping will not interfere with the smooth operation of the window.

Window Weight Treatment

There are two separate window weight treatment techniques. Choose the technique based on what treatment the window is undergoing. If the window is being weatherstripped only, then you can install pulley seals to slow air leakage through the pulley openings. If replacing the window, access the window weight cavities through the lower sash channel access panel. Cut the ropes or chains that the weights hang on and remove along with the weights themselves. Remove the pulleys from the upper sash channels and cover the opening with duct tape. Then dense pack the window weight cavities using a fill tube and enter from the lower sash access panel. Reinstall the access panels in the lower sash channel.

MATERIAL REQUIREMENTS

Use V-Seal type or equivalent vinyl weatherstripping with a deflection range of at least 1/4 inch.

INSTALLATION REQUIREMENTS

All weatherstripping will be permanently installed with fasteners (tacks, staples, brads, etc.) and will make positive contact between surfaces to prevent air leakage. The weatherstripping will form an airtight seal when the window is closed and latched. Apply a small bead of caulk as necessary to prevent air leakage behind the weatherstripping.

Install weatherstripping on any sash, meeting rail, or sill surface that leaks air as long as placement does not interfere with the smooth operation of the window.

1. “Three-sided” LOWER sash channels and sill. Or, if window has spring-loaded channels, top, bottom, and meeting rail.
2. “Four-sided” LOWER sash channels, meeting rail, and sill.

DOOR WEATHERSTRIPPING

LOCATIONS & USE

You must weatherstrip doors between conditioned and unconditioned (or semi-conditioned) space. Always weatherstrip doors connecting the house to an attached garage.

Door weatherstripping.

MATERIAL REQUIREMENTS

Interior Doors

"Q-Lon" with either wood or steel carrier (preferred), "Q-Lon" strips allowed.

Exterior Doors

Schlegel "Q-Lon with carrier" (preferred), Porta Seal (I-D17) or equivalent.

Door Sweeps

Door sweeps must be aluminum and vinyl, Dennis 905 (non-retracting), Pemko P307-AV (non-retracting), or equivalent.

Other

Weatherstripping must have a deflection range of at least 1/4 inch. Weatherstripping must remain pliant in cold weather.

INSTALLATION REQUIREMENTS

1. All weatherstripping must be permanently installed with effective mechanical fasteners and must make positive contact between surfaces to prevent air leakage.
2. The weatherstripping must form an airtight seal when the door is closed. Apply a small bead of caulk as necessary to prevent air leakage behind the weatherstripping.
3. The weatherstripping must not interfere with the smooth operation of the door.
4. Use one of two types of sweeps on exterior doors, depending on frequency of door usage. For doors that have high usage, use a spring-loaded sweep that will only engage and contact the floor when the door is closed. For low-use doors, use either the spring-loaded sweep or a non-retracting sweep that always makes contact with the floor.
5. After installing the weatherstripping, test the door for ease of use. It should not be necessary to slam or exert excessive force on the door for the lock set to engage.
6. In addition to weatherstripping of doors and windows, it may sometimes be necessary to install window sash locks, eye hooks, barrel bolts, etc. to make the installed weatherstripping engage effectively.

Weatherstripping.

CONDITIONED BASEMENT AIR SEALING

GENERAL

Basements are spaces that are primarily below grade. Basements are considered to be conditioned spaces in this section of the guidelines. See **Crawlspace & Unconditioned Basement Air Sealing** for unconditioned basements and crawlspaces.

HEAT SOURCES

The following penetrations from the basement to the exterior or the basement to the conditioned space are considered heat sources:

1. Flue pipes from heating or domestic hot water system (DHW) systems.
2. Flue pipes from solid fuel burning appliances.
3. Dryer vent pipe (regardless of fuel type).
4. Kitchen exhaust vent pipe.

LOCATIONS & USE

The following basement locations must be air sealed:

1. Mechanical chases and other large openings.
2. Rim joists and sills.
3. Water pipes.
4. Basement windows: Basement windows in older homes can be a significant source of low infiltration into a home.
5. Dryer vents.
6. Plumbing penetrations.
7. Small openings between the basement and conditioned basement and conditioned or exterior spaces.

MATERIAL REQUIREMENTS

Basement air sealing materials will have different requirements based on the potential for high relative humidity in the space. Do not use organic materials that support mold growth or materials that lose their rigidity after absorbing moisture. In addition to these requirements, rigid foam board in the finished basement will need to be either fire-resistant or have a thermal barrier. Rigid foam board in an unfinished basement that is accessible and has storage or mechanicals will also need a thermal barrier.

Approved Backers

Materials that do not need a fire barrier:

1. Thermax rigid foam board or other approved rigid foam board.
2. Metal flashing.
3. Mineral wool.
4. Polyethylene.
5. Foil bubble wrap.

Approved backer materials that do need a fire barrier:

1. Rigid foam board (except Thermax/Hunter Panels Xci 286).

Approved Sealants

Sealants that do not need an ignition barrier:

1. One-part foam.
2. Siliconized latex sealants meeting ASTM C834.
3. Silicone urethane sealants meeting ASTM C920.
4. Water-based duct mastic meeting UL181A, UL181B-M.

Sealant that requires an ignition barrier:

1. Two-part foam used in the basement space.

INSTALLATION REQUIREMENTS

The following installation instructions for basement air sealing locations detail the most common acceptable materials and practices.

Chimney in basement sealed with sheet metal and high-temp caulk.

Heat Sources

If the gap around heat sources is too great for sealant alone, close the gap with metal flashing mechanically fastened to surrounding framing. If the appliance burns solid fuel or oil, seal the edges and gaps using fire-rated caulk meeting ASTM E136. If the appliance burns natural gas or propane, seal the edges and seams with high-temperature silicone RTV meeting ASTM C920.

Dryer Vents

Dryer vents must be treated as a heat source regardless of the fuel type. If the gap between the dryer vent and the building surface is less than 1/4 inch, you can seal it with high-temperature silicone for gas vents meeting ASTM C920. If there is a gap too wide to be bridged by sealant alone, seal the gap using either metal flashing or mineral wool. You should then seal the edges and seams with high-temperature silicone for gas vents meeting ASTM C920.

Mechanical Chases & Other Large Openings

You will need to back large openings between the basement and the conditioned space with a fire-resistant material that does not support mold growth. For this reason, materials such as wallboard or other paper-based products are not allowed. Further, if the opening is between the basement and the conditioned space, then the material should also be a Class I vapor retarder. Acceptable materials for closing large gaps include Thermax, mineral wool, metal flashing, or polyethylene. Materials such as XPS or other foil-faced foam boards are acceptable if they are either covered with insulation after installation or treated with a fire barrier. You should cut the rigid material to fit over the opening with at least an inch of overlap where possible. Fasten the backer material into place with mechanical fasteners (screws, staples, etc.). Once the backer is secured firmly into place, seal the edges using caulk or one-part foam.

Rim joist sealed to sill (and insulated) with foam board and one-part foam.

One two-part foam sill box.

Rim join sealed to sill.

Rim Joists & Sills

You may seal rim joists and sills with one of several different methods:

1. Sealed with two-part foam. In this application the foam can extend from the subfloor to the junction of the foundation and the sill plate. In areas where termite pressure exists, code may require an inspection break between the foam and the bottom of the sill. If there is a termite inspection break, you must seal the seam between the foundation and the bottom of the sill using silicone caulk.
2. You can seal the rim joist by cutting blocks of rigid foam board to fit in the rim joist area and sealing the edges with caulk or one-part foam. In this application, you will also need to caulk the sill-to-foundation seam and the seam between the two sill plates.
3. You can use caulk to seal the seams in the framing where the rim joist and the sill and the rim joist and the floor joists meet. You can then insulate the rim joist with a section of unfaced glass fiber batt cut to fit. In this application, you will also need to caulk the sill-to-foundation seam and the seam between the two sill plates.

Water Pipes

In spaces where pipes are at risk, seal the perimeter of the basement tightly using one of the methods described in **Band Joist, Rim Joist, and Sill Insulation – Installation Requirements.**

Basement Windows

Use caulk to seal gaps in the frame and joints between the frame and the surrounding air barrier that are smaller than 1/4 inch. For larger gaps, back with a backer rod and caulk the seams.

CRAWLSPACE & UNCONDITIONED BASEMENT AIR SEALING

GENERAL

Crawlspaces have the same requirements as basements above, with the following exceptions:

1. Code compliance: When working in crawlspaces, follow all applicable national, state, and local codes regarding vapor retarders, ventilation, and ignition barriers (based on use type).
2. Access considerations: When specifying energy upgrades in a crawlspace, auditors should keep access restrictions and ease of installation in mind when specifying methods and materials. (e.g., sheet goods might not fit into the space).
3. Use the appropriate safety measures when crawlspaces qualify as confined spaces.

LOCATIONS & USE

See **Conditioned Basement Air Sealing – Material Requirements**.

MATERIAL REQUIREMENTS

See **Conditioned Basement Air Sealing – Material Requirements.**

INSTALLATION REQUIREMENTS

Plumbing Penetrations

If the gap between the pipe wall and the subfloor is less than 1/4 inch, you may seal the gap using caulk. If the gap is between 1/4 inch and 1 inch, you can seal using one-part foam. If the gap is greater than 1 inch, bridge it using a moisture-resistant, fire-resistant material. Foam board, metal flashing, OSB, or plywood are acceptable materials for this application. Foam board must either be rated for exposure (e.g., Thermax) or covered with an approved fire barrier. Once the gap is closed, seal the edges and seams with either caulk or one-part foam.

Small Openings Between the Basement & Conditioned or Exterior Spaces

Seal small openings using a fire-rated sealant. This can be a one-part foam product or a fire-rated caulk.

See **Conditioned Basement Air Sealing – Installation Requirements**.

Compatible Crawlspace & Unconditioned Basement Air Sealing Materials

(Note: This table lists combinations of backers, fasteners, and blockers that, when used together, will satisfy the requirements. Other combinations are possible but must be approved by Focus on Energy staff before use.)

Crawlspace & Basement Locations	Backer	Fastener	Sealant	Notes
Heat sources	Metal flashing	4d box nails	High-temp sealant	Use compatible sealant and fuel combination.
Heat sources	Mineral wool	Friction fit	High-temp sealant	If gaps are 1/4" or less, stuff and seal.
Mechanical chases	1" Thermax	2" drywall screws	1- or 2-part foam or caulk	Use Thermax/Hunter Panels Xci 286, not any other type of rigid foil-faced board.
Mechanical chases	Metal flashing	4d box nails	1- or 2-part foam or caulk	
Mechanical chases	Polyethylene	1/2" staples	1- or 2-part foam or caulk	
Mechanical chases	1" or 1 1/2" XPS	2" drywall screws	1- or 2-part foam or caulk	Must have a fire barrier based on space use if not covered by insulation.
Mechanical chases	Rigid insulations	2" drywall screws	1- or 2-part foam or caulk	Any rigid board insulation other than Thermax must have a fire barrier based on space use if exposed.
Mechanical chases	1" FSK	2" drywall screws	1- or 2-part foam or caulk	
Mechanical chases	Foil-faced wrap	1/2" staples	1- or 2-part foam or caulk	
Large openings				See Mechanical Chases.
Rim and band	N/A	N/A	Spray foam	
Rim and band	Rigid insulations	Friction fit	1-part foam or caulk	
Rim and band	N/A	N/A	1-part foam or caulk	The framing junctions can be caulked or foamed and batt insulation added.
Pipe penetration	Fiberglass	Friction fit	1-part foam	For gaps greater than 1".
Pipe penetration	Foil-faced wrap	1/2" staples	1-part foam or caulk	For gaps greater than 1".
Pipe penetration	N/A	N/A	1-part foam	For gaps between 1/4" and 1".
Pipe penetration	N/A	N/A	Caulk	For gaps 1/4" or less.
Windows/Doors	Backer rod	Friction fit	Caulk	For gaps more than 1/4".
Windows/Doors	N/A	N/A	Caulk	For gaps less than 1/4".
Windows/Doors	N/A	N/A	1-part foam	Gaps between 1/4" and 1". Care must be taken during installation to avoid overfilling.
Dryer vent				See Heat Sources.

KNEE WALL ATTIC AIR SEALING

GENERAL

Roof vs. Wall and Floor

A knee wall attic can be air sealed one of two ways. You can seal following the line of the roof rafters, which will bring the knee wall attic space inside the conditioned area. The alternative would be to follow the knee wall itself from the sloped ceiling to the attic floor and then across the knee wall attic floor to the exterior wall top plate. This alternative would keep the knee wall attic as unconditioned attic space.

Vapor Permeable Air Barrier on Knee Walls

If the knee wall attic is air sealed as unconditioned attic space, you must ventilate this space according to state and local codes. Ventilating this space will make the knee wall insulation susceptible to wind washing. Therefore, you will need to install a vapor permeable air barrier on the attic side of the knee wall to create a six-sided wall cavity that will protect the installed insulation from wind washing.

LOCATIONS & USE

Knee wall or other side-attic areas, including rim joist areas under single-story shed roof, gambrel, garage, or other floor framing, open into vented or unconditioned attic areas. If some areas are inaccessible, consider strategic dense-pack insulation to slow or stop leakage.

MATERIAL REQUIREMENTS

If the attic has been sealed along the knee wall and attic floor and has been pushed outside of the conditioned space, refer to **Attic Air Sealing – Material Requirements** for acceptable air sealing materials for this space.

Air Barrier Aligns With Roof Rafters

This plane will need to be sealed with an air-impermeable barrier. If the rafter bays are insulated with glass fiber or cellulose insulation, the following air barriers are acceptable:

1. Wallboard.
2. Foam board (must either be rated for exposure (e.g., Thermax) or be covered with an approved fire barrier based on space use and accessibility).
3. Plywood.
4. OSB.
5. Structural insulated sheathing.
6. Polyethylene.
7. Building wrap.

If the rafter bays are insulated with spray foam, the air barrier will also need to be a fire barrier. Approved materials in this situation would be:

1. Wallboard.
2. Foam board (must either be rated for exposure (e.g., Thermax) or be covered with an approved fire barrier).
3. 3/8-inch particle board.
4. 3 1/2 inches of unfaced fiberglass batt.

Air Barrier Aligns With Knee Wall & Attic Floor

If the air barrier aligns with the attic knee wall, the interior face of the knee wall will be the air barrier. The material used to seal the knee wall transition area will depend on access. If the knee wall attic floor is not decked, the following materials are acceptable for sealing the opening between the floor joist cavities:

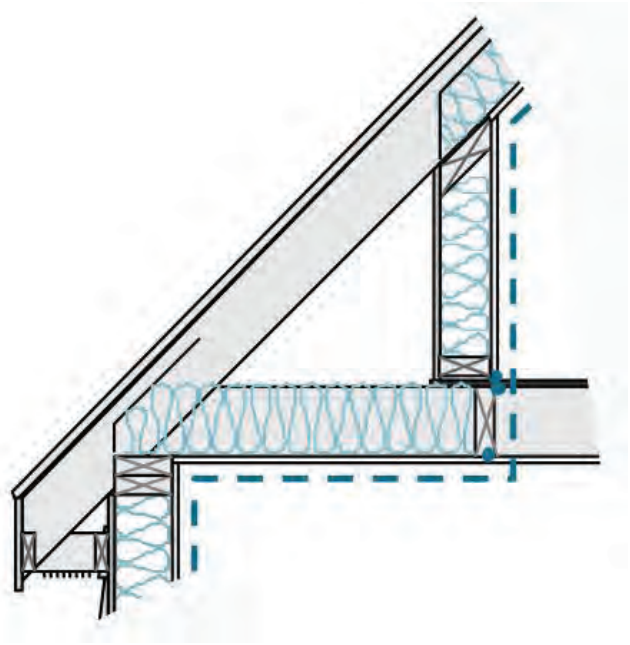
1. Rigid foam board.
2. Wallboard.
3. Framing lumber.
4. Structural insulated sheathing.
5. Foil-faced bubble wrap.

INSTALLATION REQUIREMENTS

Air Barrier Aligns With Roof Rafters

If the air barrier is going to align with the roof rafters and bring the knee wall attic inside the conditioned space, run an air barrier material from the top plate of the knee wall to the top plate of the exterior wall. This air barrier can be a rigid material like Thermax, wallboard, or XPS (XPS will need a fire barrier), or it could be polyethylene or building wrap. The air barrier must be mechanically fastened with screws for rigid materials or staples for flexible barriers. Seal all seams and edges with one-part foam on rigid materials, 3M 8086 or equivalent tape on polyethylene, or building wrap tape on building wrap. See **Attic & Roof Slope Insulation – Installation Requirements** for proper venting and wind wash protection of insulation before sealing this space.

Knee wall attic air sealed along rafter line.



Knee wall attic diagram for air sealing along wall.

Air Barrier Aligns With Knee Wall & Attic Floor

If the air barrier aligns with the attic knee wall, the interior face of the knee wall will be the air barrier. Use caulk to seal the seam where the shoe plate of the knee wall sits on the subfloor. If the knee wall attic floor is not decked, you can use rigid foam board to seal the knee wall area. Cut the foam board into sections and make sure it is rigid fit under the interior edge of the shoe plate so that it aligns with the interior face of the knee wall. Use one-part foam or caulk to seal the seams between the foam board and the floor joists, ceiling, and subfloor. Re-cover the foam board with either glass fiber or cellulose insulation for fire protection. If the attic knee wall floor is sheathed, air seal this area using dense-pack insulation.

In some cases, it may be desirable to stop blown-in material from penetrating too far down a bay above the living space when dense packing. In this case, you may use a burlap “feedbag” as an inflatable insert into the floor joist bay. Stuff the bag through the drill hole while holding onto the opening of the feedbag. You can then insert the fill tube into the feedbag and inflate the feedbag with blown-in material until it fills the bay and forms a plug under the knee wall. The remainder of the bay can then be dense packed without fear of insulation entering areas unintended. Treat the top plate of the exterior wall and any penetrations through the attic knee wall floor as specified in **Attic Air Sealing**.

Compatible Knee Wall Attic Air Sealing Materials
(Note: This table lists combinations of backers, fasteners, and blockers that, when used together, will satisfy the requirements. Other combinations are possible but must be approved by Focus on Energy staff before use.)

Knee Wall Attic Locations	Backer	Fastener	Sealant	Notes
Conditioned knee wall	1/2" drywall	1" drywall screws	One-part foam or caulk	Qualifies as a thermal barrier if used over foam insulation.
Conditioned knee wall	1" Thermax	2" drywall screws	One-part foam or caulk	Qualifies as a thermal barrier if used over foam insulation.
Conditioned knee wall	1/2" plywood/ OSB	1" drywall screws	One-part foam or caulk	Qualifies as a thermal barrier if used over foam insulation.
Conditioned knee wall	Structural insul. sheath	1" drywall screws	One-part foam or caulk	Qualifies as a thermal barrier if used over foam insulation.
Conditioned knee wall	Polyethylene	1/2" staples	Sheathing tape	Does not qualify as an ignition barrier.
Conditioned knee wall	Building wrap	1/2" staples	Sheathing tape	Does not qualify as an ignition barrier.
Unconditioned knee wall				The interior face of knee wall will be the air barrier. See **Attic Knee Wall Transition** for materials to be used in that area. Seal holes in knee wall to conditioned space using Wall Air Sealing table.

FLOORS OVER UNCONDITIONED SPACES OR AMBIENT CONDITIONS AIR SEALING

CODE COMPLIANCE

Rigid foam board installed in the box sill of the basement or ground floor is not required to be covered with an ignition barrier (Uniform Dwelling Code (UDC) Comm21.11 foam plastic).

OVERHANG AIR SEALING

General

Overhangs are a type of floor over unconditioned space, usually outside. Because of its exposure to the exterior, it is necessary to protect the insulation from the weather as well as from air movement.

Access Considerations

Access to the overhang will determine the method used to seal the floor joist bay transition area. If you cannot gain access to seal by other means, use dense pack to slow airflow through this area.

Confined Spaces

Use special safety measures when crawlspaces qualify as confined spaces.

Material Requirements

The following materials are acceptable for use in the following overhang configurations:

1. Accessible from interior:
   a. Backers:
      i. Foam board (must either be rated for exposure (e.g., Thermax) or be covered with an approved fire barrier based on space use and accessibility).
      ii. Rolled batt.
      iii. Foil-faced bubble wrap.
      iv. Structural insulated sheathing.
      v. Framing lumber.
      vi. Wallboard.
   b. Sealants:
      i. One-part foam.
      ii. Two-part foam (with fire barrier based on space use and accessibility).
      iii. Silicone caulk.
      iv. Duct mastic.
2. Accessible from exterior:
   a. Backers: same as Section a above.
   b. Sealants: same as Section b above.
3. Exterior exposure:
   a. XPS.
   b. 3/8-inch plywood.
   c. 3/8-inch OSB.

Installation Requirements

Methods and materials for sealing overhangs will depend on existing conditions and access. For all overhangs in cold climates, you must inspect the floor joist bays to ensure that water pipes running through these areas will end up inside the conditioned area. Generally, this means installing 75% of the insulation on the exterior side of the water pipes. If floor bays have ducts installed in them, you must make the ducts airtight before pushing them outside with air sealing, especially before dense packing the joist bay. For the following configurations, seal as specified below.

OVERHANG ACCESSIBLE FROM INTERIOR SPACE

Before sealing the transition area, you should fill the floor bay with insulation. Seal the area where the floor joist crosses over the sill plate, or seal the exterior wall top plate with an approved backer and seal the seams on all four sides of the backer with one part foam or siliconized caulk. On the exterior, seal the seam between the sheathing on the bottom surface of the floor joist and the surrounding siding/sheathing using a silicone caulk rated for exterior use.

EXTERIOR OVERHANG WITH SHEATHING REMOVED FOR ACCESS OR NO SHEATHING

Seal the transition area using an approved backer. Seal the seams around the backer using one-part foam or silicone caulk. Fill the overhang floor bays with batt insulation. If there is enough clearance at the bottom of the floor joist and the bottom of the siding/sheathing, consider adding a layer of rigid foam board to break the thermal bridge before replacing or installing the overhang sheathing. Seal the overhang sheathing to the surrounding siding or sheathing using silicone caulk.

NO ACCESS TO THE OVERHANG FLOOR BAYS

This area can be dense packed to slow airflow. A thorough inspection of the floor joist bays should be made to ensure that there are no water pipes, ducts, or recessed fixtures in the area to be dense packed. To stop the unwanted flow of blown insulation down the floor bays and into the conditioned space, you can use the burlap feedbag method. (See **Knee Wall Attic Air Sealing – Installation Requirements**.) Use silicone caulk to seal the seam between the overhang sheathing and the exterior sheathing or siding.

FRAME FLOOR OVER GARAGE AIR SEALING

Material Requirements

The following materials are acceptable for use in frame floor configurations when sealing the ends of bays exposed to outside air movement or large openings between the garage and conditioned space above:

1. Accessible from adjacent knee wall attic:
   - a. Backers:
     - i. Foam board (must either be rated for exposure (e.g., Thermax) or be covered with an approved fire barrier).
     - ii. Rolled batt.
     - iii. Foil-faced bubble wrap.
     - iv. Structural insulated sheathing.
     - v. Framing lumber.
     - vi. Wallboard.
   - b. Sealants
     - i. One-part foam.
     - ii. Two-part foam (with fire barrier).
     - iii. Silicone caulk.
     - iv. Duct mastic.
2. Accessible from exterior:
   - a. Backers: same as Section a above.
   - b. Sealants: same as Section b above.

Installation Requirements

Methods and materials for sealing frame floors over garages will depend on existing conditions and access. For all frame floors in cold climates, you must inspect the floor joist bays to ensure that water pipes running through these areas will end up inside the conditioned area. Generally, this means that 75% of the insulation installed will be on the exterior side of the water pipes. If floor bays have ducts installed in them, make sure the ducts are airtight before pushing them outside with air sealing, especially before dense packing the joist bay. For the following configurations, seal as specified here:

GARAGE CEILING NOT SHEATHED HEAT SOURCES

If the gap around heat sources is too great for sealant alone, close the gap with metal flashing mechanically fastened to surrounding framing. If the appliance burns solid fuel or oil, seal the edges and gaps using fire-rated caulk meeting ASTM E136. If the appliance burns natural gas or propane, seal the edges and seams with high temperature silicone RTV meeting ASTM C920.

MECHANICAL CHASES & OTHER LARGE OPENINGS

Use a fire-resistant material to back large openings between the garage and the conditioned space above. Acceptable materials for closing large gaps are Thermax, plywood or OSB, drywall, or structural insulated sheathing. Materials such as XPS or other foil-faced foam boards are acceptable if they will be either covered with insulation after installation or treated with a fire barrier. Cut the rigid material to fit over the opening with at least 1 inch of overlap where possible. Fasten the backer material into place with mechanical fasteners (screws, staples, etc.).

Once the backer is secured firmly into place, seal the edges using caulk or one-part foam.

PLUMBING PENETRATIONS

If the gap between the pipe wall and the subfloor is less than 1/4 inch, seal the gap using caulk. If the gap is between 1/4 inch and 1 inch, seal it using one-part foam. If the gap is greater than 1 inch, bridge it using an approved backer. Foam board, metal flashing, OSB, or plywood is an acceptable material for this application. (Foam board must either be rated for exposure (e.g., Thermax) or be covered with an approved fire barrier.) Once the gap is closed, seal the edges with either caulk or one-part foam.

SMALL OPENINGS BETWEEN THE GARAGE & CONDITIONED SPACES ABOVE

Seal small openings using a fire-rated sealant. This can be a one-part foam product or a fire-rated caulk.

RIM JOISTS & SILLS

The area where frame walls separate the garage from occupied space must be air sealed thoroughly to stop the exchange of air between the garage and the house. You can seal rim joists and sills with one of several different methods:

1. Seal with two-part foam. In this application the foam can extend from the subfloor to the top plate.
2. Seal the rim joist by cutting blocks of foam board to fit in the rim joist area and seal the edges with caulk or one-part foam.
3. Use caulk to seal the seams in the framing where the rim joist and the sill and the rim joist and the floor joists meet. Then insulate the rim joist with a section of unfaced glass fiber batt cut to fit.

GARAGE CEILING SHEATHED

This area can be dense packed to slow air flow. A thorough inspection of the floor joist bays should be made to locate water pipes, ducts, or heat sources in the area to be dense packed. To stop the unwanted flow of blown insulation down the floor bays and into the conditioned space, use the burlap feedbag method. (See **Knee Wall Attic Air Sealing – Installation Requirements**.)

1. Water pipes in area to be dense packed: See **Overhang Air Sealing – Installation Requirements**.
2. Ducts located in area to be dense packed: See **Overhang Air Sealing – Installation Requirements**.
3. Heat sources located in area to be dense packed: A heat source in an enclosed space will need to have the bay that is blocked with an approved backer with a clearance of at least 3 inches between the dam and the heat source. Ensure the backer is airtight with the surrounding materials to remove the chance that insulation dust under pressure could be forced within 3 inches of the heat source. If the heat source is close to one side of the bay and blown material in an adjacent bay is within 3 inches of the heat source, the adjacent bay must have a non-combustible insulation type (e.g., fiberglass or mineral wool) installed anywhere in that bay that is within 3 inches of the heat source.

INSULATION

ALL INSULATION

GENERAL

To receive a Focus on Energy rebate, projects must follow the criteria below:

1. Install attic, basement wall/ceiling, garage, and wall insulation upgrades according to Focus on Energy specifications, based on customer work order. You must install insulation at the levels specified by Focus on Energy. All insulation upgrades in any location must conform to state and local codes.
2. Install strategic dense-blown insulation in enclosed cavities to control air leakage and increase insulation levels in attic, basement, and living space cavities.
3. Rigid foam board insulation installed with exposure to finished spaces must be rated for exposure or be covered with a thermal barrier. Rigid foam board insulation installed in accessible areas that are used for storage, or contain mechanicals, must be rated for exposure or be covered with a thermal barrier.

Insulate wall framing.

4. It is the installing Trade Ally contractor's responsibility to verify pre-installation requirements and measurements of insulated areas, as well as to install insulation products according to these specifications. In some cases, the technical assessor may also be the insulation Trade Ally contractor. Bring any discrepancies to the attention of the Program field supervisor before work commences.
5. Installation will meet or exceed the standards set forth in the Criteria for the Installation of Energy Conservation Measures publicized by the National Bureau of Standards, including, but not limited to, the standards set forth below. Documentation of installed insulation levels, material or bag counts, and insulated area will be left at the electrical panel or, when it is not possible to leave it at the electrical panel, with the customer according to Federal Trade Commission (FTC) rules.
6. All insulation must meet the requirements listed in All Insulation – Physical Properties. Failure to follow posted requirements, or if the product is not covered in the M&I Standards, will make the materials ineligible for Focus on Energy rebates.
7. Ineligible Material and Approval Process:
   To get a product approved for use in the program, submit a copy of the manufacturer's product specifications, product data, ICC-ES report, and installation instructions to the technical field staff for approval. The following materials have been reviewed and deemed ineligible for Focus on Energy rebates: Styrofoam attic access/recessed light covers, vermiculite, and standalone radiant barriers.

MEASUREMENT OF AREAS

1. There are three locations from which you can measure the components of a building: outside, in the living space, or in a buffer zone such as an attic or crawlspace. Measuring from the outside is always preferred. When the building floor plan and the area you are insulating, such as the attic floor plan, are the same, use exterior dimensions.
2. Use interior measurements from the living space (preferable) or from inside the attic/ knee wall space (second option if living space measurements are inconvenient or not accessible) for attic areas that do not match the building floor plan, such as knee walls, slopes, cathedral ceilings, knee wall floors, and attic flat areas that are smaller than the building floor plan. When using interior measurements, add an additional foot to each dimension to compensate for exterior wall thickness.
3. When taking measurements, round up to the next half-foot. If the dimension is between 24 ft. 1 inch and 24 ft. 5 inches, you should round up to 24 ft. 6 inches.
4. Changes in the methods used for measurements may be altered on a job-by-job basis but must be specifically noted directly on the work order.
5. Base the measurements for wall insulation on the gross wall area determined by the exterior perimeter multiplied by the interior wall height(s). Add one extra foot of height for the band joist perimeter of the floor system between two conditioned floors if the home is balloon framed. Basic windows and doors will be deducted from this area. Large sections that cannot be insulated, such as brick walls or fireplaces, should be deducted and noted on insulation work orders.
6. If exterior dimensions cannot be taken for the building shell and interior dimensions are used, add an additional 2 linear feet to the perimeter before it is multiplied by the interior wall height.

PHYSICAL PROPERTIES

Insulation materials must satisfy the requirements of the following national standards:

1. Batts – ASTM Standard C665.
2. Loose-fill (blown) cellulose – ASTM C739.
3. Loose-fill (blown) fiberglass – ASTM C764.
4. Preformed polystyrene boards – ASTM C578.
5. Preformed polyurethane/polyisocyanurate boards – ASTM C591.

ATTIC & ROOF SLOPE INSULATION

GENERAL

Before insulating the attic, ensure that all bypasses at chimneys, soil stacks, interior walls, dropped ceilings, and any other penetrations through the attic floor or at attic transitions (e.g., changes in ceiling height) are sealed. Use pressure differential testing and visual inspections to address all identifiable leakage. Do not proceed with attic insulation until properly sealing the area and completing documentation.

MATERIAL REQUIREMENTS

Loose-fill blown, batt, and rigid foam board insulations in attic spaces must meet all of the requirements listed in **All Insulation – Physical Properties**. Where the brand name Thermax is specified for rigid foam board, use a foam board that is rated for exposure to conditioned areas without a thermal barrier. Otherwise, the foam board must have a fire barrier as specified in Section R316.5.3 of the 2009 IRC. Hunter Panels Xci 286 may be used vertically or horizontally, up to 4 inches thick. They may not be used both vertically and horizontally. Area spray foams used in areas exposed to attic areas will also conform to Section R316.5.3 unless rated for exposure in conditioned spaces.

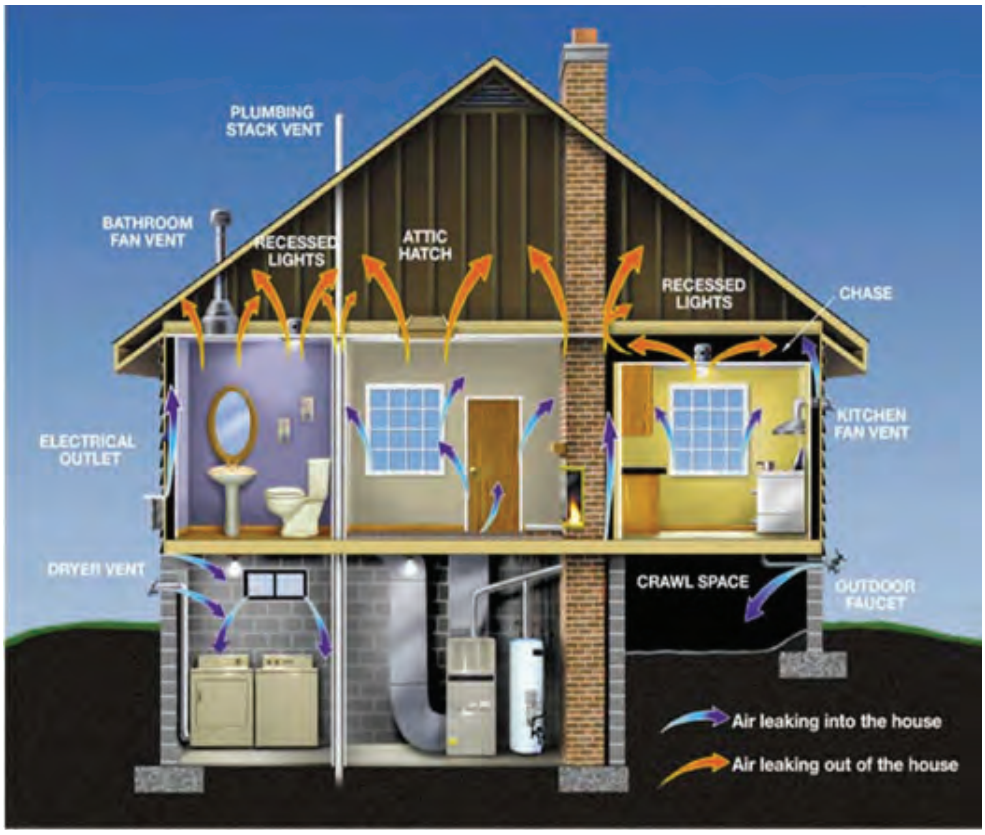


Diagram of general air leakage paths.

INSTALLATION REQUIREMENTS

Baffles/Proper Vents

Install baffles in the following areas before insulation work begins:

1. The end of each ceiling joist bay that connects to a soffit. When soffit vents are to be installed or already exist, install baffles in the space connected to the soffit vents in such a way that you can insulate the top plate. Where possible, provide a clearance of 1 inch from the top of the baffle to the underside of the roof sheathing in accordance with building code. Blocking will be air sealed to ensure the free movement of air through soffit vents into the attic, but not allow the air to "wind wash" the insulation and reduce its effectiveness.

   Wind washing is air movement through insulation that degrades insulation performance. The two most common areas where this occurs in an attic are at the eaves where ventilation air can pass through the edges of the insulation that abut the soffit area, and on the back side of unprotected knee wall cavity insulation where, once again, ventilation air can move through wall cavity insulation. At the eaves, you can stop wind washing by installing a rigid, air-impermeable baffle that extends from the outer edge of the exterior wall top plate to within 2 inches of the roof sheathing and attaching it to the joists on either side of the cavity that is being protected.

   Once this baffle is either installed by rigid fit or fastened with staples, seal any remaining gaps with foam. It will be rigid enough to restrain loose-fill insulation from congesting the soffit vents at the eaves and obstructing ventilation. These baffles must extend above the final level of resulting insulation by at least 4 inches in order to be visible upon inspection. Pre-cut Styrofoam baffles or a moisture-resistant material like foam board is preferred.

Insulation wind wash baffle.

2. When specified, install ventilation chutes in each slope cavity before insulating. These will allow air to flow from soffit or knee wall area into peak. Baffles will be mechanically fastened at sides and at bottom, and will be carefully fitted with insulation packed in place at the bottom to prevent wind intrusion into or under insulation.
3. Install permanent baffles around all recessed light fixtures. Maintain a minimum clearance of 3 inches from the light fixture to the baffle. For further guidance on treating recessed lights, refer to **Work-Related Standards & Regulations – Recessed Lights.**

Roof line venting chute.

4. Install permanent baffles or dams around all attic hatch covers in the following manner:
   a. They will not interfere with the opening of the hatch cover.
   b. When the hatch is opened, they will prevent loose-fill insulation from falling into the living area.
   c. They will allow for easy access into the attic for future inspection.
   d. You may accomplish this damming by using unfaced fiberglass batts of greater thickness than the installed insulation placed around the perimeter of the hatch, or by using a framing lumber fixed in place around the hatch.
   e. Insulation levels immediately surrounding the hatch will equal or exceed the R-value of the rest of the attic space.

Electric Radiant Strip Heating Elements

Do not install blown-in or faced insulation in contact with electric radiant strip heating elements. First, install a minimum 3-inch thick unfaced mineral wool fiber batt.

Doors & Hatchways

Insulate all hinged attic doors (walk-in, knee wall access, crawlspace) to unconditioned spaces with a minimum of 4 inches of Focus on Energy-approved, foil-faced polyisocyanurate insulation boards. The insulation should be mechanically attached. If using any other rigid foam insulation material, cover it with a thermal barrier that complies with ASTM E84 recommendations. Use door latches/locks where necessary to ensure a tight seal of weatherstripping materials.

Bathroom Fans

Dam or treat all bathroom fans with lights in a similar fashion as a non-IC rated recessed light. Exceptions can be made if it is a fixture designed to use only LED or CFL lighting. Contact your regional manager prior to treating this type of fixture. Use non-combustible materials to dam around bathroom fans with heating elements and leave the top open to prevent heat buildup.

Vent all bathroom fans through the roof with insulated ductwork. If roof penetrations are prohibited, devise an alternative route. For new installations Y connectors in the ductwork are not allowed.

Existing bathroom fans must be vented outside to a dedicated exhaust port. Venting into attic venting (soffit/roof) is not allowed.

Access Openings

Where entry to the attic via pre-existing hatchway or access panel is not possible, you can gain access to attic areas from the exterior through roof or gable vent openings. If this is not feasible, use the following procedures for access openings:

1. Surface openings: Cut existing wallboard halfway on two studs (preferably through a closet). Close the opening with the same type of materials flush with existing wall material and tape and cover with one coat of joint compound.
2. Plywood openings: Cut existing wall between two studs. Close the opening with 1/2-inch plywood (G1S/AC) with four (4) 1 1/2 inch x 8 flat-head wood screws secured into studs, with heads countersunk or set flush with the plywood surface.
3. Finished openings: Cut existing ceilings. Head off the opening, and install a 2 1/2-inch casing around the rough opening. Allow a 3/8-inch reveal into opening to receive 1/2-inch plywood (G1S/AC) to complete opening. Ensure plywood cover is weatherstripped and insulated. Casing must be mitered neatly.

Loose-fill attic insulation evenly installed.

Insulation depth marker.

Open Blow Insulation

Install loose-fill blown-in insulation according to manufacturer's specifications and recommended densities. All open blow attics must be installed to a level condition. Install insulation depth markers at one per every 300 sq. ft. of attic area, with lettering at least 1-inch in size and with the lettering facing the access.

Insulation in open blow areas will have minimum material count, per manufacturer's instructions, as follows: Thickness as specified in work order is average settled thickness. A cellulose table and example is provided below.

Example: Work order specifies 12-inch cellulose open blow. R-value from chart is R-42. Attic area is 1,000 sq. ft. Look at chart on product bag. If chart says that installed R-42 = 60 bags for 1,000 sq. ft., you need to install 60 bags. Minimum thickness specified on work order also applies.

1. Use depth charts provided by the manufacturer as a guide to specifying the number of inches to be installed. The installer will need the depth estimate to monitor insulation installation amounts. Check the depth and desired R-value periodically to ensure that the projected number of bags for the desired density are being installed.
2. In attics with existing fiberglass batts, remove the batt that is in the last joist bay on any gable end, or other perimeter configuration that runs perpendicular to strapping ends. Fill this space to capacity with blown-in insulation. In addition, pull back existing batts from front and rear soffit plates approximately 12 inches during baffling. Insulate this area to specifications with blown-in insulation.
3. Damming: You will need to contain blown-in insulation using damming at the following areas and listed clearances: chimneys and double wall flues (3 inches), single-wall flues (6 inches), recessed lights or bath fans with heat lamps or lights (3 inches), attic hatches or pulldown stairs, whole house fans, mechanical access walkways, air conditioner drip pans, and storage areas. On sloped surfaces where the slope terminates at a vertical wall, dam the end of the slope with a fiberglass batt of sufficient depth to maintain the blown insulation depth and prevent the blown insulation from falling over the edge of the wall to the attic below (no clearance required).

Inches on Work Order	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Installed R-value	11	14	18	21	25	28	32	35	39	42	46	49	53	56

Dense-Pack Insulation

1. Blown-in insulation in restricted or dense-packed applications must be 3.5 lbs./cu. ft. for cellulose and 2.2 lbs./cu. ft. for blown fiber that is manufactured for dense-pack installation.
2. Unless the area is sealed by other means, install dense-pack insulation to a minimum density of 3.5 lbs./cu. ft for cellulose or 2.2 lbs./cu. ft. for blown fiber beneath all sections of the knee wall in the joist cavity. The cavity must be sufficiently packed and sealed to make it extremely difficult to force a fist through or detect any air movement with infrared (IR) scan and blower door.
3. Ventilate closed slopes according to state and local codes. If they can be adequately ventilated, seal the top and bottom opening of the slope with a firmly rolled unfaced batt. Ensure ceiling bay is dense packed to the required density for the material used. Under no circumstances should you compress an air-permeable insulation against the roof sheathing and blow dense-pack insulation between the air-permeable insulation and the interior sheathing.
4. Open slopes with netting must be ventilated to state and local codes before the netting is installed. Once the netting is in place, dense pack the ceiling bays to the required density for the material being used. Under no circumstances should you compress air-permeable insulation against the roof sheathing and blow dense-pack insulation between the air permeable insulation and the interior sheathing.

Attic insulation dammed away from chimney.

WALL INSULATION

Exterior wall fill tube.

MATERIAL REQUIREMENTS

Installed insulation materials must conform to the specifications listed in **All Insulation – Physical Properties**. On exterior siding, use caulks rated for at least 20 years. In general, use pure silicone in exterior applications, unless paintability is needed. Use pure silicone anywhere that needs sealants between wood and metal, wood and concrete, or other materials with differential expansion as moisture and temperature vary, or where greater flexibility is needed. Siliconized acrylics will generally only be used in interior locations or where paintability is important. Only use backer materials that are waterproof in exterior wall applications. These include 6 mil polyethylene, closed cell foam backer rod, metal flashing at heat sources, or extruded polystyrene. Exterior drill and plug repair on painted wood surfaces will require insertion of a wooden plug and DAP exterior vinyl spackling or equivalent. Drill and plug applications through drywall or plaster require the use of a Styrofoam plug and joint compound.

PRE-INSTALLATION REQUIREMENTS

Measurement of Areas to Insulate

See **All Insulation – Measurement of Areas.**

Knob & Tube Wiring

Verify that knob and tube wiring has been replaced with approved wiring. Receive certification that existing knob and tube wiring is not live. (See **Work-Related Standards & Regulations – Knob and Tube Wiring** for complete policy.)

Moisture

Prior to insulating the sidewall cavities, make sure to correct moisture conditions detected in the structure during the course of the initial inspection. You may accomplish this with one or more of the following techniques:

1. Thoroughly seal all cracks and holes through the interior wall surfaces in high-moisture areas (kitchen, bathrooms, etc.).
2. You may install a vapor barrier, when possible, on the interior surface of the walls in bathrooms, kitchens, laundry rooms, and any other high-moisture areas.
3. Install a vapor barrier floor covering and possibly mechanical ventilation into high-moisture crawlspace per specification.
4. Correct exterior structural flaws that admit rainwater into wall cavities: Repair gutter, downspout, and drainage system and seal gaps above door/window casings.
5. Install an adequate moisture control system in the house, including indoor mechanical ventilation (A.3) and passive attic ventilation (B.2).

Cellulose insulation.

6. Vent clothes dryers to the outside. Heat traps in dryer ducts are not allowed and need to be removed.
7. Advise the owners/occupants to lower their humidifier because it can contribute to significantly high humidity.

Sidewall Openings

Ensure that all openings in sidewalls through which the insulation can escape to the interior or exterior of the building are blocked as follows:

1. Cover missing interior wall surfaces with a compatible material (e.g., drywall) and seal into place. Generally, this will happen at owner's expense prior to beginning work, unless other arrangements are specified. If such conditions are found and not noted on work order, contact a regional manager before proceeding.
2. Replace/repair missing or damaged exterior siding on homes with incomplete or no subsiding. Generally, this will happen at owner's expense prior to beginning work, unless other arrangements are specified. If such conditions are found and not noted on work order, contact a regional manager before proceeding.
3. Block all openings in sidewalls through which the insulation may escape. Seal all wall cavities that open into a basement or crawlspace with unfaced fiberglass batts before installing wall insulation. Also check for pipes that enter kitchen cabinets and block them as needed.
4. Use an air-impermeable barrier, such as rigid polystyrene insulation, to block and seal wall cavities that have no top plate and/or are open at the sill plate.

Avoiding Hazards

Ensure insulating cavities will neither allow insulation to escape nor present a hazard to the occupant, installer, or the home's structural/mechanical integrity, e.g., heat ducts, recessed lights, vent fans, electrical service entrances, etc.

Interior & Exterior Inspections

Prior to starting a job, conduct an interior and exterior inspection to determine any potential problem areas. You must identify and address these problem areas prior to working on that area. Examples of problem areas include recessed radiators, ductwork in wall cavities, recessed bookshelves, stairways on exterior walls, loose or cracked plaster on walls, poor siding, etc. Check wall areas for valuables to remove prior to working on walls. Explain to the client this process and the work that you will perform.

For buildings with masonry exteriors, the Trade Ally contractor must confirm through visual observation that there is a barrier in the wall system that will prevent blown-in insulation from coming into contact with the masonry. The purpose of this observation is to ensure that the insulation will not absorb moisture when the masonry gets wet. The visual observation can be made with the naked eye or via borescope and you should do it for each cavity that is being insulated. This barrier will typically be in the form of sheathing attached to a frame wall, but other systems that separate the insulation from the masonry are also acceptable.

Siding

Because the siding on a house is the most obvious indicator regarding the quality of an insulation job, it is extremely important to do the siding work properly. Trade Ally contractors should always demonstrate to the homeowner how the siding will be removed and replaced before beginning work.

WOOD SHINGLE SIDING REMOVAL

1. Wood lap siding (clapboards) and wood shingles require careful prying with a flat bar underneath the nails fastening the siding to the framing. Installers must cut the paint between pieces of siding with a utility knife before prying.
2. Remove wood shingles with great care to minimize stray knife marks, splits, and broken shingles. Use a 45-degree bevel cut when removing existing shingles. Make the bevel cut at the butt of the shingle above, and make it as straight as possible. Use the butt of the shingle above as a guide.
3. In certain cases, you may also remove clapboards using a 45-degree bevel cut. Make this cut at the butt of the course above, and make it as straight as possible. Do not follow the grain of the clapboard. The bevel cut should be as deep as possible to reduce the possibility of splits. Use a flat bar to pry the clapboard far enough away from the house to remove the nails from the butt of the clapboard.
4. Sometimes, when removing clapboards, it is necessary to make a vertical cut and remove a portion of a clapboard. When this is done, the vertical cut must be perpendicular (straight up and down from the butt) to the courses of clapboards. This cut must be all the way through the clapboard before prying the clapboard from the house.

VINYL SIDING REMOVAL

1. Remove vinyl siding using a "zip tool" to unlock the siding. After the siding is unlocked, remove the nails in the top of the siding course below and the siding will come off the house.
2. Take great care when working around windows, doors, and inside and outside corners to reduce the possibility of breaking or chipping the J-channels and corner posts.
3. When removing siding, workers' hands should be clean so that the siding does not have hand- and fingerprints on it.

ALUMINUM SIDING REMOVAL

1. In most cases, remove aluminum siding using a zip tool. Once the siding is unlocked, follow the procedures for vinyl siding removal above.
2. In some cases, aluminum siding cannot be zipped off. When this occurs, call it to the attention of the Program field supervisor for further instructions. Do not proceed with removal of the siding if it varies from the normal procedure until Focus on Energy approves a different technique.
3. To reduce the possibility of bending or denting aluminum siding, take great care when handling it, particularly in windy conditions.

ASBESTOS SIDING REMOVAL

1. Take care not to disturb the siding material itself or cause dust or cracking, which may release asbestos fibers.
2. Remove single-nailed asbestos siding by removing the exposed nails at the butt of the shingle using "nippers" or straight diagonal cutters. By placing the cutter on the shingle and pressing against it, you can expose, grab, and remove the nail head. Once you remove the nails, the shingles will come off the house.
3. Remove double-nailed asbestos siding in the same manner as single-nailed. The only additional step is to remove the nails in the butt of the shingle above that go through the top of the shingle to be removed. The process for nail removal is the same as described above.
4. Blind-nailed asbestos siding presents a unique problem. First, remove any exposed nails using the procedures previously mentioned. The blind nails covered by the butt of the shingle above must be cut off before you can remove the shingle. To do this, use a reciprocating saw (Sawz-all) with a thin hacksaw blade to cut the heads off the blind nails. Once this is done, remove the shingle. If you cannot cut nails without damaging the siding or causing dust, stop work and call a Program field supervisor before proceeding.
5. Note: If any suspected asbestos-containing siding shakes are damaged during removal, please handle and dispose of them in accordance with all applicable regulations. Infill gaps with siding taken from an inconspicuous location on house and provide non-asbestos-containing replacements matching size, bottom (straight or wavy), and texture (wood grain or straight).

ASPHALT SHINGLE REMOVAL

1. Use straight diagonal cutters to remove exposed nails by pushing on the shingle around the nail head with the cutter blades.
2. Remove the nails on the bottom of the shingles directly above the shingle to be removed.
3. Carefully lift the bottom of the top shingle and locate the nails that are holding on the shingle to be removed. Use a sharp chisel and a hammer to cut the heads off the nails.
4. Carefully remove the shingle and place to the side.

INSTALLATION REQUIREMENTS

Dense-Pack Insulation

Blown-in insulation in restricted or dense-packed applications must be 3.5 lbs./cu. ft. for cellulose and 2.2 lbs./cu. ft. for blown fiber that is manufactured for dense-pack installation. The cavity will be sufficiently packed and sealed to make it extremely difficult to force a fist through or detect any air movement with infrared (IR) scan and blower door.

Drill & Plug (D&P) Applications

For all blown-in wall insulation, install with minimum 2 1/8-inch holes. Locate entry holes in walls to permit complete filling of wall cavities. Perform exterior drill and plug applications as neatly as possible. Be sure to use sharp drill bits designed to cleanly cut holes with no tear-out or other surface damage, properly sized for the wooden plugs being used. Do not use speed-bore bits for this application.

INTERIOR APPLICATIONS

1. Before beginning work on interior drill and plug applications, clear as much homeowner property as possible from the work area. Cover any remaining large pieces of furniture, etc., with drop cloths and seal tightly. Tightly seal the drill area from the remainder of the house using polyethylene sheeting, extension poles, and duct tape.

   When drilling interior walls, stagger the holes horizontally to avoid drilling out the same row of lathe, as this weakens the wall and can cause large sections to detach. It is recommended that two drills be used for the interior drill process. The first drill will cut through the plaster and will be very dull. Use the second drill on the same hole after clearing the plaster to cut cleanly through the lathe and minimize pulling and cracking.
2. Make an example of the drilled and plugged hole in an inconspicuous place and show to the owner at the beginning of the job for approval.

EXTERIOR APPLICATIONS

1. When drilling holes through siding that cannot be removed and has no repeating reference marks, snap a line (do not use waterproof cement chalk) to keep the plugs level across the wall. Examples of this type of application are Texture 1-11, novelty siding, knotty pine siding, frieze boards, and any other sheathing-type siding. Interior drill and plug applications would be attic stairway walls and exterior walls (when not done from the outside).
2. Drill holes as neatly as possible through all siding and sheathing materials, including plaster and wallboard.
3. During the hole drilling process, probe cavities in four directions (left, right, up, and down) to ensure stud and blocking locations are correctly identified and blind bays are not left uninsulated.
4. Do not leave holes in the wall open overnight. Plug any holes at the end of the day if work is not complete.

Two-Hole Installation Method (Walls, Ceilings, Etc.)

1. A double-hole method preparation is mandatory for all drill and plug applications on exterior walls exceeding 4 feet in height. See installation procedures below for requirements for hole preparation in all wall cavities.
2. Always use a fill tube to ensure consistent insulation coverage and density. Only one hole is required per cavity if a fill tube is used, provided the tube is long enough to reach both ends of the cavity from the opening.
3. Use only equipment compatible with the insulation material used. Follow the manufacturer's recommendations for air pressure and density.
4. Keep a record of the number of bags used to ensure the installed insulation conforms to the manufacturer's recommended coverage shown on the material label.
5. Using smoke devices to test dense packing:
   a. To test density of installed insulation, dense pack one bay.
   b. Use the blower door to depressurize the house to 50 Pascals (PA) with respect to outside and use a smoke puffer to generate smoke at the drill hole of the insulated cavity.
      i. If the smoke is drawn into the cavity, adjust the material and air settings on the insulation machine and re-blow the bay.
   c. Repeat the test until the smoke is not drawn into the cavity when the house is under pressure.

POST-INSTALLATION REQUIREMENTS

General

1. Prior to reinstalling siding, cover all holes opened in a wall with one of the following: 15# felt paper stapled in place, wood, cork, or Styrofoam plugs.
2. Repairing drainage planes: Before replacing the siding, tie back into the existing drainage plane. You can do this using 15# felt paper or building wrap (do not use building wrap with cedar shingles). Cut a 4x4-inch patch from the felt paper or wrap, slide the upper edge of the patch under the piece of siding above, and staple into place over the plug at all four corners.
3. Reinstall all types of siding as close to the original condition as possible. One of the most important aspects of this procedure is to ensure that the siding is weather-tight. Replace or repair damaged siding as needed. Use materials that match the original to replace clapboards and wood shingles that are split or broken as a result of removal or installation. The new siding must be primed white (pre-primed in inclement weather) on the front, back, and both ends. If the owner provides the paint to match the building, the Trade Ally contractor should apply it to all areas requiring touch up as a result of the removal work, weather permitting.
4. It is not acceptable to patch siding with materials that are not intended for exterior use (e.g., plastic wood, spackle, and joint compound). Patch small areas using a paintable siliconized acrylic caulking compound.

Reinstallation of Wood Shingles

1. After installation, reinstall the shingle by tapping the butt lightly, making sure the bevel cut is closed completely. Re-nail the shingle with at least two four-penny galvanized finish nails through the butt of the shingle.
2. When replacing damaged shingles with new shingles, make a bevel cut on the new shingle and install it according to the above procedure. If the bevel cut does not match properly, use a siliconized acrylic caulking compound to seal this area.

Reinstallation of Wood Clapboards

1. After insulating, reinstall the clapboards by tapping the butt lightly, making sure the bevel cut is closed completely. Nail the clapboard, with four-penny galvanized finish nails through the butt of the clapboard. When nailing the clapboard, do not nail into the existing nail holes. Fill these holes with a paintable siliconized acrylic caulking compound and leave flush with the clapboard.
2. When replacing damaged clapboards with new clapboards, do not simply cut the new clapboard. Remove the top of the clapboard that was originally cut, including the nails through the butt of the clapboard above. Once this is done, install the entire new clapboard and nail in the butt of both the new clapboard and the clapboard above. Seal old nail holes as mentioned above.
3. Prime the front, back, and both ends of the new clapboard. (In inclement weather, it should be pre-primed.)

Reinstallation of Vinyl Siding

1. Reinstall the panels that were removed. Lock the bottom of the panel that was removed and nail the top of that panel in the nailing strip using roofing nails. Do not nail the panels tight; the nail must be just loose enough in the nailing slot to allow for expansion and contraction of the vinyl due to changes in weather.
2. Punch slots with a slot tool where nailing is required and no factory-installed slot is available.
3. Once this is completed, lock the butt of the panel above with the top of the panel that was removed.
4. Do not face nail vinyl siding.

Reinstallation of Aluminum Siding

1. Reinstall the panels that were removed. Lock the bottom of the panel that was removed and nail the top of that panel in the nailing strip using aluminum roofing nails. Do not nail the panels tight; the nail must be just loose enough in the nailing slot to allow for expansion and contraction of the aluminum due to changes in weather.
2. Punch slots with a slot tool where nailing is required and no factory-installed slot is available.
3. Once this is completed, lock the butt of the panel above with the top of the panel that was removed. If necessary, nail six-penny galvanized finish nails through the weep holes to secure the panels.
4. Do not face nail aluminum siding.

Reinstallation of Asbestos Siding

1. You can put single-nailed asbestos siding in place and nail through the existing holes. If the original siding nails are not used, use a galvanized five-penny box nail.
2. You can put double-nailed asbestos back in place and nail through the existing holes both in the course above and remove the butt of the shingle.
3. You must put blind-nailed asbestos siding back in place and nail through the existing holes in the same manner as double-nailed asbestos. You cannot reinstall blind nails.

Reinstallation of Asphalt Siding

1. You can put single-nailed asphalt siding back in place and nail through the existing holes.
2. You can put double-nailed asphalt back in place and nail through the existing holes both in the course above and remove the butt of the shingle.
3. You must put blind-nailed asphalt siding back in place and nail through the existing holes in the same manner as double-nailed asbestos. You cannot reinstall the blind nails.

Repair of Drill & Plug (D&P) Applications

EXTERIOR APPLICATIONS

Complete exterior drill and plug applications on painted surfaces in the following manner:

1. After installation, insert the plug so it is slightly (1/16 inch) recessed.
2. Apply one coat of an exterior-rated sealer (DAP exterior vinyl spackling or equivalent) and use a putty knife to bring sealant close to flush to the exterior siding.
3. This procedure also applies to drill and plug applications on window sills, frieze boards, and entrances.

Complete exterior drill and plug applications on stained surfaces in the following manner:

1. After installation, insert a plug so that it is flush with the existing siding, and the wood grains of the plug and the sheathing are in the same direction.
2. Apply a small bead of caulk around the radius of the plug where it will contact the surrounding sheathing.
3. Install the plug by placing a block of wood over the plug and tapping it until the plug is flush with the siding.

INTERIOR APPLICATIONS

Complete interior drill and plug applications in the following manner:

1. After installation, insert a plug so that it is slightly (1/16 inch) recessed. Apply one or two coats of patching material flush to the existing surface. Z-brick adhesive (or equivalent) is recommended since it has less tendency to shrink and crack.
2. Some examples of this application would be exterior walls (not done from the outside), stairway walls, garage ceilings, and slopes.

WORK REVIEW

Walk the entire job to ensure that all aspects of the job are completed. Verify the following:

1. All the siding is repaired and/or reinstalled.
2. Paint touch-up is complete.
3. Shutters are reinstalled.
4. Yard, porches, driveways, and all exterior areas are swept clean.
5. All work areas in the basement/house are swept or vacuumed clean, and all work-related debris has been removed from the site.
6. Job documentation is complete.

ADDING INSULATED SHEATHING TO EXTERIOR SURFACE OF EXTERIOR WALLS

GENERAL

Many existing homes have wall stud cavities of 4 inches or less in depth. This limits the amount of insulation R-value that can be added to this space by filling the cavity alone.

By installing insulated sheathing, you can greatly increase exterior wall R-values and decrease the infiltration of outdoor air through the walls. The installation of insulated sheathing is an energy-efficient measure that you can only install when also re-siding the house. The installation if done correctly should effectively increase wall R-values, decrease air infiltration, and control moisture movement. The installation details are critical and you should follow them as closely as site conditions will allow.

MATERIAL REQUIREMENTS

The insulated sheathing installed must use moisture-resistant materials. Approved products are XPS or foil-faced polyisocyanurate. For this application, only use approved tapes on seams and only apply to the sheathing material for which it is approved.

Foil-faced polyisocyanurate.

INSTALLATION REQUIREMENTS

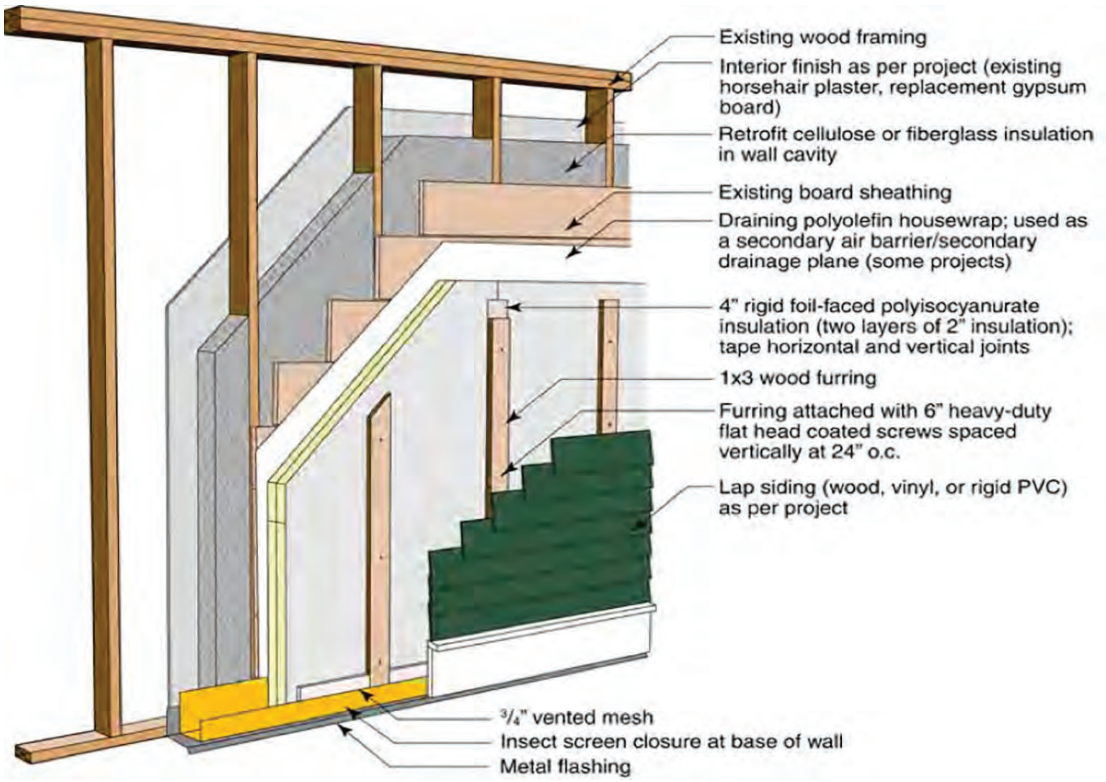
Below is the suggested method for installing insulated sheathing on the exterior of a home. The R-value of the exterior sheathing should be great enough to keep the interior face of the sheathing above the dew point based on the climate zone in which the sheathing is being installed. This R-value will vary based on the R-value of the insulation being installed in the cavity. The 2012 IRC, Table R702.7.1 provides guidelines for the R-value of insulated sheathing that must be applied to the exterior surface of the wall based on climate zone and cavity insulation. It is recreated here for convenience:

Zone 6:

Insulated sheathing with R-value ≥ 7.5 over 2x4 wall.
Insulated sheathing with R-value ≥ 11.25 over 2x6 wall.

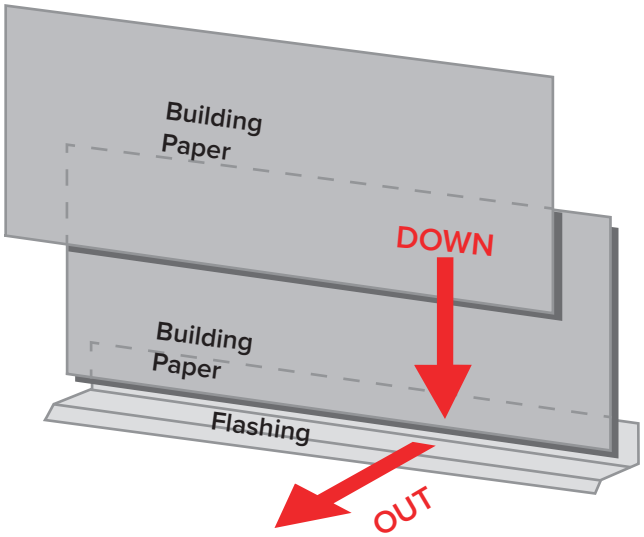
Zone 7:

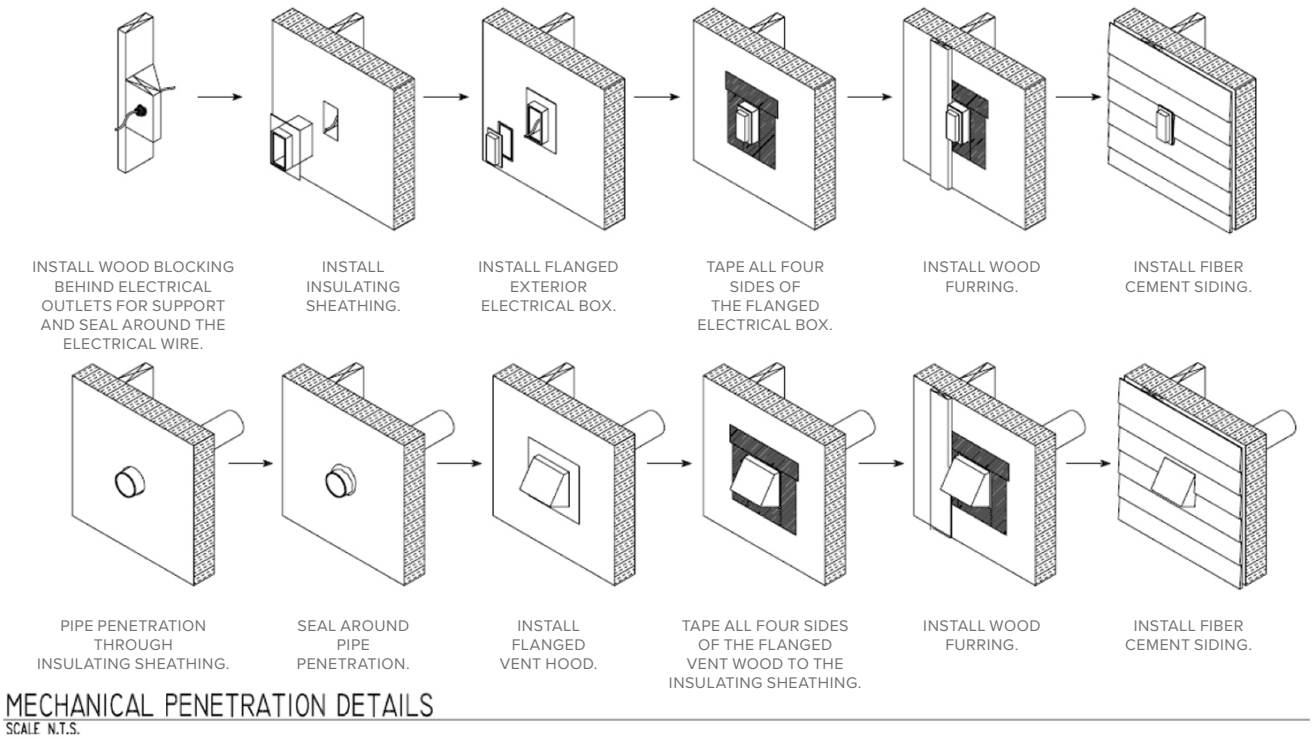
Insulated sheathing with R-value ≥ 10 over 2x4 wall.
Insulated sheathing with R-value ≥ 15 over 2x6 wall.



Exterior wall insulation cross-section diagram.

In addition to this general guidance on how to layer materials to facilitate drainage of bulk moisture and control of moisture vapor intrusion, pay careful attention to flashing details at windows and doors as well as where roofs intersect walls. See suggested details to the right.



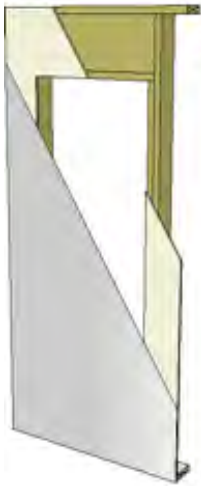


MECHANICAL PENETRATION DETAILS
SCALE N.T.S.

Address other penetrations such as electrical outlets and exhaust fan terminations at the outside face of the insulation and, as much as possible, integrate into the primary water barrier. Suggested installation methods are shown below.

When installing the secondary water barrier prior to installing the insulated sheathing, window and door openings should be made to shed water. Follow the steps below as closely as possible to ensure windows and doors do not leak.

INSTALLING WINDOW WITH HOUSEWRAP ON OSB OVER A WOOD FRAME WALL

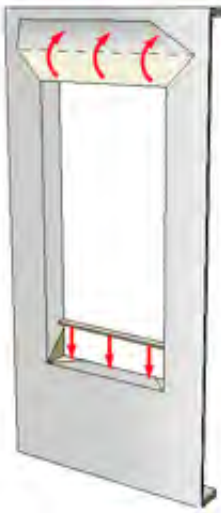


STEP 1

- Wood frame wall with OSB and housewrap.

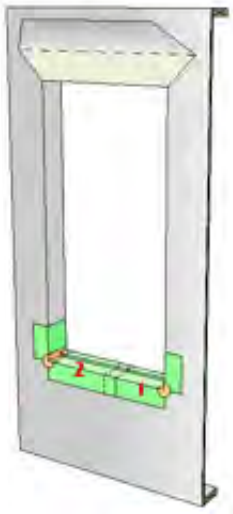
STEP 2

- Modified “I” cut in housewrap.



STEP 3

- Fold in housewrap or tuck head flap under.
- Install wood back beam.

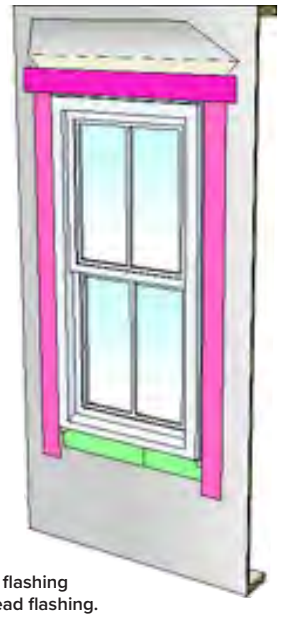


STEP 4

- Install first piece of adhesive-backed flashing.
- Install second piece of adhesive-backed sill flashing.
- Install corner flashing patches at sill.

STEP 5

- Install window



STEP 6

- Install jamb flashing first then head flashing.

STEP 7

- Fold down head housewrap.

STEP 8

- Apply corner patches at head.

BASEMENT & CRAWLSPACE WALL INSULATION

GENERAL

Inspect basements and crawlspaces for signs of standing water or existing moisture problems. Remedy any existing moisture issues before working to bring the basement or crawlspace inside the conditioned area.

LOCATIONS & USE

You may insulate basements and crawlspaces on the interior side of foundation walls.

MATERIAL REQUIREMENTS

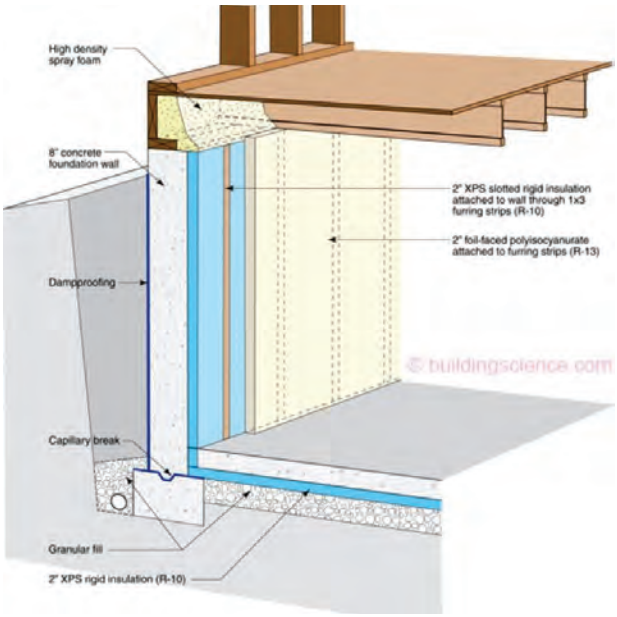
Installed insulation must meet specification in **All Insulation – Physical Properties**. Installed two-part spray foam must meet specifications from **Spray-Applied Polyurethane Foam**.

INSTALLATION REQUIREMENTS

Interior Wall Treatment

CONTINUOUS BOARD

The following illustration (courtesy of Building Science Corp) shows an approved method for insulating basements and crawlspaces with continuous rigid board insulation. The wall shown has two layers of insulation to increase the R-value to R-23. The second layer is not necessary to conform to Table 22.31-1 of the UDC requirement of R-10 continuous insulation on conditioned basement and crawlspace walls.



Enclosures that work.

High-R foundation 05: 2-inch XPS, 2-inch foil-faced polyisocyanurate by Building Science Corporation created 2011/01/15.

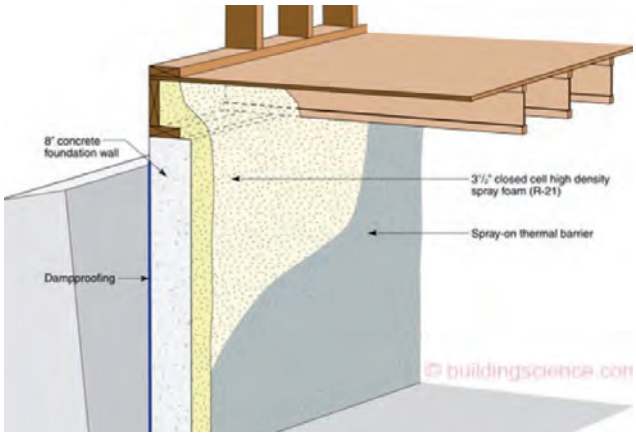
When constructing with plastic board foams, the building codes require that the foam not be left exposed as a fire hazard. Thermal barriers are required over both board foams and spray foams in many cases. This proposed wall system performs very well thermally at approximately R-23. Provided that air cannot bypass the insulation layers, this strategy will not experience any moisture-related issues from vapor diffusion. The seams in the two layers of foam insulation should be offset and well-sealed. A thermal barrier is required by code in most jurisdictions.

Basement and crawlspace insulation interior wall treatment.

SPRAY FOAM

Closed cell spray foam is approved for installation on the foundation walls of conditioned basements and crawlspaces. The illustration below (courtesy of Building Science Corp) shows the correct installation details. Install the spray foam in accordance with the specifications of **Spray-Applied Polyurethane Foam**.

High-R foundation 06: 3 1/2 inches of 2.0 PCF closed-cell spray polyurethane foam by Building Science Corporation created: 2011/01/15.



As shown above, the spray foam can be applied directly to the concrete. If the foam is left exposed it will require a thermal barrier, typically a spray-on thermal barrier. The other option is to build a stud wall in front of the spray foam and use gypsum wallboard as the thermal barrier.

Closed-cell spray foam provides very good continuous thermal control. Spray foam is an air barrier, so convective looping and air leakage thermal losses do not occur. This wall system has an R-value of R-21. More thermal control could easily be added by spraying more foam against the wall. Because closed-cell spray foam is an air and vapor barrier, there are no risks to air leakage or vapor diffusion condensation.

GROUND COVER

You must install a vapor barrier on exposed dirt floors any time the house is tightened by air sealing and/or insulation. Install the vapor barrier with the following qualifications:

1. Minimum 6 mil polyethylene.
2. Installed neatly and covering the entire area, with seams lapped a minimum of 12 inches.
3. Seams sealed with 3M 8086 tape or acoustic sealant.
4. Penetrations with foam, acoustic sealant, or compatible roofing mastic.
5. Perimeter edges run 6-inch minimum up wall and sealed to walls with acoustic sealant or roofing mastic.
   a. Exceptions made only where access is impossible due to low clearance.
   b. If vapor barrier is not present and not specified, or if proper installation is not possible, the situation must be brought to the attention of the Program field supervisor before work commences.

Crawlspace ground cover.

BAND JOISTS, RIM JOISTS, & SILLS INSULATION

MATERIAL REQUIREMENTS

Installed insulation must meet specification in **All Insulation – Physical Properties**. Installed two-part spray foam must meet specifications from **Spray-Applied Polyurethane Foam**.

INSTALLATION REQUIREMENTS

Use any of the following or combination of the following methods to insulate the rim and band joist:

1. You may use two-part spray foam insulation. In this application, you can extend the foam from the subfloor to the junction of the foundation and the sill plate. In areas where termite presence exists, code may require an inspection break between the foam and the bottom of the sill. If there is a termite inspection break, seal the seam between the foundation and the bottom of the sill with caulk.
2. You can seal the rim joist by cutting blocks of 2-inch rigid foam board insulation to fit in the rim joist area and seal the edges with one-part foam. In this application, use caulk to seal the sill to foundation seam and the seam between the two sill plates.
3. If access to the gable wall joist bay prevents installation of 2-inch rigid foam board insulation, you may enclose the bay and dense pack the cavity. Take care to ensure that the exposed foundation top is covered to prevent wicking into the insulation.

Rim joist insulated (and sealed to sill) with foam board and one-part foam.

4. Joist area, dense-packed, blown-in insulation may be specified when basement ceiling is plastered.
5. Use batt insulation in the rim and band area if the seams between the box beam and the sill, the floor joists and the box beam, and the box beam and the subfloor have been sealed with either caulk or one-part foam. If the batt insulation is faced, the vapor retarder must be toward the warm surface. Cut the batt large enough to friction fit in the box sill area. Along gable walls (joists parallel to foundation wall), neatly install batts and run them in full contact with exterior joist—full dimension batt may be needed to fill joist bay and held with metal rods.
6. Cut exposed sill seal material back to edge of sill and apply a sealant where the sill plate meets the foundation wall.

KNEE WALL INSULATION

MATERIAL REQUIREMENTS

Insulate attic knee walls with batt insulation, blown-in blanket, or two-part spray foam. Protect batt insulation from wind washing with an air barrier. Accepted materials for wind wash protection are building wrap, extruded polystyrene, insulated structural sheathing, plywood or OSB, or wallboard. Blown-in blanket may or may not need an additional air barrier depending on the properties of the restraining mesh used.

INSTALLATION REQUIREMENTS

Insulating Knee Walls With Batt Insulation

Cut batts to fit and fill the entire bay. There should be no gaps, compression, or stuffing of insulation. Install an air-impervious wind wash barrier on the back side of the installed batt insulation. Pull the air barrier tight and mechanically fasten with either staples every 6 inches for building wrap or screws every foot for rigid materials. Seal seams in the wind wash barrier using building wrap tape on building wrap or one-part foam on rigid materials.

Insulating Knee Walls With Blown In and Mesh

You can seal and insulate knee walls using dense-pack cellulose or fiberglass. Verify the density of the blown-in material by using an area vs. coverage chart comparison or a smoke test as detailed in **Wall Insulation – Two-Hole Installation Method**. If the material is dense packed and protected by the fiber-reinforced mesh, it is not necessary to install a wind wash barrier.

Insulating Knee Walls With Two-Part Spray Foam

See **Spray-Applied Polyurethane Foam.**

Insulating Knee Wall Transitions

See **Knee Wall Attic Air Sealing – Air Barrier Aligns With Knee Wall and Attic Floor**.

FLOORS OVER UNCONDITIONED SPACES OR AMBIENT CONDITIONS INSULATION

OVERHANG INSULATION

General

Overhangs that were not sealed and fully insulated during construction are weak spots in a building's thermal envelope. The sheathing material that is used on the underside of the overhang, or even ventilated overhang floors, are contributing factors to the poor performance of this building detail.

Material Requirements

The insulating material you use to insulate an overhang can depend on access. If the overhang is unsheathed or accessible through the rim and band joist, you can fill the floor joist bay with batt insulation or dense pack, or spray with two-part foam. If the overhang is sheathed and there is no access through the rim and band, then you can dense pack the floor joist bays with blown insulation. If limiting the flow of blown-in material into the conditioned area of the floor bays is necessary, use the inflated feedbag method requirements described in **Knee Wall Attic Air Sealing – Installation Requirements**.

Installation Requirements

INSULATING AN OVERHANG WITH BATTS

When an overhang is accessible because it is unsheathed or accessible through the transition area at the top plate, you may use fiberglass batts to insulate the floor bays. Install batt insulation to fill the entire cavity without voids or compression. The depth of the fiberglass batt should equal the depth of the cavity. Because fiberglass batts do not stop air movement, thoroughly seal the transition area at the top plate after batt installation and use exterior-rated caulk to seal the sheathing that will be added to the bottom chord of the floor joists to the surrounding finish.

Consider adding a layer of rigid foam board on the floor joist bottom chord before re-sheathing if conditions permit as an option to increase overall R-value and reduce thermal bridging.

Fiberglass basement.

DENSE PACKING AN OVERHANG

When an overhang is sheathed or otherwise inaccessible, use dense-pack insulation to reduce airflow and increase the R-value of this area.

1. Conduct a thorough inspection of the floor joist bays that will be affected before beginning work.
2. Do not dense pack around recessed lights (unless they are ICAT) and HVAC ducts. You can control the flow of insulation using the feedbag method described in **Knee Wall Attic Air Sealing – Installation Requirements**.
3. Although not mandatory, the feedbag method is strongly recommended for use in every floor bay to control the flow of insulation into non-specified areas.
4. When dense packing overhangs using the feedbag method:
   a. Make the drill hole in each floor bay as close to the transition area, where the floor joist passes over the exterior wall top plate, as possible.
   b. Insert the feedbag there and inflate to block the rim joist area.
   c. Once the rim joist area is sealed with the inflated feedbag, withdraw the fill tube, reinsert into the joist bay cavity, and dense pack the remainder of the overhang.
   d. If the overhang extends over the outside space more than 6 feet, drill additional holes to ensure that the fill tube can reach all areas that are to be insulated.
5. Check the density of the installed insulation using a coverage chart and the number of bags installed, or by depressurizing the house and checking for air movement at the drill holes with smoke.

Overhang dense pack.

6. Once the floor bays are dense packed, plug the drill holes.
   a. If there are frayed edges at the drill holes, push the strands into the drill hole and insert a wooden plug.
   b. The wood grain of the plug should run the same way as the wood grain of the sheathing.
   c. Make the plug flush using a block and hammer.

INSULATING AN OVERHANG WITH TWO-PART SPRAY FOAM

If the overhang is unsheathed and accessible, you may use two-part spray foam to seal and insulate this area. Use rolled batt to back the transition area at the exterior wall plate. See **Spray-Applied Polyurethane Foam** for the proper installation of two-part spray foam.

FRAME FLOOR OVER GARAGE INSULATION

Batt Insulation

1. If faced insulation is specified, install vapor barrier facing that faces the heated space.
2. Push the insulation into the floor bay far enough to ensure that the insulation contacts the subfloor. Take care not to compress the insulation more than necessary to achieve contact.
3. Secure insulation with support rods every 2 feet.
4. Insulate areas above (freeze-ups and heat loss) and below pipes and ducts, and around cross braces. Cut insulation and fit neatly around all obstructions. Pipes and ducts will not be thermally isolated from the house.
5. Do not leave insulation exposed in areas of heavy use (house wrap will be specified to cover insulation).
6. For crawlspaces exposed to the outdoors (unconditioned, ventilated crawlspaces), install house wrap or equivalent beneath insulation for wind wash protection. Drywall or an equivalent air barrier is recommended for garage ceilings. You can use house wrap in garage applications if you securely fasten it with staples and seal the seams with house wrap tape.

Dense-Pack Insulation

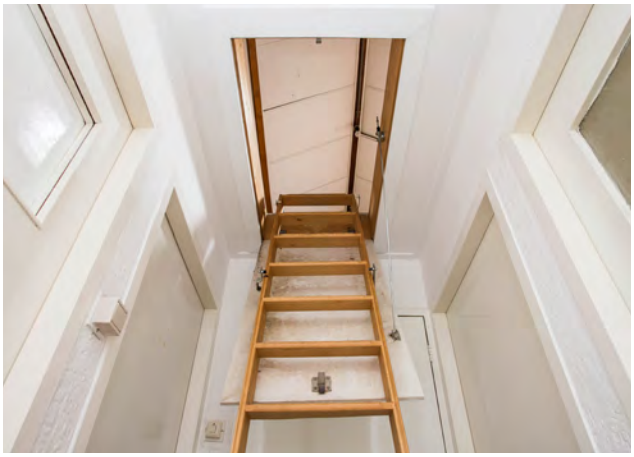
Thoroughly seal all openings between the garage, overhang, or crawlspace and the conditioned space.

1. If a rigid air barrier (drywall, structural insulated panels, etc.) is already in place, follow the dense packing procedures detailed in section **Dense Packing an Overhang**.
2. If there is no rigid air barrier in place, follow the procedures detailed below in sections 3–6.
3. Securely staple a fiber-reinforced membrane to the floor joist at 2-inch intervals.
4. Slit the membrane every 6 feet and use a fill tube to dense pack the insulation to the required density for the material used.
5. Seal the slits using 3M 8086 tape or equivalent.
6. Compare the area and cavity depth to the number of bags installed to verify density.
7. For crawlspaces exposed to the outdoors (unconditioned, ventilated crawlspaces), install house wrap or equivalent beneath insulation for wind wash protection.

ATTIC ACCESS INSULATION

GENERAL

To maintain a continuous thermal envelope, it is recommended that the attic accesses be insulated to the same level as the surrounding surfaces. These guidelines recommend methods to achieve this requirement while recognizing the difficulty of compliance. Maintain existing access to the attic. Permanently affix weatherstripping to panel or trim. “Q-Lon Type” strips or equivalent is the preferred standard. Do not permanently seal an access panel closed with caulk, screws, adhesive, or by any other method.



Attic hatch access.

MATERIAL REQUIREMENTS

Attic Doors

Weatherstrip attic doors using Q-Lon Type strips and install them on a metal or wood carrier (the trim-like material around a hatch). Q-Lon Type weatherstripping has an angled side that seals better under pressure and will stay flexible for years where some rubber will harden and not work. Sweep the bottom of the door with a standard non-spring-loaded sweep. Insulate the back side of the door with 4 inches of Focus on Energy-approved, foil-faced polyisocyanurate insulation boards.

Attic Hatches

Weatherstrip attic hatches using Q-Lon Type strips if the framing allows. If it does not allow the use of Q-Lon Type strips, then use a closed cell foam with adhesive backer. You may insulate the back side of the attic hatch either with rigid foam board rated for exposure or with a thermal barrier, but it must reach the level of R-value of the surrounding insulation unless space prohibits such levels.

Pull-Down Stairs

Treat pull-down stairs with an attic staircase cover that you can either make on site, or purchase as a kit, and insulate to the level of the surrounding attic. The cover must have the capability to make the staircase both airtight and insulated to Focus on Energy standards.

INSTALLATION REQUIREMENTS

Attic Doors

Knee wall access doors fall under this category. Weatherstrip the door using Q-Lon Type strips that have been cut to fit, and miter the corners to form an airtight seal. The Q-Lon Type will be effectively mechanically fastened. Seal the seam between the framing or finish and the Q-Lon Type with a bead of caulk. Sweep the door with a non-spring-loaded door sweep. Attach 4 inches of Focus on Energy-approved, foil-faced polyisocyanurate insulation board to the back side of the door. Attach the insulation with screws and space 1-inch washers 8 inches apart.

Attic Hatches

Weatherstrip attic hatches using Q-Lon Type strips cut to fit, with mitered corners to form an airtight seal. Mechanically fasten the Q-Lon Type. Seal the seam between the Q-Lon Type and the finish with a bead of caulk. Install a positive closing mechanism (such as eye hook) on the hatch if needed to compress the weatherstripping. Insulate the back side of the hatch using Focus on Energy-approved, foil-faced polyisocyanurate insulation boards. It is required that the hatch be insulated to the same level as the surrounding attic. This may require five to six layers of foam board. Mechanically attach the first layer of foam board. Add additional layers by gluing to the lower layer using construction adhesive, not caulk. Do not seal attic hatches shut with any method.

Attic Pull-Downs (Therma-Dome)

If the attic access is a pull-down staircase, build an attic staircase cover either from Focus on Energy-approved, foil-faced polyisocyanurate insulation boards and weatherstripping constructed on site or using a kit. Cut the cover to lengths that fully encompass the framing surrounding the staircase. The side should be of sufficient height to accept the folding stairs without being disturbed. Adhere joints in the cover to each other using construction glue and seal the seams with foil tape. Make the framing around the stair opening level enough to engage Q-Lon weatherstripping. Secure the box in place with some type of mechanical fastener that will compress the Q-Lon weatherstripping and form an airtight seal. Insulate the box to the same R-value as the surrounding attic. To achieve this, attach additional layers of rigid foam board to the original box frame. An exception may be made when low attic roofs prohibit matching levels of box insulation to that of the surrounding attic space.

See **Attic Doors**.

Whole House Fans

Treat whole house fan covers like attic staircase covers with regard to acceptable materials, installation techniques, and code compliance. The fan itself should be dammed off from any blown material for a distance of 2 feet around the fan perimeter using batts laid flat.

SPRAY-APPLIED POLYURETHANE FOAM

GENERAL

Description

WORK INCLUDED

Building insulation required for this work includes, but is not necessarily limited to:

1. Spray-applied polyurethane foam in wall, roof slope, and floors.
2. Spray-applied polyurethane foam in attic floors.
3. Spray-applied polyurethane foam at crawlspace walls and rim joists.

Related work and materials described elsewhere:

1. Low-expansion foam sealants: Air Barrier Systems.
2. Vapor barriers/slip sheets: Section 07200.
3. Caulking materials: Air Barrier Systems.

SCOPE & CONDITIONS OF THE WORK

1. Provide all labor, materials, accessories, services, and equipment necessary to complete the work.
2. Comply with the Installation Requirements and all other Contract Documents.
3. Coordinate with other portions of the work and cooperate with other trades.
4. Design Intent – Air barrier: This material is part of the air barrier system of the building envelope of this building. It is installed to provide a continuous, structurally supported plane of materials that contains the indoor air (reduce exfiltration) and prevents outdoor air from entering the building (reduce infiltration).

Special Requirements & Regulations

1. All materials, products and equipment must be delivered, handled, stored, fabricated, assembled, installed, and operated in accordance with the manufacturer's printed instructions.
2. Trade Ally contractor or owner must clear building areas to be foamed in place of debris and materials prior to the commencement of foam-in-place operations. Comply with all federal, state, and municipal codes, laws, and regulations for thermal insulation and vapor retarders.
3. See the **Installation Requirements – Air Barrier Systems Applications**.

Submittals & Tests

1. Submit a copy of manufacturer's product specifications, product data, ICC-ES report, and installation instructions. Include minimum and maximum ambient and substrate installation and curing temperatures for warm and cold weather conditions, including duration of minimum temperature requirements for the curing period.
2. Submit a copy of manufacturer's safety data sheet (SDS). Trade Ally contractor to maintain a copy of this documentation at the job site at all times and must provide copy upon request to the owner, Project Inspector, or Code or OSHA authority.
3. Submit a copy of the Trade Ally contractor's written safety plan prior to commencing the work. This should include an air quality management plan specific to all materials included in the work.

Quality Assurance

1. When required by the contract documents, submit certified test reports from a blower door test performed by a technician approved by Focus on Energy. The installer should identify areas of leakage and undertake additional sealing if required to meet these performance specifications. Alternate methods allowed include infrared thermography (seasonal) and pressurized fog air leakage testing.
2. You must inspect the installation to verify the minimum foam thickness required to achieve the specified R-value.
3. Perform industry-standard pull testing to assure substrate bond strength is adequate if the substrate has existing coatings or surface defects.

Spray foam installation.

Protection

1. Protection from deterioration: Protect installed insulation materials from physical damage and from becoming wet, soiled, or covered with ice or snow between phases of the work or after the completed installation. Do not expose to sunlight, except to the extent necessary for period of installation and concealment.
2. Protection of the premises from damage: Protect against ignition at all times. See **Ignition Barrier vs. Thermal Barrier**.
3. Thermal protection of raw materials: Protect from freezing or extreme heat. Maintain chemical components at a minimum of 60°F while stored on site.
4. Fire protection: The code states that the use of completely exposed foamed plastic in interior applications presents a fire hazard unless the foam is protected by one of the code-approved 15-minute fire-resistive barriers (1/2-inch sheetrock or other approved finish or coating). Follow all code requirements for unoccupied areas (attics, crawlspaces, etc.). Comply with insurance ratings indicated in the **Installation Requirements**.

Spray foam installation.

5. R316.6 Specific approval. Foamed plastic insulation not meeting the requirements of Sections R316.3 through R316.5 must be specifically approved on the basis of one of the following approved tests: National Fire Protection Association (NFPA) 286 with the acceptance criteria of Section R302.9.4, Factory Mutual (FM) 4880, UL 723, UL 1040 or UL 1715, or fire tests related to actual end-use configurations. The specific approval must be based on the actual end-use configuration and must be performed on the finished foam plastic assembly in the maximum thickness intended for use. Assemblies tested must include seams, joints, and other typical details used in the installation of the assembly and must be tested in the manner intended for use.
6. Listed here are the spray foam insulations that currently do not require thermal barriers when installed and at the listed thicknesses and parameters laid out in Section R316.5.3 for attic spaces or Section R316.5.4 for crawlspaces.
   a. One-Step – Preferred Solutions, Inc.
   b. Rigid board insulations that currently do not require thermal barriers are listed in 2.3 Other Materials.
7. Health and safety: Protect areas where ventilation is adequate with signage and require personnel in the unvented area to wear proper personal protection equipment. Follow the procedures in the OSHA-compliant safety plan, including all indoor air quality management plan protocols.

MATERIAL STANDARDS

Manufacturer

Field-applied foamed-in-place polyurethane foam insulation must be as supplied by a manufacturer with at least five years as a provider of this material. Examples include:

1. Certainteed Closed-Cell ESR-2669.
2. FoamLok 2000, ESR-2629.
3. Permax RT-2041 – Resin Technologies.
4. Walltite – BASF.
5. One-Step – Preferred Solutions, Inc.
6. Other approved equivalent foam products.

Building Insulation

SPRAY-APPLIED CLOSED-CELL RIGID POLYURETHANE FOAM (SPF)

1. Polyurethane foam product must be a two-component mix for producing high-quality rigid insulation. All products must be labeled with Model Building Code approvals and UL or FM listings where required.
2. Blowing agent: Product having a zero ozone depletion potential blowing agent.
3. Surface-burning characteristics: Maximum flame-spread and smoke-developed indices of 75 and 450, respectively, based on tests performed on unfaced core by ASTM E84 test method.
4. K-value: 0.15 minimum when aged 90 days at 140°F dry heat.
5. Only use materials that have Engineering and Construction Contract (ECC) Evaluation Reports for air barrier and insulation. Submit manufacturer's documentation.

Spray foam installation in attic.

6. Physical properties:
   a. ASTM D1622 in-place density: 2.1–2.5 lbs. per cubic foot.
   b. ASTM D1621 minimum compressive strength: 25 PSI.
   c. ASTM D1623 minimum tensile strength: 30 PSI.
   d. ASTM D2126 dimensional stability at -20°F: -.5%.
   e. ASTM D2126 dimensional stability at 100°F: +6%.
   f. ASTM D2842 or ASTM C272-76 maximum water absorption: 3% by volume.
   g. ASTM D2856 closed-cell content: 90% minimum.
   h. ASTM E96 moisture permeance (insulation on sheathing): .53 perms.
   i. ASTM E283 air permeance: .004 cu. ft./min./pi2.
   j. ASTM C518 thermal resistance: 6.0 BTU/sq. ft. hr. °F in 30 days minimum.
   k. Underwriters Laboratory Solutions of Canada (CAN/ULC)-S708.1 off-gassing: passes.

OPEN-CELL, SEMI-RIGID, FIELD-APPLIED, ZERO OZONE DEPLETION POTENTIAL (ODP), POLYURETHANE FOAM

1. Foam product will be a polyurethane two-component mix for producing semi-rigid, self-adhered, open-cell insulation/sealant. Examples include: Icynene as manufactured by Icynene Corporation; Sealection 500 as manufactured by Demilec (USA) LLC.
2. Only use materials that have ECC Evaluation Reports for air barrier and insulation.
3. Physical properties:
   a. ASTM D1622 in-place density: 0.5-0.7 or 2.1 lbs. per cubic foot.
   b. ASTM D2126 dimensional stability at -20°F: -0.5%.
   c. ASTM D2126 dimensional stability at 100°F: +6%.
   d. ASTM D2842 or ASTM C272-76 maximum water absorption: 3% by volume.
   e. ASTM E96 moisture permeance (insulation on sheathing): 0.53 perms.
   f. ASTM E283 air permeance: .004 cu. ft./min/pi2.
   g. ASTM C518 thermal resistance (R-value): BTU/sq. ft. hr. °F in 30 days (varies with product specified).
   h. CAN/ULC-S708.1 off-gassing: passes.
4. Must be labeled with Model Building Code approvals and UL listings.
5. Surface-burning characteristics: Maximum flame-spread and smoke-developed indices of 75 and 450, respectively, based on tests performed on unfaced core by ASTM E84 test method.

Other Materials

1. Thermal and protect-from-ignition (PFI) barriers materials, and coatings. (See **Protection**.)
2. Prescriptive thermal and PFI barriers are always allowed. These include the following:
   a. 1 1/2-inch (38 mm) mineral fiber insulation.
   b. 1/4-inch (6.4 mm) wood structural panels.
   c. 3/8-inch (9.5 mm) particleboard.
   d. 1/4-inch (6.4 mm) hardboard.
   e. 3/8-inch (9.5 mm) gypsum board.
   f. Corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).
3. In the case of non-prescriptive barriers, documentation from the fire protection product manufacturer must state in writing that the material meets the code requirements (cite the code reference) for use with field-applied polyurethane foam and the specific application in which the foam will be used.
4. Some newer sprayed polyurethane foam (SPF) products do not require PFI barriers in certain applications (attics, rim joists between floors, etc.) and at least one SPF product does not require a 15-minute thermal in any application. Ignition barrier is not required where the foamed plastic insulation has been tested in accordance with Section R316.6. The use of these products is acceptable if the manufacturer's documentation provides clearly stated evidence that the product meets the code and cites the specific exception or compliance criteria that allow their product to meet the conformance requirements. This provision is subject to approval by the Job Hazard Analysis (JHA).
5. Where required, install a vapor retarder to protect the framing and foam insulation from high humidity conditions. This material must be a minimum of 6-mil polyethylene, liquid-applied coating designed for this use, or other material of equivalent vapor-resistive performance.

INSTALLATION STANDARDS

Examination

1. Prior to beginning work, examine all substrates and conditions for compliance with **Installation Requirements** to determine if conditions affecting performance of insulation are satisfactory. Do not proceed with installation until you have corrected unsatisfactory conditions in a manner acceptable to the installer and the Project Administrator.
2. Examine all substrates for soundness, such as tightness of connections, crumbling or looseness of surface, level tolerance of surface, and other conditions that would affect the installation. Notify the Project Administrator of any adverse or unsatisfactory conditions. Do not proceed with work until you correct such conditions.
3. Verify that the substrate is dry and free of water, snow, or ice. Solidly support and fasten joints in insulation, sheathing, and other substrate components.
4. Ensure chemical components are maintained at a minimum of 60°F while stored on site.

Preparation

1. Clear building cavities to be sprayed-in-place of debris and materials prior to the commencement of the installation. Clean substrates of substances harmful to the insulation, including moisture, dirt, or unbonded coatings that will affect the insulation or prevent an airtight seal. Remove projections that might puncture vapor retarders.
2. Seal all joints and close off openings in the sheathing to be sprayed to prevent foam leakage.
3. Check to ensure that the framed cavities are free of debris and that the surface to be sprayed is securely anchored to the framing members.
4. Brace or fasten wiring, conduit, boxes, etc. securely so that expansion of foam sealant does not cause wiring to “float.” Locate wiring within the wall/ceiling cavity to be foamed, so as to prevent damage to wiring during the trimming and/or planing of the foam. Ensure that all electrical connections are made in a box and that all boxes have covers securely screwed shut.
5. Clear all cracks, spaces, voids, and openings to be sealed of debris, moisture, ice, and materials prior to the commencement of foaming operations. Clean substrates of substances harmful to insulations, including moisture, dirt, or unbonded coatings that will affect the insulation or prevent an airtight seal.
6. Mask areas to be protected from over-spray.

Processing

1. Process a two-component polyurethane foam system with 1:1 ratio by volume, positive-displacement, industry-standard pumping equipment.
2. Monitor and maintain the component ratio and mix the components of the polyurethane chemicals in accordance with the manufacturer's product specifications and processing instructions to achieve the desired density and physical properties. Verify the product component ratio with flow meters and programmable ratio monitoring equipment that can prevent the installation of product that is off-ratio by more than the manufacturer's prescribed limits.
3. Maintain the component temperatures in accordance with the manufacturer's product specifications and processing instructions to achieve the desired mix, density, and physical properties.
4. Chemical components are to be maintained at a minimum of 60°F while stored on site.

Installation

1. Perform application of SPF in strict accordance with the manufacturer's recommendations. Apply only when surfaces and environmental conditions are within limits prescribed by the manufacturer. The SPF insulation and transition sealants form the primary air barrier system for the structure walls. Maintain continuity of the air/vapor barrier created by the spray-applied polyurethane foam insulation system at all intersections of the building assemblies (floor to foundations, walls to floors, walls to roofs, etc.), across expansion and control joints, and around elements penetrating through the building envelope (doors, windows, louvers, vents, etc.) by sealing as per the **Air Sealing Installation Requirements.**
2. Apply the insulation onto the substrate to a minimum or average cured depth/thickness in consecutive passes of no more than the maximum lift thickness recommended by the manufacturer. Average thickness specifications will be to a plus-or-minus 1/2-inch tolerance. Areas determined to be less than this tolerance must be re-coated to the minimum and areas greater than this tolerance that extend beyond the framing must be trimmed to the maximum specified thickness.
3. The ambient and substrate temperatures at the time of application must be at or above the minimum required by the manufacturer before and during the foam installation. You must maintain the manufacturer's minimum cure temperature for the required period after the foam has been installed.
4. Use vented or non-open flame sources to provide temporary space heating required during foaming operations.

5. Execute the work in accordance with the indoor air quality (IAQ) management plan.
6. During foaming operations, the above temperature requirements must be met while providing two air changes per hour for ventilation for installation personnel. OSHA-compliant personal protection equipment must be utilized by the installers or as necessary to maintain an acceptable level of indoor air quality in accordance with the IAQ management plan.
7. Trim foam flush with the inside surfaces. Remove foam from finished surfaces such as window glass, casings, and gypsum board.

Special Requirements

Use type non-metallic sheathed cable (NMB) or NMC-B non-metallic electrical wiring in the areas to be sprayed.

Cleaning

Clean work area daily by sweeping and disposing of debris and scraps in a location designated by the owner. Upon completion of the work of this section in any given area, remove tools, equipment, and all rubbish and debris from the work area; leave area in broom-clean condition.

DENSE PACKING VS. VENTING OF SLOPED ROOFS

GENERAL

There is a perception of a disparity between code requirements for roof/attic venting and a long-standing offering approach to dense packing sections of roof areas without venting.

BACKGROUND

For at least 15 years, insulation Trade Ally contractors working in Home Performance Programs in Massachusetts have used dense-packed cellulose in sloped roof areas of Cape-style houses, eyebrow roofs, mansard roof cavities, and the like. Although this practice is not explicitly allowed by building code, it has been commonly accepted by building officials and we have no evidence of roof sheathing or other failures in Massachusetts despite thousands of homes receiving this treatment. At least one major regional manufacturer (National Fiber) offers warranty service for assemblies—not just material, but all building components in contact with the insulation, including rafters, sheathing, and drywall—provided the material was installed at the required density.

A dense-pack approach is not optimal from a building science perspective. Best practice to avoid risk of moisture damage in unvented roof cavities is to include sprayed polyurethane foam (SPF) or other non-air-permeable insulation in contact with the underside of the roof sheathing, or rigid foam on the outside of the sheathing (see **Best Practice: Unvented Attics and the IRC** for further discussion on this approach). However, using SPF or rigid foam is cost-prohibitive for most retrofits; it is better suited to new construction, gut-rehab, or re-roof situations.

The code is clear that this approach is accepted for constructing unvented attics, but it is more ambiguous about the requirements for venting in sub-components of more complex attic systems. Further, it is clear that conventional methods (batt insulation, propavents, and continuous ridge and soffit vents) are insufficient to prevent roof sheathing or cavity condensation even in relatively mild climates, when air leaks exist. The combination of the Program Implementer's (CLEAResult's) extensive experience in climate zone 5, along with the details of the building code language, leave Trade Ally contractors working in CLEAResult's programs with some latitude regarding acceptable applications of insulation in a variety of situations.

The following sections outline limitations on Focus on Energy's acceptance of unvented dense-pack cellulose due to increased risk, and provide some analysis of the code language that suggests there is significant latitude for Trade Ally contractors and code officials in less risky situations.

LIMITATIONS OF USE

Dense-packed cellulose is considered to be too risky to install in unvented roof assemblies under the following circumstances:

1. If there are any known roof or flashing leaks, or visible evidence of leaks, these must be fixed before a Trade Ally contractor considers dense packing.
2. International Energy Conservation Code (IECC) climate zones 7 and 8 provide too much risk of winter condensation; climate zone 6 is questionable, though less risky.
3. If an entire attic, roof, or cathedral ceiling is to be insulated, it must be done in accordance with best practices for unvented attics, or continuous vent chutes must be installed along with conventional eave and ridge vents or equivalent.
4. If the length of the enclosed cavity to be dense packed exceeds 8 feet.

To be considered for dense-packed cellulose, expose at least the upper end of every cavity to an open, fully vented attic. This allows the cavities to dry to the vented area; for example, an area of sloped roof with knee wall attic below and cap attic above as is typical in a Cape-style house is a candidate for this treatment. The attic area used for net free vent calculation must include the dense-packed cavity area added to the adjacent vented attic areas. In the case of low-slope roofs, dense pack applied along the eave edge cannot exceed 1/3 of the total attic area, and cannot block existing soffit vents. Other requirements include the following:

1. Install cellulose between any existing insulation and the roof sheathing (not between existing insulation and the plaster or drywall).
2. Leave a minimum space of 4 inches between the existing insulation and the roof sheathing to ensure adequate space for full dense pack.
3. Ensure the existing ceiling is finished and in good shape and able to support the weight of the cellulose, with no cracks or gaps in the material or materials that are too thin or improperly secured (such as wood paneling, Homasote tiles, etc.).

CODE REQUIREMENTS

The 2009 International Residential Code (IRC), section 806 addresses attic ventilation:

1. **806.1:** "...attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters must have cross ventilation for each separate space."

   "Cross ventilation" is not defined anywhere in the IRC. It does not say the ventilation must be continuous for the length of the cavity, only that each "separate space" must be ventilated. "Cross ventilation" is also used for open attic areas and crawlspaces. One could infer that it simply requires that the air can move laterally. If every rafter space is exposed to the vented air, then each space could be considered to be cross-ventilated.

2. **806.2:** "The total net free ventilating area must not be less than 1/150 of the area of the space ventilated except that reduction of the total area to 1/300 is permitted provided that at least 50% and not more than 80% of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet (914 mm) above the eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents. As an alternative, the net free cross-ventilation area may be reduced to 1/300 when a Class I or II vapor barrier is installed on the warm-in-winter side of the ceiling."

This clearly says that if there are both high and low vents, the vent area may be reduced. That implies that as long as you provide a total area of 1/150, all the vents may be located high, all of them low, or any combination. If there is not at least a 3-foot height difference, 1/150 must be used. Although it would not be good practice, a sloped cathedral ceiling that is insulated traditionally with an air space and vent chutes would meet code if all the ventilation was at the ridge (none at the soffit), as long as the venting meets the 1/150 requirement. But if all of the ventilation is at the ridge, then what good do the vent chutes do anyway? The only "cross-ventilation" air flow would be laterally across the top of the cavities, with no flow from the bottom to top of each cavity.

3. **806.3:** "Where eave or cornice vents are installed, insulation must not block the free flow of air. A minimum of a 1-inch (25 mm) space must be provided between the insulation and the roof sheathing and at the location of the vent."

   This section aims to ensure insulation does not block airflow at eave (soffit) or cornice vents. Even in the case of a cavity that is completely blind at the bottom (such as a 2- or 3-foot wide sloped roof at either end of a shed dormer), if there is no eave or cornice vent, then 806.3 does not appear to apply at all. Because it goes on to say: "Between the insulation and the roof sheathing and at the location of the vent," it appears that if there is an eave vent, an air space is required, even if the insulated section in question is many feet away from the eave vent. But that language is inconsistent, and certainly could reasonably be interpreted as not required in any other cases. Again, although most Trade Ally contractors who build new homes or re-roof existing ones will automatically install soffit and ridge vents for any full vaulted ceiling, there is actually no language in the code to prohibit ridge-vent only (provided it meets the 1/150 area). Nor is there language that would prevent full contact of insulation against the roof sheathing, as long as there are no soffit vents. This would actually be a very bad idea for a full cathedral ceiling or flat roof, whether insulated with cellulose or fiberglass, but it would be difficult to argue that it violates code.

UNVENTED ATTICS & THE IRC

806.4 addresses an approach to constructing an unvented attic assembly. The approach requires sprayed foam or exterior rigid foam and is best practice for new, remodeled, or retrofit construction in any climate. However, the code does not state that if a relatively small section of an otherwise properly vented attic has insulation in contact with the roof sheathing, the insulation must be sprayed foam.

In the approach described in 806.4, the key parameter of the insulation is that it be "air-impermeable"—usually closed cell foam, or open cell foam with an added membrane or spray-on vapor retarder as required by climate zone. The R-value of the foam must be sufficient to protect the inner surface of the foam from condensing temperatures.

Note: In the 2006 IRC, this was specified by a calculation based on the proportion of the sprayed foam R-value to the total of the foam plus any additional air-permeable insulation, and using assumed interior humidity conditions and monthly average outdoor temperatures. The calculation was replaced in the 2009 IRC with prescriptive R-values, based on climate zone, presumably for simplicity of use.

However, these prescriptive values are based on the energy code minimum requirements for total roof/ceiling R-values. If they are used as part of a much higher total R-value, the minimum R-value requirements for the foam will be inadequate to protect against condensing.

As an alternative, you can install the required R-value as rigid foam on top of the structural sheathing, warming the sheathing (now the first condensing surface) to the same level. These requirements and a series of additional pre-conditions are detailed in IRC section R806.4.

SUMMARY

When possible, consider best practices for unvented attic assemblies as part of the work scope. However, due to prohibitive cost or practical limitations in many cases, dense packing enclosed rafter spaces can be an appropriate treatment if the limitations noted above are followed. As always, work must be done in accordance with the code but the final interpretation of code is always at the discretion of the local code official. We believe that there is latitude in the code to support this approach and that Trade Ally contractors should not be prohibited from doing so by Focus on Energy rules.

DUCT SEALING

DUCT SEALING

Sealing ducts.

GENERAL

Duct sealing is one of the most cost-effective energy upgrades. Unlike a house, there is no lower boundary of air tightness for a duct system. When sealing ducts, it makes the most sense to seal leaks close to the air handler where the pressure is greatest first and then work to the extremities of the system. Air seal all structural and mechanical penetrations. As appropriate, caulk windows along the full perimeter of the interior or exterior; including sill area, side stops, apron, and casings. As appropriate, caulk doors along the interior or exterior casings and door jambs/stops.

LOCATIONS & USE

For energy savings, only seal ducts in unconditioned space. Ducts in unconditioned crawlspaces have proven to have marginal payback but may be sealed. Seal all the openings in the duct system, starting closest to the system air handler and moving toward supply and return registers. Pay particular attention to ducts located within unconditioned crawlspaces with regards to indoor air quality. At minimum, seal all accessible return ducts located in these areas to insure contaminants are not drawn into living spaces. Seal duct systems with joints not located entirely within the conditioned space or with joints located on the unconditioned side of stud bays, joist cavities, and similar spaces, in accordance with this section.

MATERIAL REQUIREMENTS

To seal, use mastics, mastic-plus-embedded-fabric systems, or tapes, installed in accordance with the manufacturer's instructions. The following materials are approved for duct sealing:

1. Water-based (latex) mastic conforming to UL-181A-P, UL-181A-M, UL-181A-H, or UL-181B-M.
2. 2-inch roll mesh tape.
3. Tapes and mastics used with rigid fibrous glass ducts must be listed and labeled as complying with UL-181A.
4. Tapes and mastics used with flexible air ducts must be listed and labeled as complying with UL-181B.
5. Do not use tapes with rubber-based adhesives. Note: Standard duct tape or "duck tape" has a rubber-based adhesive and does not comply with the requirements of this section.
6. One- or two-part spray foam insulation that provides a continuous air barrier may be used in lieu of sealing metal ducts.
7. 100% silicone caulk (for use at component-to-component and component-to-plenum connections).

INSTALLATION REQUIREMENTS

1. Ensure all joints, seams, and connections of the duct system are mechanically fastened with screws in at least three points. Seal these joints, seams, and connections with duct mastic.
2. Ensure any seam or hole in the duct system greater than 1/4 inch is backed with mesh tape and sealed with duct mastic.
3. Seal air handler access panels and seams that may need to be opened for service with a UL-181-rated tape.
4. Seal connections between the air handler and the cooling coil or hot water coil with 100% silicone caulk.
5. Ensure flex duct connections are made with hard duct connectors, held in place with a vinyl tension strap, and that the strap is screwed into place. Seal the connection between the inner liner and the hard duct it is connected to with duct mastic.
6. Make sure the boot to floor, wall, or ceiling connections for supplies and returns are mechanically fastened to the surface or surrounding framing and sealed to the wallboard or subfloor with mastic.
7. If there is a filter door, it should have an operable door that closes securely and is reasonably tight.

Metal ductwork sealed with mastic.

Air handler sealed with silicone caulk.

Supply and return heating ducts, or portions thereof, that are not located completely within the thermal envelope, must have insulation with a thermal resistance of at least R-8.

DUCT INSULATION

DUCT INSULATION

GENERAL

1. Insulate any sections of duct systems that are in unconditioned spaces to code levels.
2. Do not insulate the duct before conducting duct sealing. If ducts have not been sealed, check with your regional manager before proceeding.

LOCATIONS & USE

Ensure air conditioning ducts in unconditioned spaces all have a continuous Class I vapor retarder to avoid condensation and water damage. The entire duct system must be insulated, but pay special attention to ducts that run near the roof sheathing in cold climates. Failure to seal ducts in this area can lead directly to ice damming.

Insulated duct.

MATERIALS REQUIREMENTS

1. Use vinyl duct wrap with an R-value of 6 to insulate ducts in unconditioned basements, crawlspaces, or garages.
2. Use vinyl duct wrap with an R-value of 8 in unconditioned attics.
3. Vinyl tape made especially for use on vinyl duct insulation (e.g., Nashua all-service jacketing tape (ASJ) tape or equivalent).
4. Clamp stapler and staples.

INSTALLATION REQUIREMENTS

1. Install duct insulation by wrapping insulation around ductwork and attaching neatly using a clamp stapler. Add 2 inches to the width of the duct wrap to provide the excess wrap needed to create a neat tight seam that can be stapled without compressing the insulation. Do not pull the insulation too tight as this will compress it and decrease its R-value.
2. Leave no fiberglass exposed. All seams and tears in the vinyl vapor retarder must be sealed using vinyl tape.
3. Leave no part of the duct system uninsulated, including supply and return boots. When insulating cooling system ducts, make sure the vapor retarder is continuous.
4. For floor joist bays used as return ducts, wrap duct insulation around three sides and staple near the top of each joist or to the subfloor on each side. Make sure duct insulation is in substantial contact with all sides of duct area. Mechanically reinforce seams using vinyl tape.

Sealed vapor retarder on attic ductwork.

ATTIC, ROOF, & CRAWLSPACE VENTING

ATTIC, ROOF, & CRAWLSPACE VENTING

GENERAL

When attic spaces are insulated and air sealed to remove moisture and heat, make sure they are in compliance with state and local code requirements. The IRC 2009 defines required venting levels in Section R806.2. This section calls for a ratio of 1 sq. ft. of net free venting area for every 150 sq. ft. of attic area. This ratio can be decreased to 1 sq. ft. of net free area for every 300 sq. ft. of attic area if a Class I or II vapor retarder exists at the warm-in-winter side of the ceiling, or if at least 50% and not more than 80% of the required venting area is provided by ventilators located in the upper portion of the space to be ventilated at least three feet above the eaves or cornice vents with the balance of the required ventilation provided by eaves or cornice vents. If state or local codes are unclear regarding required attic venting levels, use this guideline. The first choice for venting attic space will always be passive venting installed as detailed below. In attic space where it is not possible to achieve the needed levels of passive venting, achieve active (mechanical) venting with **Active (Mechanical) Attic Venting**. Wisconsin code SPS 322.39((2)a.6) calls for ventilation to be installed in any unconditioned space 40 sq. ft. or greater.

Attic eaves and venting.

PASSIVE ATTIC VENTING

DESIGN GUIDELINES

Attic ventilation installed in enclosed attics or enclosed slopes must be designed and installed for cross ventilation. In practice, this means that as much as possible you must space vent openings equally between areas high in the attic or slope and low in the attic or slope. For attic spaces, high ventilation would most likely be ridge vent or roof vents, and low ventilation for attics or enclosed slopes would be soffit vents. Ensure the vents themselves are configured to protect against the entrance of rain and snow. Back the vents with a corrosion-resistant insect screen with openings of 1/16 to 1/4 inches.

Attic Roofs vs. Cathedral Slopes

Although attic roofs can have multiple configurations, from a venting perspective, there are only two types of attics: open attics and enclosed slopes. For the purpose of this guideline, enclosed slopes will be referred to as “vaulted ceilings.” Any other configuration, such as sloped ceilings with attic space above, may be called a sloped ceiling, but performs like and should be vented as an open attic.

Open & Closed Roof Slopes

Ventilate vaulted ceilings using vent chutes that connect the lower end of the vaulted bay to either a ventilated upper attic or ridge vent. Make sure each bay has vent chutes that are connected to each other and are stapled firmly into place. For open slopes, this is as easy as installing the chutes and stapling them securely. For enclosed vaulted bays, especially ones that are more than 3–4 feet in length, correctly installing the vent chutes may not be possible. If correctly installing the vent chutes is not possible, then the vaulted bays cannot be insulated with fiberglass batts or blown-in insulation.

Exception: Dense packing of enclosed slopes without the requirement of rafter bay ventilation is allowed if none of the following conditions exist:

1. If there are any known roof or flashing leaks, or visible evidence of leaks, these must be fixed before a Trade Ally contractor considers dense packing.
2. The state of Wisconsin falls into IECC climate zones 6 and 7. Climate zone 7 provides too much risk of winter condensation; climate zone 6 is questionable, though less risky.
3. If an entire attic, roof, or cathedral ceiling is to be insulated, it must be done in accordance with best practices for unvented attics, or continuous vent chutes must be installed along with conventional eave and ridge vents or equivalent.
4. If the length of the enclosed cavity to be dense packed exceeds 8 feet.

Calculating & Locating Ventilation Measure

When making attic area measurements, follow the guidelines in **All Insulation – Measurement of Areas**. Check the attic planes for the existence, location, and condition of an existing Class I or II vapor retarder. Examples of Class I or II vapor retarders are: Kraft or foil facing on a batt, polyethylene sheeting, or wallboard with two layers of latex paint. Once you have identified the class of vapor retarder situation, divide the attic area (including vaulted areas) by either 150 if there is no vapor retarder, or 300 if there is a vapor retarder. The result of this calculation is the amount of attic ventilation required by national code. Install roughly half of this ventilation high in the attic and half low in the attic. Next, assess the existing ventilation and calculate the net free area (see below), broken into high and low ventilation, and subtracted from the appropriate high or low ventilation of the code-required ventilation area. (See **Attic, Roof, & Crawlspace Venting – General**.) The results of subtracting the existing ventilation area from the code-required ventilation area is the area of ventilation that needs to be installed to ventilate the attic to code levels.

1. **Continuous soffit venting:** Newer homes may have continuous soffit venting installed when constructed. Continuous soffit venting has a net free area of 0.12 sq. ft. per linear foot. Perforated drip edge is another form of low ventilation. Assess the integrity of the drip edge before giving ventilation credit to it, as it can be crushed during installation and its net free area reduced. In some cases where attic height is very low, gable vents may be used as low ventilation. In these cases, it may be necessary to dam off the gable vent to keep it clear of blown-in insulation.

2. **Net free area vs. gross area:** Code requirements state the amount of ventilation area required as a net free area. Net free area is not the same as the external dimensions of any particular type of vent. Therefore, it is necessary to determine what amount of any vent type is required to satisfy the code guidelines based on the net free area of the vents. Most vents have their net free area stamped on them. Divide the required net free area by the net free area of the vent chosen to determine how many vents of that type are needed to satisfy the ventilation requirement.

SITE CONDITIONS

1. Test the existing condition of the attic plane to be tight by way of the blower door and pressure differential or visual inspection of all bypasses before adding more passive ventilation. If you are going to test the attic plane with a blower door rather than a visual inspection of bypasses, you must use the “Add a Hole” or “Open a Door” method to quantify leakage across the attic plane. To be considered tight, the CFM50 across the attic plane must be less than 0.5 cubic feet per minute at 50 pascals (CFM50)/sq. ft.
2. Make sure all exhaust equipment (bath fans, kitchen fans, clothes dryers) are vented to the outside of the structure. **This measure must be performed in all cases or no insulation or ventilation work will be performed.**
3. Cathedral slopes: You will need to place vents to ensure the desired airflow. In addition to calculating how much net free area is required and how much will be high or low ventilation, you must take a number of other issues into account before deciding what type of vent to install and where to place the vent to ensure that minimum flow rates are achieved. Do not install vent chutes or low vents in bays that dead end in skylights, chimneys, valleys, hips, or other obstructions that will block the flow of ventilation air.

MATERIAL REQUIREMENTS

Inlets

For inlet vents, choose soffit vents in standard sizes of 4x12, 6x12, and 8x12. The common acceptable finishes will be mill, white, or brown. You must use soffit vents that have the net free area of the vent stamped on it. All soffit vents must have insect screens as an integral part of the vent. Spray paint mill-finish soffit vents to match house colors, if the homeowner supplies the paint and labor. Take care when spray painting to avoid reducing the net free area by clogging the insect screen.

Outlets

Gable vents: Standard gable vent sizes are 12x12, 12x18, and 18x24. Standard finishes are mill, white, and brown. Ensure net free area is stamped on the back of the gable vent and that an insect screen is an integral part of the vent. Spray paint mill-finish gable vents to match house colors if the homeowner supplies the paint and labor. Take care when spray painting to avoid reducing the net free area by clogging the insect screen.

Roof vents: The standard roof vent size is 8 inches. Typical colors and finishes are mill, black, grey, and brown. These vents may be made of aluminum or vinyl. Ensure net free area is stamped on the flange of the vent and that an insect screen is an integral part of the vent. Spray paint mill-finish roof vents to match house colors if the homeowner supplies the paint and labor.

Ridge vents: Ridge vents typically come in 4- and 8-foot lengths. Standard colors and finishes are mill, black, and brown. Shingle over ridge vents can be installed if cap shingles are available to complete the installation. Ensure insect screens are an integral part of the ridge vent.

Soffit baffles: Make sure soffit areas are baffled for wind wash protection, to keep a ventilation channel open and to keep blown insulation from entering the soffit area. Baffles can be site-made using rigid foam board, structural insulated sheathing, framing lumber, plywood, or OSB. Preformed baffles are also available, and are allowed to be used.

PRE-INSTALLATION REQUIREMENTS

Air barrier: Verify the existence of a complete air barrier using either a blower door and pressure differentials or by visual inspection of the major bypasses in the attic plane (see **All Air Sealing – General**).

INSTALLATION REQUIREMENTS

1. Soffit vents: Do not install bath, dryer, or heating system vent outlets in or below soffits that provide inlet ventilation to vented roof slopes or attics.
2. Properly flash all vents with roofing and siding materials.
3. Install all vents to manufacturer's specifications, and properly seal to be watertight.
4. Caulk all installed vents thoroughly to prevent any leakage.
5. Cut all vent openings to the appropriate size for the installed unit.
6. Make sure all installed soffit vents have soffit baffles installed in the bays they ventilate.
7. For continuous soffit vent, install soffit baffles in as many bays as is required to meet code requirements for low ventilation based on the net free area of the continuous soffit vent.

POST-INSTALLATION REQUIREMENTS

After installing insulation in attic areas that were either baffled to keep cellulose out of the soffit area or to hold open a ventilation path, check the area to ensure that the baffles kept the soffits clear and the vent path open. Inspect vent chutes installed in enclosed cavities and then blown with insulation to ensure that they stayed in place and are clear.

Net Free Venting Chart

Gable Vent Size	Net Free Square Inches (NFSI)	Gable Vent Size	NFSI	Gable Vent Size	NFSI
12x12 Gable	0.50	4x16 Soffit	0.22	8" Roof	0.35
12x18 Gable	0.75	6x16 Soffit	0.33	12" Roof	1.00
12x24 Gable	1.00	8x16 Soffit	0.44	12" Turbine	4.00
18x24 Gable	1.50	Cont. Soffit	.12/ft.	Ridge	0.13/ft.
Triangle Gable	0.50	2" Pop Vent	0.01	Drip Edge	0.06/ft.

ACTIVE (MECHANICAL) ATTIC VENTING

MATERIAL REQUIREMENTS

1. Ensure the attic fan is rated for continuous use and capable of having its speed adjusted by a rheostat without being damaged, humming, or vibrating.
2. Ensure the attic fan can be controlled by a thermostat that will activate the fan at a preset maximum temperature.

INSTALLATION REQUIREMENTS

1. Ensure all electrical connections that need to be installed for this system are installed by a licensed electrician.
2. Permanently mount the fan to roof or wall framing and have sound attenuators installed to minimize sound and vibration transfer.
3. If you need to install a vent to install the fan, install vent neatly and tie into existing drainage planes. Roof or siding materials must be repaired/restored to original conditions.
4. Ensure the attic plane is sealed as tightly as possible before installing an attic mechanical ventilation system.
5. Set the fan to ventilate the attic space in accordance with Section 406 of the International Mechanical Code. This calls for .02 CFM of supply and exhaust air per sq. ft. of attic area.

BASEMENT & CRAWLSPACE VENTING

GENERAL

If a crawlspace is passively ventilated to the requirements of Section 408.1 and 408.2 of the 2009 IRC (1 sq. ft. of vent area for every 150 sq. ft. of area or 1/1500 if there is a Class I vapor retarder and the vents are correctly placed for cross ventilation) then a mechanical ventilation system is not required. Crawlspaces do not have to be passively vented if:

1. They have a continuous Class I vapor retarder installed with 6-inch overlaps sealed and taped at the seams.
2. You have installed a mechanical ventilation system capable of either exhausting or supplying 1 CFM/50 sq. ft. of area including an air path to conditioned area.
3. The walls are insulated in accordance with Section N1102.2.9 of the 2009 IRC.

MATERIAL REQUIREMENTS

1. Make sure installed fan is rated for continuous use and has a Sone rating of less than 1.0.
2. Ensure fan is controlled by an on/off switch as the fan will not run on a schedule. It will run continuously.
3. If the system is an exhaust system, make sure there is a vent termination with an integral pest screen and a backdraft damper.
4. System ducting must be hard duct.

INSTALLATION REQUIREMENTS

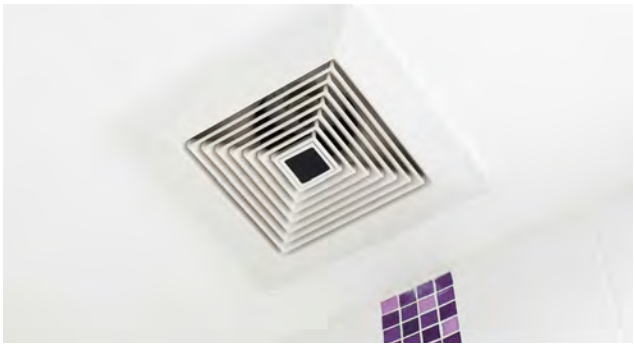
1. Ensure all electrical installations required for installation of this system are installed by a licensed electrician.
2. Securely fasten the fan to the floor framing system and use sound attenuators to minimize the transfer of vibration and sound.
3. Mount the fan control adjacent to the fan and out of easy reach of the homeowner.
4. If this is an exhaust system, hard duct the fan to the exterior with the ducts supported every 10 feet.
5. Neatly install vent termination and tie into the existing drainage plane. Ensure exterior finish surrounding the vent is returned to its original condition.
6. For exhaust systems, make a permanent opening from the conditioned space to the crawlspace large enough to relieve the pressure induced by the fan.
7. For supply systems, duct the fan to conditioned space and ensure it draws air from the house and deposits it in the crawlspace.

VENTILATION SYSTEMS

MECHANICAL VENTILATION SYSTEMS

GENERAL

Fresh air ventilation will be provided per the requirements of ANSI/BPI-1200-S-2015 Standard Practice for Basic Analysis of Buildings and ASHRAE 62.2-2013.



Bath fan.

Mechanical Ventilation Requirements, CFM

Floor Area, sq. ft.	Bedrooms				
	1	2	3	4	5
<500	30	38	45	53	60
501–1,000	45	53	60	68	75
1,001–1,500	60	68	75	83	90
1,501–2,000	75	83	90	98	105
2,001–2,500	90	98	105	113	120
2,501–3,000	105	113	120	128	135
3,001–3,500	120	128	135	143	150

WHOLE HOUSE EXHAUST-ONLY SYSTEMS

MATERIAL REQUIREMENTS

1. Fan specifications: Ensure exhaust fans that will be used as whole house ventilation fans have two qualities: They must be rated for continuous use and they must have a noise rating of 1.0 sones or less. Examples of fans of this type are: ceiling mount fan (Panasonic FV-11VQ2), ceiling mount fan/light (Panasonic FV-11VQ2L), or wall mount fan (Panasonic FV-08WQ1).
2. An in-line fan remotely mounted and connected to one or more bathrooms and controlled by a 24-hour timer is a hybrid of the exhaust-only system. Mount in-line fans with vibration attenuators.
3. Controls: Minimum requirements for the exhaust fan timer are that it is a 24-hour timer capable of turning the fan on and off at preset times without interference by the occupants. Examples of acceptable 24-hour timers are: Tamarack Airetrak control, 24-hour dial timer from Grasselin, 7-day 14-event timer from Aube.

In-line exhaust fan ventilation.

INSTALLATION REQUIREMENTS

1. Install exhaust fans and 24-hour timers neatly and according to manufacturer's installation instructions. Seal all gaps between the fan housing and surrounding finishes with caulk or one-part foam.
2. Ensure fans have an on/off switch separate from the timer that occupants can use for spot ventilation. Place the 24-hour timer remotely, out of easy reach of the occupants.
3. Install fans with air outlet facing in the direction that the duct will be run to minimize the need for elbows.
4. Exhaust location: 2009 IRC Section M1501.1 forbids the venting of exhaust fans of any type into attics, soffit vents, ridge vents, or a crawlspace. Vent exhaust vents to either a roof flapper vent or an end wall flapper vent or, if neither of these two options is available, to an exhaust vent designed to be installed in a soffit. Make sure all exterior flapper vents are equipped with a backdraft damper that works smoothly. Remove all backdraft dampers at the fan unit. Properly flash and seal vent outlets into roof or siding materials so water will not leak into the assembly.
5. Attach exhaust ducting to the fan outlet and the flapper vent connector with metal clamps. Insulate duct to current code levels for the location it passes through and ensure the duct insulation has a vapor retarder covering. Hard duct must be supported every 10 feet with 1-inch metal straps. Flex duct must be supported according to manufacturer's instructions.

WHOLE HOUSE SUPPLY SYSTEMS

GENERAL

A fresh air, positive pressure supply system that depends on the air handler and existing duct system is an acceptable ventilation system. This system consists of a duct run from the exterior to the return plenum of the central heating air conditioning (AC) system with a motorized damper in-line. The third component of this system is a controller that opens the damper in the fresh air duct and then turns on the HVAC system air handler fan on low speed. The negative pressure created by the fan draws fresh air into the HVAC system through the fresh air duct and then distributes the fresh air throughout the house using the existing duct system.

MATERIAL REQUIREMENTS

1. AirCycler controller or similar to control the system.
2. In-line motorized damper for 6-inch hard duct.
3. Industrial grade 6-inch exhaust vent with 1/8-inch steel mesh pest screen with backdraft damper removed.
4. Six-inch metal hard duct.

INSTALLATION REQUIREMENTS

1. For this alternative system it would still be necessary to have localized exhaust ventilation for spot ventilation in the bathrooms and kitchen.
2. Ensure 6-inch fresh air duct is hard-metal-duct-supported every 10 feet. All joints must be screwed together at three points.
3. Seal all joints and seams in the fresh air duct with duct mastic.
4. Ensure fresh air intake vent is not within 10 feet of any pollutant source. In cold climates it must be at least 2 feet above grade. Do not use a backdraft damper as part of this vent. There must be a pest screen. Properly flash the vent and tie into the existing drainage plane. Repair/replace the existing siding to original conditions.
5. Ensure the zone damper is motorized and controlled by the system controller. Low-voltage wiring connecting the two components must run neatly and be properly secured to the 6-inch duct using vinyl straps.
6. Securely mount the system controller on the supply plenum of the HVAC system.
7. Leave the manufacturer's literature for the controller and the motorized damper with the homeowner.

KITCHENS

GENERAL

Make sure kitchen venting at the range hood that vents into an attic space is vented to the exterior. No work can take place until this criteria is met. Kitchen venting must comply with 2009 IRC Sections M1503.

You may treat venting not at the range but in the middle of the room as if it were a bath fan.

MATERIAL REQUIREMENTS

1. Ensure kitchen exhaust fans are capable of exhausting 25 CFM continuously or 100 CFM intermittently. Any kitchen exhaust system that exhausts more than 400 CFM will be required to have a make-up air system that conforms to M1503.4.
2. Only use ducts connected to kitchen range hoods that are constructed of galvanized steel, stainless steel, or copper. Ensure the ducts have a smooth interior surface, are air tight, and have a backdraft damper installed.
3. Ducts in unconditioned areas must be insulated with a fiberglass insulation with a foil facing, meeting 2009 IRC section M1601.3 (such as 3M™ Fire Barrier Duct Wrap 615+).

INSTALLATION REQUIREMENTS

1. Ensure all kitchen exhaust fans vent directly to the exterior, and do not terminate in an attic or crawlspace area.
2. Installed duct for kitchen range hoods are considered a heat source. Seal with fireproof caulk meeting ASTM E136.
3. Install fiberglass insulation with a foil facing, meeting 2009 IRC Section M1601.3 (such as 3M™ Fire Barrier Duct Wrap 615+). Do not use spray foam or insulation with a combustible facing (vinyl duct wrap).
4. Ensure hard ducts are supported at least every 10 feet. All joints in the duct must be screwed securely at three points with no more than 3/8-inch screws.
5. Make sure all kitchen exhaust systems terminate outside of the building. Vent terminations must be equipped with a backdraft damper and be tied neatly into the existing drainage plane and finish.

Kitchen exhaust fan.

GET IN TOUCH

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