

Air Sealing Recessed Light Fixtures Below Unconditioned Space

Last Updated: 03/14/2016

Scope



Air seal around recessed can light fixtures installed through ceilings to keep conditioned air from leaking into unconditioned space.

Air seal around recessed can light fixtures installed through ceilings to keep conditioned air from leaking into unconditioned space.

- Using a saw, cleanly cut a hole that is no more than 1 inch larger in diameter than the diameter of the can.
- Install ICAT-labeled recessed lighting fixtures.
- Seal around the can with caulk before installing trim or install a trim kit with a gasket.

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

Recessed “can” ceiling fixtures, or downlights, are the most popular home lighting fixture in the United States. However, recessed can fixtures can be energy intensive in three ways—if they are not approved for insulation contact and are installed in an insulated ceiling, insulation has to be kept at least 3 inches from the fixture all the way around, leaving about 1 square foot of uninsulated ceiling space. Second, many homeowners and contractors install incandescent bulbs in the fixtures that use 4 times the electricity of fluorescents and add to air-conditioning loads. Third, if the cans are not airtight, they allow conditioned air to escape from the living area into unconditioned spaces such as the attic. Leaky recessed cans are like a hole in the ceiling, only worse. A non-airtight recessed can with an incandescent bulb can draw 3 to 5 times as much air as a hole the same size, thanks to the “stack effect.” When the light inside the can is turned on, the heat it generates turns the can fixture into a chimney, pulling air from the house up into the attic ([McCullough and Gordon 2002](#)).

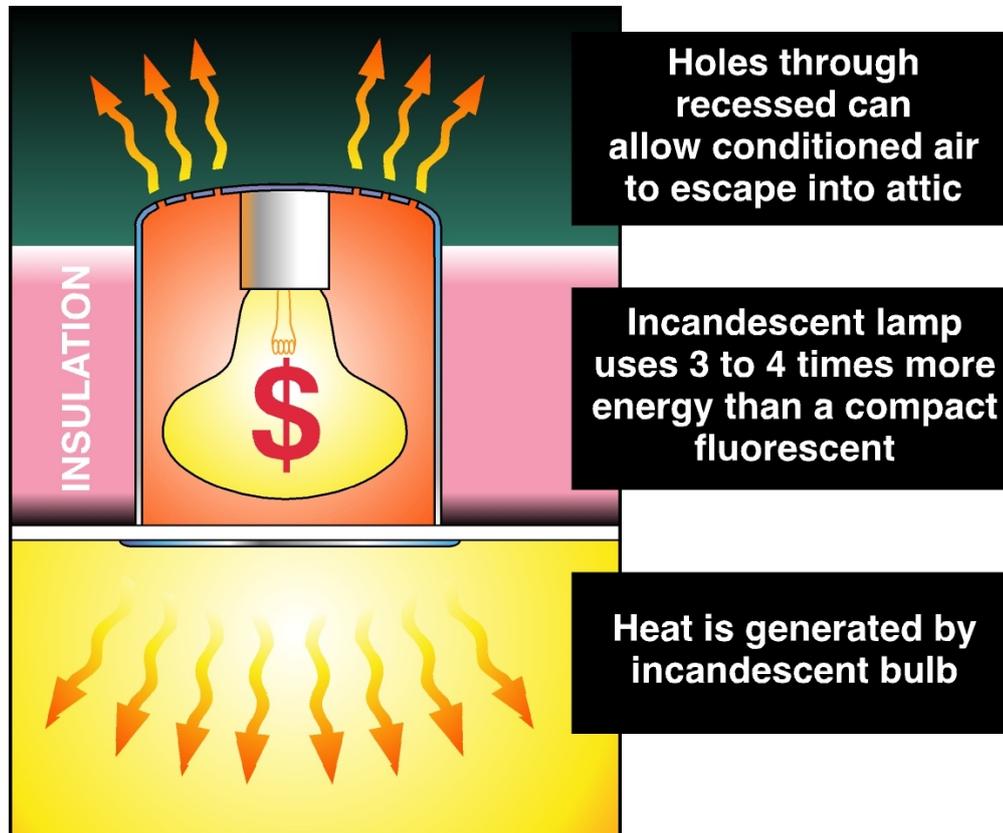


Figure 1 - Typical non-airtight recessed can light fixtures waste energy in several ways

Recessed downlights that are installed in insulated ceilings are now required by code to be rated for insulation contact (IC) so that insulation can be placed over them. The housing of the fixture should also be rated airtight to prevent conditioned air from escaping into the ceiling cavity or attic, and unconditioned air from infiltrating the conditioned space. The fixture should bear a label showing it meets the ASTM E 283 requirement of ≤ 2.0 cfm of air movement from the conditioned space to the ceiling cavity when tested at 75 Pa, and the housing should be caulked or gasketed where it meets the ceiling ([Lstiburek 2009](#)). Some brands of can lights designated ICAT may leak air; check the fixtures you intend to use to see whether they appear to be well designed to be air-tight ([EPA 2010](#)).

If recessed lights are installed in insulated cathedral ceilings, there must be at least R-10 of insulation above the can in IECC climate zones 4 and higher to minimize condensation potential. Extra caution should be taken to ensure the recessed can is airtight in unventilated cathedral ceilings. Leaky light fixtures can allow moisture-laden indoor air to enter the roof assembly. If the moisture encounters cold roof sheathing, it can condense, leading to moisture accumulation and rot ([Holladay 2011](#)).

Some building scientists recommend against putting recessed can lights in cathedral ceilings ([see for example Holladay 2011](#)) and some recommend against putting recessed can lights in any insulated ceiling ([for example, Bailes 2011](#)). Other alternatives are to install the recessed cans in an air-sealed dropped soffit or to limit use of recessed cans to only ceilings of rooms that have conditioned space above them such as a second floor. Another option is to avoid recessed can fixtures all together and use surface-mounted or pendant fixtures instead.

How to Air Seal Recessed Can Lights in Insulated Ceilings

1. Choose fixtures that are labeled ICAT, meaning they are approved for insulation contact and are airtight as determined by the ASTM E 283 air leakage test.
2. Install according to the manufacturer's instructions. Before installing the decorative trim, caulk the housing to the ceiling, or install the fixture using a manufacturer-supplied gasket.

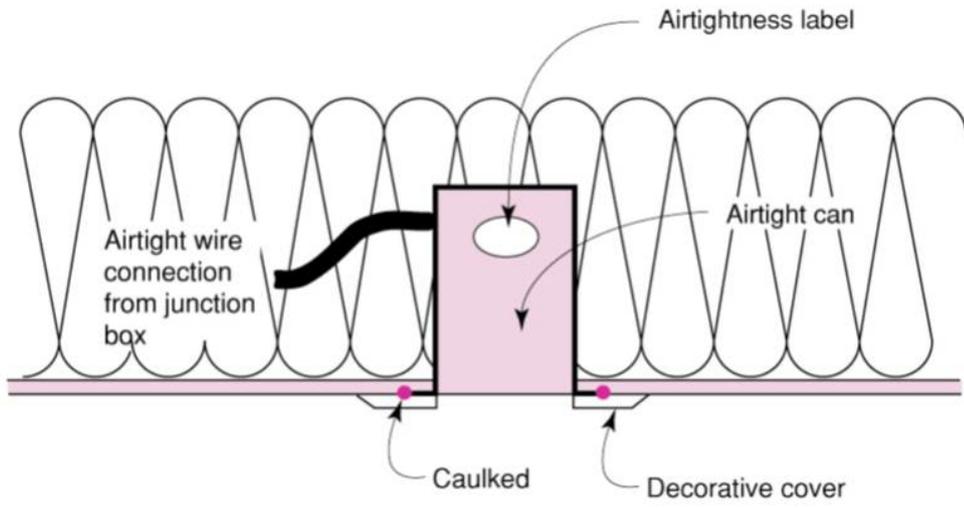


Figure 2 - Look for recessed lighting fixtures that are ICAT-rated with sealed cans. Install the manufacturer-supplied gasket or caulk around the fixture housing before installing the decorative trim ⓘ

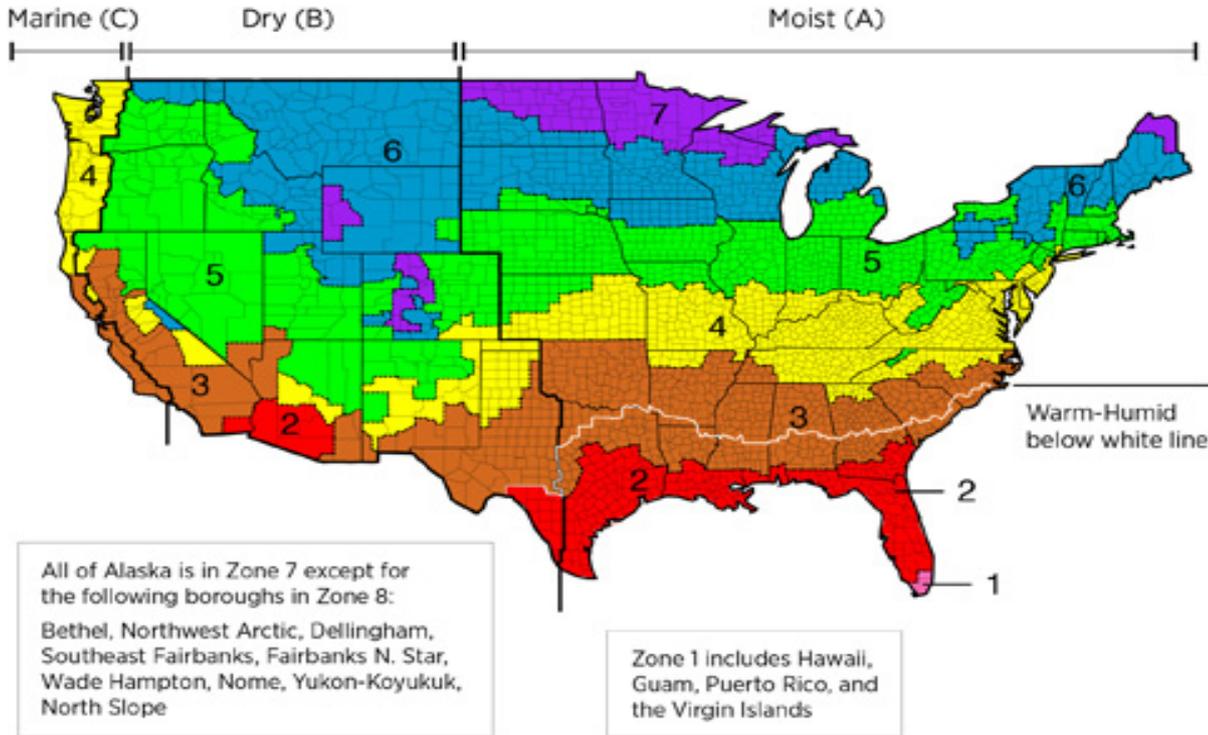
Ensuring Success

Inspect and verify that recessed can light fixtures installed in ceilings below unconditioned space are rated insulation-contact, air-tight (ICAT). Blower door testing, which is conducted as part of the whole-house energy performance test-out, may help indicate whether the recessed can lights are sufficiently air sealed. An infrared camera used in conjunction with the blower door testing may assist in detecting leakage. Experienced contractors can also detect air leakage with a smoke stick or by hand.

Climate

ENERGY STAR Version 3, (Rev. 07)

Thermal Enclosure Checklist, Air Sealing. If in insulated ceiling without attic above, exterior surface of fixture insulated to $\geq R-10$ in CZ 4 and higher to minimize condensation potential.



International Energy Conservation Code (IECC) Climate Regions

Training

Right and Wrong Images



Display Image: [ES_TESRC_5.1.5_PG136_265b_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.



Display Image: [ES_TESRC_5.1.5_PG136_265b_102811_0.jpg](#)

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

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Display Image: [ES_TESRC_5.1.5_PG136_267d_102811_0.jpg](#)

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

Author(s): EPA

Organization(s): EPA

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

Author(s): EPA

Organization(s): EPA

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Organization(s): EPA

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

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Organization(s): EPA

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

Author(s): EPA

Organization(s): EPA

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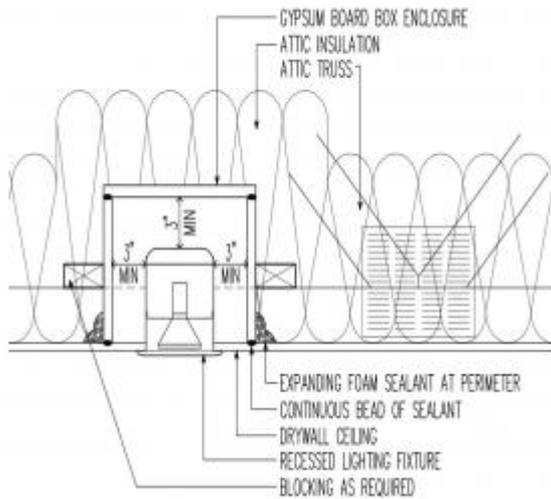
Reference: [Thermal Enclosure System Rater Checklist Guidebook](#)

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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: [515_CAD_5-4_Recessed_light_site_built_box_1_5-02041_GBA_1-31-12.dwg](#)

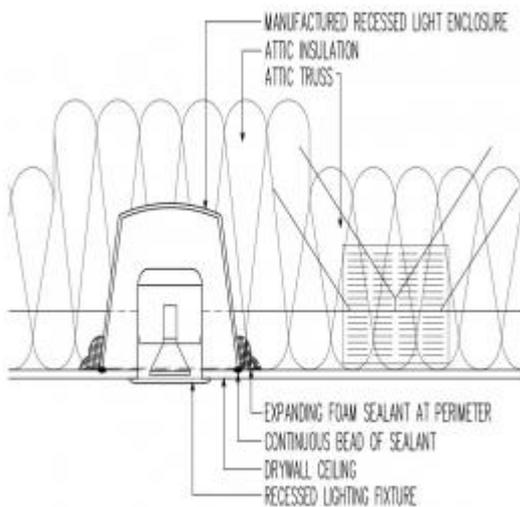
PDF: [515_CAD_5-4_Recessed_light_site_built_box_1_5-02041_GBA_1-31-12.pdf](#)

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: [515_CAD_5-4_Recessed_light_pre_made_box_2_5-02040_GBA_1-31-12.dwg](#)

PDF: [515_CAD_5-4_Recessed_light_pre_made_box_2_5-02040_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:

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

4.2 Recessed lighting fixtures adjacent to unconditioned space ICAT labeled and gasketed. Also, if in insulated ceiling without attic above, exterior surface of fixture insulated to ? R-10 in CZ 4-8.

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.

[2009 IECC](#)

Section 402.4.5 Recessed lighting. Recessed lights in the building thermal envelope are 1) type IC rated and ASTM E283 labeled and 2) sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.*

[2009 IRC](#)

Section N1102.4.5 Recessed lighting. Recessed lights in the building thermal envelope are 1) type IC rated and ASTM E283 labeled and 2) sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.*

[2012 IECC](#)

Table R402.4.1.1 Air Barrier and Insulation Installation, Recessed lighting: Recessed light fixtures installed in the building thermal envelope are IC rated, airtight labeled at air leakage rate ≤ 2.0 cfm, and sealed to the drywall with gasket or caulk.*

[2012 IRC](#)

Table N11402.4.1.1 Air Barrier and Insulation Installation, Recessed lighting: Recessed light fixtures installed in the building thermal envelope are IC rated, airtight labeled at air leakage rate ≤ 2.0 cfm, and sealed to the drywall with gasket or caulk.*

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

[2015 IECC](#)

[2015 IRC](#)

[Recessed Lighting - Code Compliance Brief](#)

Overview:

The intent of this brief is to provide code-related information about recessed lighting to help ensure that the measure will be accepted as being in compliance with the code. Providing notes for code officials on how to plan review and conduct field inspections can help builders or remodelers with proposed designs and provide jurisdictional officials with information for acceptance. Providing the same information to all interested parties (e.g., code officials, builders, designers, etc.) is expected to result in increased compliance and fewer innovations being questioned at the time of plan review and/or field inspection.

Recessed lighting is a popular lighting choice for residential applications. The U.S. Department of Energy estimates that there are 435 million recessed lighting fixtures installed in residential applications as of 2007.¹ As their name implies, these lighting fixtures are recessed into ceilings, thus creating penetrations through otherwise continuous surfaces. While not an issue when installed within the building envelope (e.g., between floors) when installed under unconditioned spaces (e.g., attics), or soffits that are likely to leak into unconditioned spaces, the number of fixtures and the surface area affected can be a significant contributor to air leakage from the building envelope. For this reason, energy codes require the fixture used to be an "airtight" design. In addition, careful attention must be paid to the interface between the ceiling drywall and the fixture housing as up to 50% of the leakage takes place at this location. Manufacturers employ a number of different methods to address this issue. Some use gaskets adhered to baseplate around the aperture, some provide air sealing tape to be installed after the ceiling is installed and others use a corresponding trim ring that seals the interface. Regardless of the method used, it is critical that all the elements of leakage system be installed, undamaged and in place before the final inspection.

An additional requirement, not related to energy efficiency but rather safety, is the proximity of the fixture housing to insulation. Codes require fixtures installed in direct contact with insulation to be IC-rated. Many people believe the term IC refers to Insulation Contact or Insulation Cover however the acronym technically refers to the UL² thermal safety environment defined for fixtures installed in Insulated Ceilings.

¹U.S. Department of Energy. 2011. *Energy Savings Estimates of Lighting Emitting Diodes in Niche Lighting Applications*. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_january2011.pdf.

²UL (Underwriters Laboratory) is a global independent safety science company that certifies, validates, tests, inspects, audits, advises, and trains.

Plan Review:

Per the **2015 IECC/IRC, Section R103.3/R106.3, Examination of Documents**. The code official/building official must examine or cause to be examined construction documents for code compliance.

This section lists the applicable code requirements followed by details helpful for plan review regarding the provisions to meet the requirement for "recessed lighting."

Construction Documentation. Review the construction documents to identify the equipment, system controls, design, and ventilation choices to the equipment.

- **2015 IECC/IRC, Section R103.2/N1101.5 Information on Construction Documents.** Construction documents should include:
 - Insulation materials and their R-values
 - Fixture thermal rating
 - Air sealing details
- **General Installation Provisions.** Review the construction documents for equipment installation and mounting. In the IRC, the Electrical Part VIII is produced and copyrighted by the National Fire Protection Association (NFPA) and is based on the 2014 National Electrical Code (NEC) (NFPA 70-2014). The section numbers appearing in brackets after the IRC text are the section numbers of the corresponding text in the NEC (NFPA 70).
 - **2015 IECC/IRC, Section R402.4.5/N1102.4.5 Recessed Lighting.** Recessed luminaires³ installed in the *building thermal envelope*⁴ should be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires should be IC-rated and *labeled*⁵ as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with *ASTM E 283*⁶ at a 1.57 psf (75 Pa) pressure differential. All recessed lighting should be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.
 - **2015 IRC, Section E4003.5 Recessed Incandescent Luminaires.** Recessed incandescent luminaires should have thermal protection and should be listed as thermally protected [410.115(C)].

Exceptions:

 1. Thermal protection should not be required in recessed luminaires listed for the purpose and installed in poured concrete [410.115 (C) Exception No 1].
 2. Thermal protection should not be required in recessed luminaires having design, construction and thermal performance characteristics equivalent to that of thermal protect luminaires, and such luminaires are identified as inherently protected [410.115 (C) Exception No 2].
 - **Section E4004.8 Recessed Luminaire Clearance.** A recessed luminaire that is not identified for contact with insulation should have all recessed parts spaced at least ½ inch from combustible materials. The points of support and the finish trim parts at the opening in the ceiling, wall or other finished surface should be permitted to be in contact with combustible materials. A recessed luminaire that is identified for contact with insulation, Type IC, should be permitted to be in contact with combustible materials at recessed parts, points of support, and portions passing through the building structure and at finish trim parts at the opening in the ceiling or wall. [410.116(A)(1) and (A)(2)].
 - **Section E4004.9 Recessed Luminaire Installation.** Thermal insulation should not be installed above a recessed luminaire or within 3 inches (76 millimeters) of the recessed luminaire's enclosure, wiring compartment, ballast, transformer, light-emitting diode driver, or power supply except where such luminaire is identified for contact with insulation, Type IC. [410.116(B)].
- **Air Sealing/Air Leakage Control**

- Review the construction documents for any recessed light fixtures that will be installed in the building thermal envelope and confirm that the details show they will be air tight, IC rated, and sealed to the drywall. (Except for the actual section numbers in the codes, the requirements have not changed in the last three versions of the IECC/IRC.)
 - **2015 IECC/IRC, Table R402.4.1.1/N1102.4.1.1**
 - **2012 IECC/IRC, Table R402.4.1.1/N1102.4.1.1**
 - **2009 IECC/IRC, Table 402.4.2/N1102.4.2**

Additions and alterations to an existing electrical system should conform to the provisions as new construction.

³"Luminaire" is defined as a complete lighting unit consisting of a light source such as a lamp or lamps together with the parts designed to position the light source and connect it to the power supply. A luminaire can include parts to protect the light source or the ballast, or to distribute the light. A lamp-holder itself is not a luminaire.

⁴"Building Thermal Envelope" is defined as the basement walls, exterior walls, floor, roof, and any other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

⁵"Labeled" is defined as equipment, materials to which has been attached label, symbol or other identifying mark of an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

⁶"ASTM E 283-04" Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.

Field Inspection:

Per the **2015 IECC, Section R104, Inspections**, construction, or work for which a permit is required is subject to inspection. Construction or work is to remain accessible and exposed for inspection purposes until approved. Required inspections include footing and foundation, framing and rough-in work, plumbing rough-in, mechanical rough-in, and final inspection.

Per the **IRC, Section R109, Inspections**, the wording is somewhat different in that for onsite construction, from time to time the building official, upon notification from the permit holder or his agent, can make or cause to be made any necessary inspections. Further details are provided for inspections regarding foundation, plumbing, mechanical, gas and electrical, floodplain, frame and masonry, and final inspection. Any additional inspections are at the discretion of the building official.

This section provides details for inspecting to the specific provisions for recessed lighting where one or more specific type of inspection per the IECC or IRC may be necessary to confirm compliance. Verifying code compliance for recessed lighting would typically be at the framing and rough-in stage of work and at final inspection. The following is a checklist of field inspection items that should be verified.

- Recessed lighting are properly located and mounted per the approved plans.
- Fixtures are labeled as for being IC-rated and having an air leakage rate of not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential.
- The interface between the fixture housing and wall or ceiling covering is sealed via gasket, caulk, or other approved means.

Technical Validation(s):

This section provides additional information and helpful resources.

Guide: "Recessed Can Fixtures Below Unconditioned Space," <https://basc.pnnl.gov/resource-guides/recessed-light-fixtures-below-unconditioned-space>.

The Pennsylvania Housing Research/Resource Center: "Air Leakage in Recessed Lighting – Builder Brief," <http://www.arizonasolarwave.com/docs/recessed-lights-air-leakage-phrc.pdf>

Hammer & Hand (2010): "Leaky Lights on the Lam, Recessed Lighting and Energy Efficiency," <http://hammerandhand.com/field-notes/leaky-lights-on-the-lam-recessed-lighting-and-energy-efficiency/>

"Advanced Air Sealing: Recessed Lights," Oikos Green Building Source: http://oikos.com/library/airsealing/recessed_lights.html

Dr. Energy Saver: "How to Seal and Insulate Can Lights," (video) <https://www.youtube.com/watch?v=OpKkWMkiYgk>

Insulation Contractors Association of America (ICAA): "Type IC Recessed Lighting Fixtures Must be Specified in the

Building Envelope," <http://www.insulate.org/tech3.html>

"Recessed Can of Worms," (2001) *The Home Performance Magazine*, Home Energy.
<http://www.homeenergy.org/show/article/id/236>

"Further Wrestling with Recessed Can Lights," (2005) *The Home Performance Magazine*, Home Energy.
<http://www.homeenergy.org/show/article/id/122>

Bennett SM and H Perez-Blanco. 1994. "Recessed Light Fixtures: Infiltration Energy Loss." *ASHRAE Journal* 36(6):82.
ISSN 0001-2491.

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. [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. [Building America Best Practices Series, Volume 10: Retrofit Techniques and Technologies: Air Sealing](#)
Author(s): Baechler, Gilbride, Hefty, Cole, Williamson, Love
Organization(s): PNNL, ORNL
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): 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. [Guide to Attic Air Sealing](#)
Author(s): Lstiburek
Organization(s): BSC
Publication Date: January, 2010
Fact sheet providing detailed information about air sealing attics.
6. [High Hats, Swiss Cheese, and Fluorescent Lighting?](#)
Author(s): McCullough, Gordon
Organization(s): PNNL
Publication Date: January, 2002
Report discussing the potential energy savings of new high-efficiency downlights, and the results of product testing to date.
7. [How to Build an Insulated Cathedral Ceiling](#)
Author(s): Holladay
Organization(s): Green Building Advisor
Publication Date: November, 2011
Information sheet presenting the correct methods for building an insulated cathedral ceiling.
- 8.

[Improving Recessed Lighting](#)

Author(s): PNNL

Organization(s): PNNL

Publication Date: January, 2011

Report providing information about techniques and approaches to improve the efficiency of recessed lighting.

9. [Kick the Can! No Recessed Lights in the Building Envelope](#)

Author(s): Bailes

Organization(s): Energy Vanguard

Publication Date: April, 2011

Information sheet discussing the downside to recessed can lights.

10. [Sealing Air Barrier Penetrations](#)

Author(s): Lstiburek

Organization(s): BSC

Publication Date: May, 2009

Information sheet about air sealing.

11. [Technical Guidance to the Indoor airPLUS Specifications](#)

Author(s): EPA

Organization(s): EPA

Publication Date: October, 2015

Website providing technical guidance to help home builders and their subcontractors, architects, and other housing professionals understand the intent and implementation of the specification requirements of the IAQ labeling program.

12. [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.

*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.

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