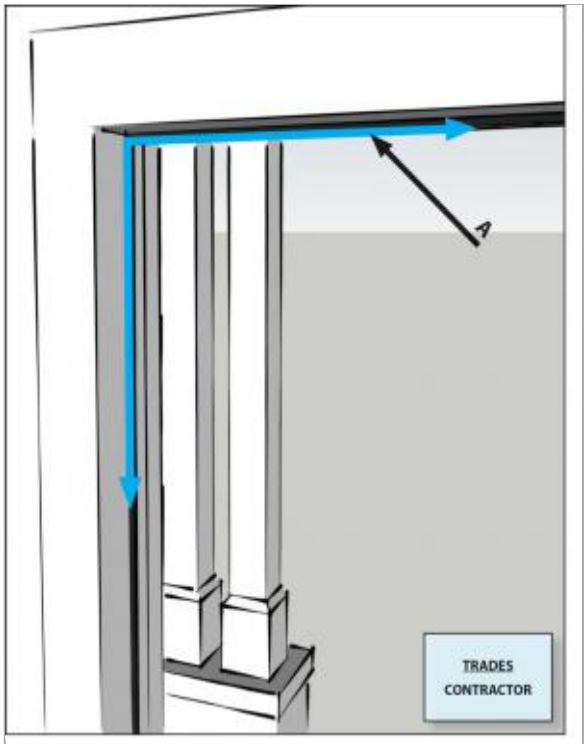
Air Sealing Doors Adjacent to Unconditioned Space

Last Updated: 12/18/2017

Scope



Air seal exterior doors to minimize air leakage.

Air seal doors adjacent to unconditioned space (e.g., outdoors, garages, vented attics, unconditioned basements, cellars, crawlspaces) to minimize air leakage. Weather stripping and sealants (e.g., gaskets, caulk, fire-retardant caulk, etc.) should be compatible with all adjoining surfaces and meet the fire and air barrier specifications according to code.

- Install a continuous gasket, such as weather stripping, around the interior perimeter of the door frame.
- Select an automatic closing door that is metal or fiberglass with an insulated foam-core and an ENERGY STAR rating if possible.
- Air seal the rough opening around the door with foam backer rod, non-expanding spray foam, and/or caulk.
- Flash around the exterior of the door frame with adhesive or liquid-applied waterproof flashing.
- Install a tight-fitting door sweep along the bottom of the door.

See the **Compliance Tab** for related codes and standards requirements, and criteria to meet national programs such as DOE's Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.

Description

Exterior doorways are essentially large holes in the exterior shell of the home connecting the indoors to the outdoors or to other unconditioned spaces like garages, attics, and porches. Doors adjacent to unconditioned spaces should be treated the same way as exterior doors and are required to meet the same code requirements as exterior doors. With proper installation and air sealing, exterior doors do not have to represent a significant source of air leakage and heat loss. Exterior doors are usually sold as a kit with the frame attached. Insulated foam-core, metal or fiberglass ENERGY STAR doors are available and should be selected if possible. When the exterior door is installed in a new house, the rough opening (the space left for the door) is typically 1.5 to 2 inches larger than the door frame to give the installer room to install, plumb, and square the door. Once the door is set in place, some installers will stuff batt insulation into any gaps remaining in the rough opening around the frame. This fiber insulation may provide some insulation value but will not stop air flow. The rough opening should be filled with non-expanding foam or backer rod (a rod-shaped closed-cell foam product) and caulk. On the exterior, the door should be flashed with a fluid-applied or self-adhesive waterproof flashing that is properly integrated with the wall drainage plane and vapor barrier materials before siding is installed. The door frame should be weather stripped and a tight-fitting door sweep should be installed along the bottom of the door.

Air sealing could be done by the framer, the insulation contractor, or the contractor who installs the door. This task should be included in the contract for the appropriate trade depending on the workflow at the specific job site.

How to Air Seal the Exterior Doors

1. Select doors that are self-closing and fire-rated; consider ENERYG STAR-labeled metal- or fiberglass-clad insulated foam core doors.
2. Install the door per the manufacturer's instructions. Install an automatic door closer. Fill the rough opening around the door with non-expanding foam or press backer rod into the wider gaps and seal the seams with caulk. Flash the door frame with adhesive waterproof flashing that is properly integrated with the wall sheathing and house wrap.
3. Install appropriate weather stripping to the door frame and threshold. See the table below for types. To determine how much weatherstripping you will need, add the perimeters of all the doors to be weatherstripped, then add 5% to 10% to accommodate any waste. Weatherstripping should be applied to clean, dry surfaces in temperatures above 20°F (-7° C). Make sure the weatherstripping meets tightly at the corners. Use a thickness that causes the weatherstripping to press tightly between the door and the door jamb when the door closes, without making it difficult to shut.

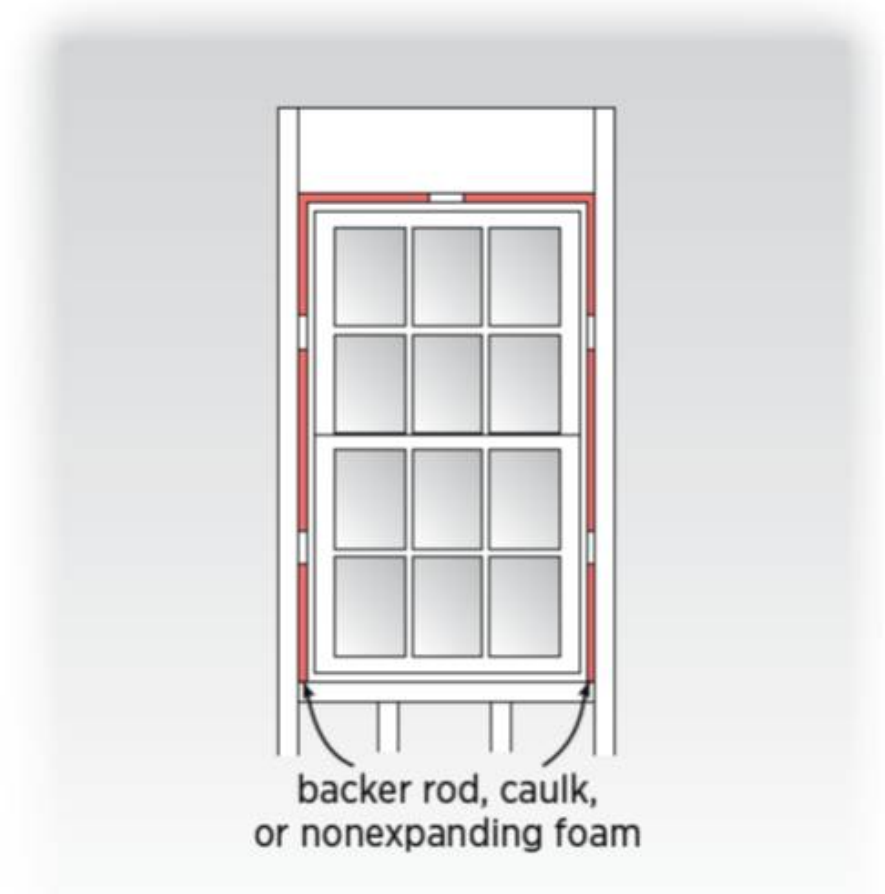


Figure 1 - Air seal door and window rough openings with backer rod, caulk, or nonexpanding foam. (Image courtesy of PNNL)

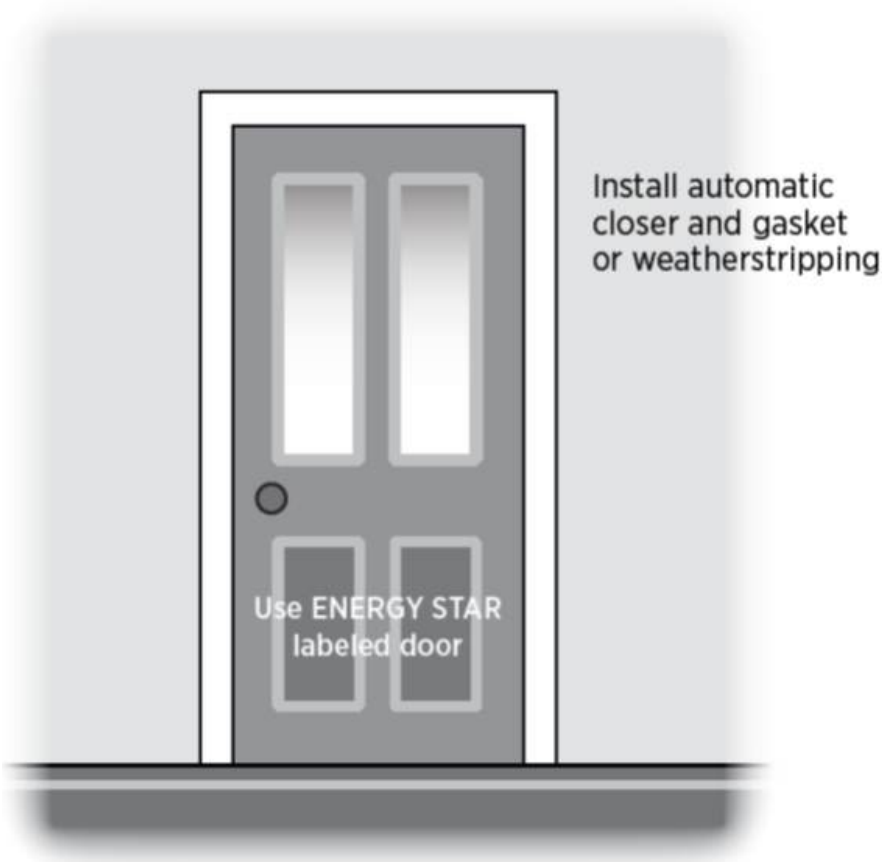


Figure 2 - Install an ENERGY STAR-labeled door with an automatic closer. Weather strip the door frame. (Image courtesy of PNNL)

Types of Weatherstripping (DOE 2012):

Weatherstripping	Best Uses	Cost	Advantages	Disadvantages
Tension seal: Self-stick plastic (vinyl) folded along length in a V-shape or a springy bronze strip (also copper, aluminum, and stainless steel) shaped to bridge a gap. The shape of the material creates a seal by pressing against the sides of a crack to block drafts.	Inside the track of a double-hung or sliding window, top and sides of door.	Varies	Durable, invisible when in place, very effective. Vinyl is fairly easy to install. Look of bronze works well for older homes.	Surfaces must be flat and smooth for vinyl. Can be difficult to install, as corners must be snug. Bronze must be nailed in place (every three inches or so) so as not to bend or wrinkle. Can increase resistance in opening/closing doors or windows. Self-adhesive vinyl available. Some manufacturers include extra strip for door striker plate.
Felt: Plain or reinforced with a flexible metal strip; sold in rolls. Must be stapled, glued, or tacked into place. Seals best if staples are parallel to length of the strip.	Around a door or window (reinforced felt); fitted into a door jamb so the door presses against it.	Low	Easy to install, inexpensive.	Low durability; least effective at preventing airflow. Do not use where exposed to moisture or where there is friction or abrasion. All-wool felt is more durable and more expensive. Very visible.
Reinforced foam: Closed-cell foam attached to wood or metal strips.	Door or window stops; bottom or top of window sash; bottom of door.	Low	Effective sealer, scored well in wind tests, rigid.	Can be difficult to install; must be sawed, nailed, and painted. Very visible. Manufacturing process produces greenhouse gas emissions.

Weatherstripping	Best Uses	Cost	Advantages	Disadvantages
Tape: Nonporous, closed-cell foam, open-cell foam, or EDPM (ethylene propylene diene monomer) rubber.	Top and bottom of window sash; door frames; attic hatches and inoperable windows. Good for blocking corners and irregular cracks.	Low.	Extremely easy to install, works well when compressed, inexpensive. Can be reinforced with staples.	Durability varies with material used, but not especially high for all; use where little wear is expected; visible.
Rolled or reinforced vinyl: Pliable or rigid strip gasket (attached to wood or metal strips.)	Door or window stops; top or bottom of window sash; bottom of a door (rigid strip only).	Low-Mod.	Easy installation, low to moderate cost. Self-adhesive on pliable vinyl may not adhere to metal; some types of rigid strip gaskets provide slot holes to adjust height, increasing durability. Comes in varying colors to help with visibility.	Visible.
Door sweep: Aluminum or stainless steel with brush of plastic, vinyl, sponge, or felt.	Bottom of interior side of in-swinging door; bottom of exterior side of exterior-swinging door.	Mod-high.	Relatively easy to install; many types are adjustable for uneven threshold. Automatically retracting sweeps also available, which reduce drag on carpet and increase durability.	Visible. Can drag on carpet. Automatic sweeps are more expensive and can require a small pause once door is unlatched before retracting.
Magnetic: Works similarly to refrigerator gaskets.	Top and sides of doors, double-hung and sliding window channels.	High	Very effective air sealer.	
Tubular rubber and vinyl: Vinyl or sponge rubber tubes with a flange along length to staple or tack into place. Door or window presses against them to form a seal.	Around a door.	Mod-high.	Effective air barrier.	Self-stick versions challenging to install.
Reinforced silicone: Tubular gasket attached to a metal strip that resembles reinforced tubular vinyl	On a doorjamb or a window stop.	Mod-high.	Seals well.	Installation can be tricky. Hacksaw required to cut metal; butting corners pose a challenge.
Door shoe: Aluminum face attachment with vinyl C-shaped insert to protect under the door.	To seal space beneath door.	Mod-high.	Sheds rain on the exterior, durable. Can be used with uneven opening. Some door shoes have replaceable vinyl inserts.	Fairly expensive; installation moderately difficult. May require door bottom planing.
Bulb threshold: Vinyl and aluminum	Door thresholds.	Mod-high.	Combination threshold and weatherstrip; available in different heights.	Wears from foot traffic; relatively expensive.
"Frost-brake" threshold: Aluminum or other metal on exterior, wood on interior, with door-bottom seam and vinyl threshold replacement.	To seal beneath a door.	Mod-high.	The use of different materials means less cold transfer. Effective.	Moderately difficult to install, involves threshold replacement.
Fin seal: Pile weatherstrip with plastic Mylar fin centered in pile.	For aluminum sliding windows and sliding glass doors.	Mod-high.	Very durable.	Can be difficult to install.

Weatherstripping	Best Uses	Cost	Advantages	Disadvantages
Interlocking metal channels: Enables sash to engage one another when closed	Around door perimeters.	High.	Exceptional weather seal.	Very difficult to install as alignment is critical. To be installed by a professional only.

Ensuring Success

Visually inspect exterior doors to see that weather stripping has been installed and that doors fit snugly with no air movement around perimeter or along trim when the door is closed. Verify that doors open freely with no drag on the threshold. Visually inspect that rough openings around door frames are air sealed before the drywall or door trim is installed. Check for air movement around the closed door and door trim with a smoke pencil or hand. Leaks will be easier to detect during a blower door test.

Climate

Exterior doors should meet U-factor requirements for the home's climate zone, as required by local building codes. See the Compliance Tab.

Training

Right and Wrong Images

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CAD

None Available

Compliance

The Compliance tab contains both program and code information. Code language is excerpted and summarized below. For exact code language, refer to the applicable code, which may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

ENERGY STAR Certified Homes (Version 3, Rev. 08)

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

Thermal Enclosure System:

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

4.9 Doors adjacent to unconditioned space (e.g., attics, garages, basements) or ambient conditions made substantially air-tight with weatherstripping or equivalent gasket

ENERGY STAR Revision 08 requirements are required for homes permitted starting 07/01/2016.

DOE Zero Energy Ready Home

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

AAMA/WDMA/CSA 101/I.S.2/A440-08 NAFS

North American Fenestration Standard/Specification for Windows, Doors, and Skylights. Available from AAMA. This is a voluntary standard/specification that covers requirements for the following components for new construction and retrofits: single and dual windows, single and dual side-hinged door systems, sliding doors, tubular daylighting devices, and unit skylights.

ASTM E-2112-07 and ASTM E-2112-18

Standard Practice for Installation of Exterior Windows, Doors and Skylights. Available from ASTM. The standard covers fenestration product installation from pre-installation through post-installation procedures in new and existing construction.

2009 IECC and 2009 IRC

IECC Table 402.4.2/IRC Table N1102.4.2. Air Barrier and Insulation Inspection Component Criteria, Windows and doors: Seal space between window/door jambs and framing.

2009 IECC 402.4.1/ IRC N1102.4.1 Air leakage, Building Thermal Envelope - The building thermal envelope should be constructed to limit air leakage. Methods used to seal between dissimilar materials should allow for differential expansion and contraction. Sources of infiltration (see listing below) should be caulked, gasketed, weather-stripped, or otherwise sealed with an air-barrier material, suitable film, or solid material: All joints, seams, and penetrations, Utility penetrations, Rim joist junction, Other sources of infiltration.

2012, 2015, and 2018 IECC / 2012, 2015, and 2018 IRC

IECC Table R402.4.1.1/IRC Table N1102.4.1.1. Air Barrier and Insulation Installation, Windows, skylights and doors: Seal space between window/door jambs and framing and skylights and framing. Table R402.4.1.1 Air Barrier and Insulation Installation, Narrow cavities: Batts in narrow cavities are cut to fit; or narrow cavities are filled with insulation that readily fills the available cavity space. Continuous air barrier. Confirm that construction documents specify a continuous air barrier for the building components associated with the insulation of the exterior wall(s). Breaks or joints in the air barrier should be sealed. Air-permeable insulation should not be used as a sealing material.

2015 IECC/IRC, R402.4./N1102.4 Air Leakage. The building thermal envelope should be constructed to limit air leakage.

R402.4.1/N1102.4.1 Building Thermal Envelope. Methods used to seal between dissimilar materials should allow for differential expansion and contraction.

R402.4.1.1/N1102.4.1.1 Installation. The components listed in the Air Barrier and Insulation Installation Table should be installed in accordance with the manufacturer's instructions and the criteria listed as the applicable method of construction.

Retrofit: 2009, 2012, 2015, and 2018 IECC

Section R101.4.3 (Section R501.1.1 in 2015 and 2018 IECC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)

Retrofit: 2009, 2012, 2015, and 2018 IRC

Section N1101.3 (Section N1107.1.1 in 2015 and 2018 IRC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)

Appendix J regulates the repair, renovation, alteration, and reconstruction of existing buildings and is intended to encourage their

continued safe use.

More Info.

Access to some references may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

Case Studies

1. **New Whole-House Solutions Case Study: Nelson Construction: Hamilton Way, Farmington, CT**
   (662KB)
   Author(s): PNNL
   Organization(s): PNNL
   Publication Date: April, 2012
   Case study about design and testing 10 high-performance homes in Farmington, Connecticut.

References and Resources*

1. **ASTM E2112-18: Standard Practice for Installation of Exterior Windows, Doors and Skylights**
   Author(s): American Society for Testing and Materials
   Organization(s): American Society for Testing and Materials, ASTM
   Publication Date: January, 2018
   Standard covering the installation of fenestration products in new and existing construction.

2. **Building America Best Practices Series, Volume 10: Retrofit Techniques and Technologies: Air Sealing**
   Author(s): Baechler, Gilbride, Hefty, Cole, Williamson, Love
   Organization(s): Pacific Northwest National Laboratory, Oak Ridge National Laboratory
   Publication Date: April, 2010
   Report identifying the steps to take, with the help of a qualified home performance contractor, to seal unwanted air leaks while ensuring healthy levels of ventilation and avoiding sources of indoor air pollution.

3. **DOE Zero Energy Ready Home National Program Requirements**
   Author(s): Department of Energy
   Organization(s): DOE
   Publication Date: April, 2017
   Standard requirements for DOE's Zero Energy Ready Home national program certification.

4. **ENERGY STAR Certified Homes, Version 3 (Rev. 08) National Program Requirements**
   Author(s): U.S. Environmental Protection Agency
   Organization(s): EPA
   Publication Date: December, 2015
   Webpage with links to Document outlining the program requirements for ENERGY STAR Certified Homes, Version 3 and 3.1 (Rev. 08).

5. **North American Fenestration Standard/Specification for Windows, Doors, and Skylights**
   Author(s): American Architectural Manufacturers Association
   Organization(s): American Architectural Manufacturers Association
   Publication Date: May, 2008
   Standard covering requirements for single and dual windows, single and dual side-hinged door systems, sliding doors, tubular daylighting devices, and unit skylights for new construction and replacement applications.

6. **Thermal Enclosure System Rater Checklist Guidebook**
   Author(s): U.S. Environmental Protection Agency
   Organization(s): EPA
   Publication Date: October, 2011
   Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

7. **Weatherstripping**
   Author(s): Department of Energy
   Organization(s): DOE
   Publication Date: May, 2012
   Information sheet explaining how weatherstripping can be an easy and cost-effective way to save money on energy costs and improve comfort by reducing drafts.

*Publication dates are shown for formal documents. Dates are not shown for non-dated media. Access dates for referenced, non-dated media, such as web sites, are shown in the measure guide text.

Contributors to this Guide

The following authors and organizations contributed to the content in this Guide.

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