Air Sealing Window and Door Rough Openings

**Scope**

Air seal the rough opening around doors and windows to minimize air leakage.

- Fill the rough opening around windows and exterior doors with caulk, canned spray foam, or foam backer rod. If spray foam, use a low-expansion foam designated for doors and windows.
- Do not rely on fibrous insulation alone to block airflow; it will not air seal.

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

Window and door rough openings are essentially big holes in the building envelope, and while these holes get filled with window and door units, the gaps between the units and the framing rough openings can be major sites for uncontrolled air leakage in a home (DOE 2000). However, by sealing these rough opening gaps, this air leakage can be significantly reduced. A study conducted at Oak Ridge National Laboratory’s Buildings Technology Center on window air sealing showed that windows with 3/4-inch rough-in gaps had an equivalent leakage area of 28.2 cm²/m². When the gap was sealed from the interior side of the wall, the equivalent leakage area was cut to 0.5 cm²/m² (Baechler et al. 2010).

Sealing the gaps between window and door units and the framing rough openings requires care and precision. Unlike other parts of the air barrier on exterior walls, which have layers of redundancy, the seal around a window and door unit stands on its own: usually only a single closure separates the indoor air from the outdoors (BSC 2009).

Window and Door Sealing Materials

Too often, an attempt to seal around a window or door unit is made by stuffing the gap with fiberglass insulation. However, fiberglass is not an air barrier; air can readily seep through the insulation fibers. Instead, the gap should be filled with one or more of the following materials (DOE 2000):

- Backer rod comes in both open- and closed-cell varieties. Only closed-cell products (usually made of polyethylene foam) should be used for sealing window and door rough openings, as open-cell foams can absorb and hold moisture. Closed-cell backer rod is typically stocked at hardware stores in 1/4 to 1-1/2-inch-diameters, and sold by the foot from a reel. Larger diameter backer rod (up to 4 inches) is also available in 6- or 7-foot lengths. Always use backer rod that is wider than the gap, so it can be pressed firmly into the gap and create a tight seal.

![Figure 1 - Closed-Cell Backer Rod for Air Sealing Window and Door Rough Openings](image)

- Caulk can be used to seal smaller gaps less than 1/2 inch wide. Caulk has the advantage of providing a more positive seal in irregular gaps, and when applied carefully, can create a tight seal around the shims used to install window and door units. For best results, use a silicone or polyurethane sealant that will shrink less than acrylic products when fully cured (Jackson 1997).

- Nonexpanding foam can be used to quickly and effectively seal the gap between the wall framing and window or door unit. It is important to use a nonexpanding product specially formulated for use as a window or door sealant. Ordinary expanding foam can swell with enough force to distort the jambs, and cause problems with operating the windows and doors. Use of ordinary expanding foam will often void window and door warranties.
Air Sealing Window and Door Rough Openings

Air sealing window and door rough openings is typically done by the insulation contractor, but in some cases it may be done by the window and door installer or by the finish carpenter prior to installing window and door trim.

With the window or door unit permanently installed in the rough opening, air seal the opening as follows:

1. Trim back the shims securing the window or door unit to the wall framing. If possible, try to cut these back behind the interior face of the wall and jambs, so that sealant can be applied over the shims for a tighter seal.

2. Apply the sealant toward the interior edge of the window or door unit. Using this approach, the gap to the exterior can drain freely and will be pressure equalized with the exterior, which limits the potential for an air pressure difference to force water into the joint (BSC 2009).
○ With backer rod: Press the backer rod into the gap between the wall framing and the window or door unit. Use a flat bar to push it in. Apply even pressure; don't force it in, or the tool will tear the backer rod. Push the backer rod to an even depth. If caulk will be applied over it, take care to create an even surface that will provide a uniform substrate for the caulk.

○ With caulk: If the gap is less than 1/2 inch wide, apply caulk over the backer rod for a tighter seal. Caulk should always be applied against backer rod, not just squeezed into the gap. Tool the bead against the backer rod. This will create an hour-glass shape (see Figure 3 below), which allows the sealant to expand and contract over time without cracking. Without the backer rod, the bead of caulk would be too thick and would be prone to cracking when it cures, and it would be resistant to flexing with movements in the building materials of the wall system as they change dimension with seasonal changes in temperature and humidity.

○ With nonexpanding foam, wear gloves when applying spray foam; the foam has an especially aggressive bond that will adhere to skin. Insert the spray nozzle about half an inch into the gap between the wall framing and the window or door unit. Keep the spray nozzle moving at a steady speed while applying the foam: Too slow and the foam will fill too much of the cavity; too fast will result in gaps in the bead.

3. With all types of sealant materials, pay close attention near the shims that hold the unit in the rough opening. It is important that the sealant fit tightly around these obstacles in the sealant path.

![Diagram of sealant installation with backer rod and caulk.]
Ensuring Success

Visual Inspection
Visually inspect the seals between the window rough openings and the window and door units prior to installing interior finish materials. The seal from caulk or nonexpanding foam should be uniform without any visible gaps.

Blower Door Testing with Smoke Pencil Diagnostics
Blower door testing, conducted as part of whole-house energy performance testing, may help indicate whether windows have been successfully sealed. With the blower door pressurizing the house, use a smoke pencil to check for air around windows. A smoke trail moving away from the smoke pencil into the wall around the window or door unit indicates a leak that should be sealed.
Thermal Enclosure System.

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

4.6 Rough opening around windows & exterior doors sealed.\(^{28}\)

Footnote 28) In Climate Zones 1 through 3, a continuous stucco cladding system sealed to windows and doors is permitted to be used in lieu of sealing rough openings with caulk or foam.
Training

Right and Wrong Images

Display Image: ES_TESRC_5.2.4_PG146_308b_102811_0.jpg
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 3/3.1 (Rev. 09)

National Rater Field Checklist

Thermal Enclosure System.

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

4.6 Rough opening around windows & exterior doors sealed.\footnote{Footnote 28) In Climate Zones 1 through 3, a continuous stucco cladding system sealed to windows and doors is permitted to be used in lieu of sealing rough openings with caulk or foam.}

Please see the ENERGY STAR Certified Homes Implementation Timeline for the program version and revision currently applicable in your state.

DOE Zero Energy Ready Home (Revision 07)

Exhibit 1 Mandatory Requirements.

Exhibit 1, Item 1) Certified under the ENERGY STAR Qualified Homes Program or the ENERGY STAR Multifamily New Construction Program.

AAMA/WDMA/CSA 101/1.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.

ANSI/BHMA

Door Gasketing and Edge Seal Systems. Available from ANSI. This standard sets performance and installation of gasketing systems applied to doors and/or frames. It includes definitions, general information, and tests.

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


2009 IECC

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

2012, 2015, and 2018 IECC

Table R402.4.1.1 Air Barrier and Insulation Installation, Windows, skylights and doors: Seal space between window/door jambs and framing and skylights and framing.


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.)

2009 IRC

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

2012, 2015, and 2018 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.


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
None Available

References and Resources*

1. **2009 IECC - International Energy Conservation Code**  
   Author(s): International Code Council  
   Organization(s): ICC  
   Publication Date: January, 2009  
   Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems and service water heating systems in homes and commercial businesses.

2. **2009 IRC - International Residential Code for One and Two Family Dwellings**  
   Author(s): International Code Council  
   Organization(s): ICC  
   Publication Date: January, 2009  
   Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

   Author(s): International Code Council  
   Organization(s): ICC  
   Publication Date: January, 2012  
   Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems and service water heating systems in homes and commercial businesses.

4. **2012 IRC - International Residential Code for One and Two Family Dwellings**  
   Author(s): International Code Council  
   Organization(s): ICC  
   Publication Date: January, 2012  
   Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

5. **2015 IECC - International Energy Conservation Code**  
   Author(s): International Code Council  
   Organization(s): ICC  
   Publication Date: May, 2014  
   Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems and service water heating systems in homes and commercial businesses.

6. **2015 IRC - International Residential Code for One and Two Family Dwellings**  
   Author(s): International Code Council  
   Organization(s): ICC  
   Publication Date: May, 2014  
   Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

7.  

*References and Resources are subject to change. Please refer to the latest version for the most accurate information.
2018 IECC - International Energy Conservation Code
Author(s): International Code Council
Organization(s): ICC
Publication Date: November, 2017
Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems, and service water heating systems in homes and commercial businesses.

8. 2018 IRC - International Residential Code for One and Two Family Dwellings
Author(s): International Code Council
Organization(s): ICC
Publication Date: August, 2017
Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

9. Air Sealing Windows for All Climates, Information Sheet 406
Author(s): Building Science Corporation
Organization(s): Building Science Corporation
Publication Date: May, 2009
Brochure about air sealing windows.

10. 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.

Author(s): Jackson
Organization(s): Journal of Light Construction
Publication Date: October, 1997
Document providing guidance about choosing the correct caulk for a project.

12. DOE Zero Energy Ready Home National Program Requirements (Rev. 07)
Author(s): U.S. Department of Energy
Organization(s): DOE
Publication Date: May, 2019
Standard requirements for DOE's Zero Energy Ready Home national program certification.

Author(s): American National Standards Institute
Organization(s): American National Standards Institute
Publication Date: January, 2012
Standard establishing requirements for the performance and installation of gasketing systems including intumescents applied to, or mortised to doors, frames or both.

14. ENERGY STAR Certified Homes, Version 3/3.1 (Rev. 09) National Program Requirements
Author(s): U.S. Environmental Protection Agency
Organization(s): EPA
Publication Date: September, 2018
Webpage with links to documents providing the program requirements and checklists for ENERGY STAR Certified Homes (Ver. 3/3.1, Rev. 09).

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.

16.
Retrofit Techniques & Technologies: Air Sealing, A Guide for Contractors to Share with Homeowners
Author(s): Baechler, Gilbride, Cole, Williamson, Love, Hefty
Organization(s): Pacific Northwest National Laboratory, Oak Ridge National Laboratory
Publication Date: April, 2010
Report identifying steps to seal unwanted air leaks while ensuring healthy levels of ventilation and avoiding sources of indoor air pollution.

17. Technology Fact Sheet - Air Sealing
Author(s): Southface Energy Institute, ORNL
Organization(s): DOE
Publication Date: November, 1999
Brochure with information for homeowners about the benefits of air sealing.

18. 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.

*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.

Building Science Corporation, lead for the Building Science Consortium (BSC), a DOE Building America Research Team
Pacific Northwest National Laboratory