

Garage Rim/Band Joist Adjoining Conditioned Space

Last Updated: 03/14/2016

Scope



Air seal and insulate the rim and band joists of walls separating an attached garage from the home's conditioned space.

Air seal and insulate the rim and band joists of walls separating an attached garage from the home's conditioned space.

- Design the garage so that floor joists run parallel to the wall separating the garage from the living space forming a natural air barrier or use a rigid air barrier material to block open rim joists. Rigid air barrier materials could include rigid foam insulation, drywall, plywood, or OSB, among others.
- Air seal any seams, gaps or holes in the rim joist or joist bay blocking material using caulk or foam.
- Insulate the rim joist area to code-required levels using rigid foam, spray foam, or a combination of rigid or spray foam and batt insulation.
- Ensure that the air barrier is continuous and in full contact with the insulation.
- If spray foam insulation is used for the wall cavity insulation, the spray foam can serve as the air barrier if it is at least 5.5 inches thick if open-cell or at least 1.5 inches thick if closed-cell spray foam insulation.
- ENERGY STAR requires that an air barrier be installed at the exterior vertical surface of the wall insulation in all climate zones and also that an air barrier be installed at the interior vertical surface in IECC [Climate Zones 4-8](#) ([ENERGY STAR 2015](#)).

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

Attached garages can be a significant source of indoor air pollutants. Fumes from cleaning chemicals, garden fertilizers, pesticides, and vehicle exhaust are among the many contaminants that can be drawn into homes from attached garages if the walls and doors between the home and the garage aren't adequately air sealed. Open joist bays above the garage that extend into living spaces are one air pathway. Airflow through cracks between and around the boards of the rim joist, the top plate, and the sill plate-foundation wall intersections are other areas where air can flow through if seams aren't adequately sealed. Certain conditions in the home can cause the home to become depressurized, making it even more likely for garage air to be drawn into the home through leaks in and around the rim joists. Depressurization can occur when the house is airtight and an exhaust fan, range hood, clothes dryer, or combustion appliance is operated, if adequate makeup air is not provided to the house through a fresh air intake (a duct that brings outside air to the return side of the air handler).

For occupant health and safety, consider designing homes with detached garages. If attached, the garage should be completely air sealed from the living areas of the house. When garage ceiling joists span both the living space and the garage, the joist bay cavities must be blocked off and sealed. It is preferable to design the garage so that rim joists run parallel with the adjoining wall to act as a natural air barrier. The rim joists should be insulated and all seams where components (including the rim joist, top plate, and subfloor) come together should be sealed with caulk, spray foam, or foam gaskets. Seams between the bottom plate and the slab of the adjoining wall should also be caulked, foamed, or gasketed. This air sealing could be done by the framer or the insulation installer. This task should be included in the contract for the appropriate trade depending on the workflow at the specific job site.

If the air handler for a central furnace must be located in the garage, it should be in an air-sealed closet with a dedicated air intake for combustion, a flue that exhausts to the outside, and a fresh-air intake ducted from the outside to the return plenum so that it is not drawing garage air to circulate through the house. Do not have supply or return registers in the garage. Determine whether a garage exhaust fan is advisable.

Install carbon monoxide detectors inside the home.

How to Air Seal the Rim Joist between the Garage and Living Space Using Rigid Foam

1. Design walls adjoining garages so that the rim joist board runs parallel to the wall, providing a continuous natural air break. Where ceiling joists run perpendicular to the adjoining wall, one option is to make the rim joist continuous and have separate but aligned ceiling joists on each side of the rim joist (Figure 1).

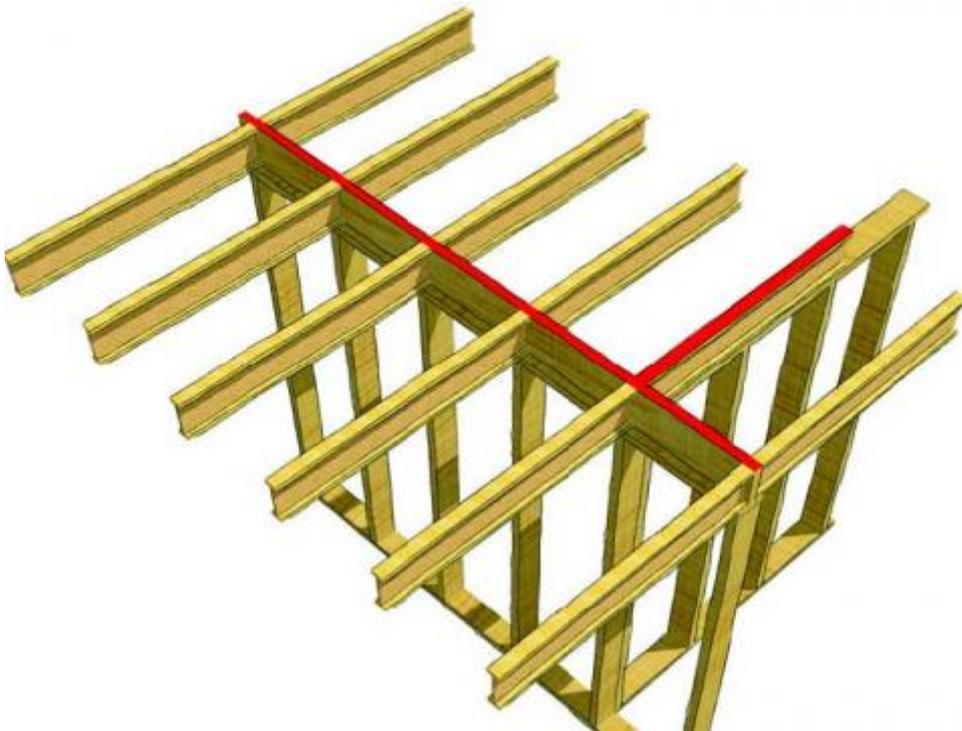


Figure 1. A continuous rim joist separates the garage ceiling joist bays from the living space ceiling joist bays. 

2. Cut a rectangle of rigid foam (polyisocyanurate or extruded polystyrene) to fit into each floor joist bay cavity. If the joist bay is open (Figure 2), make a backstop for the foam board by tacking furring strips to the framing in line with the foundation or house wall.



Figure 2. The ceiling joist bays above the garage wall are open to the adjoining living space. [i](#)

3. Insert rigid foam pieces into each joist bay (Figure 3).



Figure 3. Fitting rigid foam in garage wall rim joist cavities to insulate and serve as an air barrier. [i](#)

4. Use caulk or spray foam to air seal all four edges in each bay (Figure 4). Make sure to completely air seal around the rigid foam to prevent moist air from reaching and condensing on the rim joist.



Figure 4. Caulk around each piece of rigid foam in garage wall rim joist cavities. [i](#)

5. Add an additional layer of rigid foam or batt insulation to meet or exceed the code-required insulation level for an exterior wall.

How to Air Seal the Rim Joist between the Garage and Living Space Using Spray Foam

1. Use urethane spray foam insulation to cover the rim joist and seam with the top plate or subfloor (Figure 5). Spray foams that are high density (closed cell, 2 pounds/cubic foot) or low density (open cell, 0.5 pounds/cubic foot) can provide acceptable results; open-cell foams might require additional vapor and condensation control measures in IECC Climate Zone 6 and higher. Foam can be applied by a spray foam subcontractor or by trades using two-part spray foam kits.

Spray foam in band joists is typically concealed between floors, so no other thermal barrier is required. However, the International Residential Code (2009 IRC and 2012 IRC R316.5.11) allows the spray foam at rim joists to be exposed (i.e., without a 15-minute thermal barrier such as drywall) as long as the thickness is less than 3-¼ inch, the foam has a density between 0.5 and 2.0 pounds per cubic foot (PCF), and the foam has a flame spread index of ? 25 and a smoke index of ? 450 when tested in accordance with ASTM E 84. High-density (closed-cell, 2-PCF) spray foams were approved in the 2003 IRC and low-density (open-cell, 0.5-PCF) foams were approved in the 2009 IRC, as well as any intermediate densities ([BSC 2009](#)).

Although open-cell spray foam is acceptable in this application, closed-cell spray foam is preferred in hot-humid or extreme cold climates (IECC Climate Zones 1A, 2A, 7, and 8) ([CARB 2009](#)).



Figure 5. Spray foam insulates the rim joist and air seals the subfloor-rim joist and rim joist-top plate connections i

2. For additional protection when living space is located above the garage, consider a “flash” seal approach - spray the entire ceiling of the garage with a thin layer of foam to air seal any cracks, holes, or seams in the subfloor. Then add batt insulation to meet the insulation R-value requirement (Figure 6). This reduces costs compared to filling joists to the required thickness with spray foam alone. Cover the ceiling insulation with taped and mudded drywall.



Figure 6. Garage ceiling with spray foam flash air seal plus batt insulation i

Other Considerations

1. Seal all penetrations through the common wall and ceiling. Use gaskets, airtight drywall technique, etc., to make the common wall and ceiling airtight. Caulk or spray foam the garage slab-foundation wall junction.
2. Install a self-closing, insulated, metal, fire-rated door with a good weather seal between the living space and the garage.
3. Install a passive roof vent to keep the garage at a negative pressure in relationship to the house or consider installing a timer-operated exhaust fan that vents to the outside.

4. If the central HVAC system is installed in the garage, install a closed-combustion unit that draws intake combustion air from outside, vents exhaust air to outside, and has a fresh air intake ducted to the outside. Install the unit in an air-sealed closet. Mastic seal any ducts located in the garage. Do not install any return registers in the garage.

Ensuring Success

If the home has an attached garage, visually inspect for cracks or improper sealing along the rim joist above walls separating the garage from the home. For joist bays that extend from over the garage ceiling to over or under living areas of the house, the joist bay cavities should be blocked off at the common wall with a rigid air barrier that is caulked or foamed at all edges and insulated. Rim joists that run parallel to the shared wall should be air sealed and insulated..

Blower door testing conducted as part of the whole-house energy performance testing can indicate if the garage is sealed off from the house. It can also be used to determine whether the rim joists have been successfully air sealed. With the home depressurized, check for air leaks at the rim joist with a smoke pencil or infrared camera. Blower door testing can also help determine if the home is depressurized compared to the outside. If so, additional ventilation may be called for to prevent garage fumes from being pulled into the home.

The following actions are also recommended to ensure that garage air is separated from house air. Visually inspect for cracks along the base of garage walls that adjoin living space and along sill plates on top of foundation walls on adjoining walls. Visually inspect that all penetrations through adjoining walls and garage ceilings below living spaces are sealed. Test the seal tightness of doors linking the garage with the rest of the home. Visually inspect that furnaces installed in the garage have cabinets and ducts that are air sealed with mastic or metal tape or, preferably, that furnaces are installed in an air-sealed closet. No return air registers should be installed in the garage. Any ducts installed in the garage should be sealed with mastic and tested for air tightness.

Climate

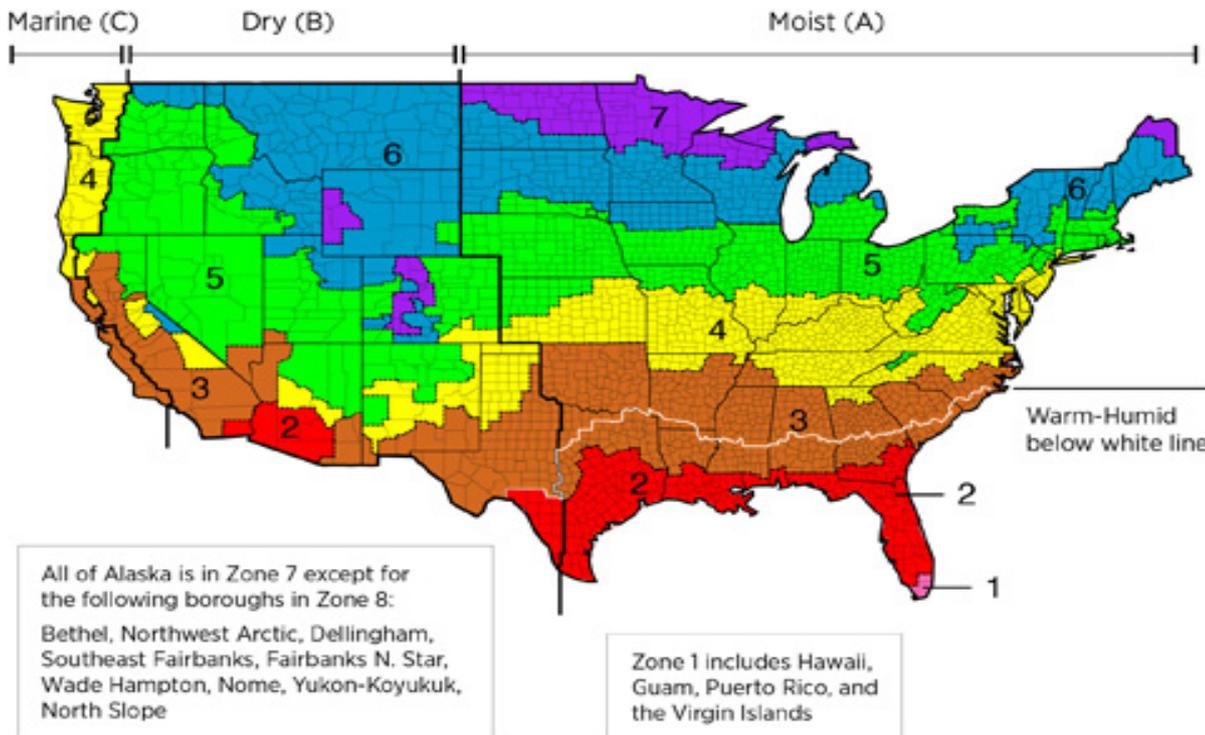
If the rim joists are to be sealed with spray foam, although both open-cell and closed-cell spray foam are acceptable in this application, closed-cell spray foam is preferred in hot-humid or extreme cold climates (IECC Climate Zones 1A, 2A, 7, and 8) ([CARB 2009](#)).

ENERGY STAR Certified Homes

ENERGY STAR Certified Homes (Ver. 3/3.1 Ver 08) Rater Field Checklist, A complete air barrier that is fully aligned with insulation is installed at the exterior vertical surface of wall insulation in all climate zones and also at the interior vertical surface of wall insulation in Climate Zones 4-8.

DOE Zero Energy Ready Home

DOE Zero Energy Ready Home (Rev 05) Exhibit 2: Infiltration: Climate Zones 1-2: 3 ACH 50; Zones 3-4: 2.5 ACH50; Zones 5-7: 2 ACH50; Zone 8: 1.5 ACH50. Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.



International Energy Conservation Code (IECC) Climate Regions

Training

Right and Wrong Images



Display Image: [ES_TESRC_3.1.8_PG70_88b_102811_0.jpg](#)

Reference: [Thermal Enclosure System Rater Checklist Guidebook](#)

Author(s): EPA

Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.



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Author(s): EPA

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Organization(s): EPA

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Reference: [Thermal Enclosure System Rater Checklist Guidebook](#)

Author(s): EPA

Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.



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Reference: [Thermal Enclosure System Rater Checklist Guidebook](#)

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Reference: [Thermal Enclosure System Rater Checklist Guidebook](#)

Author(s): EPA

Organization(s): EPA

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Author(s): EPA

Organization(s): EPA

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Author(s): EPA

Organization(s): EPA

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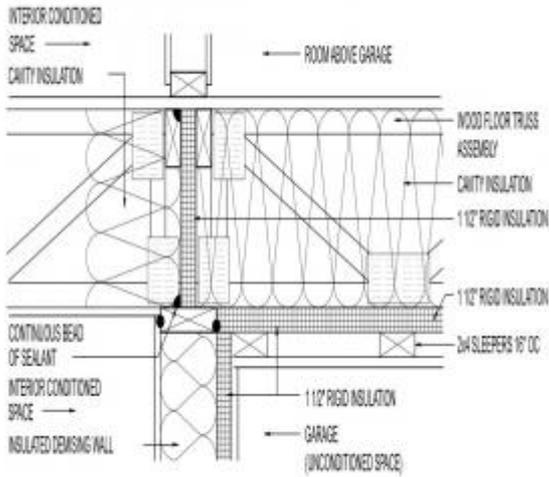
Reference: [Thermal Enclosure System Rater Checklist Guidebook](#)

Author(s): EPA

Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

CAD



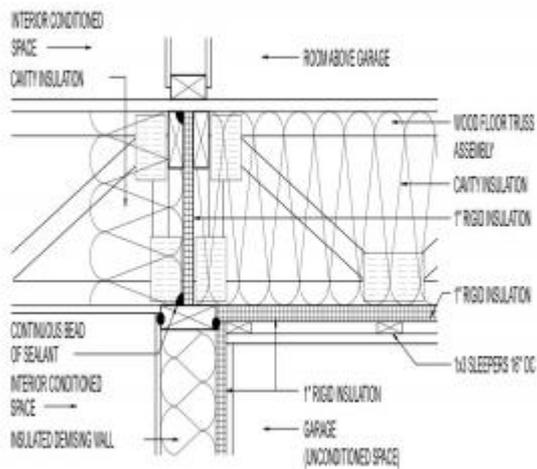
CAD FILE: [318 CAD 1-2 Air_barrier_garage_band_joist_1-5-inch_rigid_foam_2x4_sleeper_5-01001_GBA_1-31-12.dwg](#)
PDF: [318 CAD 1-2 Air_barrier_garage_band_joist_1-5-inch_rigid_foam_2x4_sleeper_5-01001_GBA_1-31-12.pdf](#)

Reference: [Building Plans for Advanced Framing](#)

Author(s): Green Building Advisor

Organization(s): Green Building Advisor

Website providing CAD files and drawings of advanced framing details.



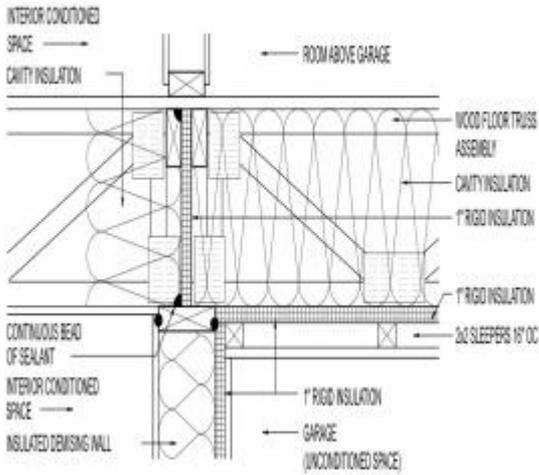
CAD FILE: [318 CAD 1-2 air_barrier_garage_band_1-inch_rigid_foam_1x3_furring_5-01002_GBA_1-31-12.dwg](#)
PDF: [318 CAD 1-2 air_barrier_garage_band_1-inch_rigid_foam_1x3_furring_5-01002_GBA_1-31-12.pdf](#)

Reference: [Building Plans for Advanced Framing](#)

Author(s): Green Building Advisor

Organization(s): Green Building Advisor

Website providing CAD files and drawings of advanced framing details.



CAD FILE: [318 CAD 1-2 air barrier garage band joist 1-inch rigid foam 2x2 furring 5-01003 GBA 1-31-12.dwg](#)
PDF: [318 CAD 1-2 air barrier garage band joist 1-inch rigid foam 2x2 furring 5-01003 GBA 1-31-12.pdf](#)

Reference: [Building Plans for Advanced Framing](#)

Author(s): Green Building Advisor

Organization(s): Green Building Advisor

Website providing CAD files and drawings of advanced framing details.

Compliance

The Compliance tab contains both program and code information. Exact code language is copyrighted and 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](#)

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

Thermal Enclosure System:

2. Fully-Aligned Air Barriers.⁵ At each insulated location below, a complete air barrier is provided that is fully aligned as follows:

Walls: At exterior vertical surface of wall insulation in all climate zones; also at interior vertical surface of wall insulation in Climate Zones 4-8⁷

2.4 Walls adjoining porch roofs or garages

Floors: At exterior vertical surface of floor insulation in all climate zones and, if over unconditioned space, also at interior horizontal surface including supports to ensure alignment. See Footnotes 10 & 11 for alternatives.^{9, 10, 11}

2.7 All other floors adjoining unconditioned space (e.g., rim / band joists at exterior wall or at porch roof).

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

4.7 Walls that separate attached garages from occupiable space sealed and, also, an air barrier installed and sealed at floor cavities aligned with these walls.

Footnotes:

(5) For purposes of this Checklist, an air barrier is defined as any durable solid material that blocks air flow between conditioned space and unconditioned space, including necessary sealing to block excessive air flow at edges and seams and adequate support to resist positive and negative pressures without displacement or damage. EPA recommends, but does not require, rigid air barriers. Open-cell or closed-cell foam shall have a finished thickness \geq 5.5 in. or 1.5 in., respectively, to qualify as an air barrier unless the manufacturer indicates otherwise. If flexible air barriers such as house wrap are used, they shall be fully sealed at all seams and edges and supported using fasteners with caps or heads \geq 1 in. diameter unless otherwise indicated by the manufacturer. Flexible air barriers shall not be made of kraft paper, paper-based products, or other materials that are easily torn. If polyethylene is used, its thickness shall be \geq 6 mil.

(7) All insulated vertical surfaces are considered walls (e.g., above and below grade exterior walls, knee walls) and must meet the air barrier requirements for walls. The following exceptions apply: air barriers recommended, but not required, in adiabatic walls in multifamily dwellings; and, in Climate Zones 4 through 8, an air barrier at the interior vertical surface of insulation is recommended but not required in basement walls or crawlspace walls. For the purpose of these exceptions, a basement or crawlspace is a space for which \geq 40% of the total gross wall area is below-grade.

(9) EPA highly recommends, but does not require, an air barrier at the interior vertical surface of floor insulation in Climate Zones 4-8.

(10) Examples of supports necessary for permanent contact include staves for batt insulation or netting for blown-in insulation. Alternatively, supports are not required if batts fill the full depth of the floor cavity, even when compression occurs due to excess insulation, as long as the R-value of the batts has been appropriately assessed based on manufacturer guidance and the only defect preventing the insulation from achieving the required installation grade is the compression caused by the excess insulation.

(11) Alternatively, an air barrier is permitted to be installed at the exterior horizontal surface of the floor insulation if the insulation is installed in contact with this air barrier, the exterior vertical surfaces of the floor cavity are also insulated, and air barriers are included at the exterior vertical surfaces of this insulation.

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

[DOE Zero Energy Ready Home](#)

DOE Zero Energy Ready Home (Rev 05) Exhibit 1: Mandatory Requirements: Item 1, Homes must be certified under ENERGY STAR Qualified Homes Version 3. Item 2, Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 or 2015 IECC levels. Exhibit 2: Design the home to meet the HERS index of the DOE Zero Energy Ready Home Target Home, for which insulation levels must meet the 2012 IECC and achieve Grade 1 installation, per RESNET standards.

Exhibit 2: Infiltration: Climate Zones 1-2: 3 ACH 50; Zones 3-4: 2.5 ACH50; Zones 5-7: 2 ACH50; Zone 8: 1.5 ACH50. Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.

[EPA Indoor airPLUS](#)

The U.S. Environmental Protection Agency (EPA) Indoor airPLUS program checklist Item 4.3 requires that builders not locate air handling equipment or ductwork in garages but notes that ducts and equipment may be located in building cavities adjacent to garage walls or ceilings if the cavities are separated from the garage space with a continuous air barrier.

[ASTM E1677-11](#)

Standard Specification for Air Barrier (AB) Material or System for Low-Rise Framed Building Walls. This specification covers minimum performances and specification criteria for an air barrier material or system for framed, opaque walls of low-rise buildings. The provisions are intended to allow the user to design the wall performance criteria and increase air barrier specifications for a particular climate location, function, or design.

[ABAA 07261](#)

Self-Adhered Sheet Air Barrier. 2006. Air Barrier Association of America, Walpole, MA. This specification for self-adhered sheet air barriers is developed by a professional association, the Air Barrier Association of America, to provide guidance to the design professional.

[ABAA 07262](#)

Fluid-Applied Air and Vapor Barrier. 2012. Air Barrier Association of America, Walpole, MA. This specification for air barriers that are fluid-applied and also act as vapor barriers is developed by a professional association, the Air Barrier Association of America, to provide guidance to the design professional.

[ABAA 07263](#)

Closed Cell, Medium-Density Spray Polyurethane Foam Air Barrier. 2011. Air Barrier Association of America, Walpole, MA. This specification for closed cell, medium-density spray polyurethane foam air barriers is developed by a professional association, the Air Barrier Association of America, to provide guidance to the design professional.

[ABAA 07265](#)

Fluid-Applied Vapor Permeable Air Barrier. 2012. Air Barrier Association of America, Walpole, MA. This specification for fluid-applied vapor permeable air barriers is developed by a professional association, the Air Barrier Association of America, to provide guidance to the design professional.

[2009 IECC](#)

Table 402.4.2 Air Barrier and Insulation Inspection Component Criteria, Garage separation: Air sealing is installed between the garage and conditioned spaces.* Table 402.4.2, Air barrier and thermal barrier: Exterior wall insulation is installed in substantial contact and continuous alignment with the air barrier. Air permeable insulation is not used as a sealing material.*

[2009 IRC](#)

Table N1102.4.2 Air Barrier and Insulation Inspection Component Criteria, Garage separation: Air sealing is installed between the garage and conditioned spaces.* Table N1102.4.2, Air barrier and thermal barrier: Exterior wall insulation is installed in substantial contact and continuous alignment with the air barrier. Air permeable insulation is not used as a sealing material.*

[2012 IECC](#)

Table R402.4.1.1 Air Barrier and Insulation Installation, Garage separation: Air sealing is installed between the garage and conditioned spaces.* Table R402.4.1.1, Air barrier and thermal barrier: A continuous air barrier is installed in the building envelope including rim joists and exposed edges of insulation. Breaks or joints in the air barrier are sealed. Air permeable insulation is not used as a sealing material.*

[2012 IRC](#)

Table N1102.4.1.1 Air Barrier and Insulation Installation, Garage separation: Air sealing is installed between the garage and conditioned spaces.* Table N1102.4.1.1, Air barrier and thermal barrier: A continuous air barrier is installed in the building envelope including rim joists and exposed edges of insulation. Breaks or joints in the air barrier are sealed. Air permeable insulation is not used as a sealing material.*

[2015 IECC](#)

Table R402.1.2 Insulation and Fenestration Requirements – meet or exceed the insulation levels listed in this table.

Table R402.4.1.1 Air Barrier and Insulation Installation, Garage separation: Air sealing is installed between the garage and conditioned spaces.* Table R402.4.1.1, General requirements: A continuous air barrier is installed in the building envelope including rim joists and exposed edges of insulation. Breaks or joints in the air barrier are sealed. Air permeable insulation is not used as a sealing material.*

Section R402.4.1.2 Testing. The building should be tested for air leakage in accordance with ASTM E 779 or E 1827 and should have an air leakage rate of ? 5 in CZ 1 and 2 or ? 3 in CZ 3-8.

[2015 IRC](#)

Table N1102.4.1.1 Air Barrier and Insulation Installation, Garage separation: Air sealing is installed between the garage and conditioned spaces.* Table N1102.4.1.1, General requirements: A continuous air barrier is installed in the building envelope including rim joists and exposed edges of insulation. Breaks or joints in the air barrier are sealed. Air permeable insulation is not

used as a sealing material.*

*Due to copyright restrictions, exact code text is not provided. For specific code text, refer to the applicable code.

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](#)
(662 KB)
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. [Building America Best Practices Series Volume 12: 40% Whole-House Energy Savings in the Cold and Very Cold Climates](#)
Author(s): Baechler, Gilbride, Hefty, Cole, Love
Organization(s): PNNL, ORNL
Publication Date: February, 2011
Guide describing measures that builders in the cold and very cold climates can take to build homes that have whole-house energy savings of 40% over the Building America benchmark with no added overall costs for consumers.
2. [Critical Seal \(Spray Foam at Rim Joist\)](#)
Author(s): BSC
Organization(s): BSC
Publication Date: September, 2009
Information sheet about air sealing.
3. [DOE Zero Energy Ready Home National Program Requirements](#)
Author(s): DOE
Organization(s): DOE
Publication Date: August, 2015
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): EPA
Organization(s): EPA
Publication Date: September, 2015
Document outlining the program requirements for ENERGY STAR Certified Homes, Version 3 (Rev. 08).
5. [How Attached Garages Poison our Indoor Air, and What Builders Can Do About It](#)
Author(s): Aspen Publishers
Organization(s): Aspen Publishers
Publication Date: January, 2000
Report with information for builders and retrofitters to help eliminate hazards and coincidental energy losses that come from attached garages.
6. [Thermal Enclosure System Rater Checklist Guidebook](#)
Author(s): EPA
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.

Which Spray Foam is Right For You?

Author(s): Zoeller

Organization(s): CARB

Publication Date: April, 2009

Information sheet about insulation materials.

*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 Building America Teams contributed to the content in this Guide.

Pacific Northwest National Laboratory