



ENERGY STAR

ENERGY STAR® Qualified Homes

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



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THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



WHAT ARE GUIDE DETAILS?

This Guide for Home Energy Raters presents Guide Details that serve as a visual reference for each of the line items in the Water Management System Builder Checklist. The details are great tools for Rater education and will help Raters answer contractor and subcontractor questions. Together, the Water Management System Builder Checklist and these Guide Details provide a comprehensive process for ensuring that building professionals meet all aspects of the ENERGY STAR V3 requirements. This page illustrates what Raters will see throughout this Guide on every odd page.

Each of the details is listed top left, followed by the actions the Rater should present to the applicable trade to successfully complete the detail.

This image illustrates the detail along with arrows to indicate steps necessary to complete it.

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST	
3	FULLY-ALIGNED AIR BARRIERS
2	FLOORS

DETAIL 3.2.3 4, 9, 10, †

Floor above unconditioned basement or vented crawlspace

- A. Install a continuous rigid air barrier or other supporting material to separate the exterior from the conditioned space.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- C. Install insulation without misalignments, compressions, gaps, or voids in floors above the unconditioned basement or vented crawlspace.
- D. Install supports for insulation to remain in contact with the air barrier. Examples include metal support rods for batt insulation or netting for blown insulation.

* EPA recommends using a rigid air barrier, but it is not a requirement.
† Footnotes located on following page.

TRADES

INSULATOR

First Page

This area presents applicable footnotes. Alternately, footnotes that require additional space will be located on a third sheet.

A list of applicable trades appears at the bottom to remind Raters which building professionals need to apply the detail.

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



WHAT ARE GUIDE DETAILS? (CONTINUED)

This page illustrates what Raters will see throughout this Guide on every even page. The photos show the detailed actions that Raters must verify are completed according to the ENERGY STAR V3 requirements.

Images of both proper and improper installation are included along with a corresponding thumbs up or thumbs down symbol.



Second Page

A letter corresponding to the front page is provided to help the reader understand which step of the process the photos present.

When necessary, additional tips, codes, or other helpful information appears in the lower half of the page.

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



WHAT ARE GUIDE DETAILS? (CONTINUED)

This page illustrates what Raters will see for certain ENERGY STAR V3 requirements. It contains footnotes pertinent to the requirement that did not fit on the first page.

A list of footnotes pertinent to the specific requirement are listed here.

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST		 ENERGY STAR
3	FULLY-ALIGNED AIR BARRIERS	
2	FLOORS	

FOOTNOTES

8. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

9. Examples of supports necessary for permanent contact include stakes for batt insulation or netting for blown-in insulation. Batts that completely fill a cavity enclosed on all six sides may be used to meet this requirement without the need for supports, even though some compression will occur due to the excess insulation, as long as the compressed value meets or exceeds the required insulation level. Specifically, the following batts may be used in six-sided floor cavities: R-19 batts in 2x6 cavities, R-30 batts in 2x8 cavities, R-38 batts in 2x10 cavities, and R-49 batts in 2x12 cavities. For example, in a home that requires R-19 floor insulation, an R-30 batt may be used in a six-sided 2x8 floor cavity.

10. Fully-aligned air barriers may be installed at the exterior surface of the floor cavity in all Climate Zones if the insulation is installed in contact with this exterior air barrier and the perimeter rim and band joints of the floor cavity are also sealed and insulated to comply with the fully-aligned air barrier requirements for walls.

Revision 02

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THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



CONTENTS

SECTION 1. High-Performance Fenestration

SECTION 2. Quality-Installed Insulation

SECTION 3. Fully-Aligned Air Barriers

SECTION 4. Reduced Thermal Bridging

SECTION 5. Air Sealing

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THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



SECTION 1. HIGH-PERFORMANCE FENESTRATION

- 1.1. Prescriptive Path: Fenestration shall meet or exceed ENERGY STAR window requirements
- 1.2. Performance Path: Fenestration shall meet or exceed 2009 International Energy Conservation Code (IECC) requirements

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DETAIL 1.1 ²

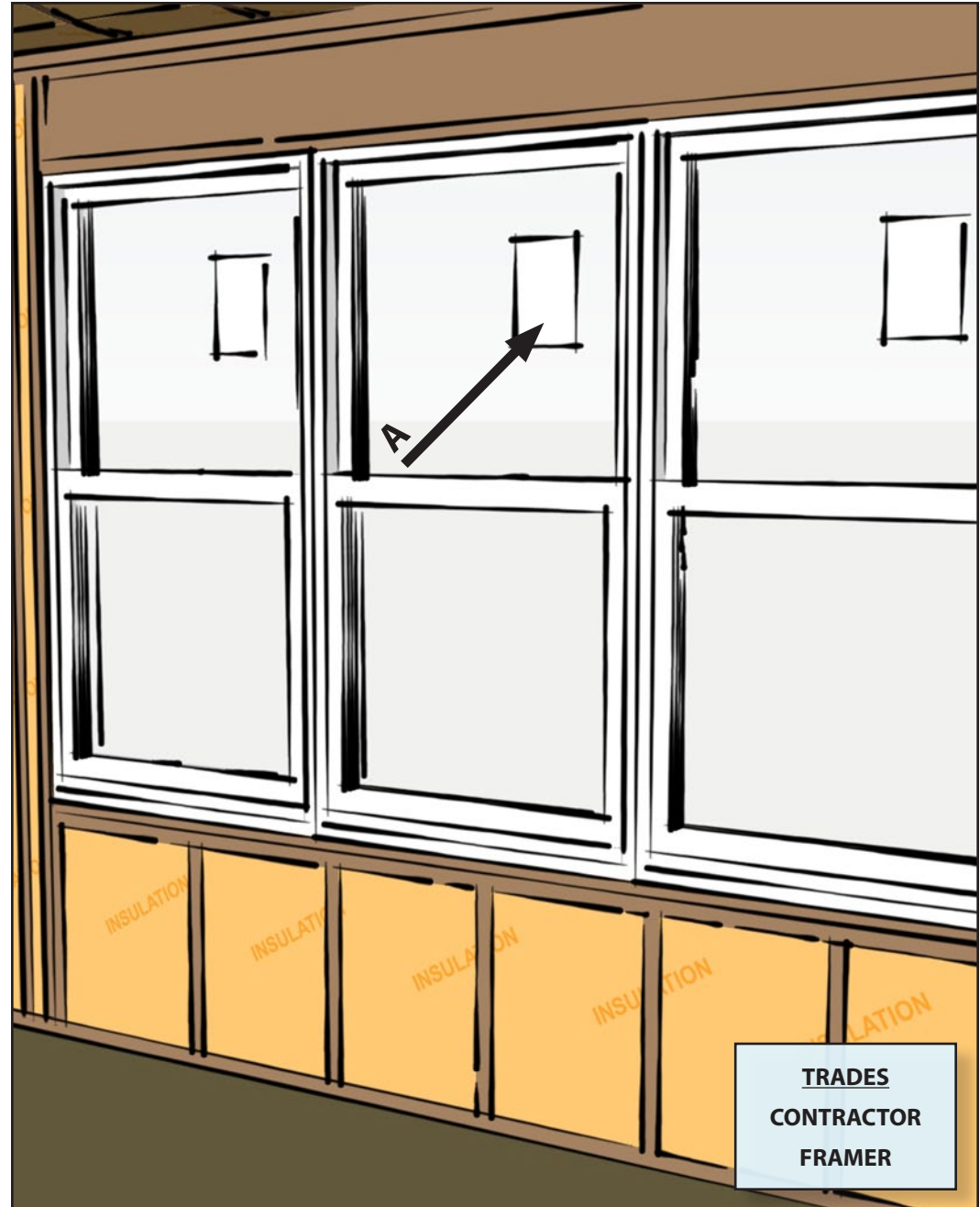
Prescriptive Path: Fenestration shall meet or exceed ENERGY STAR requirements

- A. Select windows, doors, and skylights to meet ENERGY STAR program requirements for windows, doors, and skylights.
- B. Note that the U-value and the Solar Heat Gain Coefficient (SHGC) for doors apply to the whole door, not just the glazing portion.

FOOTNOTES

2. For Prescriptive Path: All windows, doors, and skylights shall meet or exceed ENERGY STAR Program Requirements for Residential Windows, Doors, and Skylights – Version 5.0 as outlined at www.energystar.gov/windows. For Performance Path: All windows, doors and skylights shall meet or exceed the component U-factor and SHGC requirements specified in the 2009 IECC – Table 402.1.1. If no NFRC rating is noted on the window or in product literature (e.g., for site-built fenestration), select the U-factor and SHGC value from tables 4 and 14, respectively, in 2005 ASHRAE Fundamentals, Chapter 31. Select the highest U-factor and SHGC value among the values listed for the known window characteristics (e.g., frame type, number of panes, glass color, and presence of low-e coating). Note that the U-factor requirement applies to all fenestration while the SHGC only applies to the glazed portion. The following exceptions apply:

- a. An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements;
- b. An area-weighted average of fenestration products more than 50% glazed shall be permitted to satisfy the SHGC requirements;
- c. 15 square feet of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above;
- d. One side-hinged opaque door assembly up to 24 square feet in area shall be exempt from the U-factor requirements and shall be excluded from area-weighted averages calculated using a) and b), above;
- e. Fenestration utilized as part of a passive solar design shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above. Exempt windows shall be facing within 45 degrees of true south and directly coupled to thermal storage mass that has a heat capacity > 20 btu/ft³·xof and provided in a ratio of at least 3 sq. ft. per sq. ft. of south facing fenestration. Generally, thermal mass materials will be at least 2" thick.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



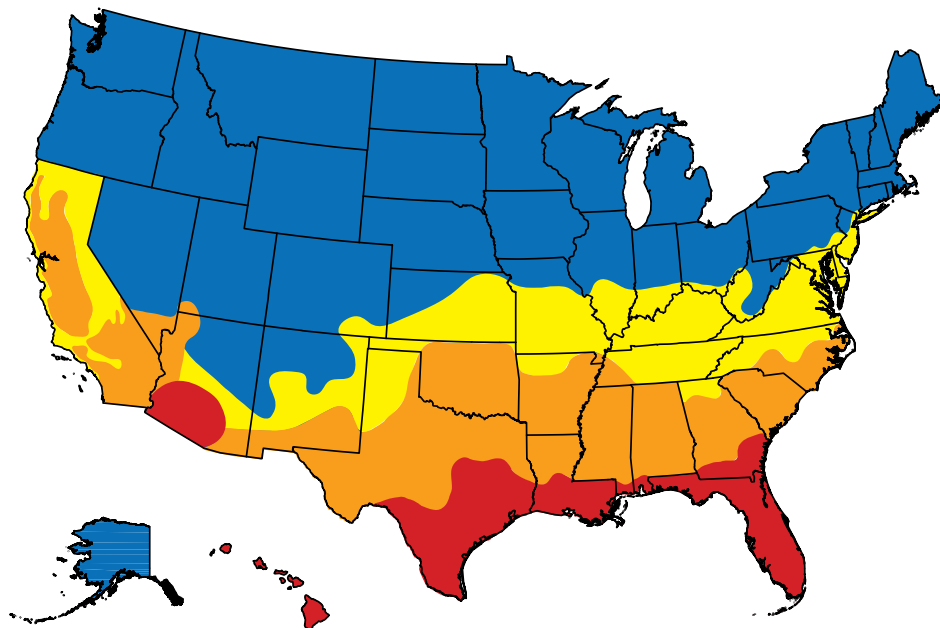
1 HIGH-PERFORMANCE FENESTRATION

1 PRESCRIPTIVE PATH



A. Window does not meet ENERGY STAR requirements.

Window meets ENERGY STAR requirements.



- Northern
- North-Central
- South-Central
- Southern

ENERGY STAR WINDOW SPECIFICATIONS

Climate Zone	U-Factor ¹	SHGC ²
Northern Prescriptive	≤ 0.30	ANY
Northern Equivalent Energy Performance	≤ 0.31	≥ 0.35
	≤ 0.32	≥ 0.40
North-Central	≤ 0.32	≤ 0.40
South-Central	≤ 0.35	≤ 0.30
Southern	≤ 0.60	≤ 0.27

ENERGY STAR SKYLIGHT SPECIFICATIONS

Climate Zone	U-Factor ¹	SHGC ²
Northern	≤ 0.55	ANY
North-Central	≤ 0.55	≤ 0.40
South-Central	≤ 0.57	≤ 0.30
Southern	≤ 0.70	≤ 0.30

ENERGY STAR DOOR SPECIFICATIONS

Climate Zone	U-Factor ¹	SHGC ²
Opaque	≤ 0.55	ANY
$\leq 1/2$ Lite	≤ 0.57	≤ 0.30
$> 1/2$ Lite	≤ 0.70	≤ 0.30

¹ Btu/h·ft²·°F

² Fraction of incident solar radiation

1 HIGH-PERFORMANCE FENESTRATION

2 PERFORMANCE PATH

DETAIL 1.2 ²

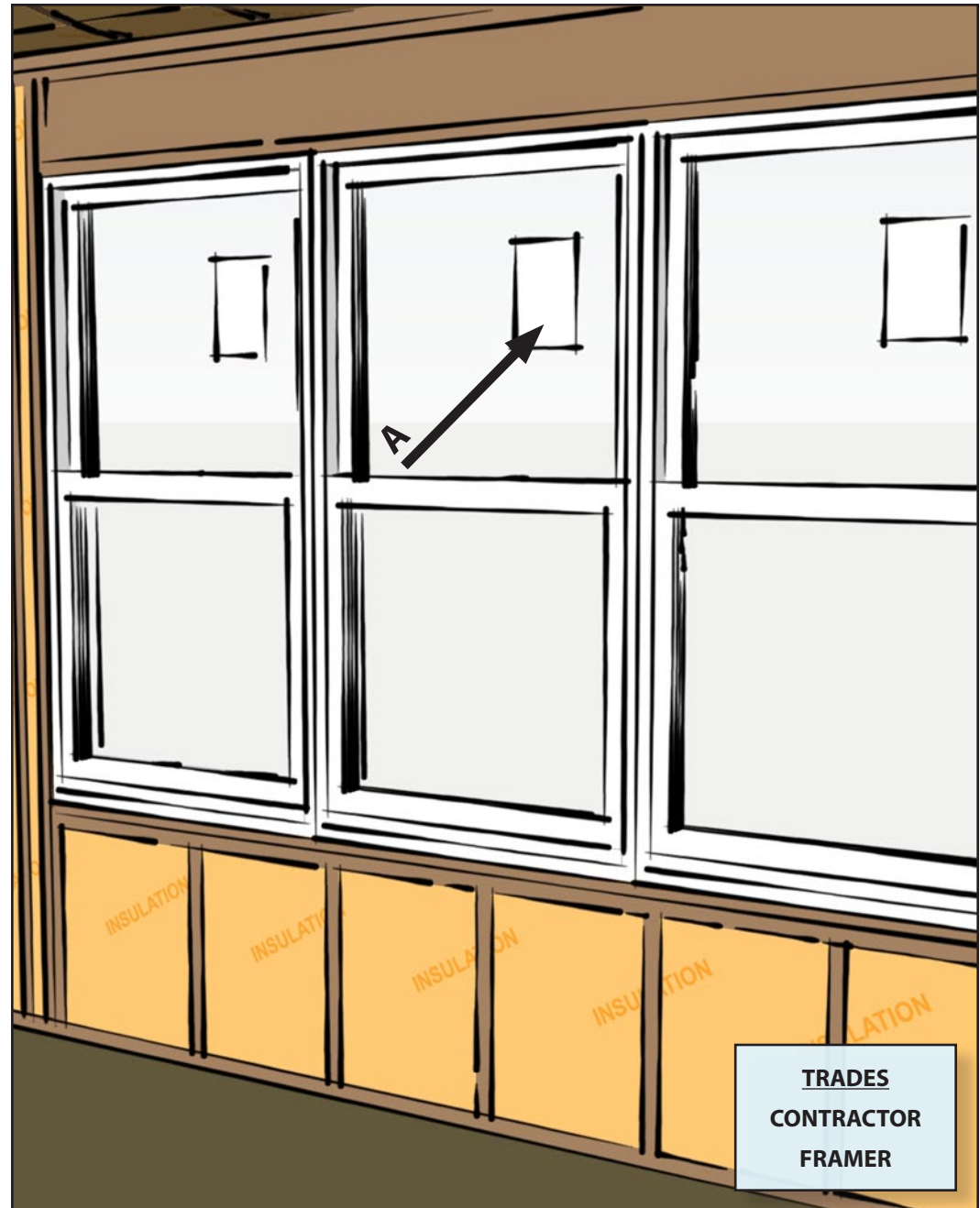
Performance Path: Fenestration shall meet or exceed 2009 IECC requirements

- A. Select windows, doors and skylights to meet 2009 IECC standards for windows, doors and skylights, except fenestration utilized as part of a passive solar design.

FOOTNOTES

2. For Prescriptive Path: All windows, doors, and skylights shall meet or exceed ENERGY STAR Program Requirements for Residential Windows, Doors, and Skylights – Version 5.0 as outlined at www.energystar.gov/windows. For Performance Path: All windows, doors and skylights shall meet or exceed the component U-factor and SHGC requirements specified in the 2009 IECC – Table 402.1.1. If no NFRC rating is noted on the window or in product literature (e.g., for site-built fenestration), select the U-factor and SHGC value from tables 4 and 14, respectively, in 2005 ASHRAE Fundamentals, Chapter 31. Select the highest U-factor and SHGC value among the values listed for the known window characteristics (e.g., frame type, number of panes, glass color, and presence of low-e coating). Note that the U-factor requirement applies to all fenestration while the SHGC only applies to the glazed portion. The following exceptions apply:

- An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements;
- An area-weighted average of fenestration products more than 50% glazed shall be permitted to satisfy the SHGC requirements;
- 15 square feet of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above;
- One side-hinged opaque door assembly up to 24 square feet in area shall be exempt from the U-factor requirements and shall be excluded from area-weighted averages calculated using a) and b), above;
- Fenestration utilized as part of a passive solar design shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above. Exempt windows shall be facing within 45 degrees of true south and directly coupled to thermal storage mass that has a heat capacity > 20 btu/ft³xoF and provided in a ratio of at least 3 sq. ft. per sq. ft. of south facing fenestration. Generally, thermal mass materials will be at least 2" thick.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

1 HIGH-PERFORMANCE FENESTRATION

2 PERFORMANCE PATH



A. Window does not meet 2009 IECC requirements.

Window meets 2009 IECC requirements.

2009 IECC WINDOW REQUIREMENTS

CLIMATE ZONE	U-FACTOR ^a	SHGC ^{a,c}
Zone 1	1.2	0.40
Zone 2	0.65 ^b	0.40
Zone 3	0.50 ^b	0.40
Zone 4	0.35	NR
Zone 5	0.35	NR
Zone 6	0.35	NR
Zone 7	0.35	NR

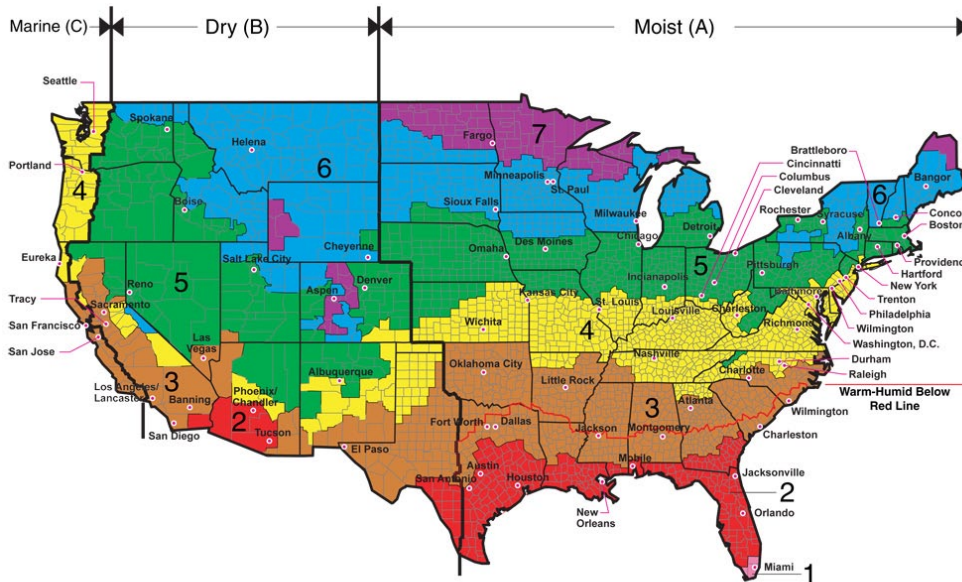
2009 IECC SKYLIGHT REQUIREMENTS

CLIMATE ZONE	U-FACTOR ^a	SHGC ^{a,c}
Zone 1	0.75	0.40
Zone 2	0.75	0.40
Zone 3	0.65	0.40
Zone 4	0.60	NR
Zone 5	0.60	NR
Zone 6	0.60	NR
Zone 7	0.60	NR

- U-factors and SHGC are maximums.
- For impact-rated fenestration complying with Section R301.2.1.2 of the International Residential Code or Section 1608.1.2 of the International Building Code, the maximum U-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.
- There are no SHGC requirements in the Marine Zone.

Interactive Map:

<http://energycode.pnl.gov/EnergyCodeReqs/>



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dillingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

Revision 02

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



SECTION 2. QUALITY-INSTALLED INSULATION

- 2.1. Ceiling, wall, floor, and slab insulation levels shall meet or exceed 2009 IECC levels
- 2.2. All ceiling, wall, floor, and slab insulation shall achieve RESNET-defined Grade I installation or, alternatively, Grade II for surfaces with insulated sheathing (see checklist item 4.4.1 for required insulation levels)

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DETAIL 2.1 ^{3, 4, 5, †}**Ceiling, wall, floor, and slab insulation levels shall meet or exceed 2009 IECC levels**

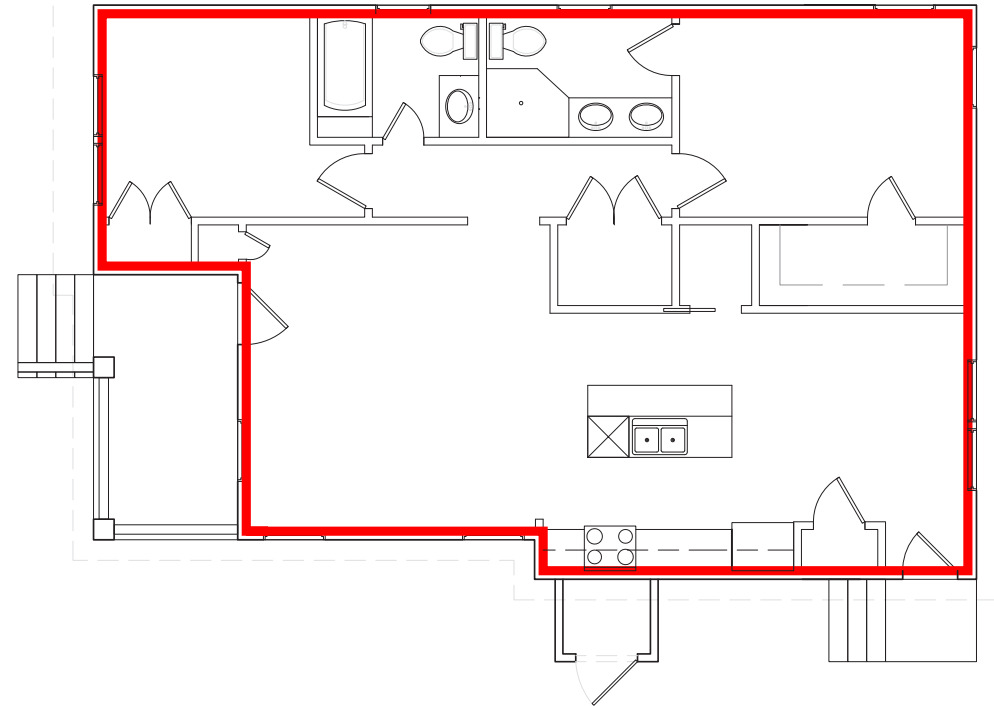
Install insulation in a home to meet or exceed the levels specified in the 2009 IECC and located on the back of this page.

- A. Verify insulation meets standards by utilizing the guide below, looking at printed R-values on the insulation product or consulting the insulator.

† Footnotes located on following page.

COMMON INSULATION MATERIALS

MATERIAL	APPROX. R-VALUE PER INCH
Cellulose	R-3.5
Fiberglass (Batts)	R-3.5
Fiberglass (Blown)	R-3
Polyurethane Rigid Board	R-6.8
EPS Insulated Concrete Forms (ICF)	R-4.25
XPS Insulated Concrete Forms (ICF)	R-5.0
EPS Structurally Insulated Panels (SIP)	R-3.1
XPS Structurally Insulated Panels (SIP)	R-4.3
Spray Foam (Closed Cell)	R-6
Spray Foam (Open Cell)	R-3.6



Knowing the exterior boundary of the house is critical for everyone involved in aligning air barriers with insulation. The Rater should first gather all plans, elevations and sections of the house. By drawing a boundary around the exterior barrier, the Rater can see the difficult areas to insulate and better communicate the required actions in those areas with the insulator and subcontractors.

TRADES
INSULATOR

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

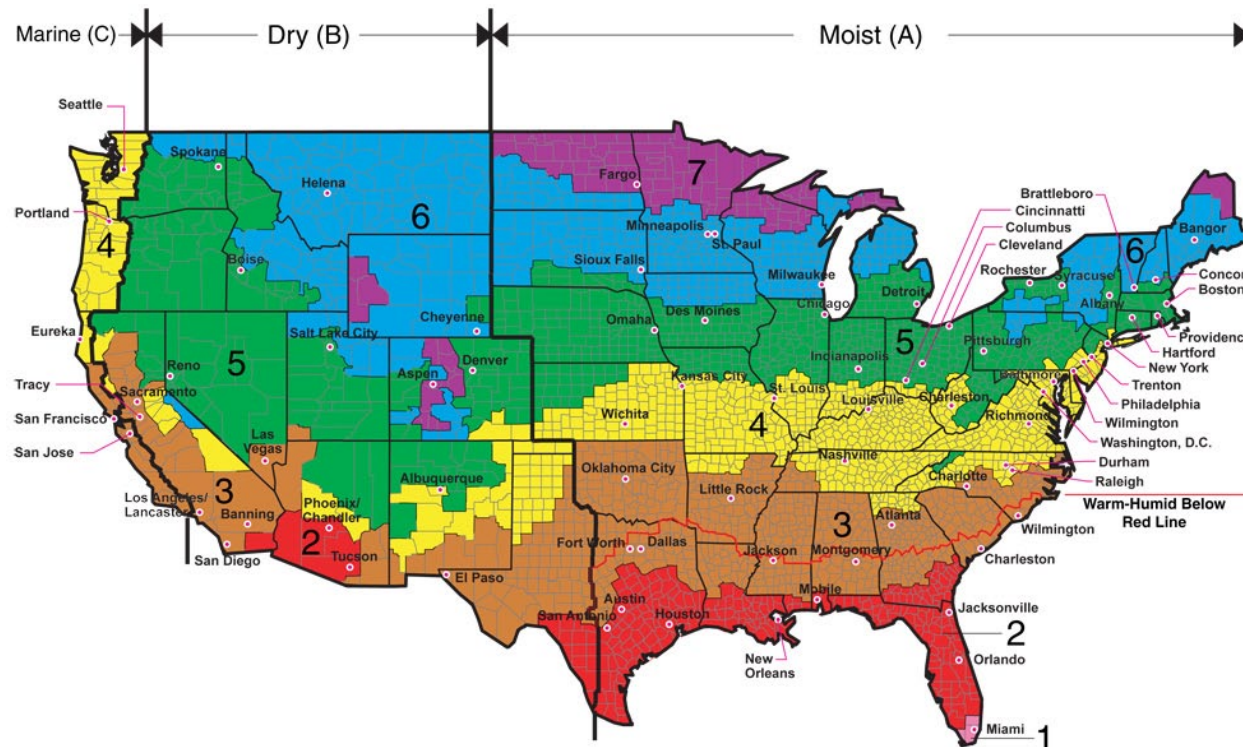
2 QUALITY-INSTALLED INSULATION

1 INSULATION LEVELS: MEET OR EXCEED 2009 IECC LEVELS



2009 IECC INSULATION REQUIREMENTS

CLIMATE ZONE	CEILING	FRAME WALL	MASS WALL ^c	FLOOR	BASEMENT WALL ^e	CRAWL SPACE WALL ^e
Zone 1	R-30	R-13	R-3	R-13	R-0	R-0
Zone 2	R-30	R-13	R-4	R-13	R-0	R-0
Zone 3	R-30	R-13	R-5	R-19	R-5/13 ^f	R-5/13
Zone 4	R-38	R-13	R-5	R-19	R-10/13	R-10/13
Zone 5	R-38	R-20 or R-13+R-5 ^b	R-13	R-30 ^d	R-10/13	R-10/13
Zone 6	R-49	R-20 or R-13+R-5 ^b	R-15	R-30 ^d	R-15/19	R-10/13
Zone 7	R-49	R-21	R-19	R-38 ^d	R-15/19	R-10/13



- a. R-Values are minimums.
- b. "R-13+R-5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulated sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of the exterior, structural sheathing shall be supplemented with insulation sheathing of at least R-2.
- c. The second R-value applies when more than half of the insulation is on the interior of the mass wall.
- d. Sufficient insulation to fill the cavity, R-19 minimum.
- e. "R-15/19" means R-15 continuous insulation sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior or exterior of the basement wall. "R-10/13" means R-10 continuous insulated sheathing or R-10 cavity insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.
- f. Basement wall insulation is not required in warm-humid locations defined by Figure 301.1 and Table 301.1 of the IECC.

All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dellingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

Interactive Map:

<http://energycode.pnl.gov/EnergyCodeReqs/>

FOOTNOTES

3. Insulation levels in a home shall meet or exceed the component insulation requirements in the 2009 IECC - Table 402.1.1. The following exceptions apply:

a. Steel-frame ceilings, walls, and floors shall meet the insulation requirements of the 2009 IECC – Table 402.2.5. In CZ 1 and 2, the continuous insulation requirements in this table shall be permitted to be reduced to R-3 for steel-frame wall assemblies with studs spaced at 24" on center. This exception shall not apply if the alternative calculations in d) are used;

b. For ceilings with attic spaces, R-30 shall satisfy the requirement for R-38 and R-38 shall satisfy the requirement for R-49 wherever the full height of uncompressed insulation at the lower R-value extends over the wall top plate at the eaves. This exemption shall not apply if the alternative calculations in d) are used;

c. For ceilings without attic spaces, R-30 shall satisfy the requirement for any required value above R-30 if the design of the roof/ceiling assembly does not provide sufficient space for the required insulation value. This exemption shall be limited to 500 square ft. or 20% of the total insulated ceiling area, whichever is less. This exemption shall not apply if the alternative calculations in d) are used;

d. An alternative equivalent U-factor or total UA calculation may also be used to demonstrate compliance, as follows:

i. An assembly with a U-factor equal or less than specified in 2009 IECC Table 402.1.3 complies.

ii. A total building thermal envelope UA that is less than or equal to the total UA resulting from the U-factors in Table 402.1.3 also complies. The insulation levels of all non-fenestration components (i.e., ceilings, walls, floors, and slabs) can be traded off using the UA approach under both the Prescriptive and the Performance path. Note that fenestration products (i.e., windows, skylights, doors) shall not be included in this calculation. Also, note that while ceiling and slab insulation can be included in trade-off calculations, the R-value must meet or exceed the minimum values listed in items 4.1 through 4.3 of the checklist to provide an effective thermal break, regardless of the UA tradeoffs calculated. The UA calculation shall be done using a method consistent with the ASHRAE

Handbook of Fundamentals and shall include the thermal bridging effects of framing materials. The calculation for a steel-frame envelope assembly shall use a series-parallel path calculation method.

4. Consistent with the 2009 IECC, slab edge insulation is only required for slab-on-grade floors with a floor surface less than 12 inches below grade. Slab insulation shall extend to the top of the slab to provide a complete thermal break. If the top edge of the insulation is installed between the exterior wall and the edge of the interior slab, it shall be permitted to be cut at a 45-degree angle away from the exterior wall.

5. Where an insulated wall separates a garage, patio, porch, or other unconditioned space from the conditioned space of the house, slab insulation shall also be installed at this interface to provide a thermal break between the conditioned and unconditioned slab. Post-tensioned slabs with integrated porch foundations are exempted from this requirement in all homes, as are post-tensioned slabs with integrated garage foundations in multi-family buildings, until feasible architectural details can be developed.

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DETAIL 2.2

All ceiling, wall, floor, and slab insulation shall achieve RESNET-defined Grade I installation or, alternatively, Grade II for surfaces with insulated sheathing (see checklist item 4.4.1 for required insulation levels)

- A. Install insulation without misalignments, compressions, gaps, or voids in all wall cavities along the thermal barrier of the house.

WHAT IS GRADE I INSTALLATION?

Grade I installation requires that the insulation material uniformly fill each cavity side-to-side and top-to-bottom, without substantial gaps, or voids around obstructions (such as blocking or bridging), and be split, installed, and/or fitted tightly around wiring and other services in the cavity.

To attain a rating of Grade I, wall insulation shall be enclosed on all six sides, and shall be in substantial contact with the sheathing material on at least one side (interior or exterior) of the cavity.

For faced batt insulation, Grade I can be designated for side-stapled tabs, provided the tabs are stapled neatly (no buckling), and provided the batt is only compressed at the edges of each cavity, to the depth of the tab itself, and provided the batt meets the other requirements of Grade I.

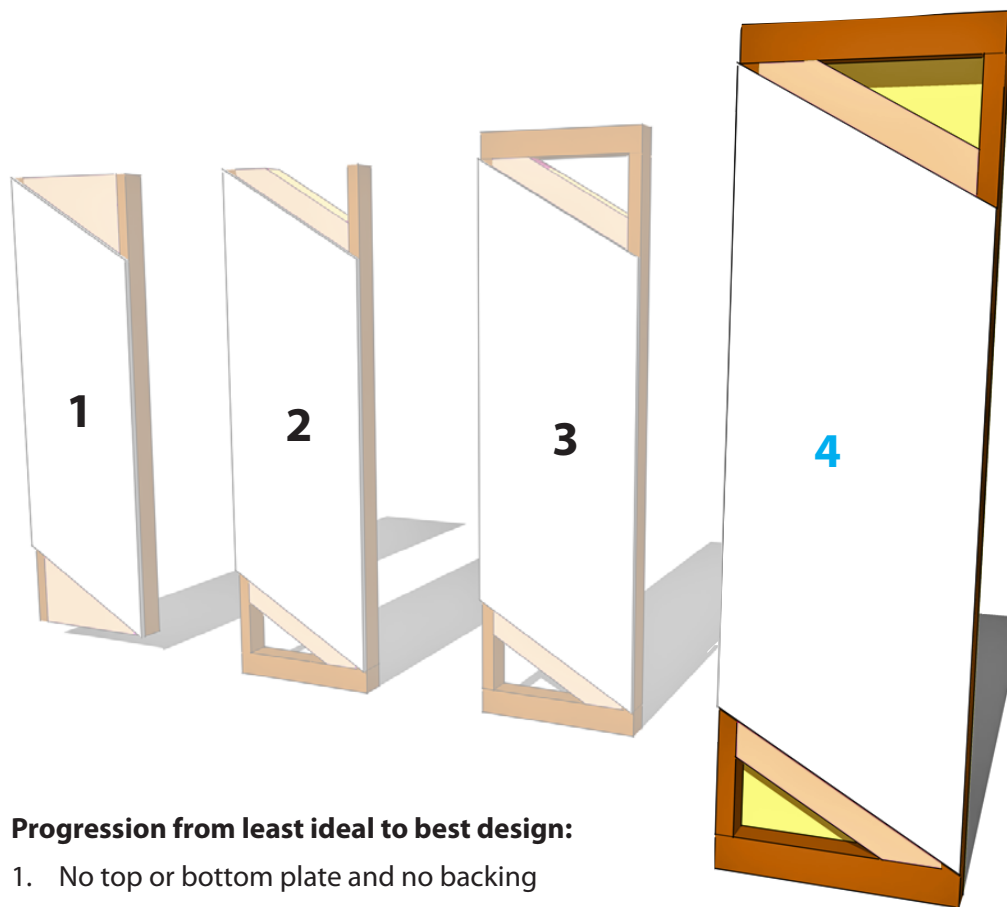
HOW DO RATERS INSPECT INSULATION?

Raters are required to inspect and probe in, around, or through the insulation and/ or vapor retarder in several places to see whether these requirements are met.

During inspection, insulation and vapor retarders may be cut or pulled away so Raters can see installation details. The Raters should replace or repair the vapor retarder and insulation as necessary. During inspection (typically before drywall is installed), if the exterior sheathing is visible from the building interior through gaps in the cavity insulation material, it is not considered a Grade I installation.

IDEAL INSTALLATION OF INSULATION

Properly installed insulation consists of insulation framed on all six sides, including top and bottom plates, rigid backing, and sheathing. The insulator should ensure that framing is correctly installed before the start of insulation.

**Progression from least ideal to best design:**

1. No top or bottom plate and no backing
2. Bottom plate, but no top plate or backing
3. Top and bottom plate, but no backing
4. **Insulation surrounded on six sides, including a top and bottom plate and backing**

TRADES
FRAMER
INSULATOR

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

2 QUALITY-INSTALLED INSULATION

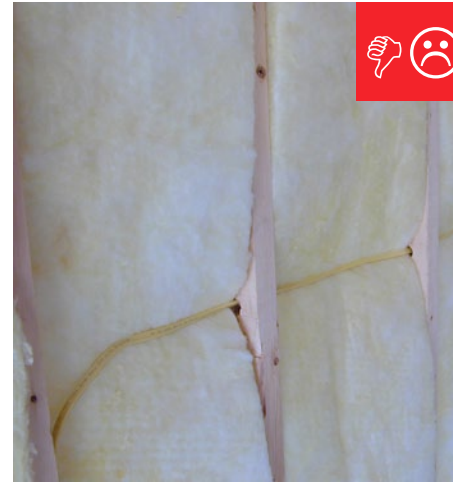
2 INSULATION: RESNET GRADE I OR GRADE II INSTALLATION



- A.** Insulation has misalignment, compression, and gaps.



- RESNET Grade I installation of batt insulation.



- A.** Compression and misalignment because insulation is not split around wires.



- Batt was properly split around wires to achieve RESNET Grade I.



- A.** Compression and misalignment because insulation is not split around plumbing.



- RESNET Grade I installation of blown insulation.



- A.** Spray foam installed with voids.



- RESNET Grade I installation of spray foam insulation.

SECTION 3. FULLY-ALIGNED AIR BARRIERS

3.1. Walls:

- 3.1.1. Walls behind showers and tubs
- 3.1.2. Walls behind fireplaces
- 3.1.3. Attic knee walls/Sloped Attics
- 3.1.4. Skylight shaft walls
- 3.1.5. Wall adjoining porch roof
- 3.1.6. Staircase walls
- 3.1.7. Double walls
- 3.1.8. Garage rim/band joist adjoining conditioned space
- 3.1.9. All other exterior walls

3.2. Floors:

- 3.2.1. Floor above garage
- 3.2.2. Cantilevered floor
- 3.2.3. Floor above unconditioned basement or vented crawlspace

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



3.3. Ceilings:

3.3.1. Dropped ceiling/soffit below unconditioned attic

3.3.2. Sloped ceilings

3.3.3. All other ceilings

DETAIL 3.1.1 ^{6, 7, 8}**Walls behind showers and tubs**

- A. Install insulation without misalignments, compressions, gaps, or voids in all exterior wall cavities behind all tubs and showers.
- B. Back with a rigid air barrier or other supporting material to prevent insulation from sagging and create a continuous thermal barrier.*
- C. Seal all seams, gaps, and holes of the air barrier with caulk or foam before tub/shower installation.

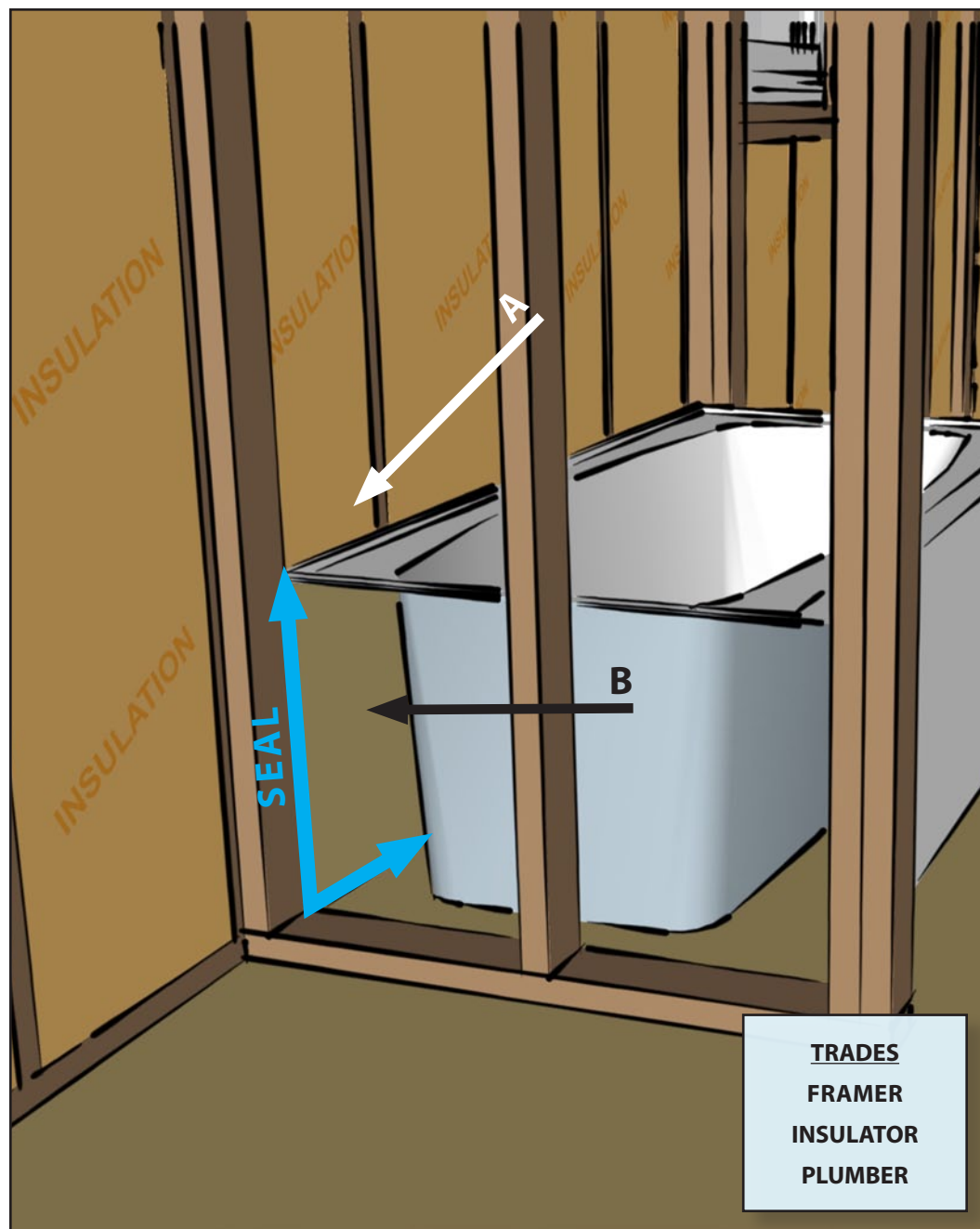
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

1 WALLS



A. Insulation has compression and misalignment.



Insulation meets RESNET Grade I prior to air barrier installation.



B. No air barrier installed prior to tub installation.



Air barrier installed behind shower stall.



B. No air barrier installed prior to tub installation.



Air barrier installed behind the tub.



C. Air barrier not sealed.



Air barrier sealed.

DETAIL 3.1.2 ^{6, 7, 8}**Walls behind fireplaces**

- A. Install insulation without misalignments, compressions, gaps, or voids in all exterior wall cavities behind all fireplaces.
- B. Back with a fire-proof rigid air barrier or other supporting material to create a continuous thermal barrier and prevent a fire hazard.*
- C. Seal all seams, gaps, and holes of the air barrier with fire-rated caulk or foam before fireplace installation.

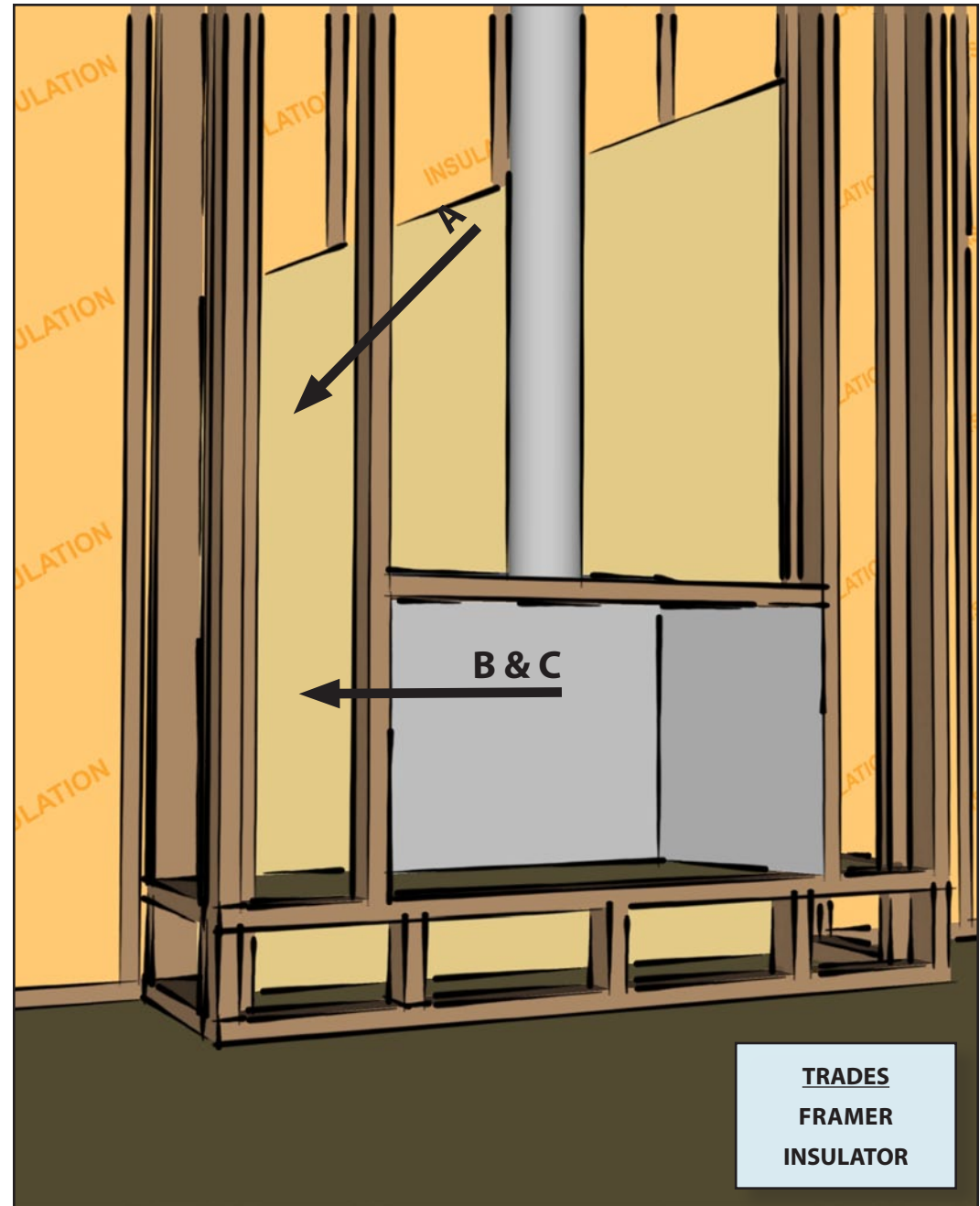
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

1 WALLS



A. No insulation installed behind fireplace.



Insulation installed behind fireplace prior to air barrier installation.



B. No rigid air barrier is installed behind fireplace.



Rigid air barrier is installed behind fireplace.



B. No rigid air barrier is installed behind fireplace.



Rigid air barrier is installed behind fireplace.



C. Vent sleeve not completely sealed.



Vent and air barrier sealed.

3 FULLY-ALIGNED AIR BARRIERS

1 WALLS

DETAIL 3.1.3 6, 7, 8, 11

Attic knee walls/sloped attics

- A. Install a top and bottom plate or blocking at the top and bottom of all knee wall cavities.
- B. Back attic knee walls with a rigid air barrier or other supporting material to prevent insulation from sagging and create a continuous thermal barrier.*
- C. Install an interior rigid air barrier for all sloped attic walls in CZ 4 and higher
- D. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- E. Install insulation without misalignments, compressions, gaps, or voids in all knee wall cavities.

* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.

11. Sloped attics shall meet the air barrier requirements for walls and are defined as sloped surfaces separating conditioned attics from ambient conditions. In contrast, sloped ceilings shall meet the air barrier requirements for ceilings and are defined as sloped surfaces separating conditioned house space from ambient conditions (e.g., sloped ceiling at the perimeter of a bedroom).

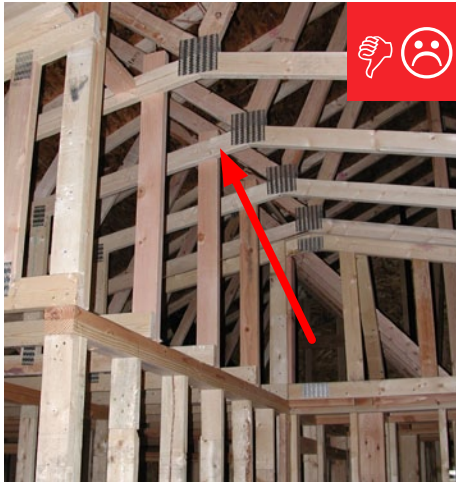


TRADES
FRAMER
INSULATOR

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

1 WALLS



A. No top plate installed.



Top and bottom plates installed prior to backing and insulation.



B. No rigid backing on knee wall.



Rigid backing installed prior to insulation.



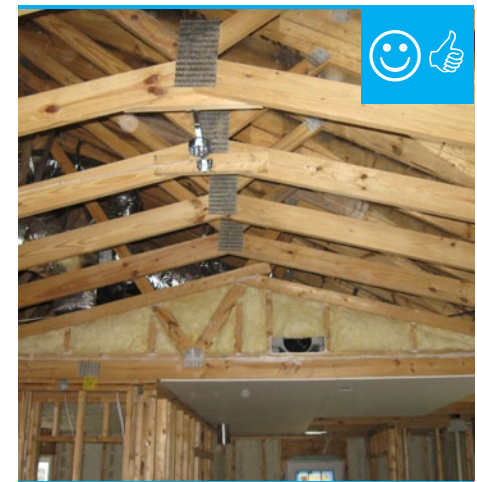
D. Backing not air sealed prior to insulation.



Backing air sealed prior to insulation.



E. Improperly installed insulation and no rigid backing.



Properly insulated, backed, and air-sealed knee wall.

DETAIL 3.1.4 ^{6, 7, 8}**Skylight shaft walls**

- A. If non-rigid insulation is used, install a rigid air barrier to prevent insulation from sagging and create a continuous thermal barrier.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- C. Install the insulation without any misalignments, compressions, gaps, or voids so that it acts as both the air barrier and thermal boundary. *Examples include foam board, spray foam or dense pack insulation.*

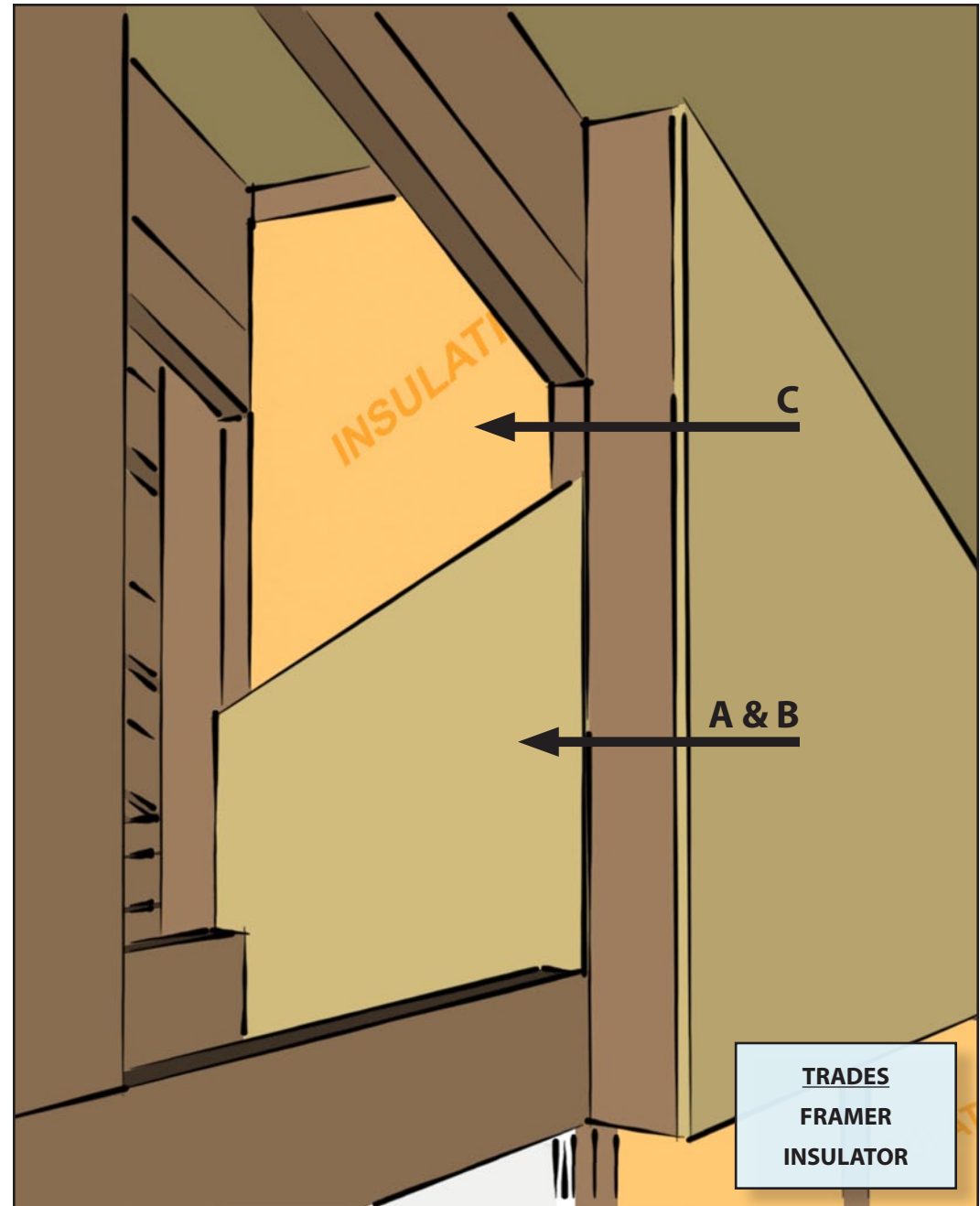
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



3 FULLY-ALIGNED AIR BARRIERS

1 WALLS



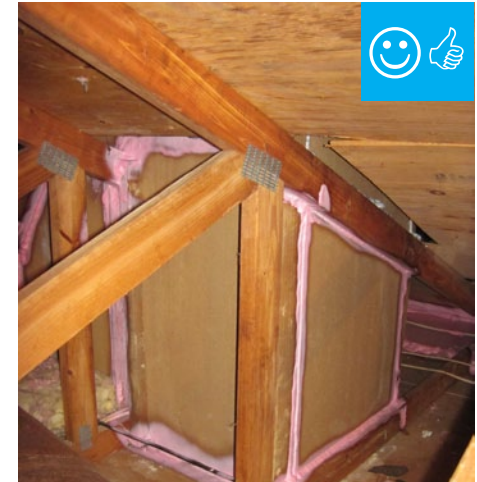
A. Rigid air barrier not installed to hold insulation in place.



Rigid air barrier is installed to hold insulation in place.



B. Rigid air barrier not properly sealed around skylight shaft.



Rigid air barrier properly sealed around skylight shaft.



C. Insulation is misaligned with air barrier.



C.



DETAIL 3.1.5 ^{6, 7, 8}**Wall adjoining porch roof**

- A. Install a rigid air barrier or other supporting material to separate the porch attic from the conditioned space.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam before building wrap installation.

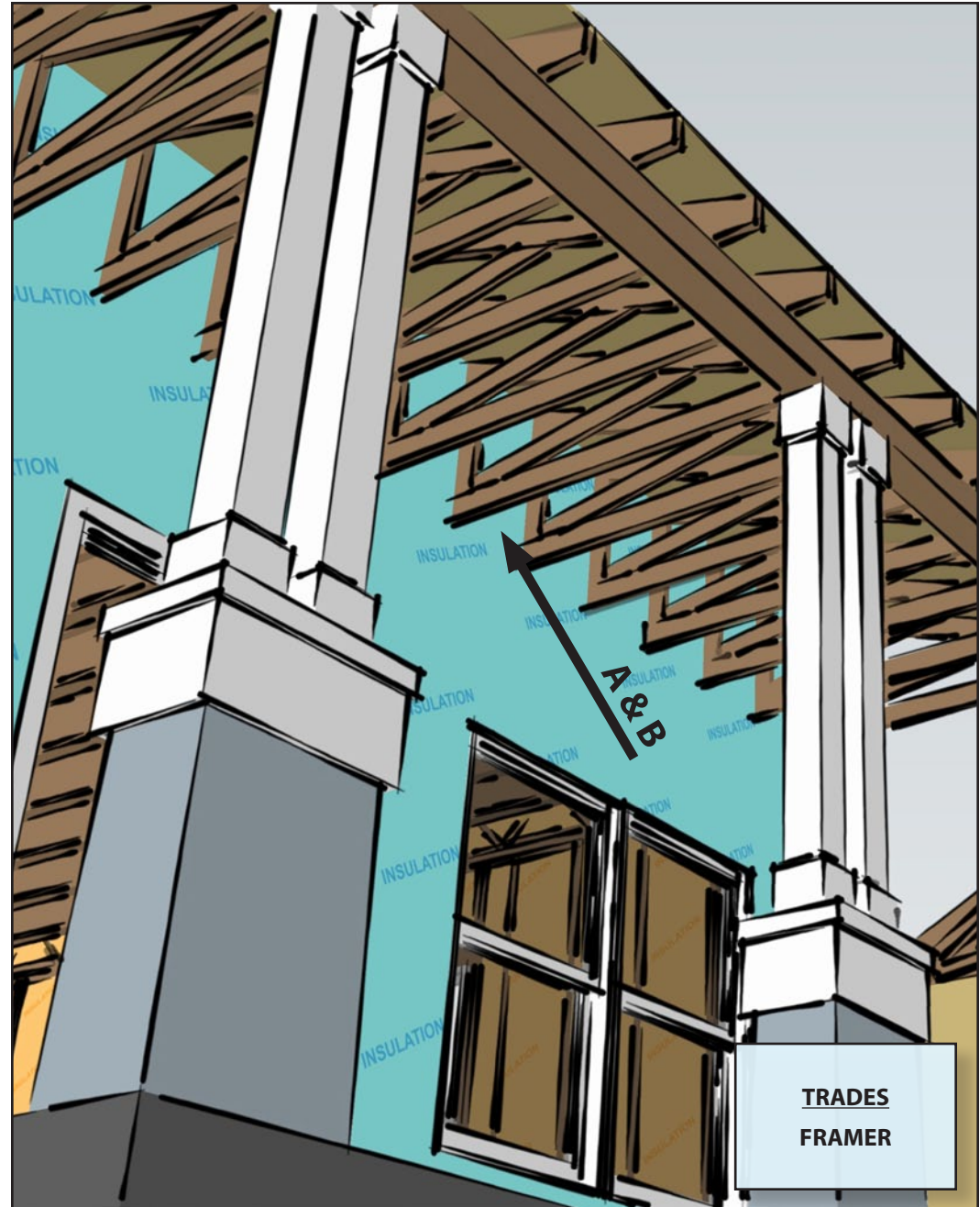
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

1 WALLS



A. No air barrier between porch attic and conditioned space.



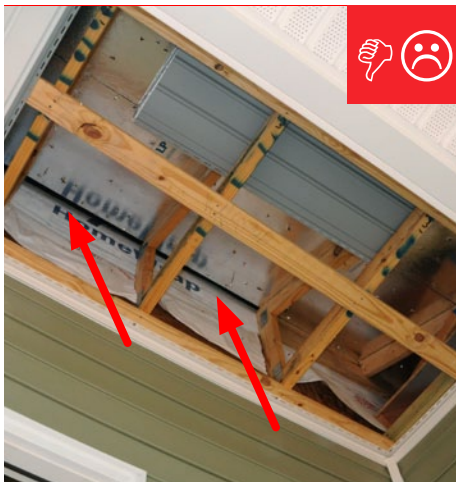
Air barrier is installed prior to porch attic framing.



A. No air barrier between porch attic and conditioned space.



Air barrier is installed prior to porch attic framing.



B. Air barrier not sealed between porch attic and conditioned space.



Air barrier and penetrations sealed between porch attic and conditioned space.



B. Air barrier not sealed between porch attic and conditioned space.



DETAIL 3.1.6 ^{6, 7, 8}

Staircase walls

- Install insulation without misalignments, compressions, gaps, or voids in all exterior wall cavities underneath all staircases.
- Install a rigid air barrier to prevent insulation from sagging and create a continuous thermal barrier.*
- Seal all seams, gaps, and holes of the air barrier with caulk or foam.

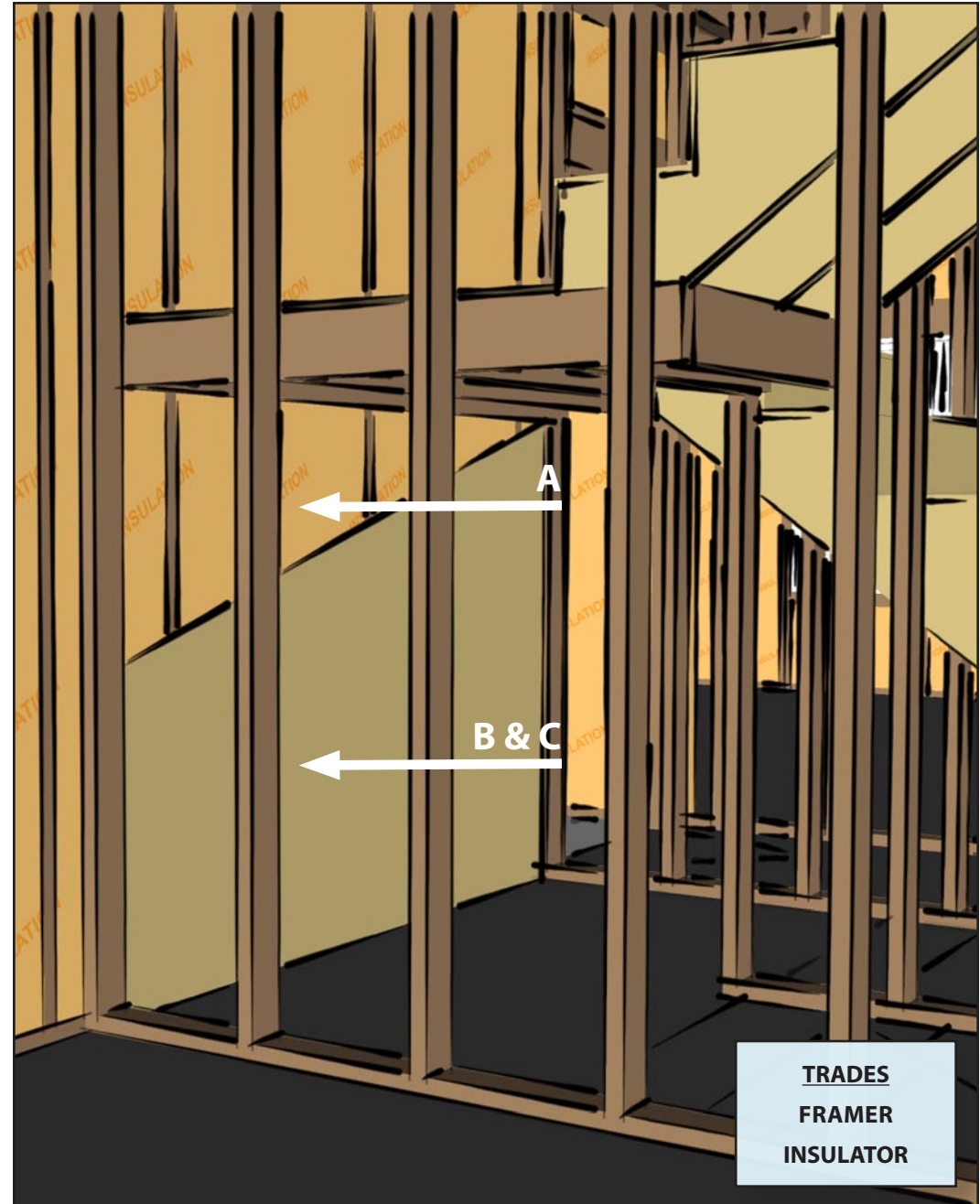
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

1 WALLS



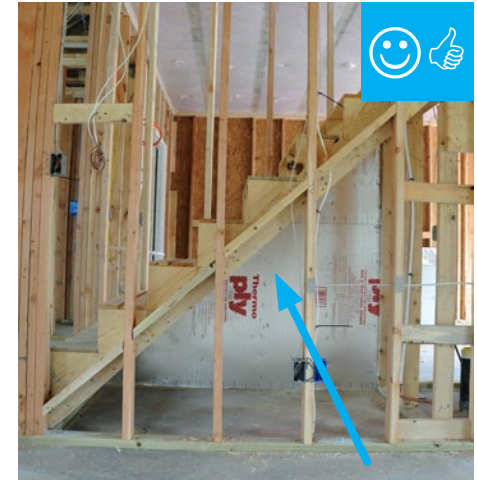
BAD PIC OF IMPROPERLY
INSTALLED INSULATION



Insulation properly installed before
air barrier.



B. No air barrier installed
under staircase.



Air barrier installed under staircase.

*Picture taken from house looking into
attached garage.*



B. No air barrier installed
under staircase.



Air barrier installed under staircase.



C. Air barrier not sealed.

*Picture taken from garage
looking into house.*

GOOD PIC OF PROPERLY
SEALED STAIRCASE



DETAIL 3.1.7 ^{6, 7, 8}**Double walls**

- A. Install a continuous air barrier on the exterior of the interior wall.
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- C. Install insulation without misalignments, compressions, gaps, or voids.

OR

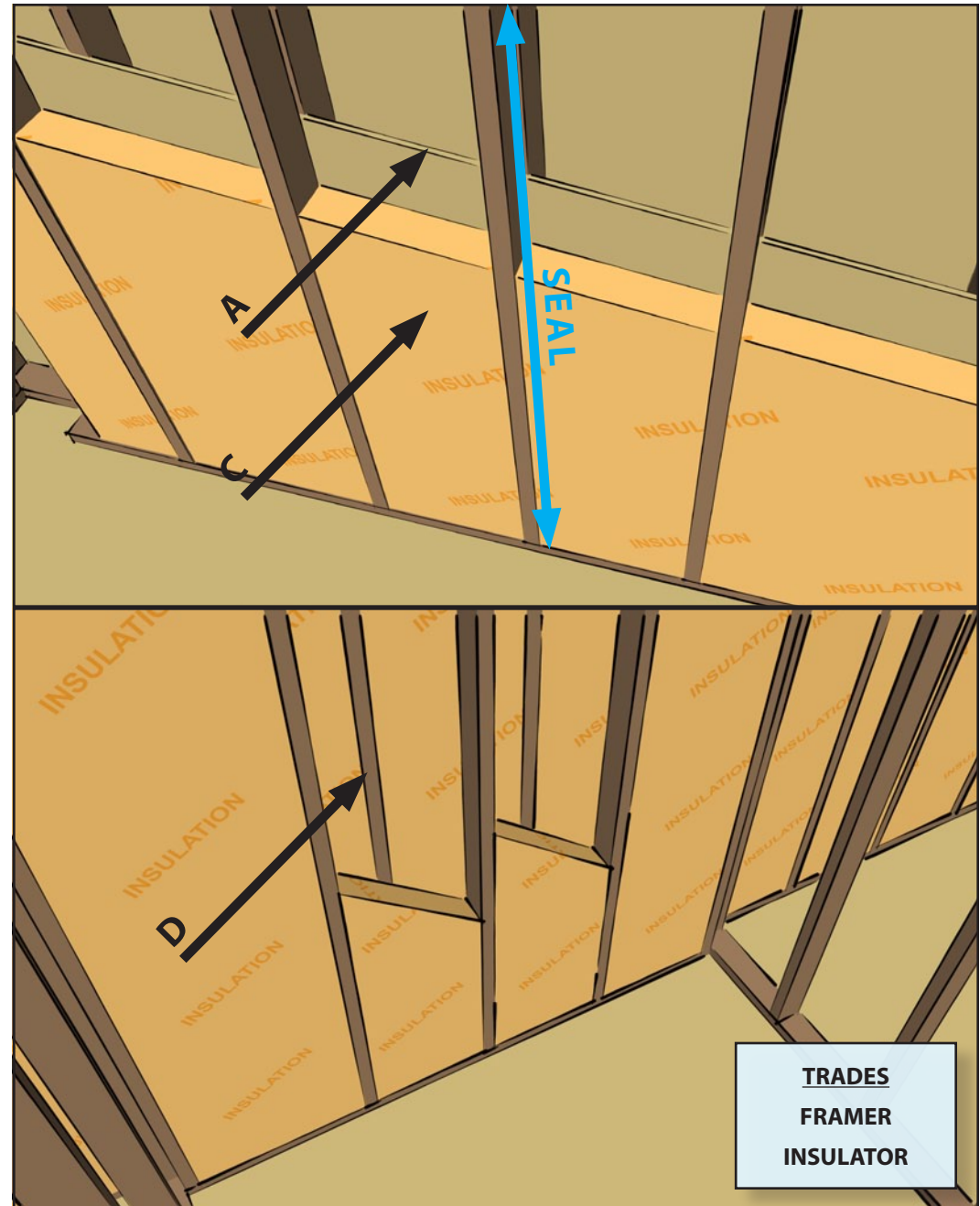
- D. Completely fill entire cavity of the double wall assembly without misalignments, compressions, gaps, or voids.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.



TRADES
FRAMER
INSULATOR

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

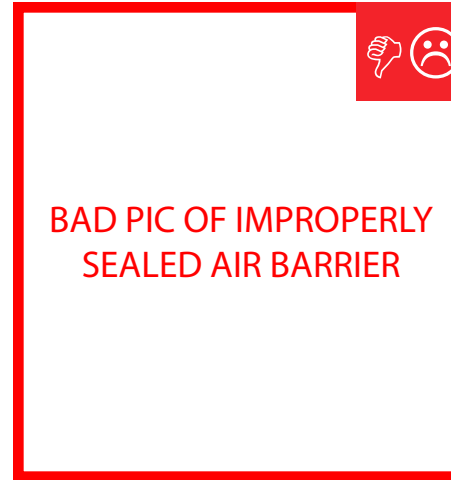
1 WALLS



A. No air barrier installed between double-wall framing.



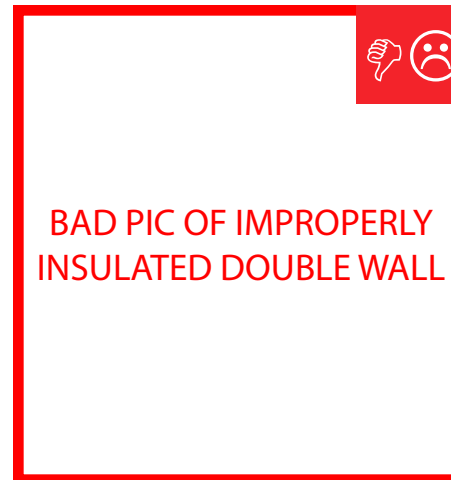
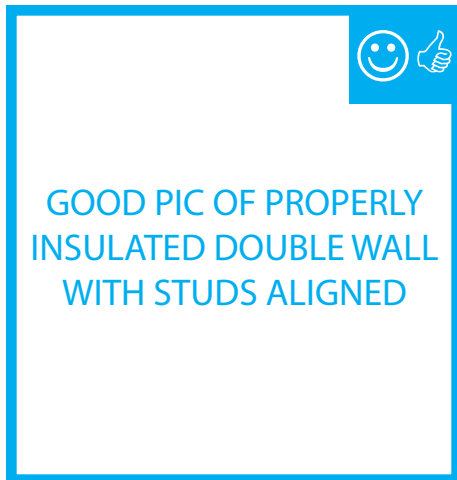
Air barrier is installed between double-wall framing.



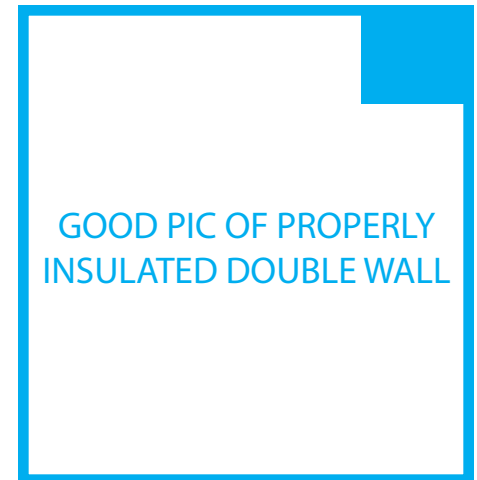
B.



C. Insulation does not fill entire cavity nor is there an air barrier present between the double wall.



C.



DETAIL 3.1.8 ^{6, 7, 8}**Garage rim/band joist adjoining conditioned space**

- A. Install a continuous rigid air barrier or other supporting material to separate the garage from the conditioned space.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam and complete before installing the insulation.
- C. Install insulation without misalignments, compressions, gaps, or voids in all band joist cavities.

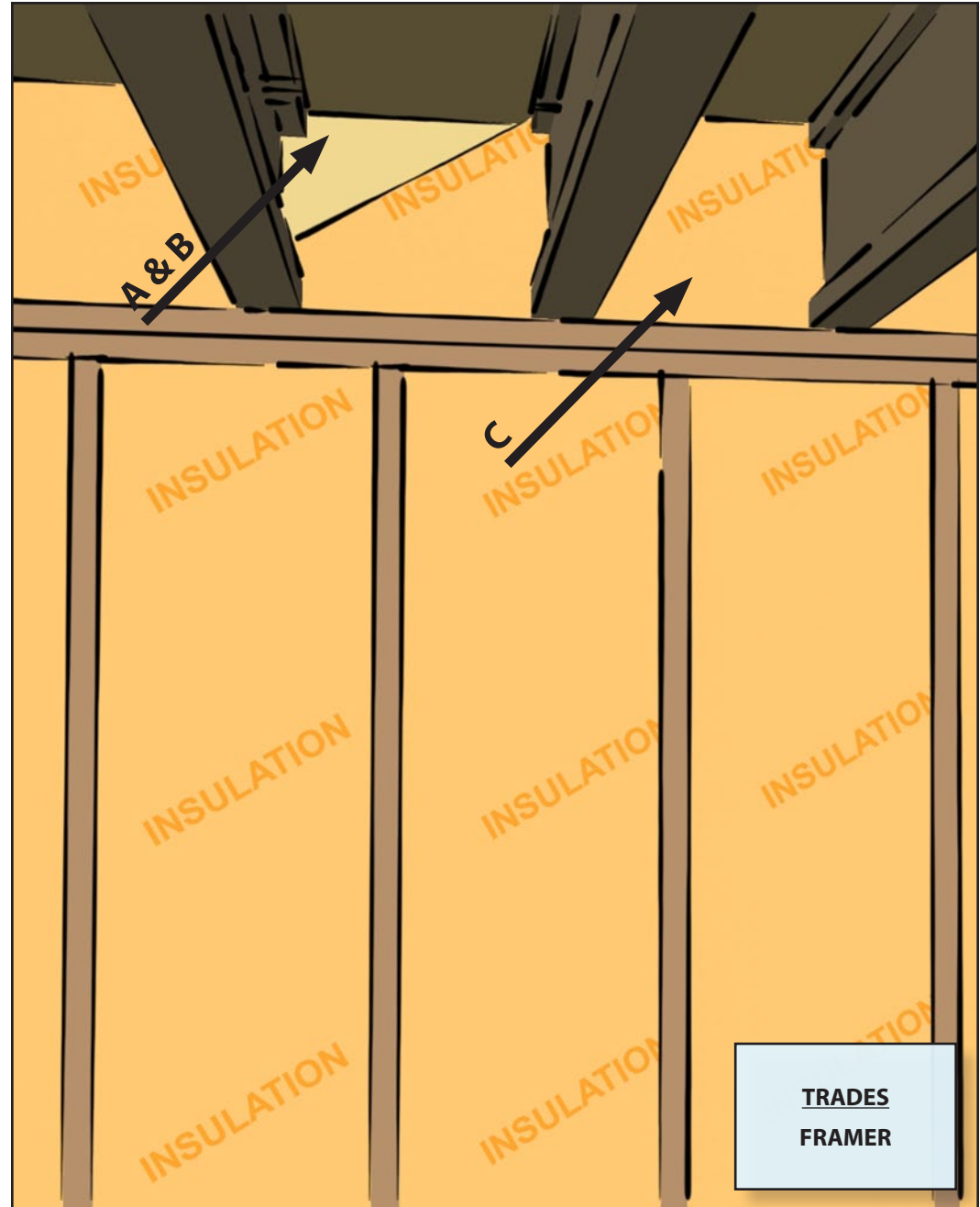
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.



TRADES
FRAMER

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

1 WALLS



- A.** No air barrier is present between garage and floor system.



- Air barrier is present between garage and floor system.



- A.** No air barrier is present between garage and conditioned space.



- Air barrier is present between garage and conditioned space.



- B.** Band not properly sealed.



- Penetrations through band properly sealed.



- C.** Gaps without insulation and not properly sealed.



- Band is properly insulated and sealed.

DETAIL 3.1.9 ^{6, 7, 8}**All other exterior walls**

- A. Install a continuous rigid air barrier or other supporting material to separate the exterior from the conditioned space.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam and complete before installing the insulation.
- C. Install insulation without misalignments, compressions, gaps, or voids in all exterior walls.

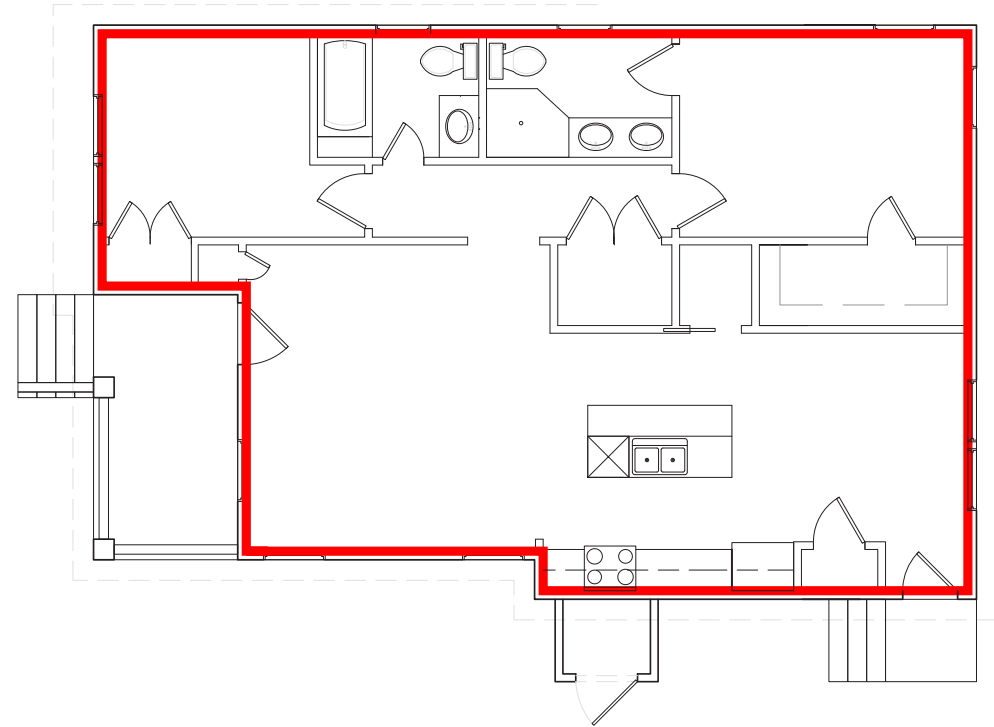
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.

8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.



Knowing the exterior boundary of the house is critical for everyone involved in aligning air barriers with insulation. The Rater should first gather all plans, elevations and sections of the house. By drawing a boundary around the exterior barrier, the Rater can see the difficult areas to insulate and better communicate the required actions in those areas with the insulator and subcontractors.

TRADES
FRAMER
INSULATOR

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

1 WALLS



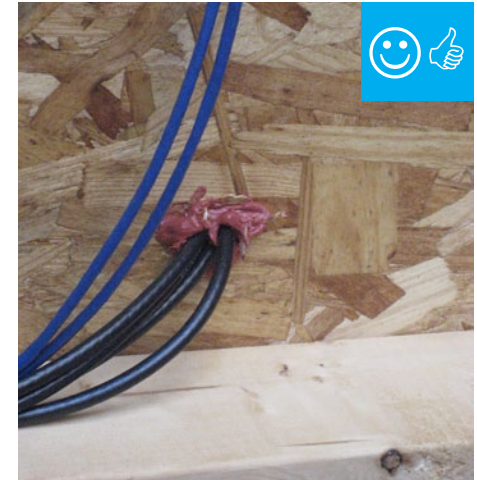
A. Air barrier is not continuous.



Continuous air barrier



B. Electrical box not air sealed.



Wiring penetrations properly air sealed.



B. Air barrier is air sealed.



Air barrier is air sealed.



C. Insulation is misaligned.



Insulation is properly installed.

3 FULLY-ALIGNED AIR BARRIERS

2 FLOORS

DETAIL 3.2.1 6, 9, 10

Floor above garage

- A. Install a continuous rigid air barrier or other supporting material to separate the garage from the conditioned space.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam and complete before insulation installation.
- C. Install insulation without misalignments, compressions, gaps, or voids in all floors above garage.
- D. Install supports for insulation to remain in contact with the air barrier.
Examples of supports include staves for batt insulation or netting for blown-in insulation.

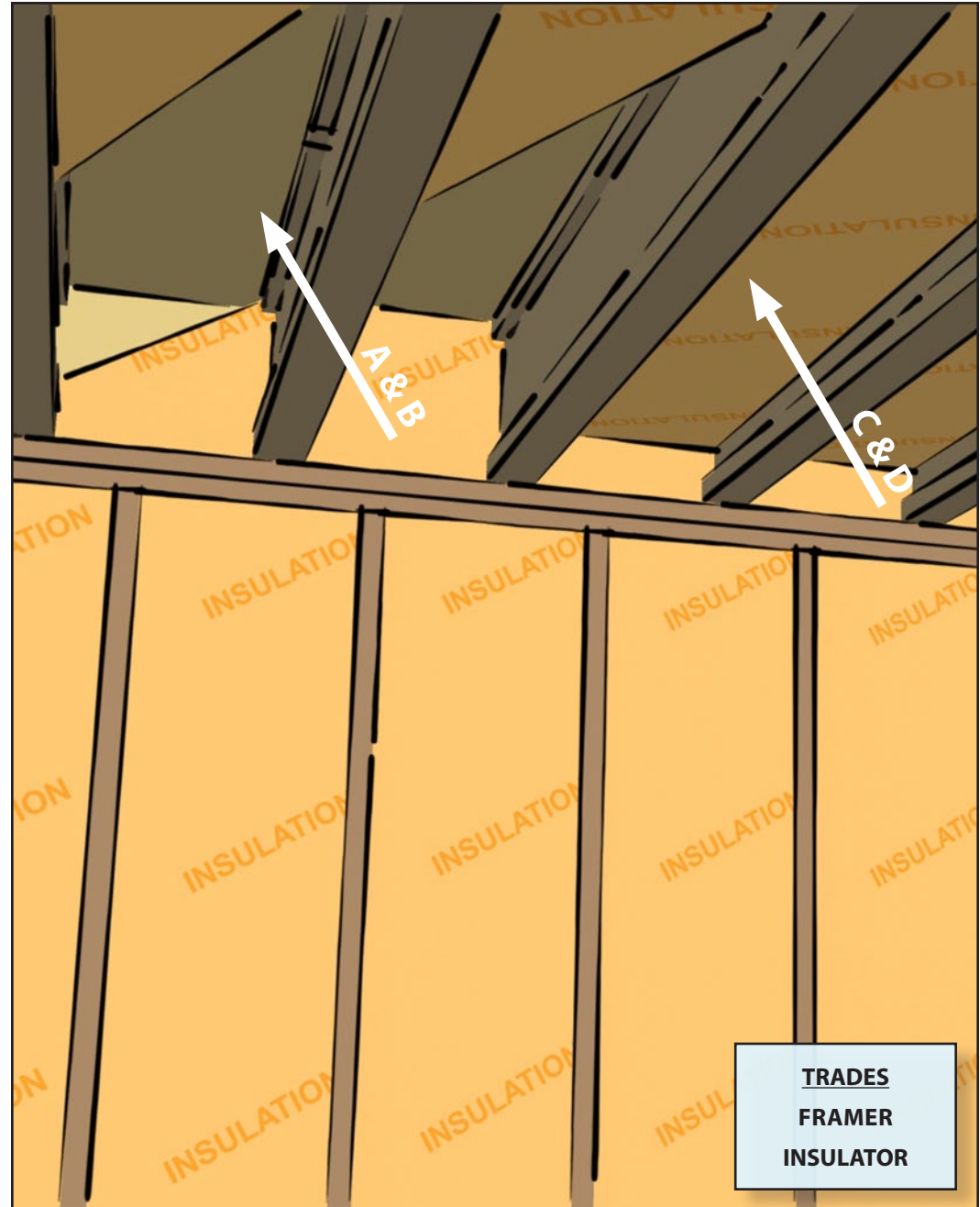
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

9. Examples of supports necessary for permanent contact include staves for batt insulation or netting for blown-in insulation. Batts that completely fill a cavity enclosed on all six sides may be used to meet this requirement without the need for supports, even though some compression will occur due to the excess insulation, as long as the compressed value meets or exceeds the required insulation level. Specifically, the following batts may be used in six-sided floor cavities: R-19 batts in 2x6 cavities, R-30 batts in 2x8 cavities, R-38 batts in 2x10 cavities, and R-49 batts in 2x12 cavities. For example, in a home that requires R-19 floor insulation, an R-30 batt may be used in a six-sided 2x8 floor cavity.

10. Fully-aligned air barriers may be installed at the exterior surface of the floor cavity in all Climate Zones if the insulation is installed in contact with this exterior air barrier and the perimeter rim and band joists of the floor cavity are also sealed and insulated to comply with the fully-aligned air barrier requirements for walls.



TRADES
FRAMER
INSULATOR

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

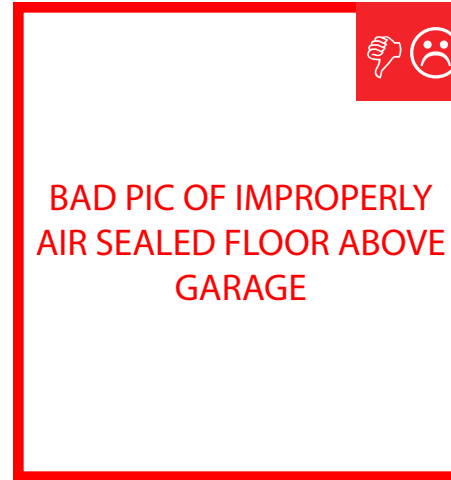
2 FLOORS



A. Floor system does not have air barrier to separate it from garage.



Floor above garage is a continuous air barrier.



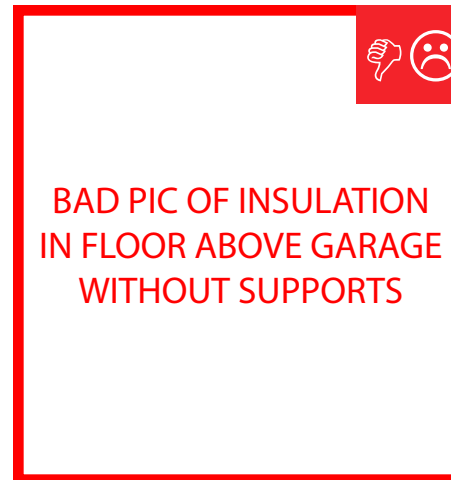
B.



C. Insulation is misaligned with floor above.



Insulation is in contact with floor above.



D.



DETAIL 3.2.2 6, 9, 10**Cantilevered floor**

- A. Install a rigid air barrier or other supporting blocking to separate the cantilever from the conditioned space.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- C. Install insulation without misalignments, compressions, gaps, or voids and align it with the sub-floor, the rigid air barrier (A), and the exterior face of the cavity.
- D. Once insulated, enclose the cavity with a rigid air barrier material.

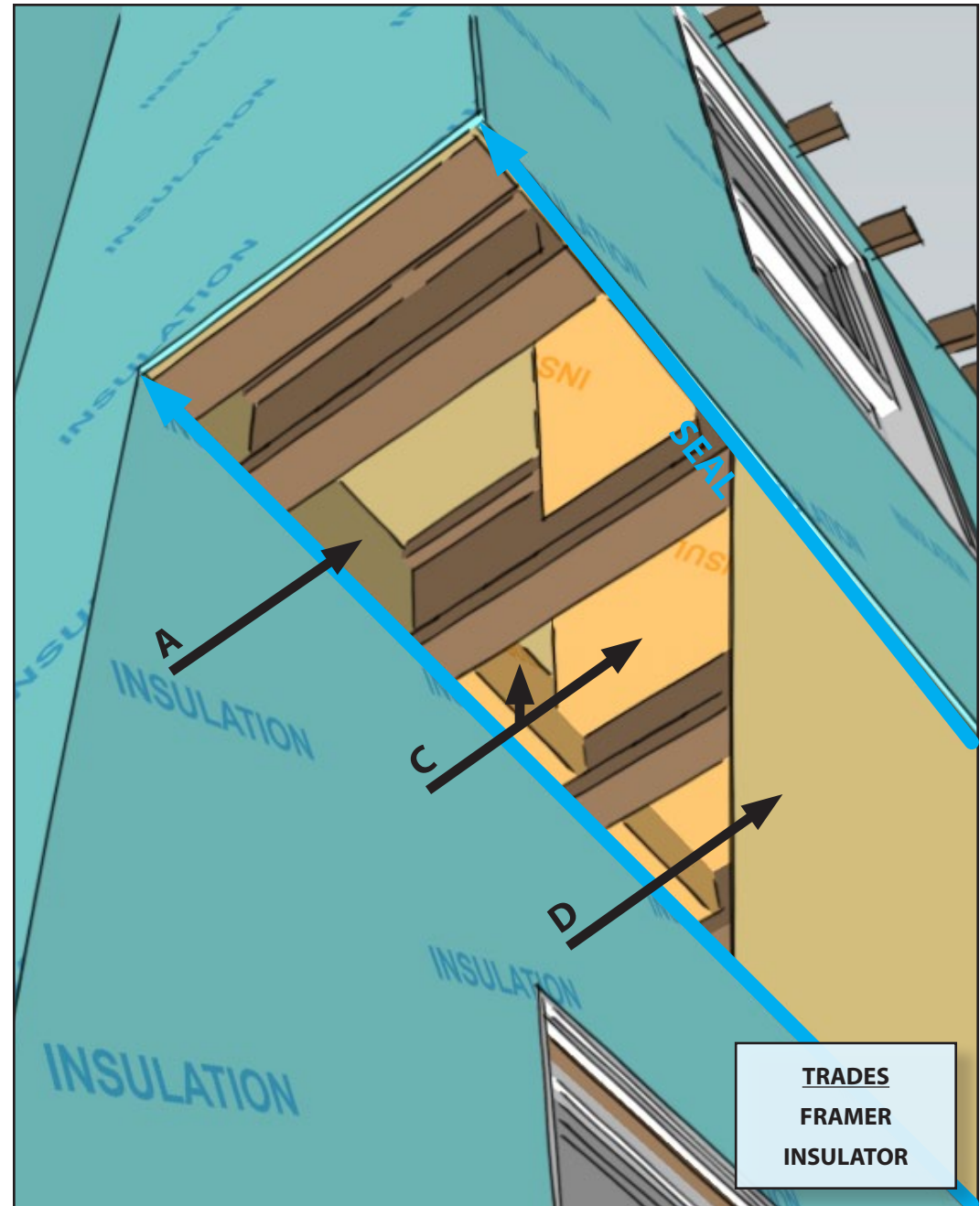
* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

9. Examples of supports necessary for permanent contact include staves for batt insulation or netting for blown-in insulation. Batts that completely fill a cavity enclosed on all six sides may be used to meet this requirement without the need for supports, even though some compression will occur due to the excess insulation, as long as the compressed value meets or exceeds the required insulation level. Specifically, the following batts may be used in six-sided floor cavities: R-19 batts in 2x6 cavities, R-30 batts in 2x8 cavities, R-38 batts in 2x10 cavities, and R-49 batts in 2x12 cavities. For example, in a home that requires R-19 floor insulation, an R-30 batt may be used in a six-sided 2x8 floor cavity.

10. Fully-aligned air barriers may be installed at the exterior surface of the floor cavity in all Climate Zones if the insulation is installed in contact with this exterior air barrier and the perimeter rim and band joists of the floor cavity are also sealed and insulated to comply with the fully-aligned air barrier requirements for walls.





GOOD PIC OF PROPERLY
BLOCKED CANTILEVER



A. No air barrier is present
between cantilever and
conditioned space.



BAD PIC OF IMPROPERLY
AIR SEALED CANTILEVER

B.



All holes, gaps, and seams of the
rigid air barrier are air sealed.



GOOD PIC OF PROPERLY
INSULATED CANTILEVER



C. Cantilever is not blocked or
insulated.



BAD PIC OF IMPROPER
INSTALLATION OF RIGID AIR
BARRIER TO UNDERSIDE OF
CANTILEVER

D.



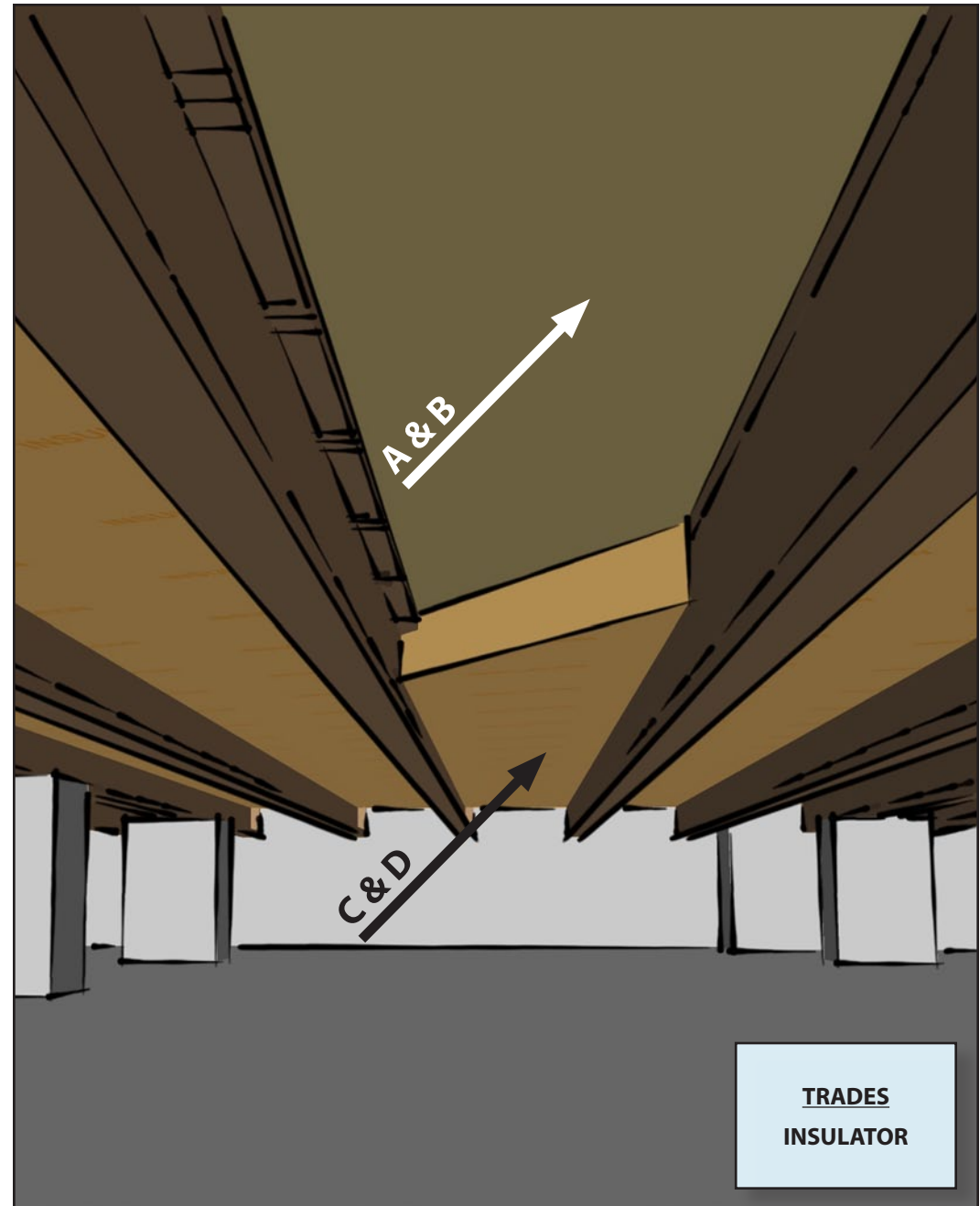
Cantilever has been properly
insulated, air sealed, and cavity has
been blocked.

DETAIL 3.2.3 6, 9, 10, †**Floor above unconditioned basement or vented crawlspace**

- A. Install a continuous rigid air barrier or other supporting material to separate the exterior from the conditioned space.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- C. Install insulation without misalignments, compressions, gaps, or voids in floors above the unconditioned basement or vented crawlspace.
- D. Install supports for insulation to remain in contact with the air barrier. *Examples include metal support rods for batt insulation or netting for blown insulation.*

* EPA recommends using a rigid air barrier, but it is not a requirement.

† Footnotes located on following page.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

2 FLOORS



A. No air barrier is present between the floor system and unconditioned space.



Air barrier is present and installed between the floor system and unconditioned space.



B. Penetration through the floor is not air sealed.



Penetrations through floor are air sealed.



C. Sub-floor insulation has gaps, compression, and misalignment.



Sub-floor insulation is properly installed and supported.



D. Sub-floor insulation is not properly installed or supported.

GOOD PIC OF SUB-FLOOR
INSULATION PROPERLY
SUPPORTED

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

9. Examples of supports necessary for permanent contact include staves for batt insulation or netting for blown-in insulation. Batts that completely fill a cavity enclosed on all six sides may be used to meet this requirement without the need for supports, even though some compression will occur due to the excess insulation, as long as the compressed value meets or exceeds the required insulation level. Specifically, the following batts may be used in six-sided floor cavities: R-19 batts in 2x6 cavities, R-30 batts in 2x8 cavities, R-38 batts in 2x10 cavities, and R-49 batts in 2x12 cavities. For example, in a home that requires R-19 floor insulation, an R-30 batt may be used in a six-sided 2x8 floor cavity.

10. Fully-aligned air barriers may be installed at the exterior surface of the floor cavity in all Climate Zones if the insulation is installed in contact with this exterior air barrier and the perimeter rim and band joists of the floor cavity are also sealed and insulated to comply with the fully-aligned air barrier requirements for walls.

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DETAIL 3.3.1 ⁶**Dropped ceiling/soffit below unconditioned attic**

- A. Install a continuous rigid air barrier or other supporting material to cap the dropped ceiling and soffits.*
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam before installation of attic insulation.

* EPA recommends using a rigid air barrier, but it is not a requirement.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

11. Sloped attics shall meet the air barrier requirements for walls and are defined as sloped surfaces separating conditioned attics from ambient conditions. In contrast, sloped ceilings shall meet the air barrier requirements for ceilings and are defined as sloped surfaces separating conditioned house space from ambient conditions (e.g., sloped ceiling at the perimeter of a bedroom).



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

3 CEILINGS



A. No air barrier is present between the dropped ceiling/soffit and the attic.



Air barrier is present between the dropped ceiling/soffit and the attic.



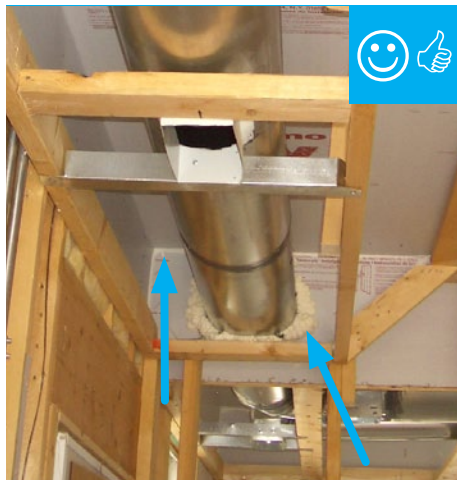
A. No air barrier is present between the dropped ceiling/soffit and the attic.



Air barrier is present between the dropped ceiling/soffit and the attic.



B. Seams of air barrier not sealed.



Seams and penetrations of air barrier properly sealed



B. Seams of air barrier not sealed.



GOOD PIC OF PROPERLY SEALED DROPPED CEILING

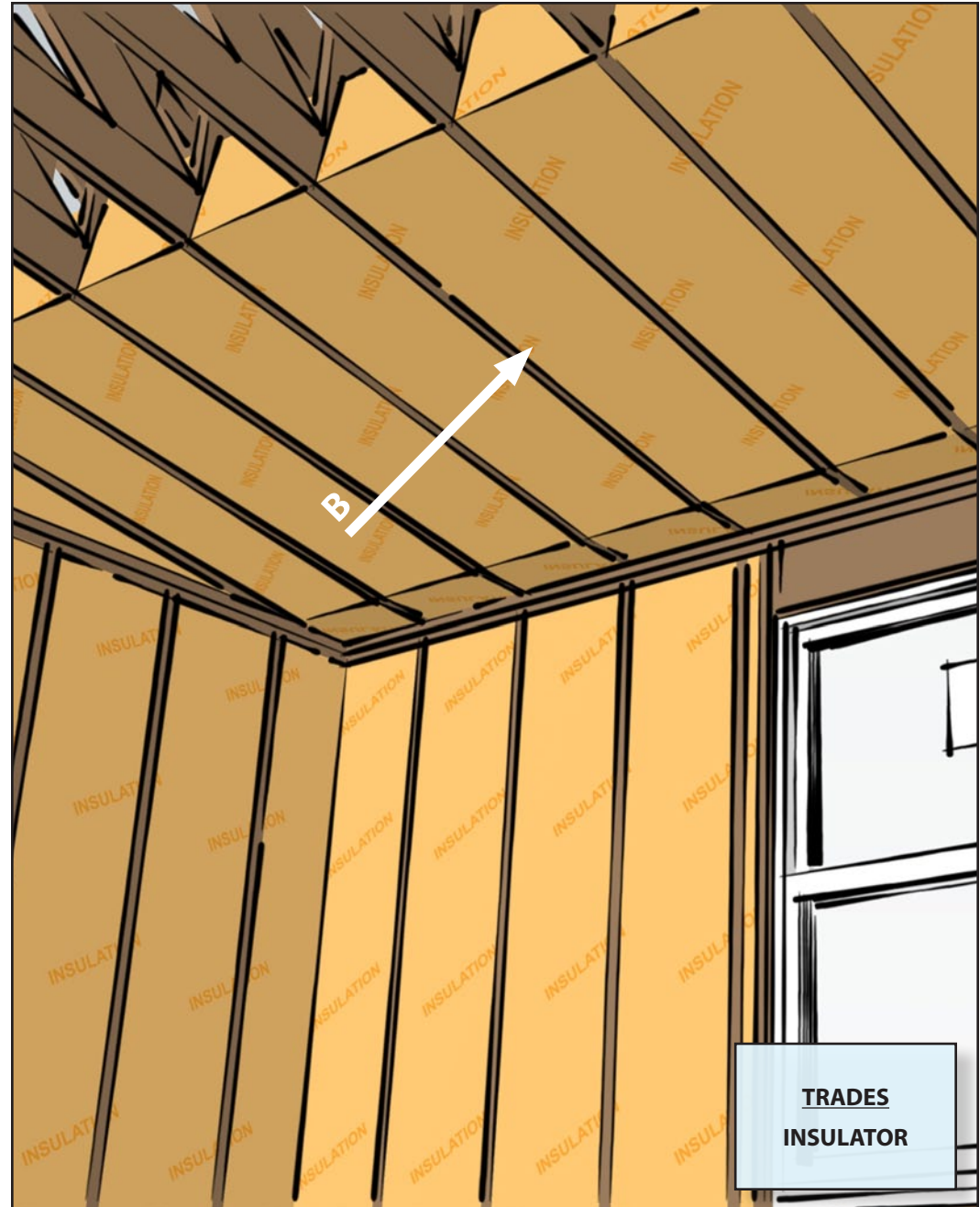
DETAIL 3.3.2 ^{6, 11}**Sloped Ceilings**

- A. Before insulating, verify wind baffles are installed to meet detail 3.3.3
- B. Install insulation without misalignments, compressions, gaps, or voids in all sloped ceilings.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.

11. Sloped attics shall meet the air barrier requirements for walls and are defined as sloped surfaces separating conditioned attics from ambient conditions. In contrast, sloped ceilings shall meet the air barrier requirements for ceilings and are defined as sloped surfaces separating conditioned house space from ambient conditions (e.g., sloped ceiling at the perimeter of a bedroom).

**TRADES**
INSULATOR

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

3 CEILINGS



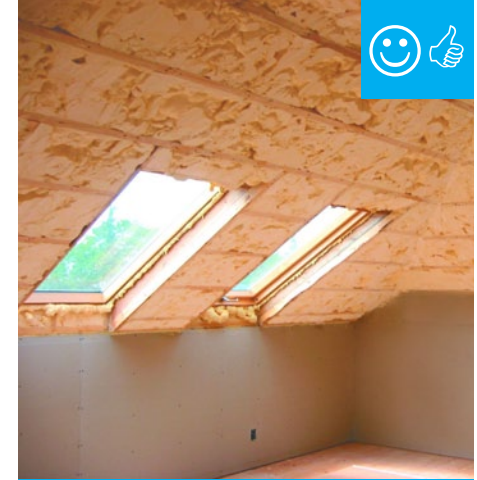
B. Insulation is misaligned.



Insulation is installed without misalignment, compression, gaps, or voids.



B. Spray foam installed with voids.



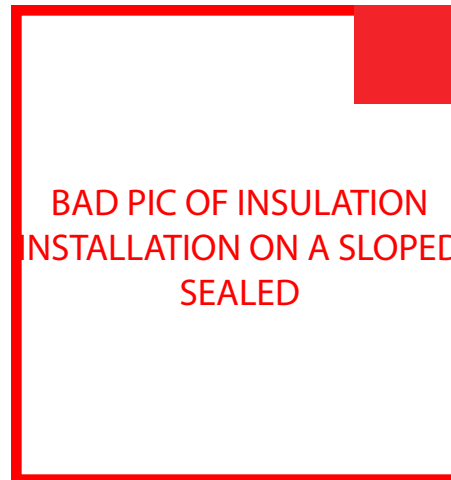
Insulation is installed without misalignment, compression, gaps, or voids.



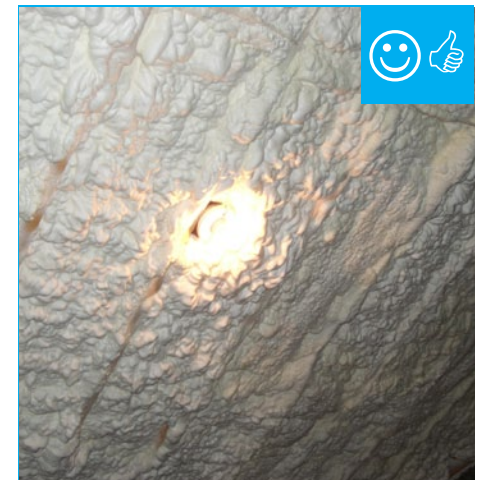
B. Insulation is compressed and misaligned.



Insulation is installed without misalignment, compression, gaps, or voids.



B.



Insulation is installed without misalignment, compression, gaps, or voids.

DETAIL 3.3.3 ⁶**All other ceilings**

- A. At interior surface of ceilings in all Climate Zones; also at interior edge of attic eave in all Climate Zones use a wind baffle that extends to the full height of the insulation. Include a baffle in every bay or a tabbed baffle in each bay with a soffit vent that will also prevent wind washing of adjacent bays.
- B. Install wind baffles with the minimum code required clearance between baffle and roof deck.

FOOTNOTES

6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

3 FULLY-ALIGNED AIR BARRIERS

3 CEILINGS



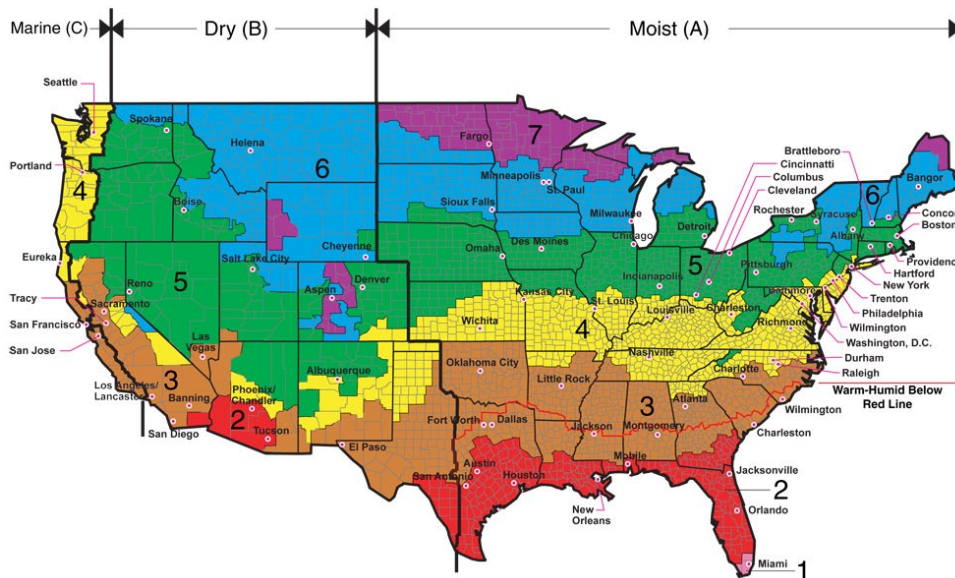
A. Wind baffle installation will not allow insulation over the top plate.

Wind baffle installation will allow proper insulation depth over the top plate.



B.

Wind baffle installation maintains necessary code clearance between baffle and roof deck.



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dillingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

Revision 02

2009 IECC INSULATION REQUIREMENTS

CLIMATE ZONE	CEILING
Zone 1	R-30
Zone 2	R-30
Zone 3	R-30
Zone 4	R-38
Zone 5	R-38
Zone 6	R-49
Zone 7	R-49

a. R-values are minimums.

Interactive Map:

<http://energycode.pnl.gov/EnergyCodeReqs/>

SECTION 4. REDUCED THERMAL BRIDGING

- 4.1. For insulated ceilings with attic space above (i.e., non-cathedralized ceilings), uncompressed insulation extends to the inside face of the exterior wall below at the following levels: CZ 1 to 5: $\geq$ R-21; CZ 6 to 8: $\geq$ R-30**
- 4.2. For slabs on grade in CZ 4 and higher, 100% of slab edge insulated to $\geq$ R-5 at the depth specified by the 2009 IECC and aligned with thermal boundary of the walls**
- 4.3. Insulation beneath attic platforms (e.g., HVAC platforms, walkways) $\geq$ R-21 in CZ 1 to 5; $\geq$ R-30 in CZ 6 to 8**
- 4.4. Reduced thermal bridging at walls (rim / band joists are exempted) using one of the following options:**
 - 4.4.1. Continuous rigid insulation, insulated siding, or combination of the two; $\geq$ R-3 in Climate Zones 1 to 4, $\geq$ R-5 in Climate Zones 5 to 8, OR;**
 - 4.4.2. Structural Insulated Panels (SIPs), OR;**
 - 4.4.3. Insulated Concrete Forms (ICFs), OR;**

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



4.4.4. Double-wall framing, or;

4.4.5. Advanced framing, including all of the items below:

4.4.5a. All corners insulated $\geq$ R-6 to edge, **AND;**

4.4.5b. All headers above windows and doors insulated, **AND;**

4.4.5c. Framing limited at all windows and doors, **AND;**

4.4.5d. All interior / exterior wall intersections insulated to the same R-value as the rest of the exterior wall, **AND;**

4.4.5e. Minimum stud spacing of 16" o.c. for 2 x 4 framing in all Climate Zones and, in Climate Zones 5 through 8, 24" o.c. for 2 x 6 framing unless construction documents specify other spacing is structurally required

DETAIL 4.1 ¹²

For insulated ceilings with attic space above (i.e., non-cathedralized ceilings), uncompressed insulation extends to the inside face of the exterior wall below at the following levels: CZ 1 to 5: $\geq$ R-21; CZ 6 to 8: $\geq$ R-30

- A. Install raised-heel trusses or equivalent framing method to allow the specified attic insulation R-value to be installed at the inside face of the exterior wall below (extending over the top plate).

FOOTNOTES

12. The minimum designated R-values must be achieved regardless of the trade-offs determined using an equivalent U-factor or UA alternative calculation. Note that if the minimum designated values are used, they must be compensated with higher values elsewhere using an equivalent U-factor or UA alternative calculation in order to meet the overall insulation requirements of the 2009 IECC. Also, note that these requirements can be met by using any available strategy, such as a raised-heel truss, alternate framing that provides adequate space, and/or high-density insulation. In Climate Zones 1 through 3, one option that will work for most homes is to use 2x6 framing, an R-21 high-density batt, and a wind baffle that only requires 0.5" of clearance.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

1 PERIMETER OF INSULATED CEILING MEETS REQUIRED LEVEL



A. Framing will not allow for required insulation depth.



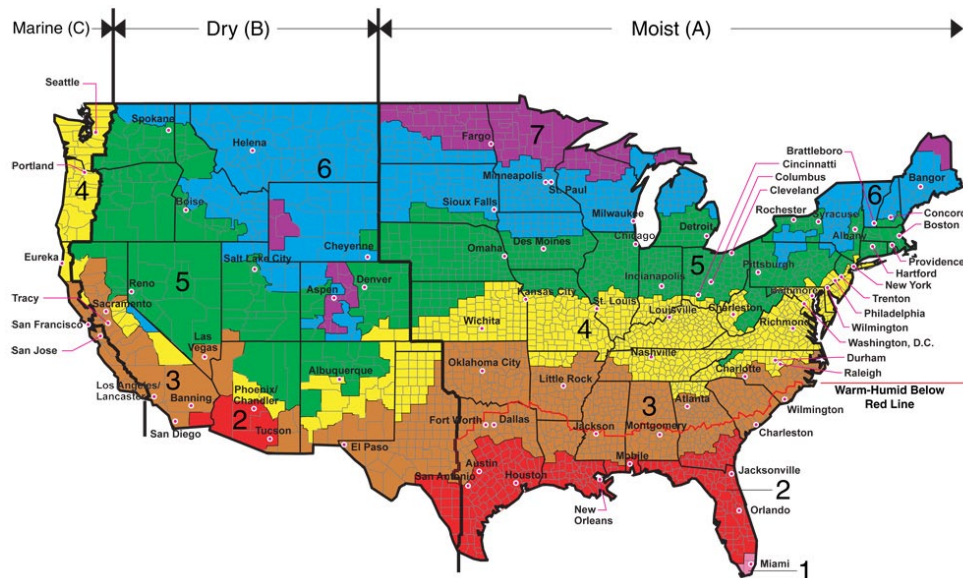
Framing allows for required insulation depth.



A. Framing and wind baffle installation will not allow for required insulation depth.



Framing and wind baffle installation will allow for required insulation depth.



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Revision 02

DETAIL 4.2^{4, 5}

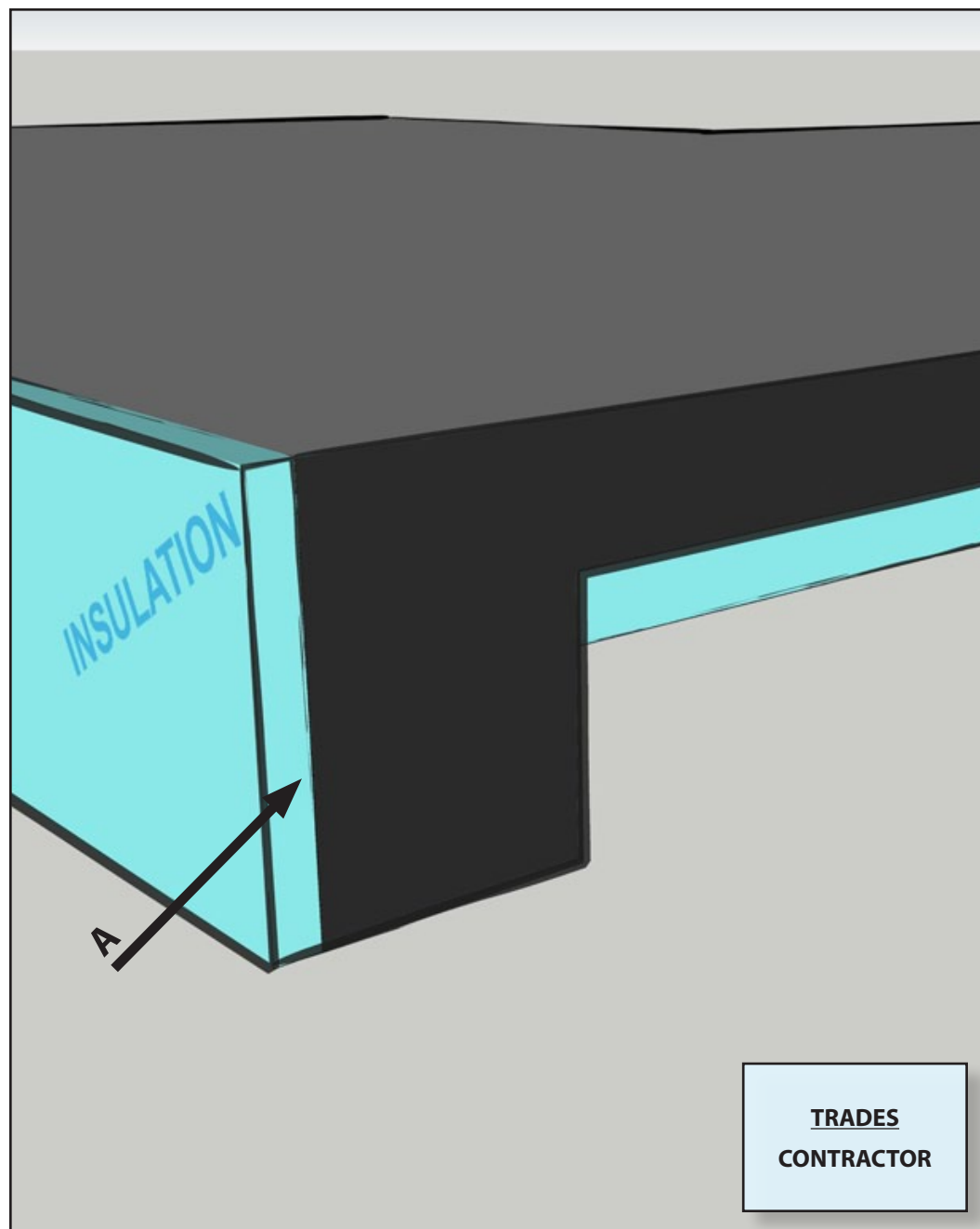
For slabs on grade in CZ 4 and higher, 100% of slab edge insulated to $\geq$ R-5 at the depth specified by the 2009 IECC and aligned with thermal boundary of the walls

- A. Install slab edge insulation to extend to the top of the slab so it provides a complete thermal break.

FOOTNOTES

4. Consistent with the 2009 IECC, slab edge insulation is only required for slab-on-grade floors with a floor surface less than 12 inches below grade. Slab insulation shall extend to the top of the slab to provide a complete thermal break. If the top edge of the insulation is installed between the exterior wall and the edge of the interior slab, it shall be permitted to be cut at a 45-degree angle away from the exterior wall.

5. Where an insulated wall separates a garage, patio, porch, or other unconditioned space from the conditioned space of the house, slab insulation shall also be installed at this interface to provide a thermal break between the conditioned and unconditioned slab. Post-tensioned slabs with integrated porch foundations are exempted from this requirement in all homes, as are post-tensioned slabs with integrated garage foundations in multi-family buildings, until feasible architectural details can be developed.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



4 REDUCED THERMAL BRIDGING

2 SLAB EDGE INSULATION

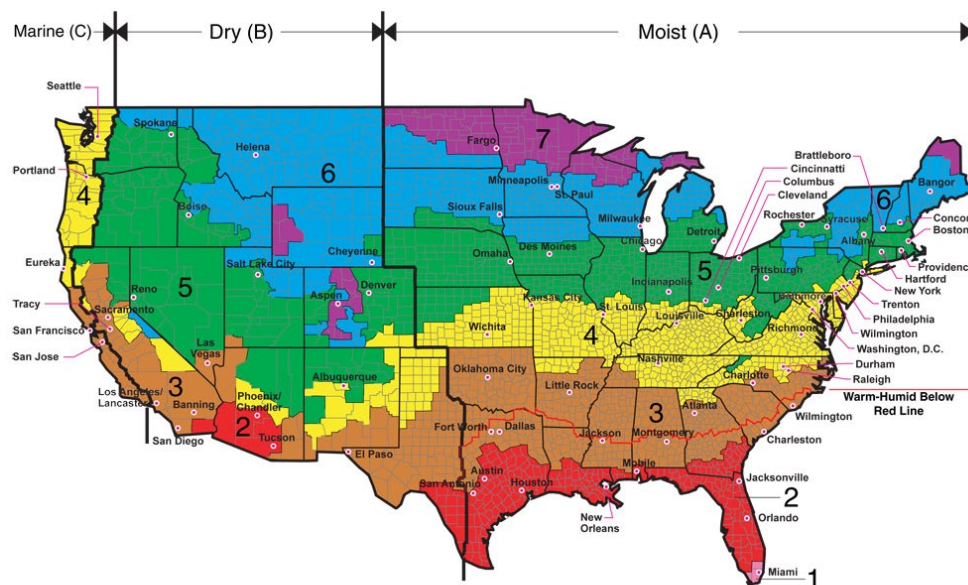


A. Slab insulation does not extend to the top of the slab.

Slab insulation extends to the top of the slab.

A. Slab insulation does not extend to the top of the slab.

Slab insulation does not extend to the top of the slab.



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Revision 02

SLABS

CLIMATE ZONE	DEPTH	R-VALUE ^{a,b}
Zone 1		0
Zone 2		0
Zone 3		0
Zone 4		10, 2 ft.
Zone 5		10, 2 ft.
Zone 6		10, 4 ft.
Zone 7		10, 4 ft.

a. R-values are minimums.

b. R-5 shall be added to the required slab edge R-values for heated slabs. Insulation depth shall be the depth of the footing or two feet, whichever is less in Climate Zones 1-3 for heated slabs.

Interactive Map:

<http://energycode.pnl.gov/EnergyCodeReqs/>

DETAIL 4.3

Insulation beneath attic platforms (e.g., HVAC platforms, walkways) $\geq$ R-21 in CZ 1 to 5; $\geq$ R-30 in CZ 6 to 8

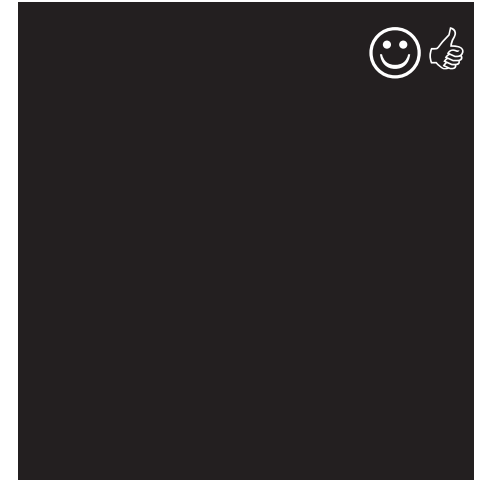
- A. Increase the height of the storage or HVAC platform in the attic to allow for proper depth of the insulation beneath the platform without compressing the insulation.
- B. Install insulation without misalignments, compressions, gaps, or voids underneath all attic platforms.
- C. Install insulation so that it is in contact with the air barrier (e.g., drywall ceiling)



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

3 ATTIC PLATFORMS



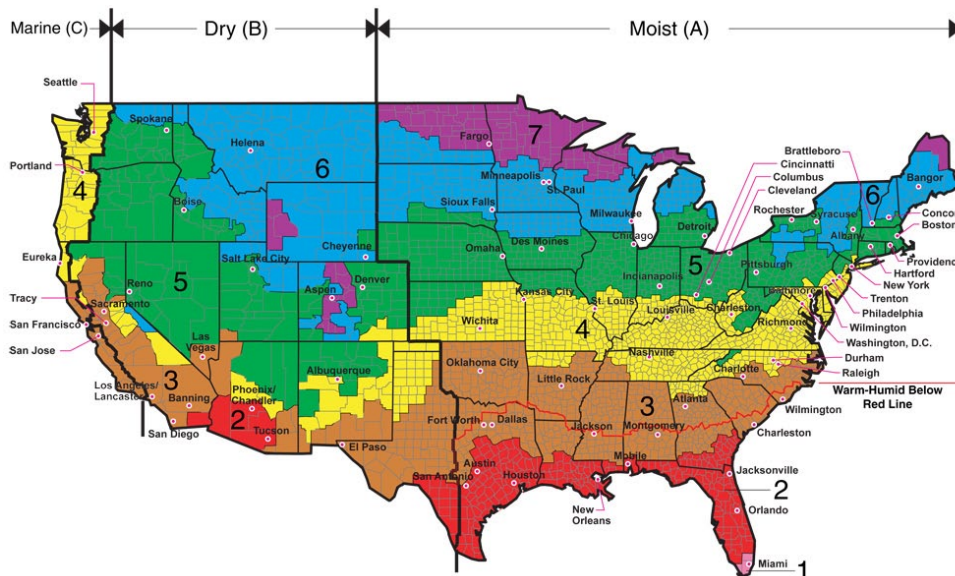
A.

HVAC platform installed to allow for proper insulation depth.

B./C.

Insulation will not be aligned with air barrier.

Insulation installed to correct depth and will be aligned with air barrier.



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Revision 02

IECC INSULATION REQUIREMENTS^a

CLIMATE ZONE	CEILING
Zone 1	R-30
Zone 2	R-30
Zone 3	R-30
Zone 4	R-38
Zone 5	R-38
Zone 6	R-49
Zone 7	R-49

a. R-values are minimums.

Interactive Map:

<http://energycode.pnl.gov/EnergyCodeReqs/>

4 REDUCED THERMAL BRIDGING

4 WALLS: CONTINUOUS RIGID INSULATION

DETAIL 4.4.1 ^{13,14}

Continuous rigid insulation, insulated siding, or combination of the two; $\geq$ R-3 in Climate Zones 1-4, $\geq$ R-5 in Climate Zones 5-8*[†]

- A. If utilizing insulated siding that is not water-resistant barrier, install a water-resistant barrier before installing siding.
- B. If utilizing exterior rigid insulation, install it on all exterior walls with cap nails.
- C. If using steel studs, install continuous rigid insulation of $\geq$ R-3 in CZ 1 to 4 or $\geq$ R-5 in CZ 5 to 8. [†]
- D. Tape and seal all seams of continuous rigid insulation if it is being utilized as a water-resistant barrier.

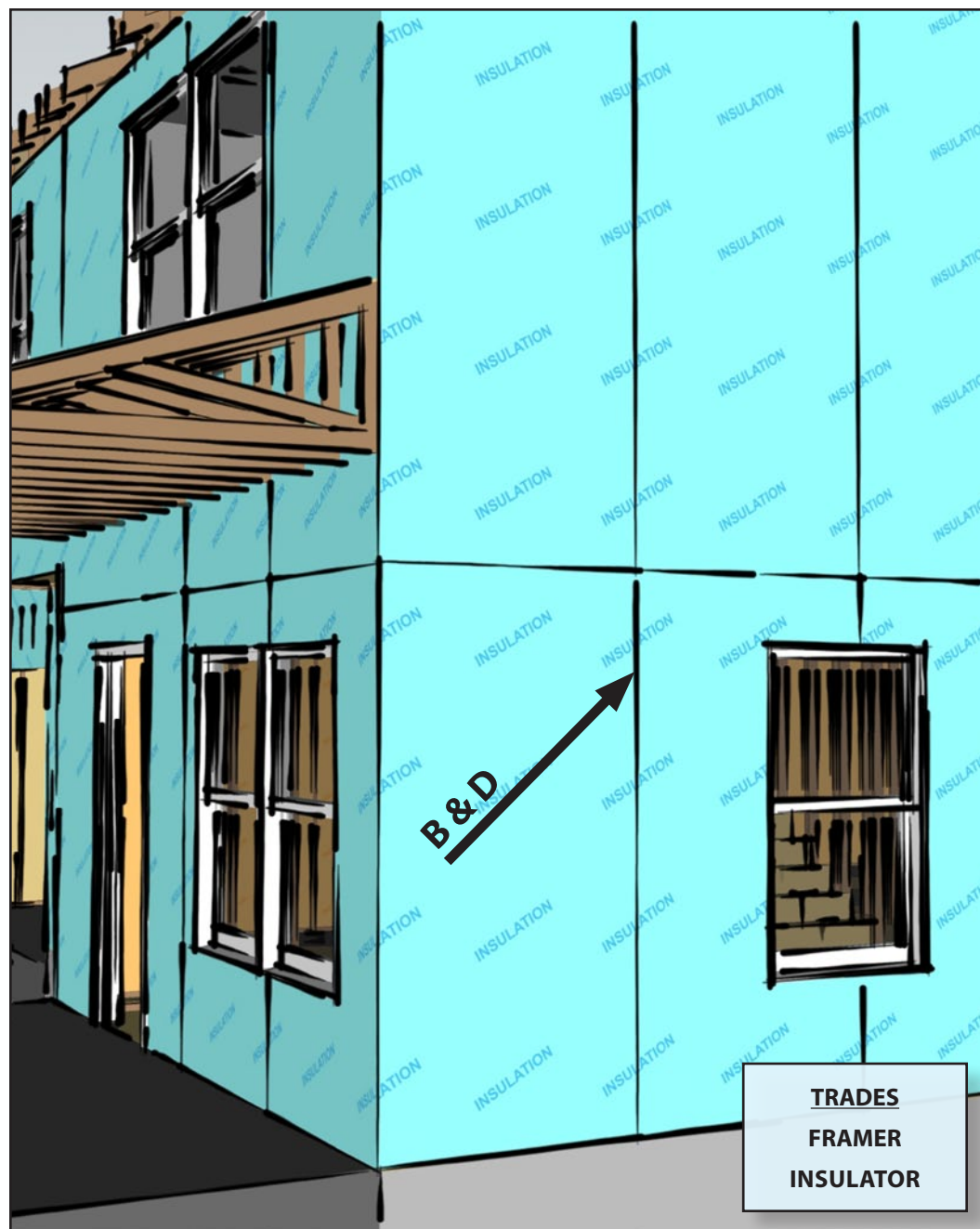
* Only one item of 4.4.1-4.4.5 must be installed to comply with ENERGY STAR.

[†] If the building utilizes steel framing, this requirement must be met.

FOOTNOTES

13. Insulated sheathing rated for water protection can be used as a water resistant barrier if all seams are taped and sealed. If the insulated sheathing is not rated for water protection, it shall be attached directly over a water-resistive barrier and sheathing. In addition, it shall provide the required R-value as demonstrated through either testing in accordance with ASTM C 1363 or by attaining the required R-value at its minimum thickness. If non-insulated structural sheathing is used at corners, advanced framing details listed under requirement 4.4.5 shall be met for those wall sections. Rigid insulation, if used, may be installed on either the interior or exterior side of the wall.

14. Steel framing shall meet the reduced thermal bridging requirements by complying with item 4.4.1 of the checklist.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

4 WALLS: CONTINUOUS RIGID INSULATION



**BAD PIC OF IMPROPERLY
INSTALLED INSULATED
SHEATHING**



Continuous rigid insulation has been installed.



B. Rigid insulation is being installed without cap nails.



Rigid insulation is being installed with cap nails.

**BAD PIC OF STEEL
FRAMING WITHOUT RIGID
INSULATION OR SIDING**

**GOOD PIC OF PROPERLY
INSTALLED RIGID
INSULATION AND STEEL
FRAMING**



**BAD PIC OF IMPROPERLY
SEALED RIGID SHEATHING**

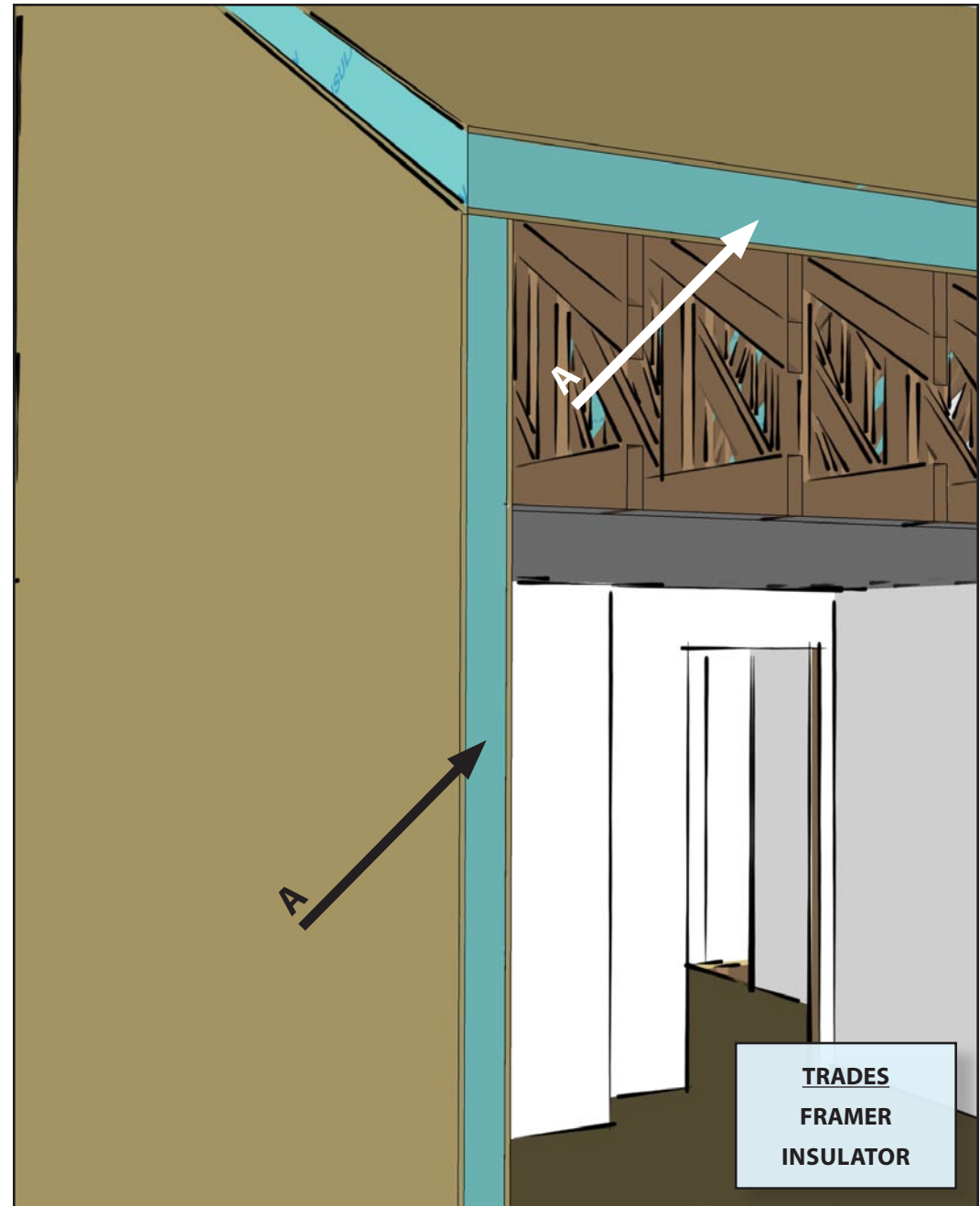


Insulated sheathing has been taped and sealed at seams.

DETAIL 4.4.2**Structural insulated panels (SIPs)***

- A. Install SIPs according to manufacturer specifications to create a continuous air barrier and thermal boundary.
- B. All seams between Structural Insulated Panels (SIPs) foamed and/or taped per manufacturer's specifications.

* Only one item of 4.4.1-4.4.5 must be installed to comply with ENERGY STAR.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

4 WALLS: STRUCTURAL INSULATED PANELS (SIPS)



BAD PIC OF IMPROPERLY
SEALED SIPS

A.



GOOD PIC OF PROPERLY
SEALED SIPS



BAD PIC OF IMPROPERLY
SEALED SIPS

A.



GOOD PIC OF PROPERLY
SEALED SIPS



BAD PIC OF IMPROPERLY
SEALED SIPS

B.



GOOD PIC OF PROPERLY
SEALED SIPS



BAD PIC OF IMPROPERLY
SEALED SIPS

B.



GOOD PIC OF PROPERLY
SEALED SIPS

DETAIL 4.4.3**Insulated concrete forms (ICFs)***

- A. Install ICFs according to manufacturer specifications to create a continuous air barrier and thermal boundary.

* Only one item of 4.4.1-4.4.5 must be installed to comply with ENERGY STAR.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

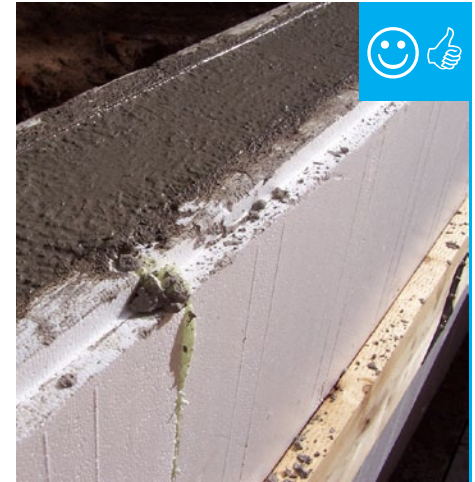
4 WALLS: INSULATED CONCRETE FORMS (ICFs)



- A.** ICFs are being installed to create a continuous air and thermal boundary.



- A.** ICFs are being installed to create a continuous air and thermal boundary.



DETAIL 4.4.4¹⁵**Double-wall framing***

- A. Install a continuous air barrier on the exterior of the interior wall.
- B. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- C. Install insulation without misalignments, compressions, gaps, or voids.

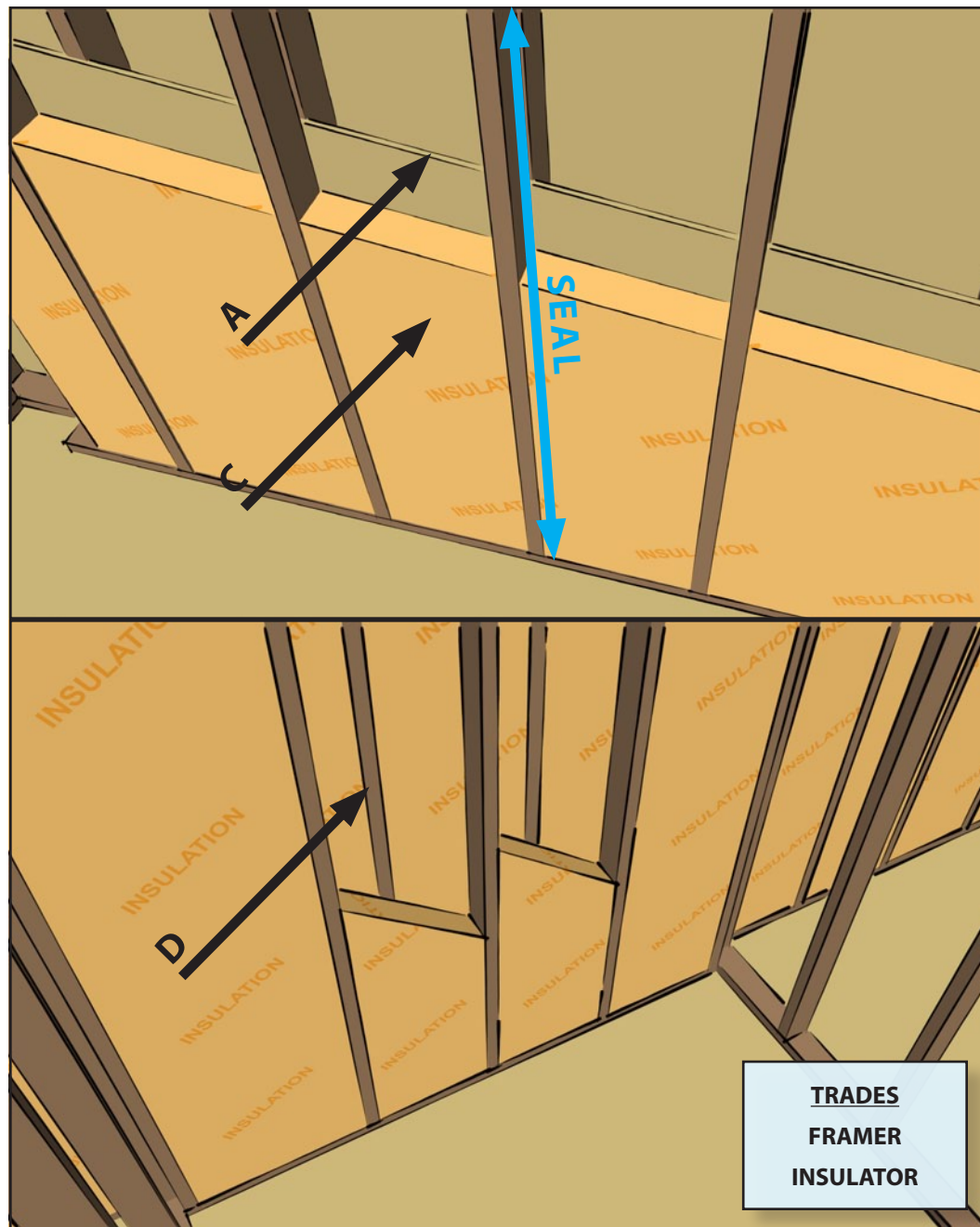
OR

- D. Completely fill entire cavity of the double wall assembly without misalignments, compressions, gaps, or voids.

* Only one item of 4.4.1-4.4.5 must be installed to comply with ENERGY STAR.

FOOTNOTES

15. Double-wall framing is defined as any framing method that ensures a continuous layer of insulation covering the studs to at least the R-value required in Section 4.4.1 of the checklist, such as offset double-stud walls, aligned double-stud walls with continuous insulation between the adjacent stud faces, or single-stud walls with 2x2 or 2x3 cross-framing. In all cases, insulation shall fill the entire wall cavity from the interior to exterior sheathing except at windows, doors, and other penetrations.

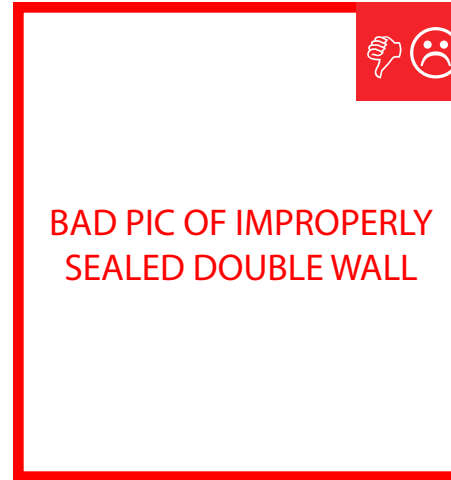


TRADES
FRAMER
INSULATOR



A. No air barrier installed between the walls and a larger gap between the walls that needs sealing.

Rigid air barrier installed between double-wall assembly. Inside cavity will be insulated.

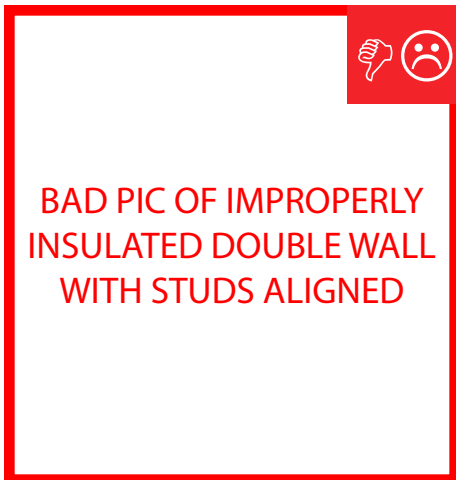


BAD PIC OF IMPROPERLY SEALED DOUBLE WALL

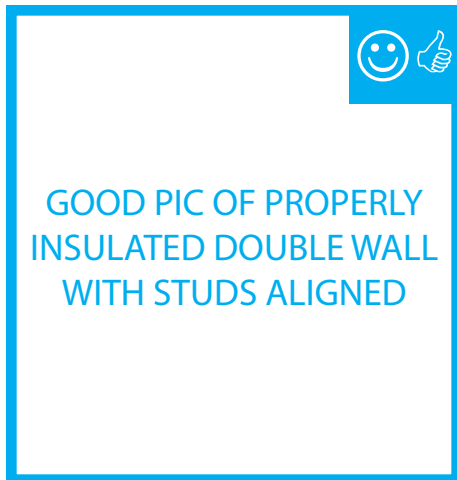


GOOD PIC OF PROPERLY SEALED AIR BARRIER

B.

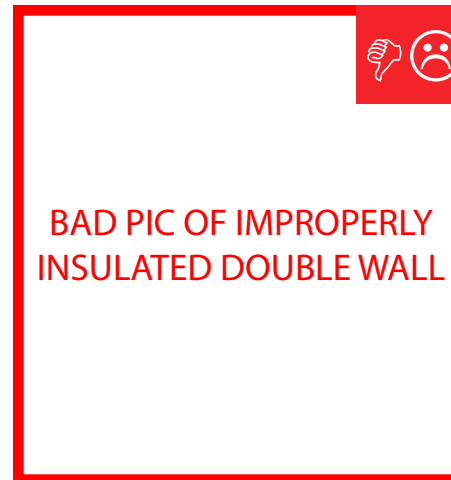


BAD PIC OF IMPROPERLY INSULATED DOUBLE WALL WITH STUDS ALIGNED

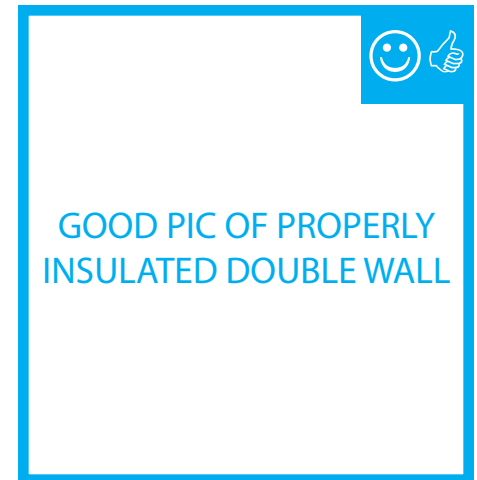


GOOD PIC OF PROPERLY INSULATED DOUBLE WALL WITH STUDS ALIGNED

C.



BAD PIC OF IMPROPERLY INSULATED DOUBLE WALL



GOOD PIC OF PROPERLY INSULATED DOUBLE WALL

D.

DETAIL 4.4.5a¹⁶**All corners insulated $\geq$ R-6 to edge***

- A. Utilize recessed corners or an equivalent framing technique that uses no more than three studs per corner to allow access to insulate the cavity to $\geq$ R-6.
- B. If the corner is conventionally framed, drill a hole and fill the cavity with insulation.

* All items of 4.4.5a-4.4.5e must be installed to comply with 4.4.5 and ENERGY STAR.

FOOTNOTES

16. All exterior corners shall be constructed to allow access for the installation of $\geq$ R-6 insulation that extends to the exterior wall sheathing. Examples of compliance options include standard-density insulation with alternative framing techniques, such as using three studs per corner, or high-density insulation (e.g., spray foam) with standard framing techniques.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

4 WALLS: ADVANCED FRAMING



A. Framing does not allow for corner to be insulated.



Framing allows for corner to be insulated.



A. Framing does not allow for corner to be insulated.



Framing does allows for corner to be insulated.



B. Framing does not allow for corner to be insulated.



GOOD PIC OF PROPERLY
INSTALLED CORNER



B. Excessive framing will not allow for corner to be insulated.



Gap in framing will allow for corner to be filled with insulation.

DETAIL 4.4.5b¹⁷**All headers above windows and doors insulated***

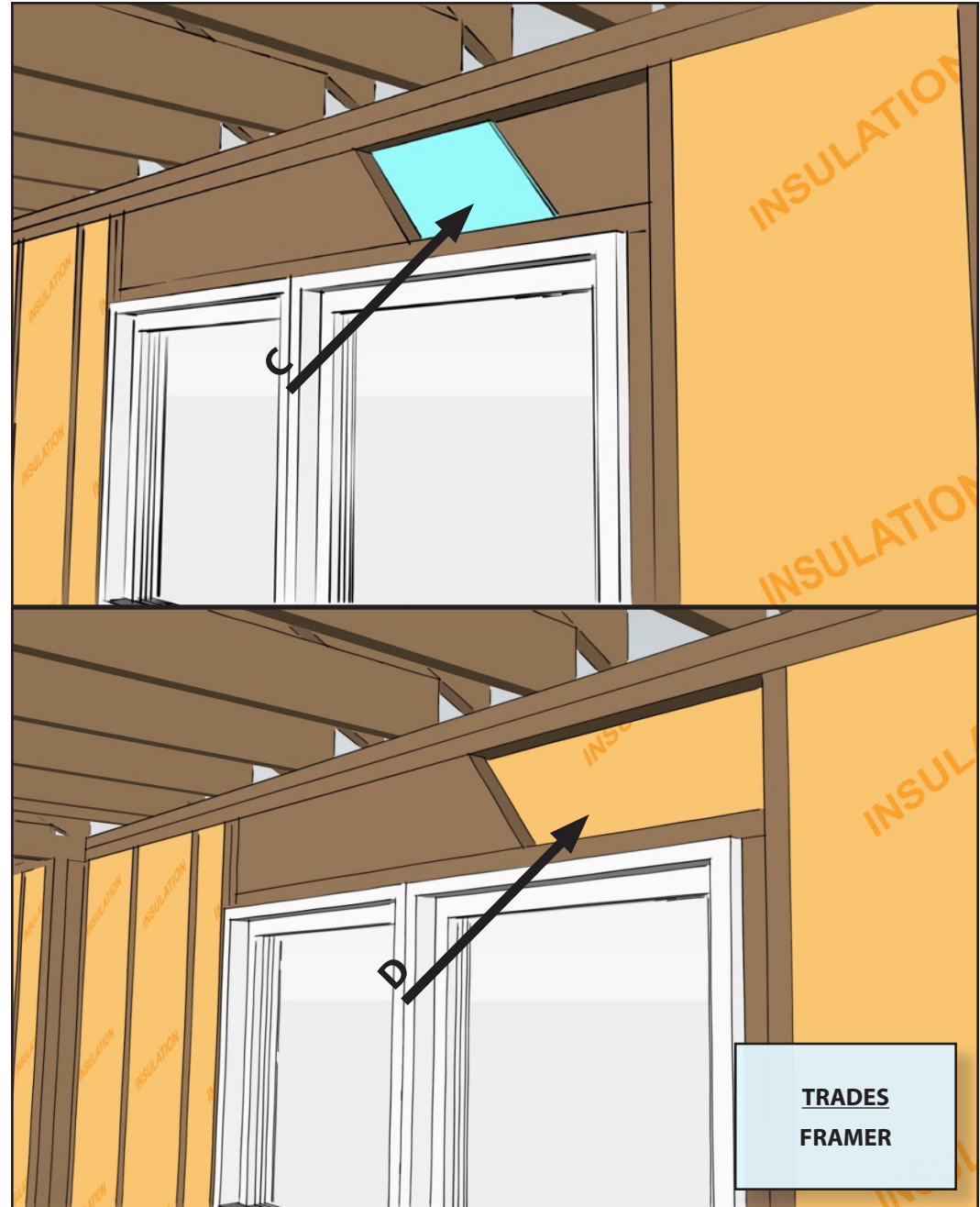
Install headers with a minimum R-3 insulation value in Climate Zones 1-4 and R-5 in Climate Zones 5-8. Use one of the methods listed below or an equivalent assembly:

- A. Continuous rigid insulation sheathing.
- B. SIP headers.
- C. Two-member headers with insulation in between.
- D. Single-member headers with insulation on one side.

* All items of 4.4.5a-4.4.5e must be installed to comply with 4.4.5 and ENERGY STAR.

FOOTNOTES

17. Headers shall be minimum R-3 for Climate Zones 1 through 4 and R-5 for Climate Zones 5 through 8 using continuous rigid insulation sheathing, SIP headers, other prefabricated insulated headers, single-member or two-member headers with insulation either in between or on one side, or an equivalent assembly, except where a framing plan provided by the builder, architect, designer, or engineer indicates that full-depth solid headers are the only acceptable option. The Rater need not evaluate the structural necessity of the details in the framing plan to qualify the home. Also, the framing plan need only encompass the details in question and not necessarily the entire home. R-value requirement refers to manufacturer's nominal insulation value.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

4 WALLS: ADVANCED FRAMING

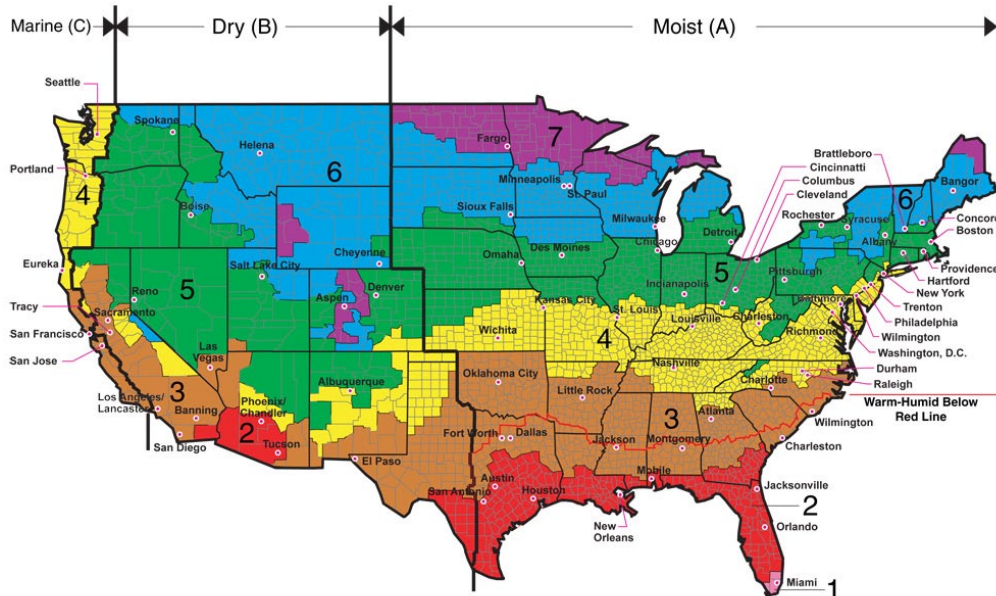


A. Verify continuous rigid insulation is installed.

B. Verify SIP headers are installed.

C. Verify two member headers with rigid insulation between are installed.

D. Verify single member headers with insulation on one side are installed.



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dillingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

Revision 02

Solid headers are allowed only where deemed necessary by a structural engineered framing plan.

Interactive Map:

<http://energycode.pnl.gov/EnergyCodeReqs/>

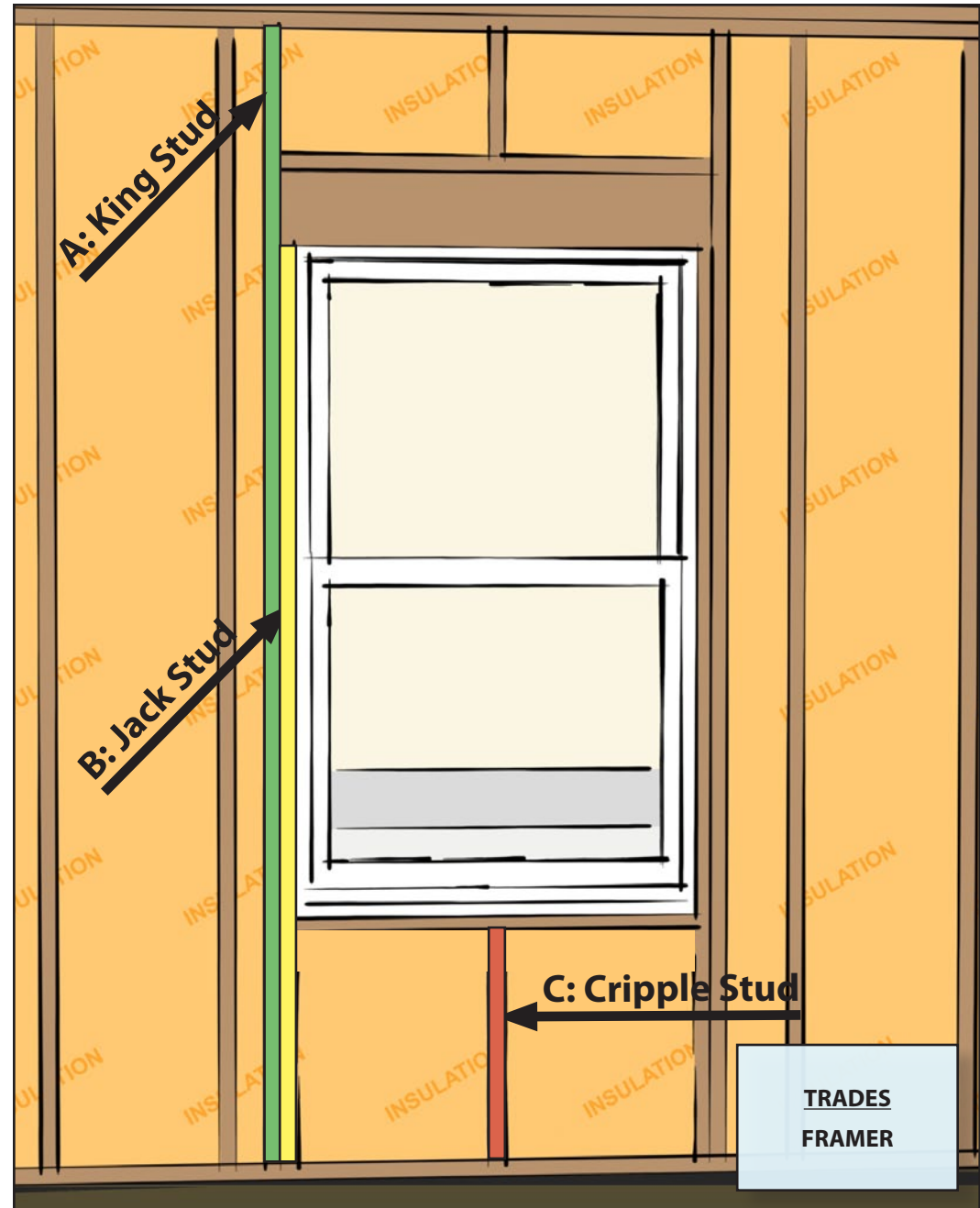
DETAIL 4.4.5c¹⁸**Framing limited at all windows and doors***

- A. Limit framing to a maximum of one pair of king studs per window opening.
- B. Limit framing to a maximum of one pair of jack studs per window opening to support the header and window sill.
- C. Install additional jack studs only as needed for structural support and cripple studs only as needed to maintain on-center spacing of studs.
- D. Limit framing to necessary structural requirements for each door opening.

* All items of 4.4.5a-4.4.5e must be installed to comply with 4.4.5 and ENERGY STAR.

FOOTNOTES

18. Framing at windows shall be limited to a maximum of one pair of king studs and one pair jack studs per window opening to support the header and window sill. Additional jack studs shall be used only as needed for structural support and cripple studs only as needed to maintain on-center spacing of studs.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

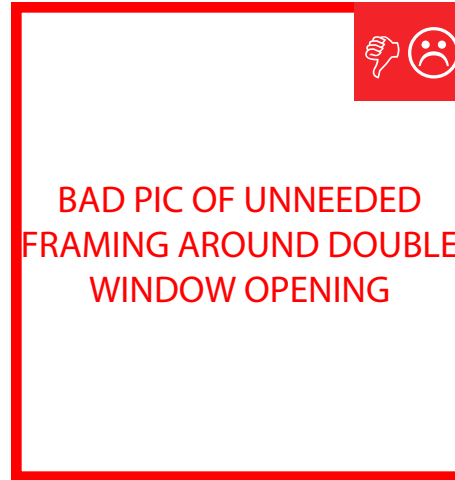
4 WALLS: ADVANCED FRAMING



A. Window has an additional non-structural king stud.



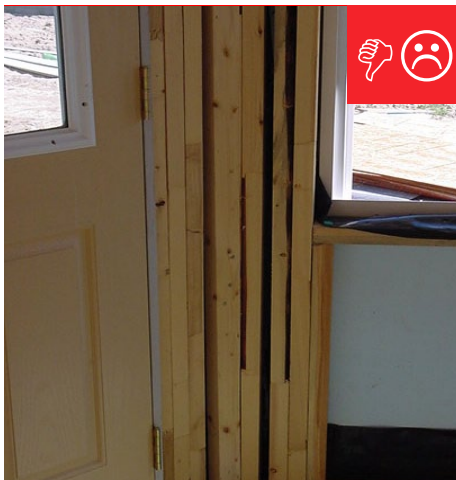
Window framing has appropriate number of king studs.



B.



Appropriate use of framing members to support double windows and additional cripples for drywall purposes.



D. Excessive and structurally unnecessary framing at door.



Appropriate door framing installed.

FRAMING DEFINITIONS

- King Stud: Full lengths placed around openings, such as windows and doors. (Green on 3D image)
- Jack Stud: A supportive stud at the inset of the king stud, typically used to frame windows or doors. (Yellow on 3D image)
- Cripple Stud: A trimmed stud inserted between the jack studs, above a header or beneath a window. (Red on 3D image)

DETAIL 4.4.5d¹⁹

All interior / exterior wall intersections insulated to the same R-value as the rest of the exterior wall*

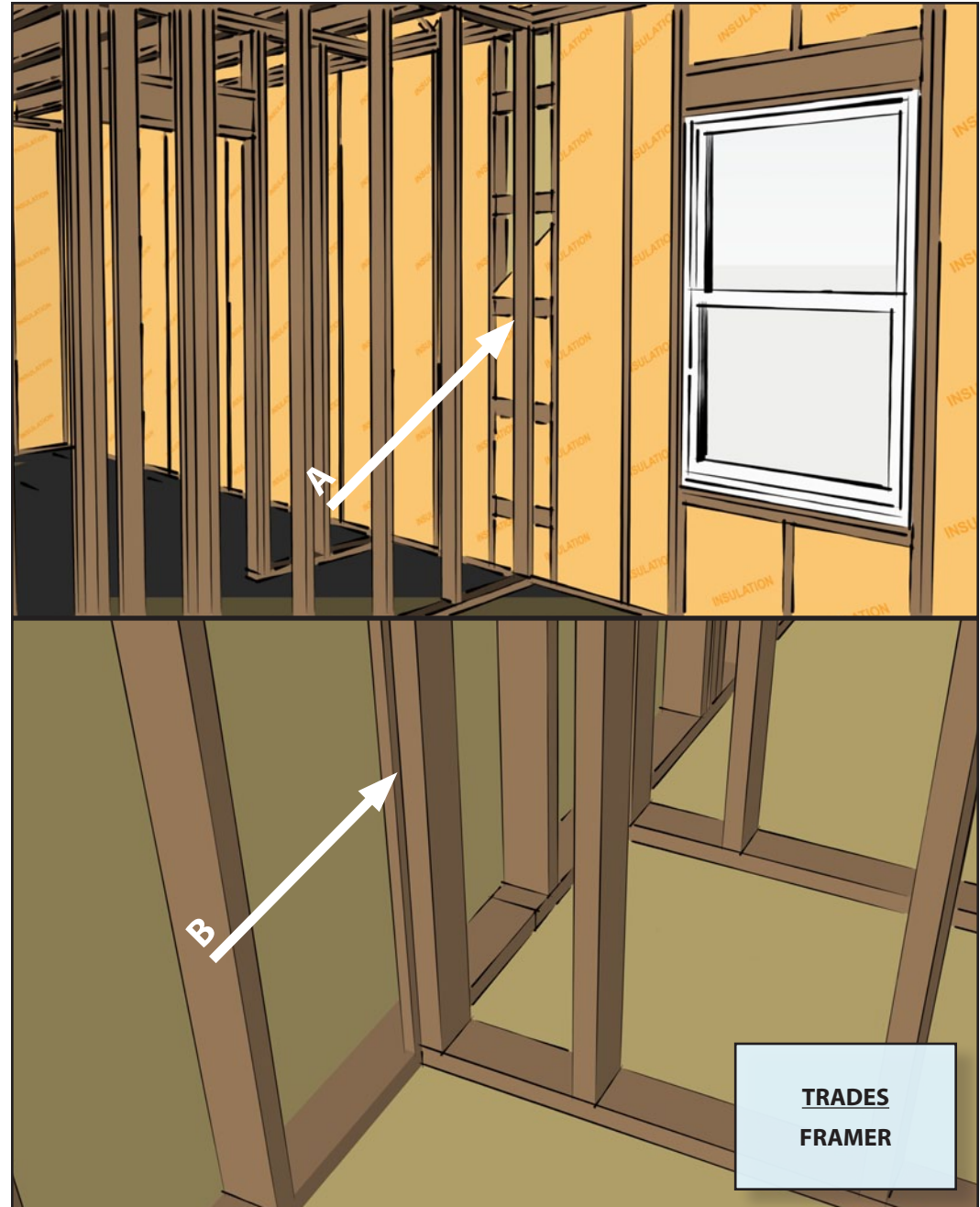
Install insulation to run continuously behind interior/exterior wall intersections. Use one of the methods listed below or an equivalent assembly:

- A. Ladder blocking.
- B. Full length 2 x 6 or 1 x 6 nailer behind the first partition stud.

* All items of 4.4.5a-4.4.5e must be installed to comply with 4.4.5 and ENERGY STAR.

FOOTNOTES

19. Insulation shall run behind interior/exterior wall intersections using ladder blocking, full length 2"x6" or 1"x6" furring behind the first partition stud, drywall clips, or other equivalent alternative.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

4 REDUCED THERMAL BRIDGING

4 WALLS: ADVANCED FRAMING



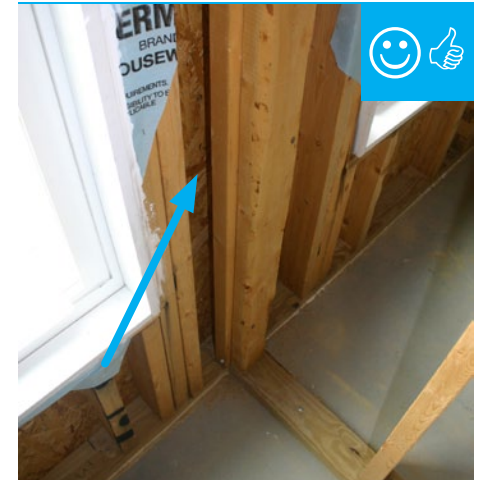
- A.** Conventional T-post detail is extremely difficult to insulate and usually doesn't happen.



- Ladder blocking allows for insulation behind the wall intersection.



- B.** Conventional T-post detail is extremely difficult to insulate and usually doesn't happen.



- Full length 2 X 6 nailer had been installed to allow space for insulation at wall intersection.

DETAIL 4.4.5e²⁰

Minimum stud spacing of 16" o.c. for 2 x 4 walls in all Climate Zones and, in Climate Zones 5 through 8, 24" o.c. for 2 x 6 framing unless construction documents specify other spacing is structurally required

- A. 16" for 2 x 4 framing on center in all Climate Zones.
- B. 24" for 2 x 6 framing on center in Climate Zones 5 to 8.

* All items of 4.4.5a-4.4.5e must be installed to comply with 4.4.5 and ENERGY STAR.

FOOTNOTES

20. Vertical framing members shall either be on-center or have an alternative structural purpose (e.g., framing members at the edge of pre-fabricated panels) that is apparent to the Rater or documented in a framing plan provided by the builder, architect, designer, or engineer. The Rater need not evaluate the structural necessity of the details in the framing plan to qualify the home. Also, the framing plan need only encompass the details in question and not necessarily the entire home. No more than 5% of studs may lack an apparent or documented structural purpose, which is equivalent to one vertical stud for every 30 linear feet of wall, assuming 16" o.c. stud spacing.





A. Excessive framing and improper spacing of studs.



Proper spacing of 2 x 4 studs.



B. Excessive framing and improper spacing of studs.



Proper spacing of 2 x 6 studs.

SECTION 5. AIR SEALING

5.1. Penetrations to unconditioned space fully sealed with solid blocking or flashing as needed and gaps sealed with caulk or foam:

5.1.1. Duct/flue shaft

5.1.2. Plumbing/piping

5.1.3. Electrical wiring

5.1.4. Bathroom and kitchen exhaust fans

5.1.5. Recessed lighting fixtures adjacent to unconditioned space ICAT labeled and fully gasketed. Also, 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.

5.1.6. Light tubes adjacent to unconditioned space include lens separating unconditioned and conditioned space and are fully gasketed

5.2. Cracks in the building envelope fully sealed:

5.2.1. All sill plates adjacent to conditioned space sealed to foundation or sub-floor with caulk. Foam gasket also placed beneath sill plate if resting atop concrete or masonry and adjacent to conditioned space.

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



- 5.2.2. At top of walls adjoining unconditioned spaces, continuous top plates or sealed blocking using caulk, foam, or equivalent material
- 5.2.3. Sheetrock sealed to top plate at all attic/wall interfaces using caulk, foam, or equivalent material. Either apply sealant directly between sheetrock and top plate or to the seam between the two from the attic above. Construction adhesive shall not be used
- 5.2.4. Rough opening around windows & exterior doors sealed with caulk or foam
- 5.2.5. Marriage joints between modular home modules at all exterior boundary conditions fully sealed with gasket and foam
- 5.2.6. All seams between Structural Insulated Panels (SIPs) foamed and/or taped per manufacturer's instructions
- 5.2.7. In multi-family buildings, the gap between the drywall shaft wall (i.e., common wall) and the structural framing between units fully sealed at all exterior boundary conditions

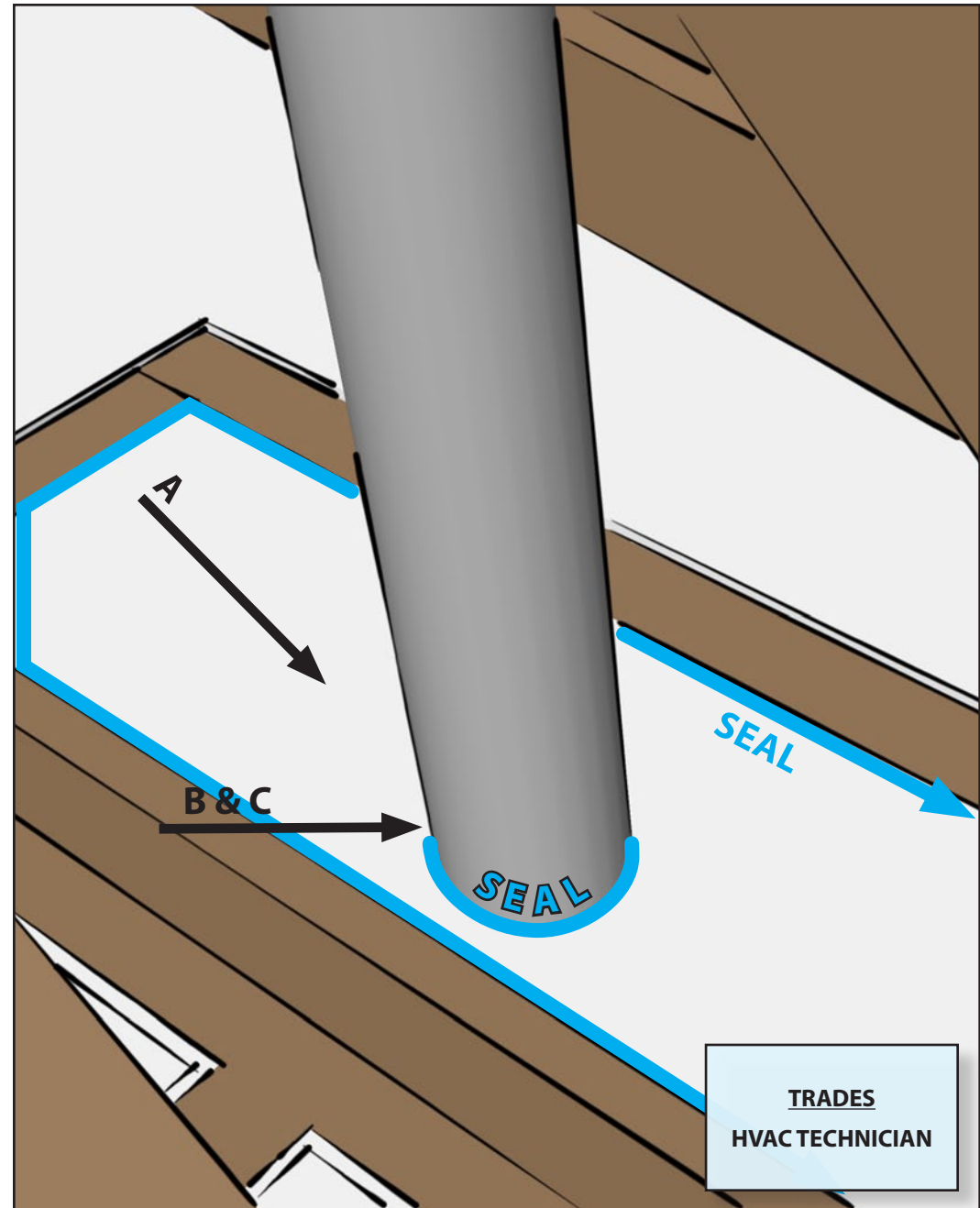
5.3. Other openings:

- 5.3.1. Doors adjacent to unconditioned space (e.g., attics, garages, basements) or ambient conditions gasketed or made substantially air-tight
- 5.3.2. Attic access panels and drop-down stairs equipped with a durable $\geq$ R-10 insulated cover that is gasketed (i.e., not caulked) to produce continuous air seal when occupant is not accessing the attic
- 5.3.3. Whole-house fans equipped with a durable $\geq$ R-10 insulated cover that is gasketed and either installed on the house side or mechanically operated

DETAIL 5.1.1**Duct / flue shaft**

- A. Install a continuous rigid air barrier material to separate the exterior from the conditioned space.*
- B. Using a saw or drill, cleanly cut all penetrating holes no more than 1 inch larger in diameter than the penetrating object to allow for proper air sealing.
- C. Seal all gaps, and holes to unconditioned space with caulk or foam. Fibrous insulation is not an air barrier and cannot be used for sealing gaps.
- D. Use high temperature caulking along with flashing or UL-rated collars. Install them continuously around all combustion flues while maintaining proper clearance from combustion materials.

* EPA recommends using a rigid air barrier, but it is not a requirement.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED



A. Chase not capped.



Chase capped with rigid air barrier and duct work penetrations properly sealed.



B. Penetration hole is larger than duct and not sealed.



Neatly cut and sealed penetration.



C. Fibrous insulation does not air seal.



Penetrations have been neatly cut and properly sealed with foam.



D. Vent sleeve not completely sealed.



Vent and air barrier sealed.

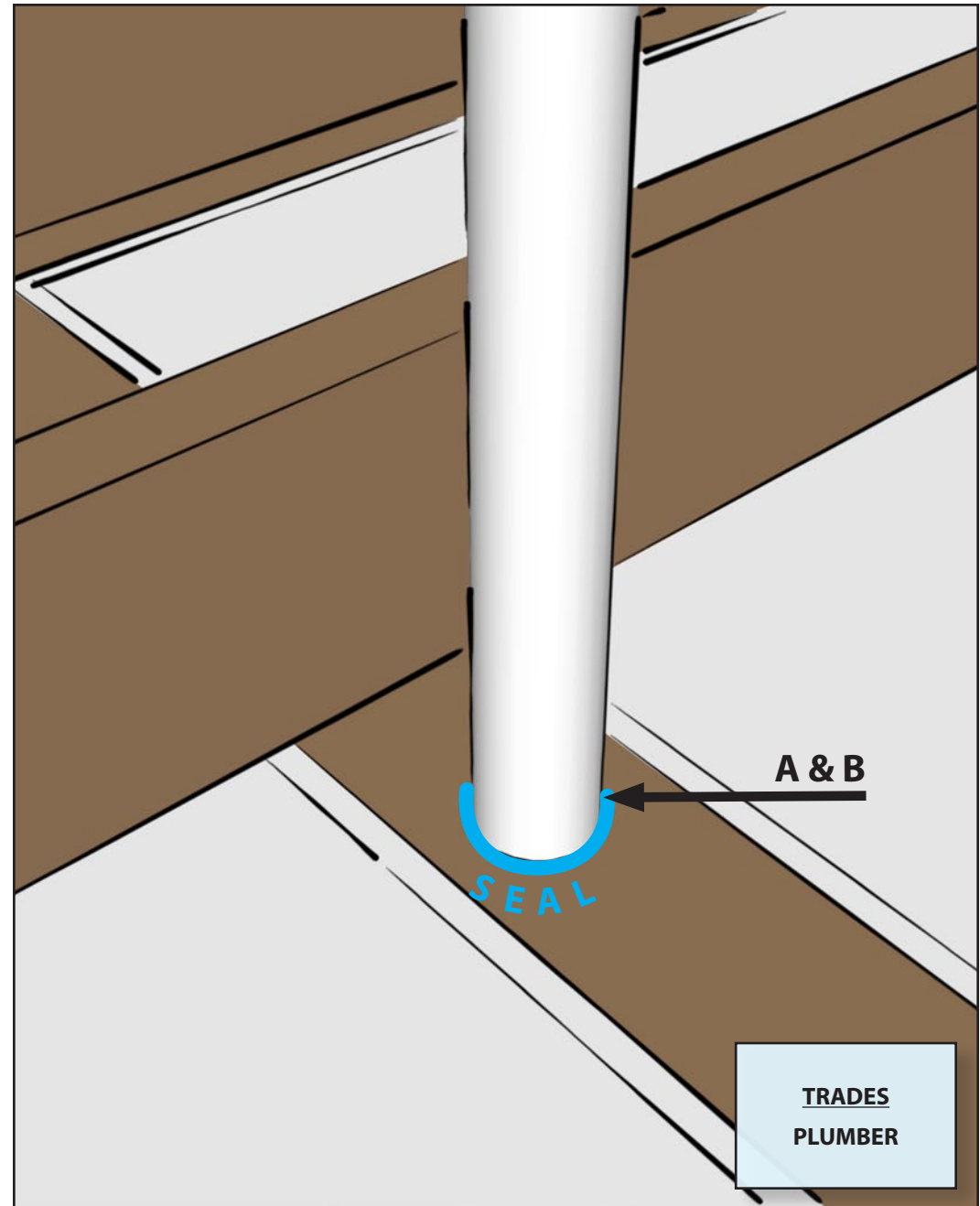
5 AIR SEALING

1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED

DETAIL 5.1.2

Plumbing / piping

- A. Using a saw or drill, cleanly cut all penetrating holes no more than 1 inch larger in diameter than the penetrating object to allow for proper air sealing.
- B. Seal all gaps, and holes to unconditioned space with caulk or foam. Fibrous insulation is not an air barrier and cannot be used for sealing gaps.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED



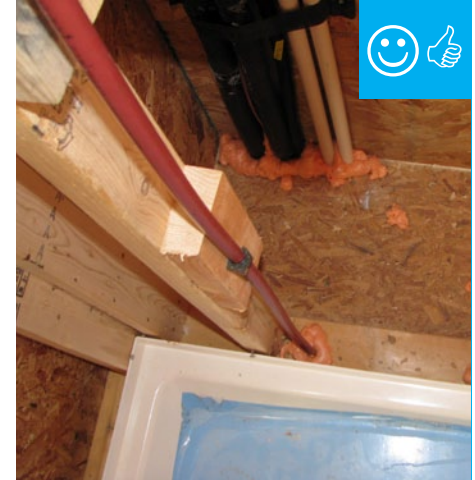
- A.** Holes have been cut excessively larger than needed making it difficult to seal.



- Neatly cut hole has been properly sealed with foam.



- A.** Holes have been cut excessively larger than needed making it difficult to seal.



- Neatly cut holes have been properly sealed with foam.



- B.** Hole has not been air sealed.



- Neatly cut holes have been properly sealed with caulk and foam.



- B.** Fibrous insulation is not an air barrier and cannot be used for sealing holes.



- Neatly cut holes have been properly sealed with foam.

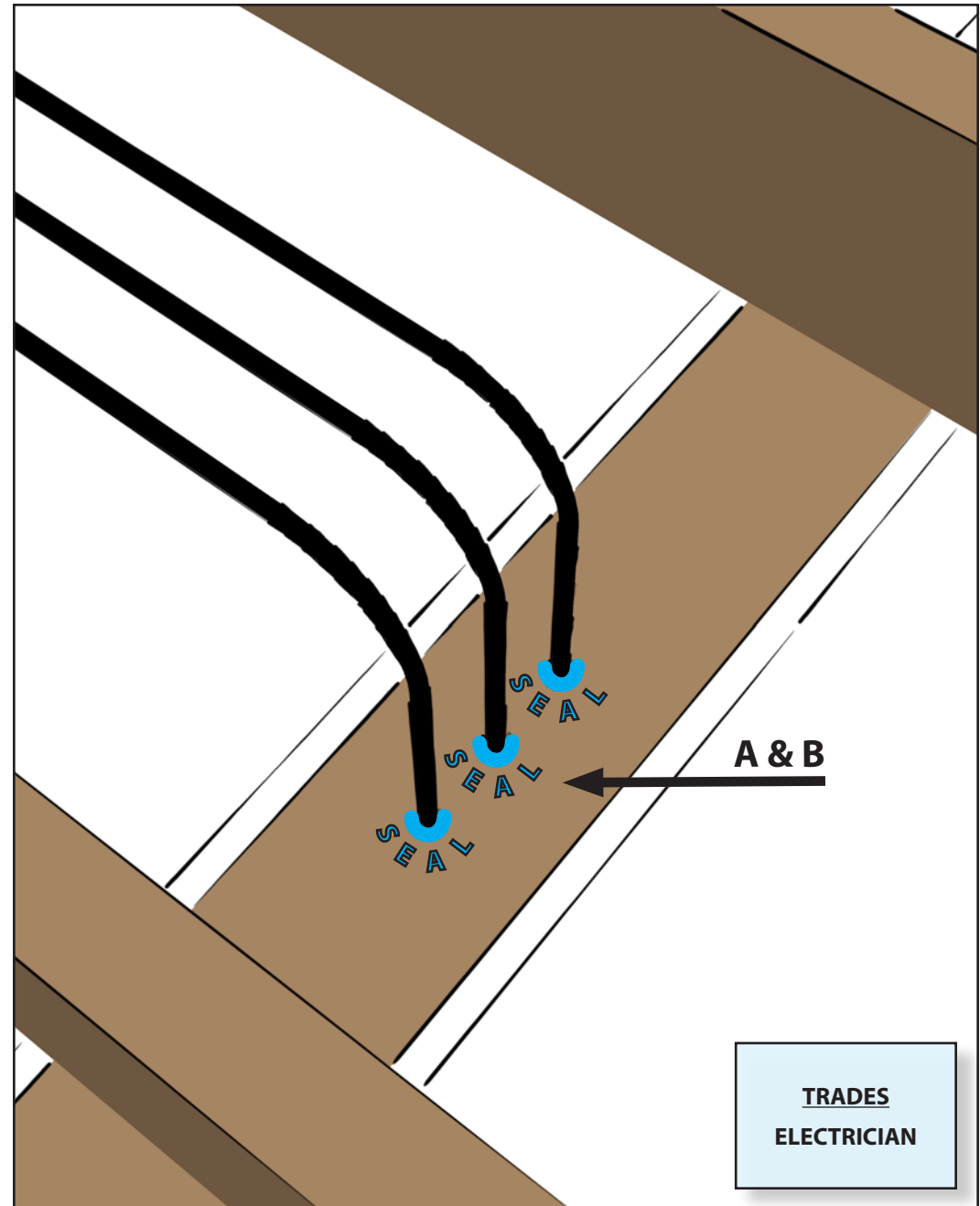
5 AIR SEALING

1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED

DETAIL 5.1.3

Electrical wiring

- A. Using a saw or drill, cleanly cut all penetrating holes no more than 1 inch larger in diameter than the penetrating object to allow for proper air sealing.
- B. Seal all gaps, and holes to unconditioned space with caulk or foam. Fibrous insulation is not an air barrier and cannot be used for sealing gaps.



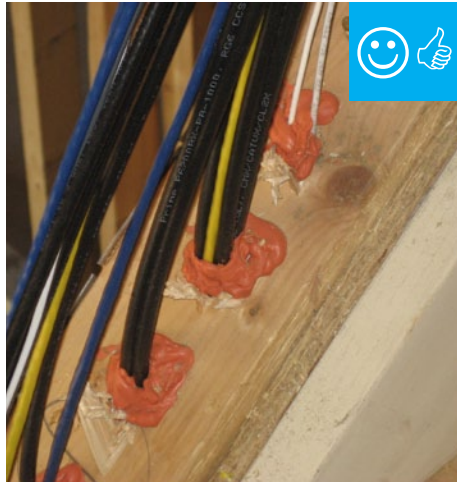
THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED



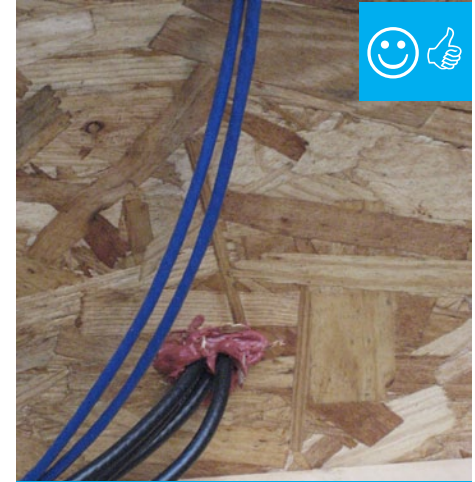
- A.** Holes have been cut excessively larger than needed making it difficult to seal.



- Wiring penetrations have been neatly sealed with foam.



- A.** Hole was not neatly cut with a saw making it difficult to seal.



- Wiring penetrations have been neatly sealed with foam.



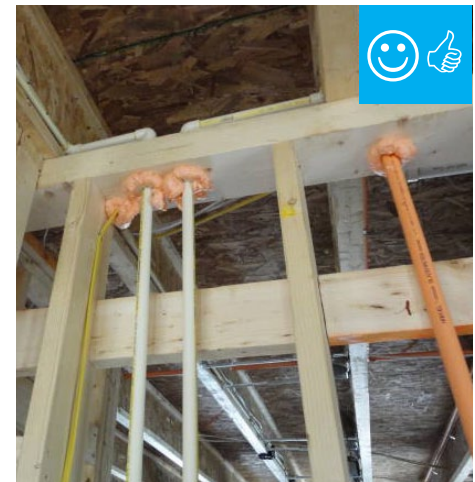
- B.** Hole has not been air sealed.



- Wiring penetrations have been neatly sealed with foam.



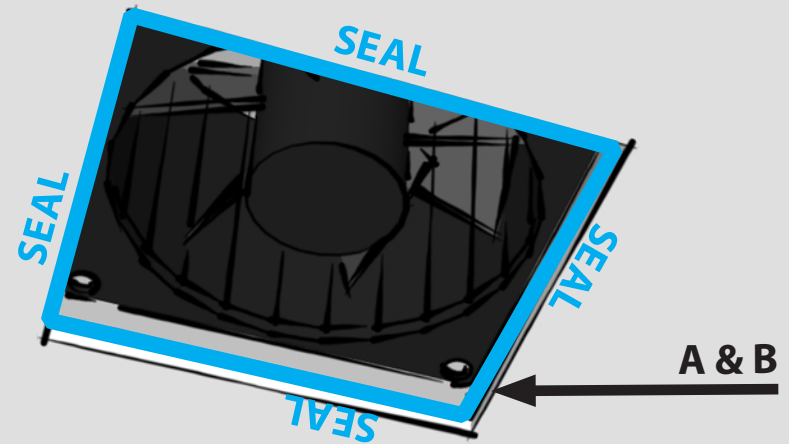
- B.** Fibrous insulation is not an air barrier and cannot be used for sealing holes.



- Neatly cut hole has been properly sealed with foam.

DETAIL 5.1.4**Bathroom and kitchen exhaust fans**

- A. Using a saw or drill, cleanly cut all penetrating holes no more than 1 inch larger in diameter than the penetrating object to allow for proper air sealing.
- B. Seal all gaps, and holes to unconditioned space with caulk or foam. Fibrous insulation is not an air barrier and cannot be used for sealing gaps.



TRADES
ELECTRICIAN
HVAC TECHNICIAN

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

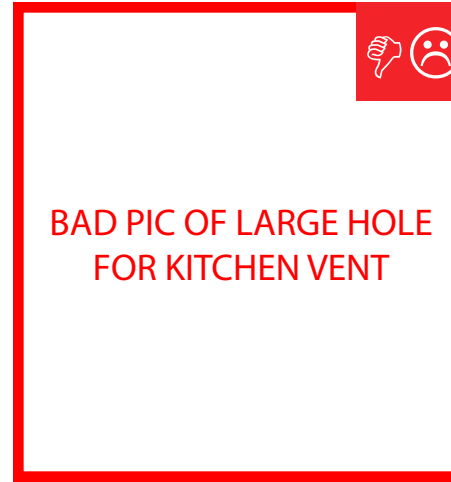
1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED



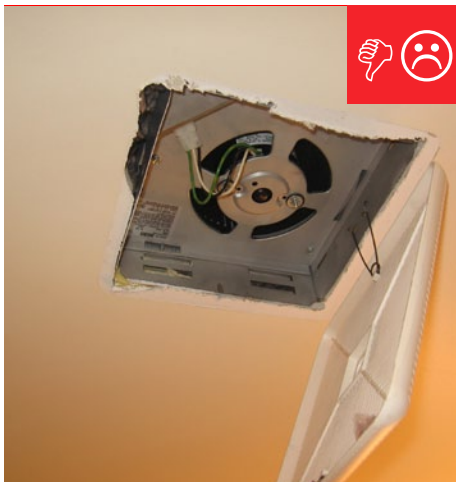
A. Roughly cut hole that is larger than the fan making it difficult to seal.



Cleanly cut and properly sized hole.



A.



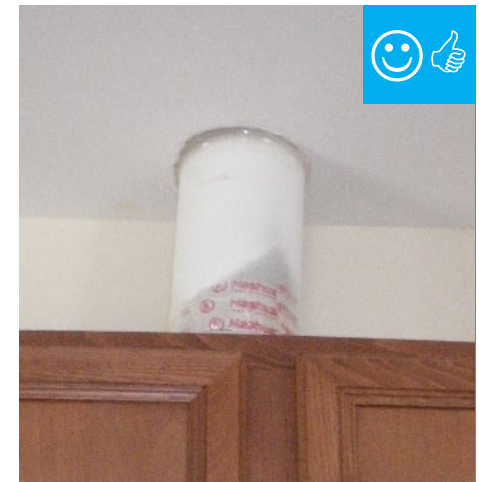
B. Roughly cut hole that is larger than the fan making it difficult to seal.



Fan with a cleanly cut and properly sized hole has been air sealed to drywall.



B. Kitchen exhaust has not been air sealed.



Kitchen exhaust penetration has been sealed with caulk.

5 AIR SEALING

1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED

DETAIL 5.1.5

Recessed lighting fixtures adjacent to unconditioned space ICAT labeled and fully gasketed. Also, 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.

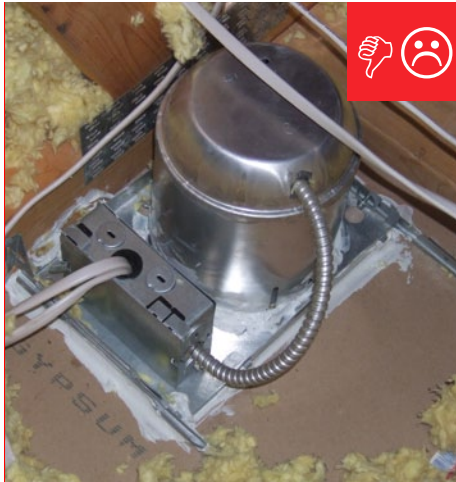
- A. Install ICAT labeled recessed lighting fixtures.
- B. Seal all gaps, and holes to unconditioned space with caulk or foam.
- C. Install a proper trim kit with a gasket.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED



A. Non ICAT recessed light installed.



ICAT labeled recessed light with trim kit installed.



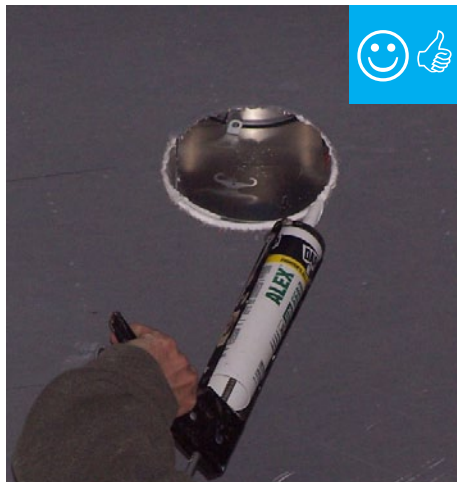
A. Non ICAT recessed light installed.



ICAT labeled recessed light installed but still needs gasket.



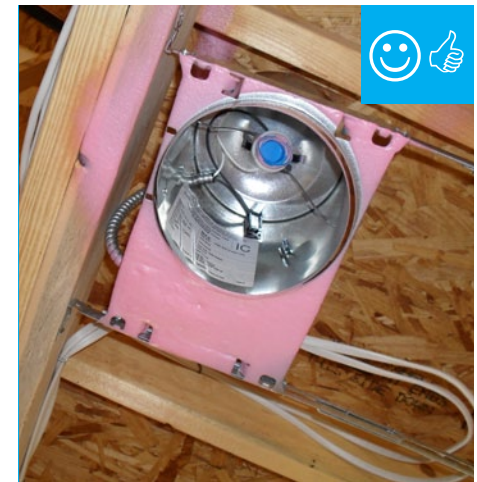
B. Recessed can light has not been sealed to drywall.



Recessed can light penetration sealed with caulk to drywall.



C. No gasket installed.



ICAT recessed light sprayed with foam to act as gasket against the drywall.

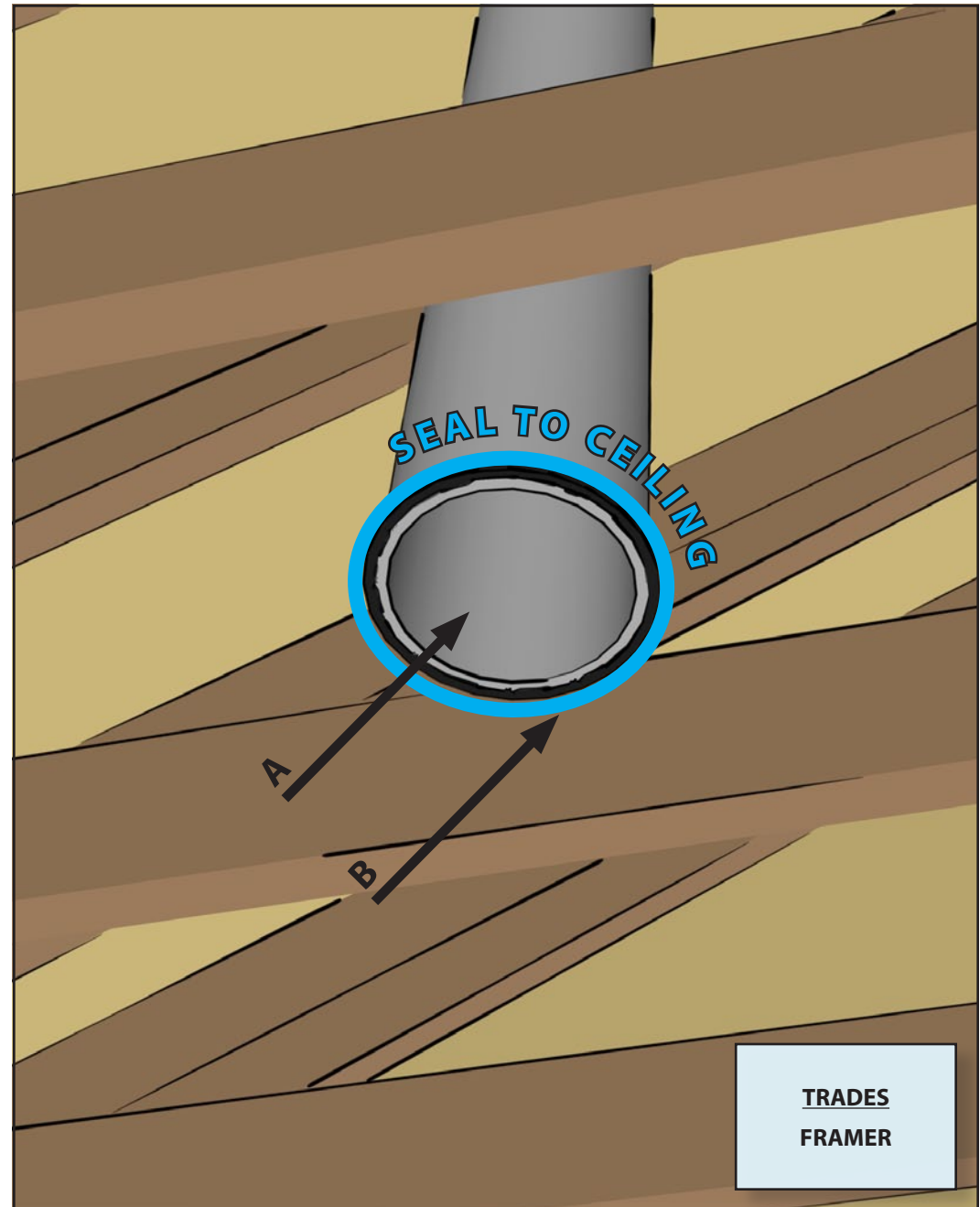
DETAIL 5.1.6 ²¹

Light tubes adjacent to unconditioned space include lens separating unconditioned and conditioned space and are fully gasketed

- A. Seal all gaps, and holes to unconditioned space with caulk or foam.
- B. Install a proper lens kit with a gasket.
- C. If the light tube does not have a lens kit with a gasket, install a light tube with at least R-6 insulation around the length of the tube.

FOOTNOTES

21. Light tubes that do not include a gasketed lens are required to be sealed and insulated $\geq$ R-6 for the length of the tube.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

1 PENETRATIONS, GAPS, AND HOLES TO UNCONDITIONED SPACE FULLY SEALED



BAD PIC OF LIGHT TUBE
NOT SEALED TO INTERIOR
SURFACE



GOOD PIC OF PROPERLY
SEALED LIGHT TUBE



BAD PIC OF LIGHT TUBE
W/O LENS KIT GASKET
AND LESS THAN R-6 OR NO
INSULATION



GOOD PIC OF LIGHT TUBE
WITH LENS KIT GASKET

A.

B.



BAD PIC OF LIGHT TUBE
W/O GASKET AND
LESS THAN R-6 OR NO-
INSULATION AROUND TUBE



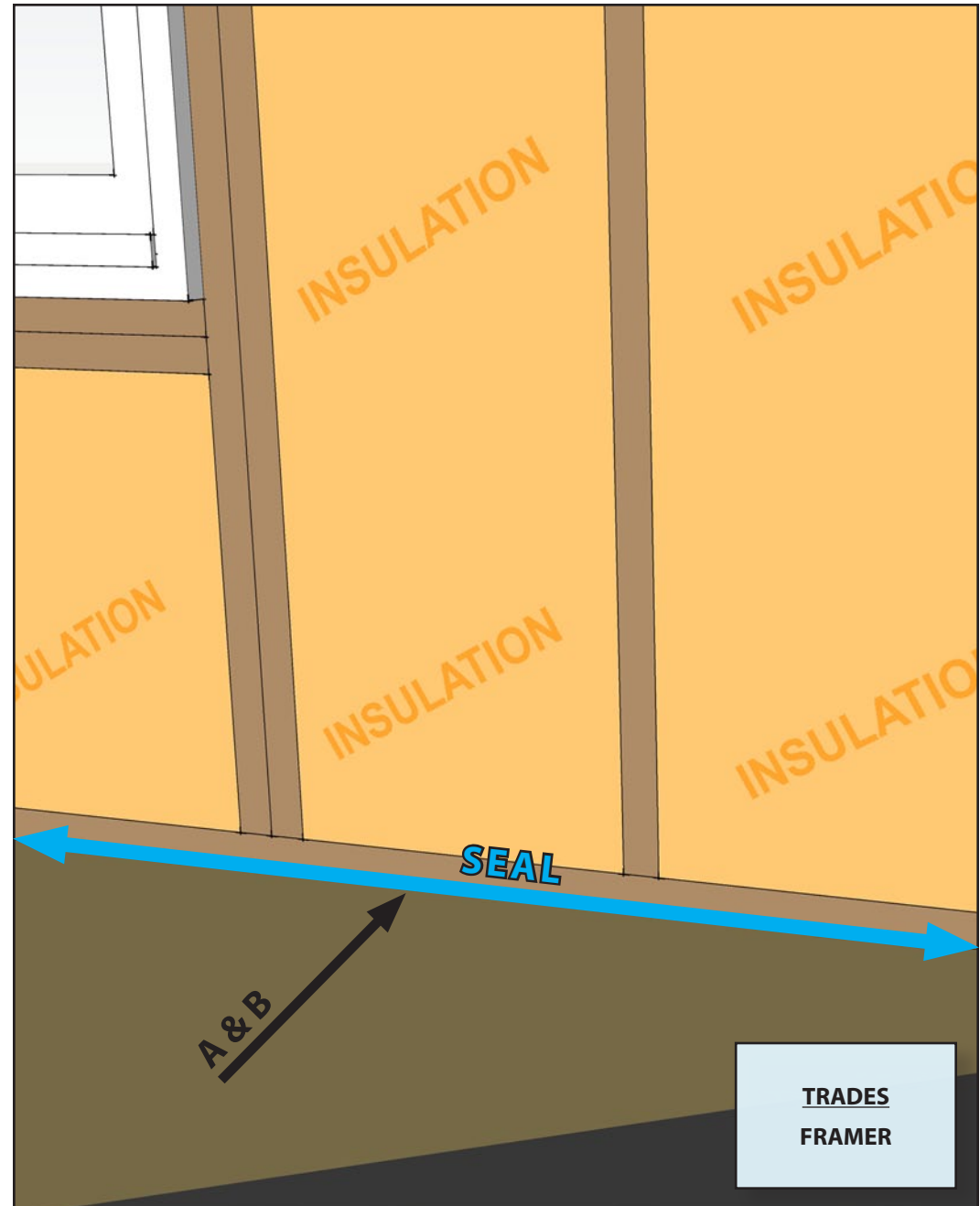
GOOD PIC OF LIGHT TUBE
W/O GASKET AND R-6
OR GREATER INSULATION
AROUND TUBE

C.

DETAIL 5.2.1

All sill plates adjacent to conditioned space sealed to foundation or sub-floor with caulk. Foam gasket also placed beneath sill plate if resting atop concrete or masonry and adjacent to conditioned space

- A. Locate all sill plates of all exterior walls, common walls, and vertical members at foundation step downs.
- B. Install a gasket to prevent air leakage and seal all exterior wall sill plates to the sub-floor or foundation to prevent air leakage.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

2 CRACKS IN THE BUILDING ENVELOPE FULLY SEALED



- A.** No foam gasket or air seal between sill plate and masonry foundation.



- Foam gasket installed between sill plate and foundation.



- A.** Caulk is too far from sill plate to properly air seal.



- Sill plate was sprayed with foam prior to installation atop foundation.



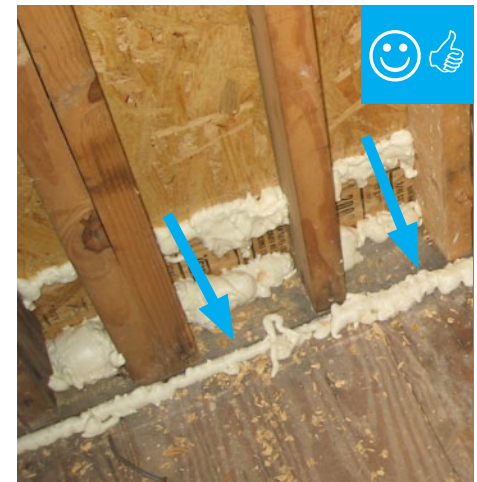
- B.** No foam gasket or air seal beneath sill plate.



- Foam gasket installed beneath sill plate.



- B.** Foam sprayed at exterior sheathing and sill plate connection leaving gaps beneath sill plate.

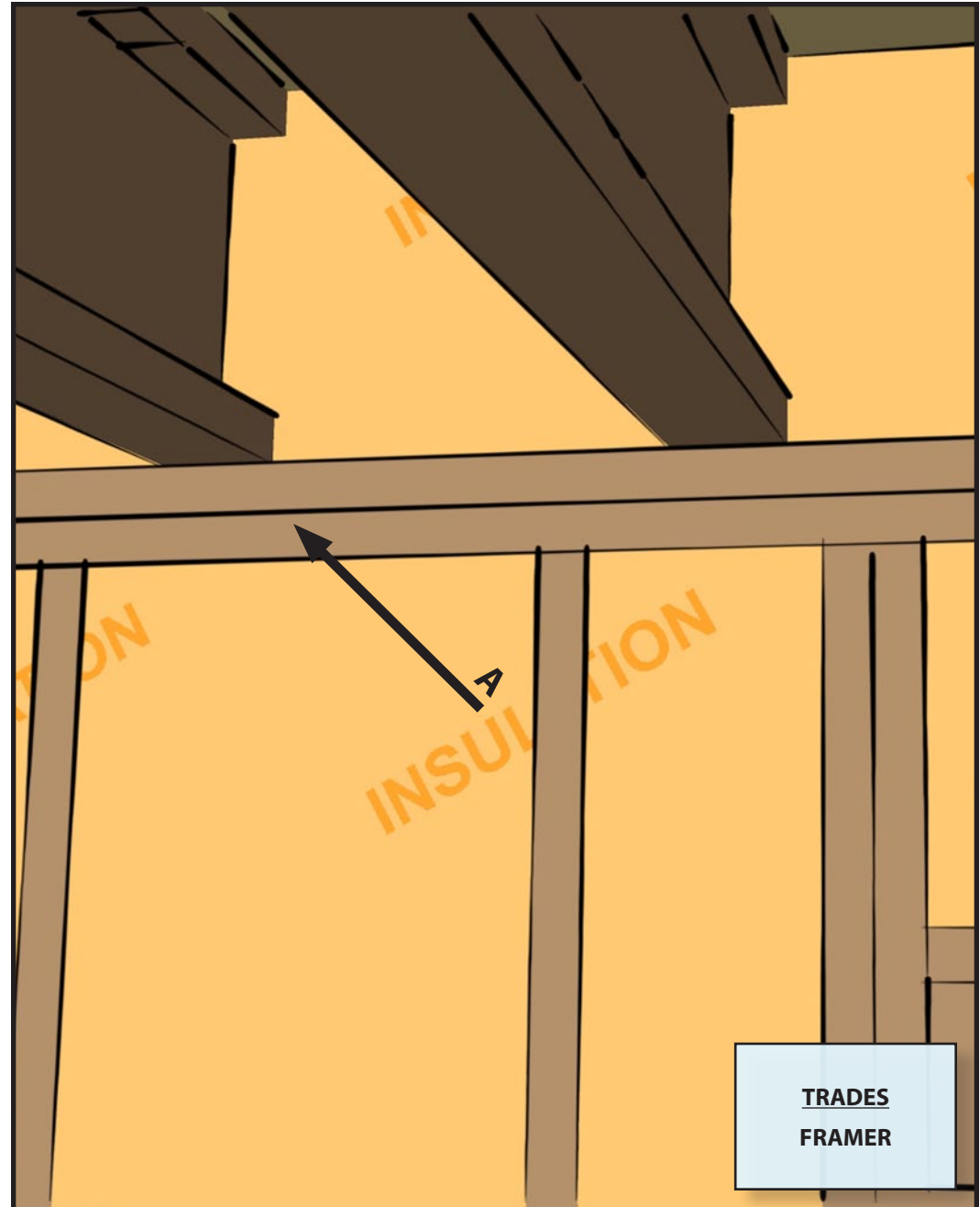


- Installed foamed exterior sheathing intersection as well as the sill plate to sub-floor connection.

DETAIL 5.2.2

**At top of walls adjoining unconditioned spaces,
continuous top plates or sealed blocking using caulk,
foam, or equivalent material**

- A. Install a continuous top plate at all full height walls.
- B. Where there is no continuous top plate, install blocking and seal.



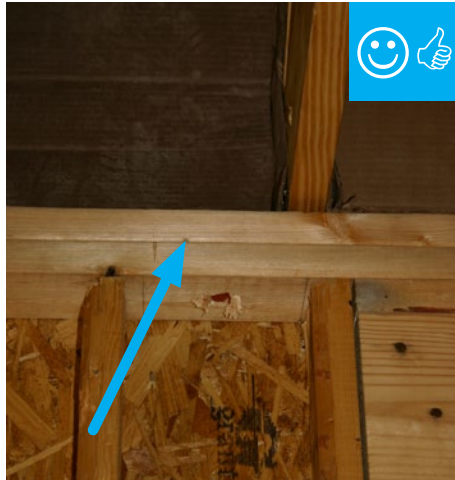
THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

2 CRACKS IN THE BUILDING ENVELOPE FULLY SEALED



BAD PIC OF NOT
CONTINUOUS TOP PLATE



Continuous top plate installed.

BAD PIC OF NOT
CONTINUOUS TOP PLATE



Continuous top plate installed.



Blocking installed and air sealed
instead of continuous top plate.

BAD PIC OF FURRED WALL
WITHOUT TOP PLATE



GOOD PIC OF FURRED
WALL WITH TOP PLATE

B. Wall from above without
top plate or blocking
installed.

B.

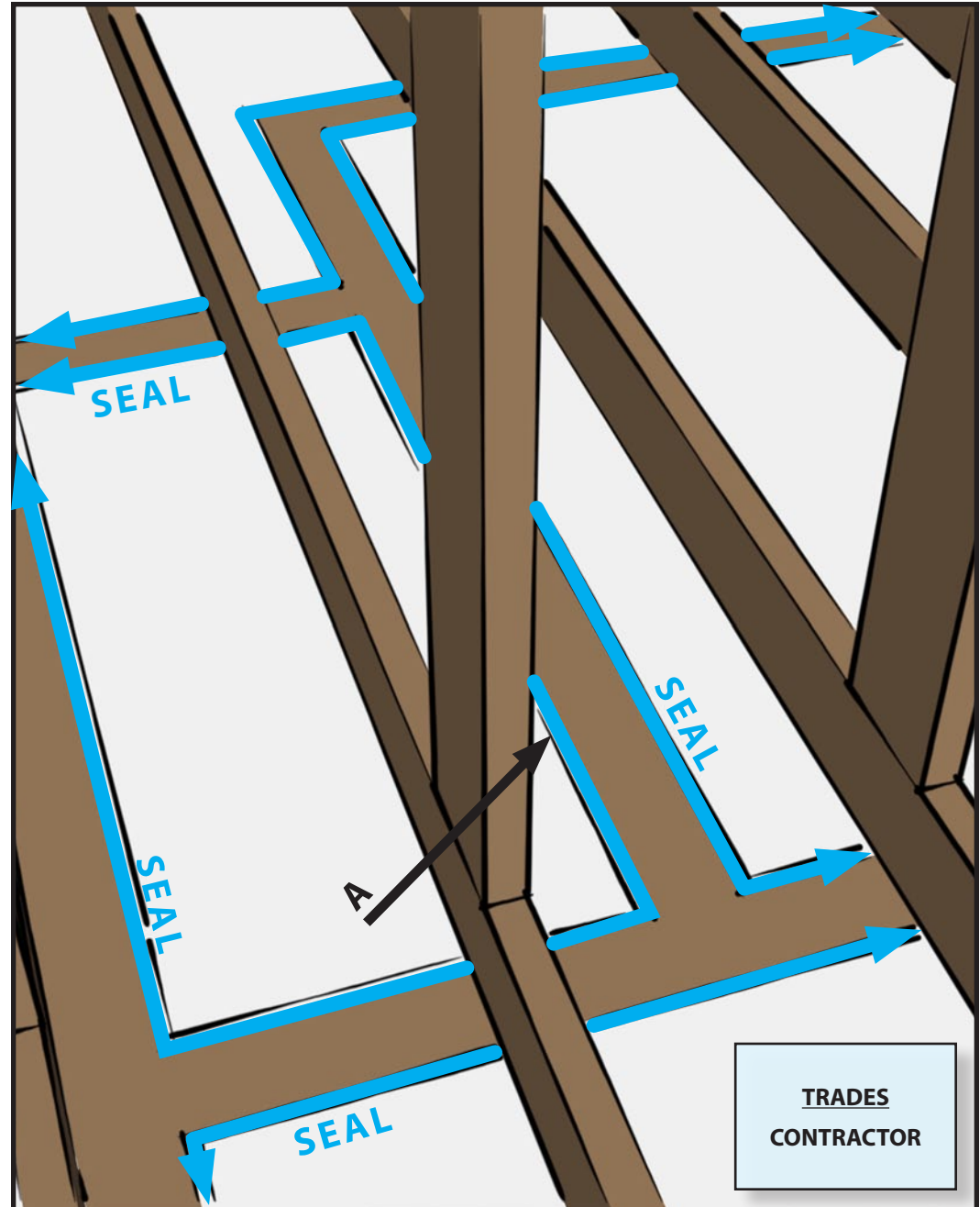
DETAIL 5.2.3

Sheetrock sealed to top plate at all attic/wall interfaces using caulk, foam, or equivalent material. Either apply sealant directly between sheetrock and top plate or to the seam between the two from the attic above. Construction adhesive shall not be used

- A. Before insulating the attic, seal all top plate to interior cladding connections with latex foam or caulk to stop air leakage between conditioned and unconditioned space.

OR

- B. Before installing drywall, use spray foam sealant or gasket product on top plate to air seal once drywall is installed. If this method is used, make sure foam/gasket remains intact during drywall installation.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

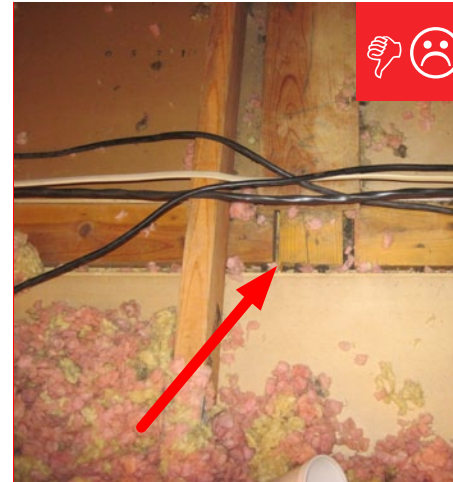
2 CRACKS IN THE BUILDING ENVELOPE FULLY SEALED



A. Top plate to drywall connection not sealed.



Top plate to drywall connection sealed from attic with foam.



A. Top plate to drywall connection not sealed.



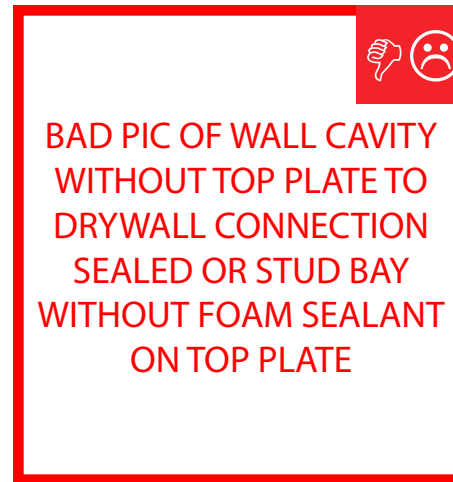
Top plate to drywall connection sealed from attic with caulk.



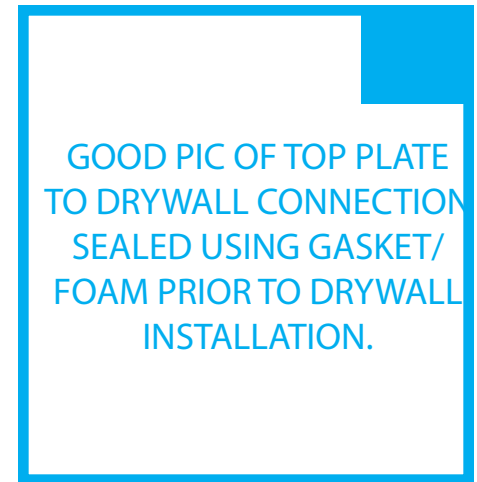
A. Top plate to drywall connection not sealed.



Top plate to drywall connection sealed from attic with foam sealant.



B.

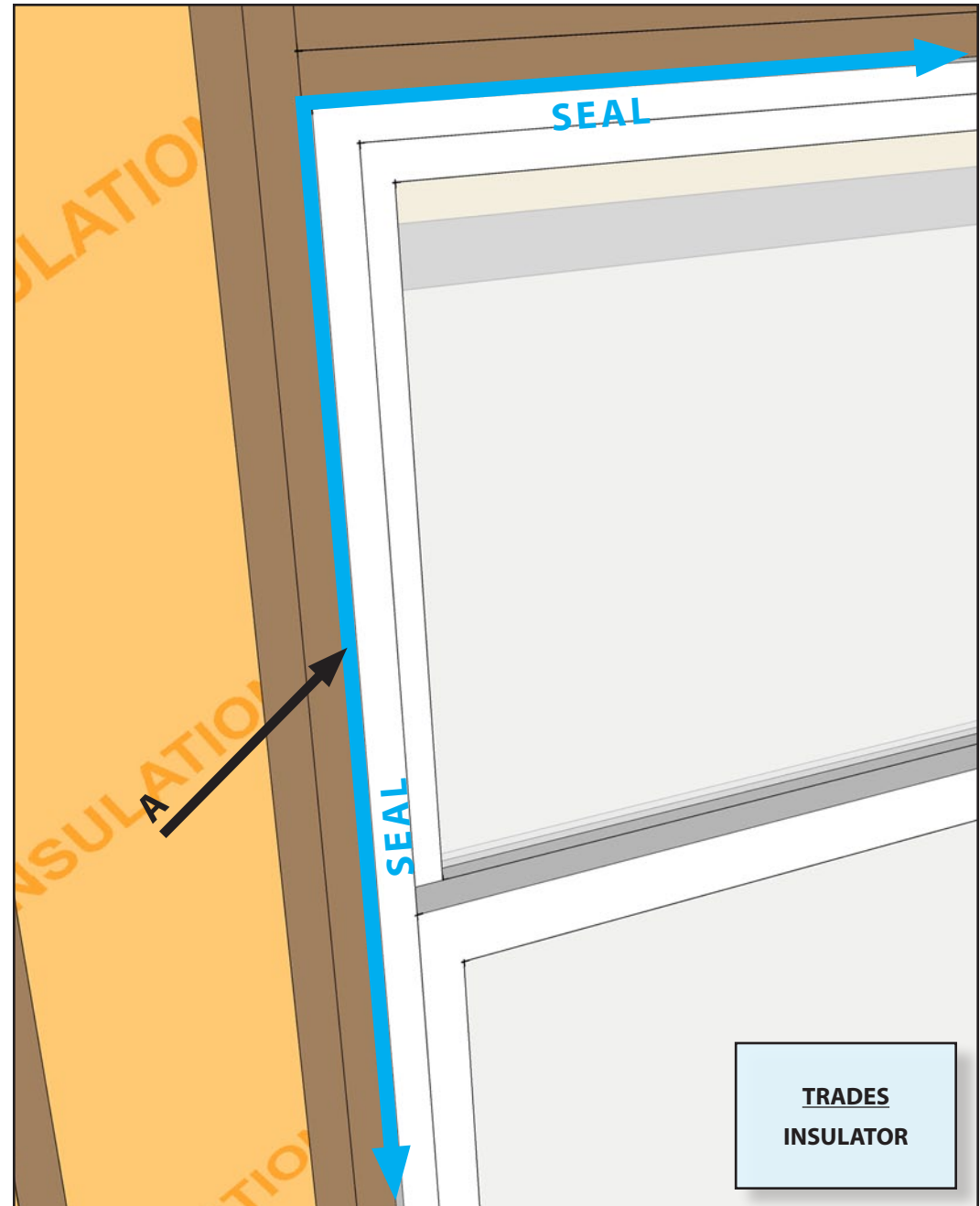


DETAIL 5.2.4**Rough opening around windows and exterior doors sealed with caulk or foam**

- A. Install backer rod or low-expansion foam in openings around windows and doors.
- B. Fibrous insulation is not an air barrier and cannot be used for sealing gaps.
- C. Avoid using typical expansion foam as it might interfere with the functioning of the window or door.

FOOTNOTES

22. In Climate Zones 1 through 3, stucco over rigid insulation tightly sealed to windows and doors shall be considered equivalent to sealing rough openings with caulk or foam.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

2 CRACKS IN THE BUILDING ENVELOPE FULLY SEALED



A. Rough opening around window not air sealed



Rough opening around window has been filled with backer-rod to air seal.



B. Fibrous insulation is not an air barrier and cannot be used to air seal openings.



Rough opening around window has been filled with low-expansion foam to air seal.

**BAD PIC OF EXPANDING
FOAM AROUND WINDOW
OR DOOR OPENING**

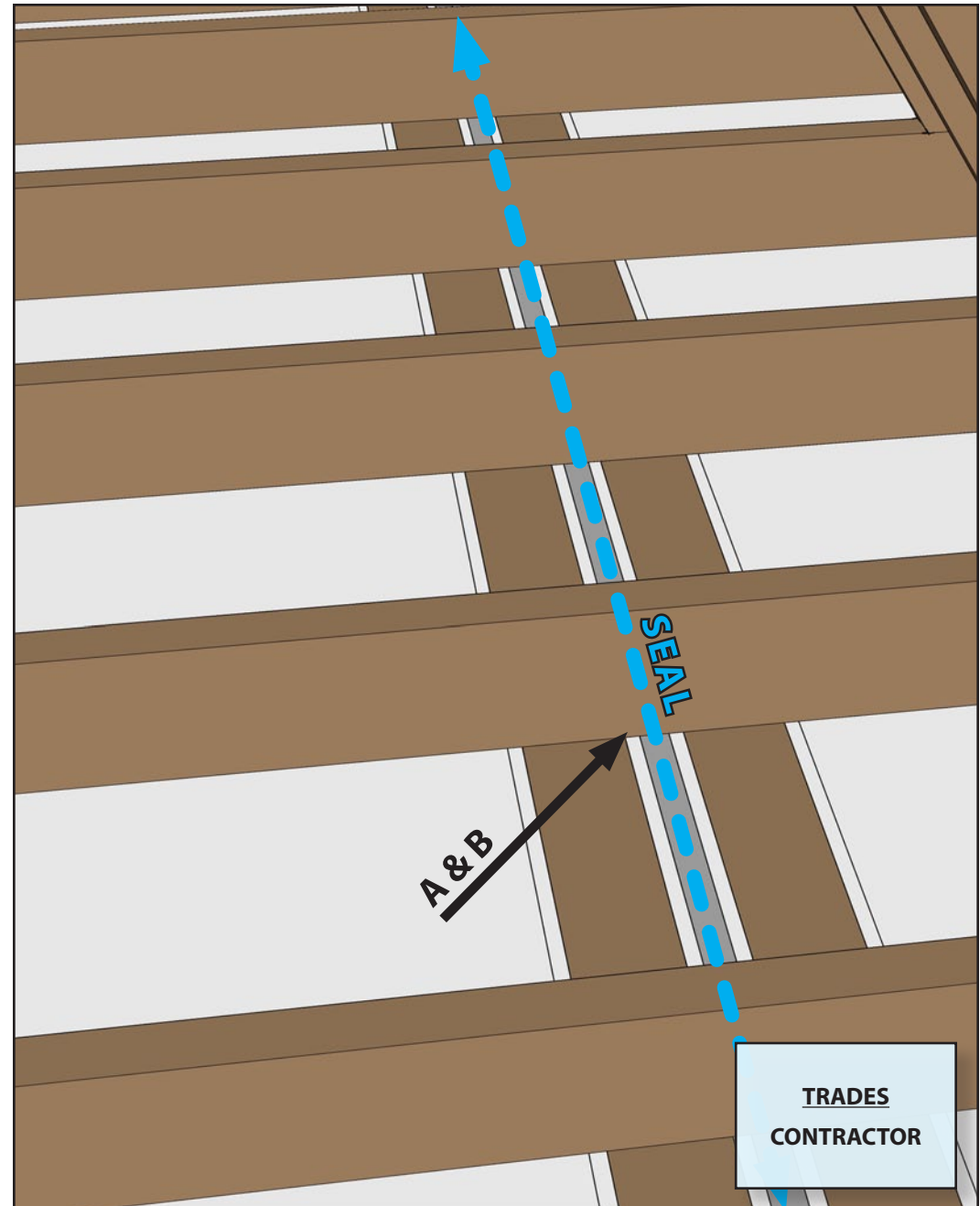


C. Backer-rod is a foam product available in various diameters that can be used to air seal openings around doors and windows.

DETAIL 5.2.5

Marriage joints between modular home modules at all exterior boundary conditions fully sealed with gasket and foam

- A. Install a gasket along the entire seam of the exterior boundary where modules are attached together.
- B. When modules are in place, seal the edge of the gasket to the module.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

2 CRACKS IN THE BUILDING ENVELOPE FULLY SEALED



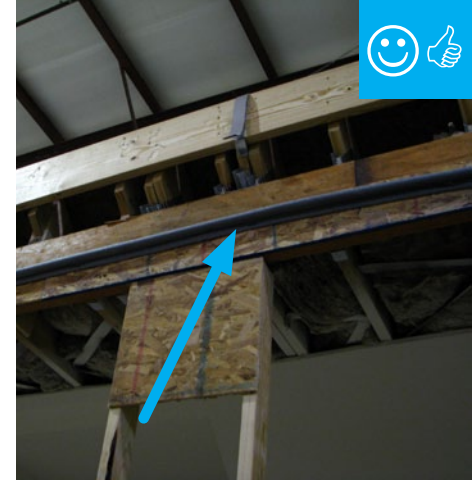
A. No gasket installed at marriage wall connection prior to assembly.



Gasket installed at marriage wall connection prior to assembling modules.



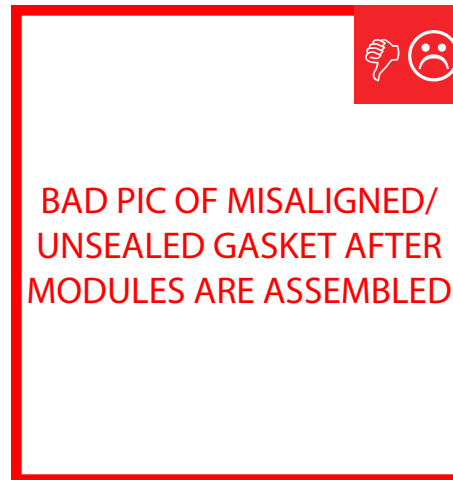
A. No gasket installed at marriage wall connection prior to assembly.



Gasket installed at marriage wall connection prior to assembling modules.



B.



B.



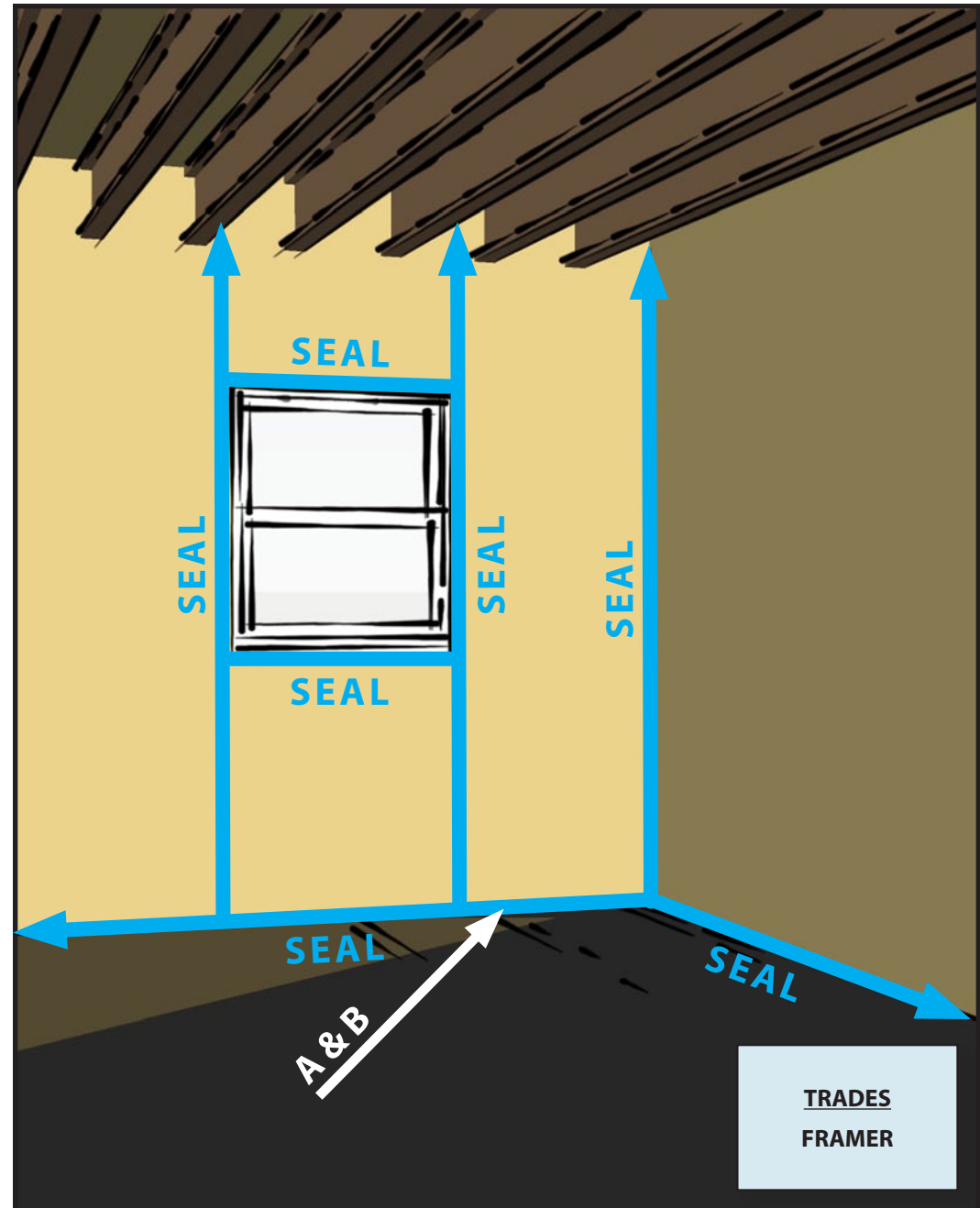
5 AIR SEALING

2 CRACKS IN THE BUILDING ENVELOPE FULLY SEALED

DETAIL 5.2.6

All seams between Structural Insulated Panels (SIPs) foamed and/or taped per manufacturer's instructions

- A. Apply manufacturer-approved sealant inside the joints of all panels and at sub-floor or foundation connections.
- B. When applying tape to walls, center on joints and provide overlap of tape to meet manufacturer's specifications.
- C. When applying tape to roof panels, start from the lowest point of the panel and continue upward.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

2 CRACKS IN THE BUILDING ENVELOPE FULLY SEALED



BAD PIC OF JOINT SEALING



Hole drilled to verify sealant is present. Hole will be sealed after verification.



BAD PIC OF WALL TAPING



GOOD PIC OF WALL TAPING

A.

B.



BAD PIC OF ROOF TAPING
AT JOINTS



GOOD PIC OF ROOF TAPING
AT JOINTS



BAD PIC OF ROOF TAPING
AT JOINTS



GOOD PIC OF ROOF TAPING
AT JOINTS

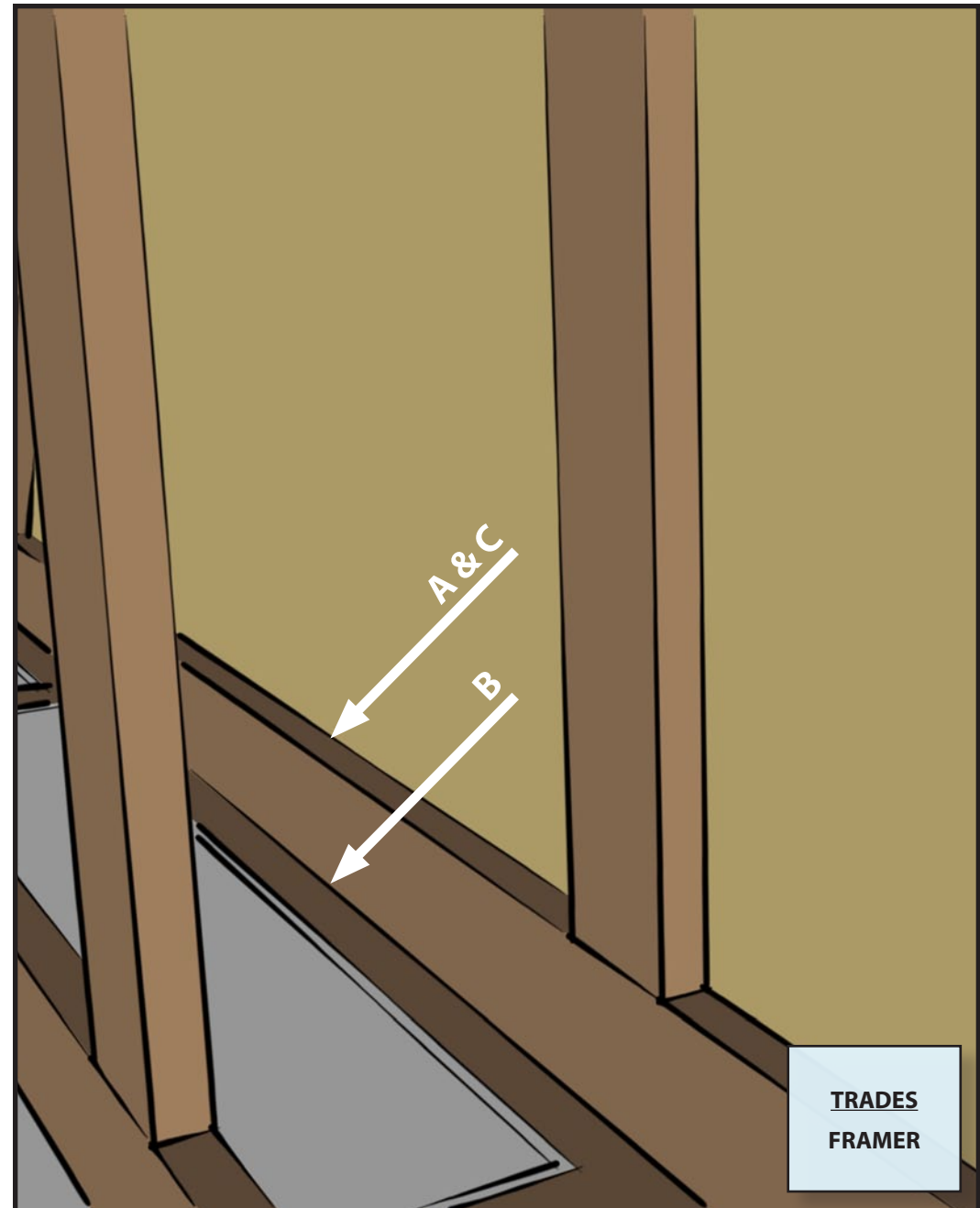
C.

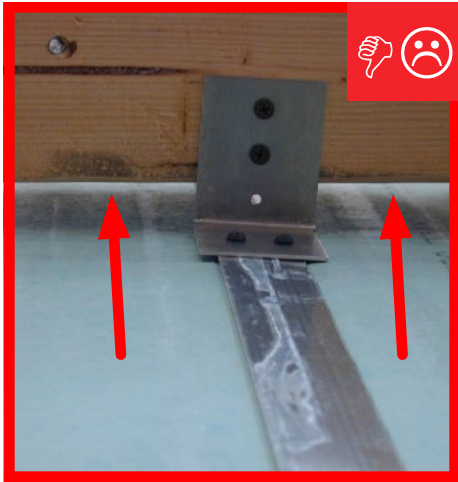
C.

DETAIL 5.2.7

In multi-family buildings, the gap between the drywall shaft wall (i.e., common wall) and the structural framing between units fully sealed at all exterior boundary conditions

- A. The gap between walls must be declared an approved assembly before being air sealed.
- B. Seal the bottom plate to sub-floor.
- C. Seal the bottom plate to sheathing connection.
- D. Seal gap between units from exterior at all common wall locations with caulk, foam, or equivalent material. (Typically fire rated foam is required by code).





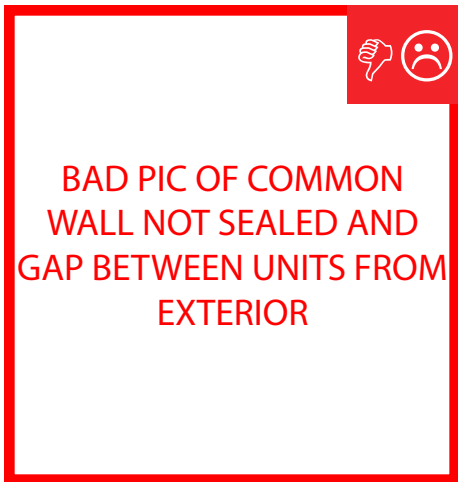
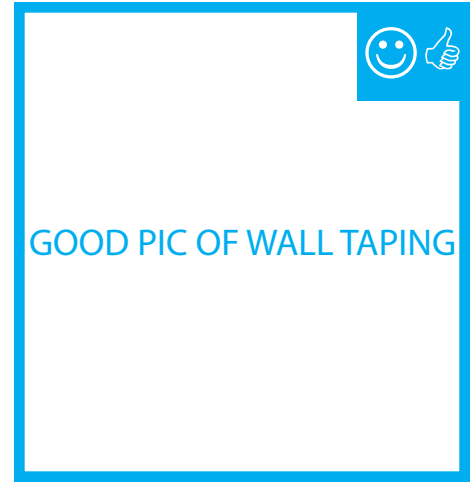
A. Air leakage path in a common wall.



Approved common assembly installed.



B./C. Common wall sheathing not properly fastened or sealed.



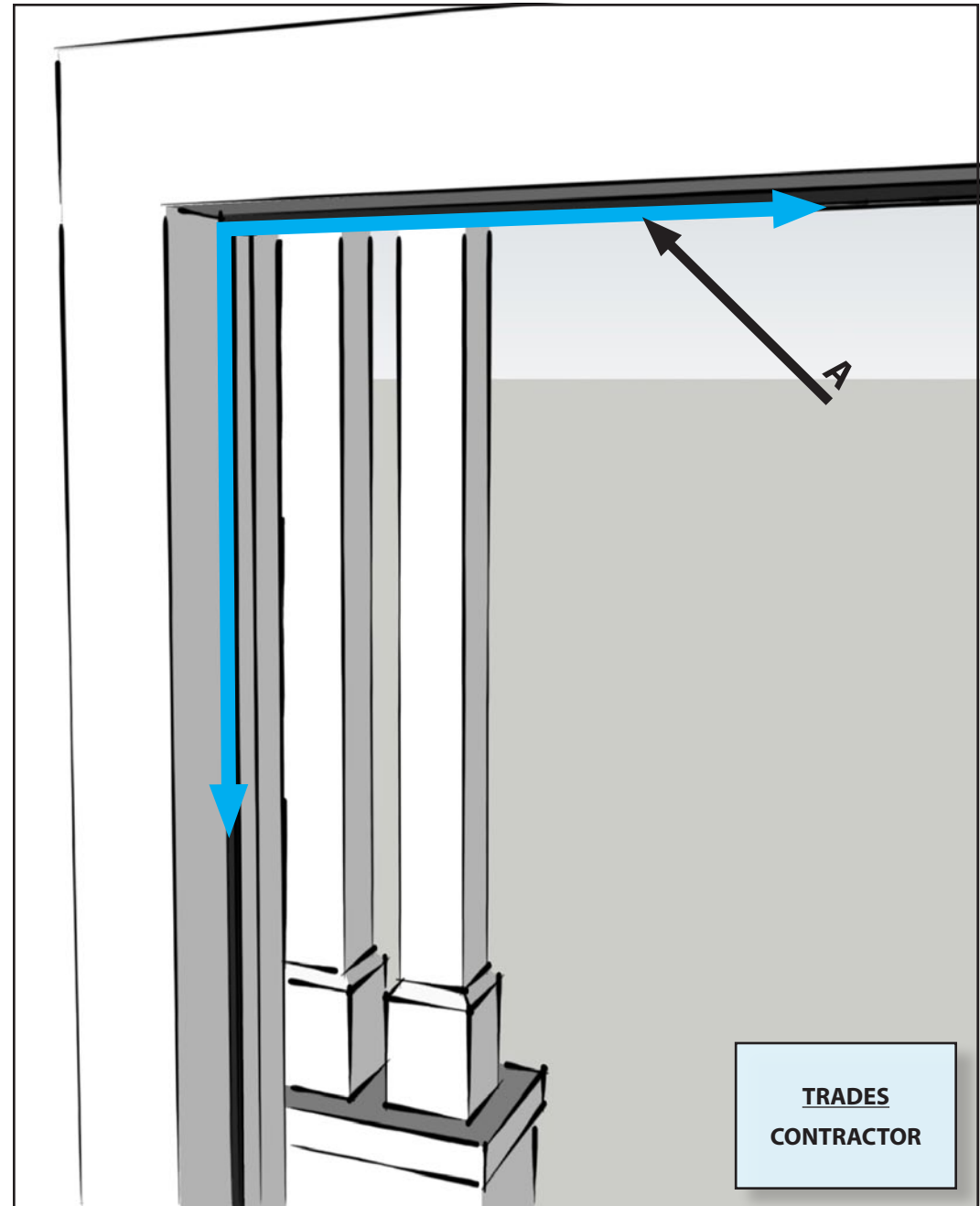
D.



DETAIL 5.3.1

Doors adjacent to unconditioned space (e.g., attics, garages, basements) or ambient conditions gasketed or made substantially air-tight

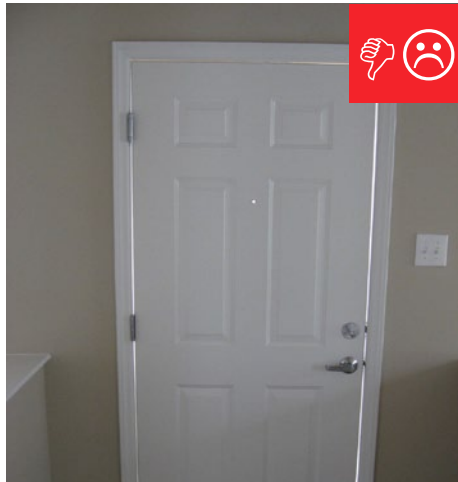
- A. Install a continuous gasket, such as weather stripping, around all exterior door openings.



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

3 OTHER OPENINGS



- A.** There is visible light around the door because no weather stripping has been installed.



- Weather stripping has been installed and remains in contact once door is closed.



- B.**



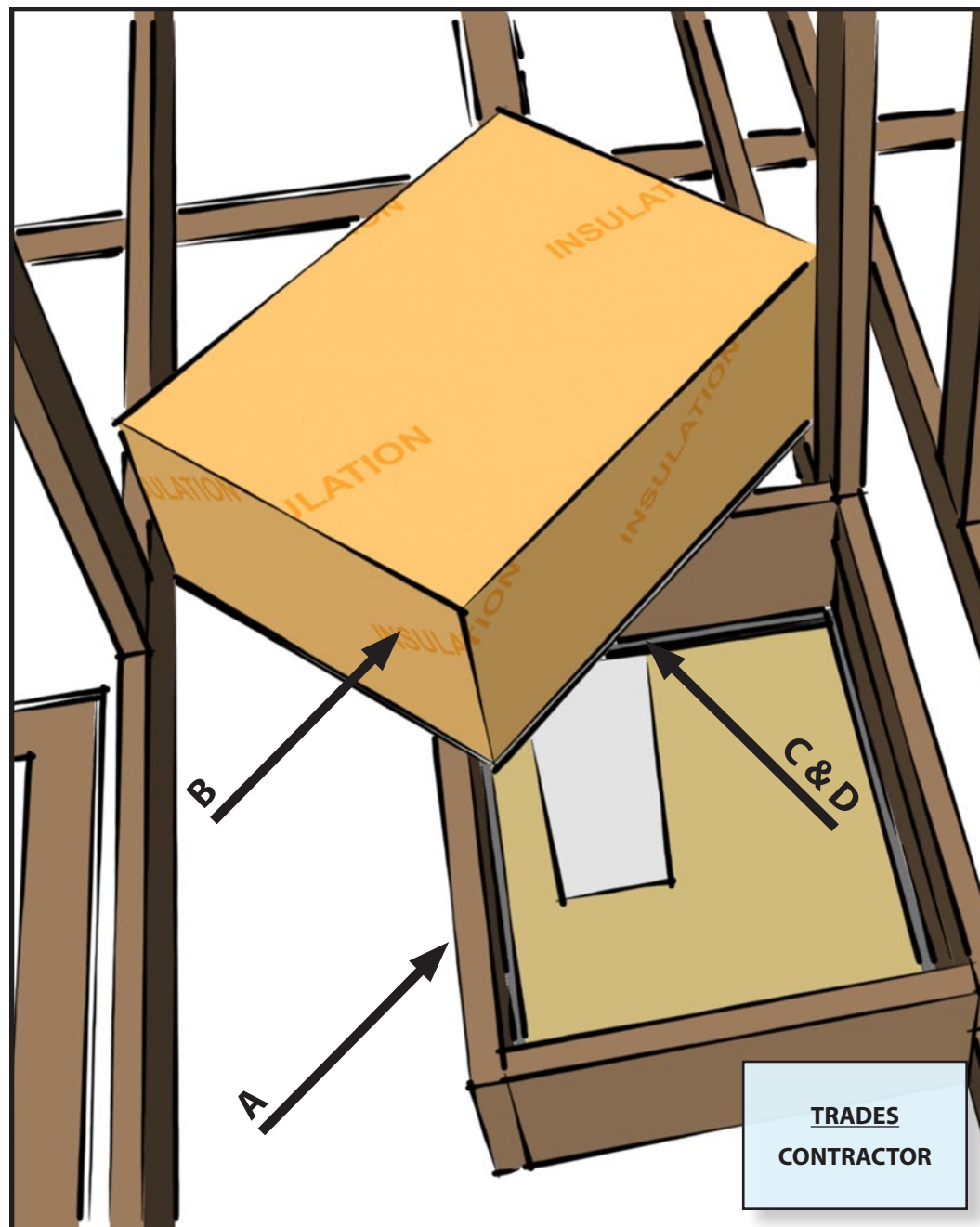
DETAIL 5.3.2 ²³

Attic access panels and drop-down stairs equipped with a durable $\geq R-10$ insulated cover that is gasketed (i.e., not caulked) to produce continuous air seal when occupant is not accessing the attic

- A. If installing ceiling access to the attic, building science experts recommend installing additional blocking to create insulation dams.
- B. Install an attic access panel that is equipped with an insulated cover to meet or exceed R-10.
- C. Seal all gaps, and holes to unconditioned space with caulk or foam.
- D. Install a continuous gasket around the attic access panel.

FOOTNOTES

23. Examples of durable covers include, but are not limited to, pre-fabricated covers with integral insulation, rigid foam adhered to cover with adhesive, or batt insulation mechanically fastened to the cover (e.g., using bolts, metal wire, or metal strapping).





A. No blocking installed to prevent attic insulation from falling into stairs and opening.



Blocking has been installed around the perimeter of this attic access to prevent insulation falling into the house.



B. Drop down stairs do not have an insulation cover installed.



B. Attic access panel does not have an insulation cover installed.



Attic access hatch has been properly insulated by attaching a fiberglass batt, gasketed, and opening has blocking.



C./D. There is no weather stripping or gasket around the attic stair hatch.



From inside attic: this attic access door has a foam and rubber weather-stripping installed that remains in contact when closed.

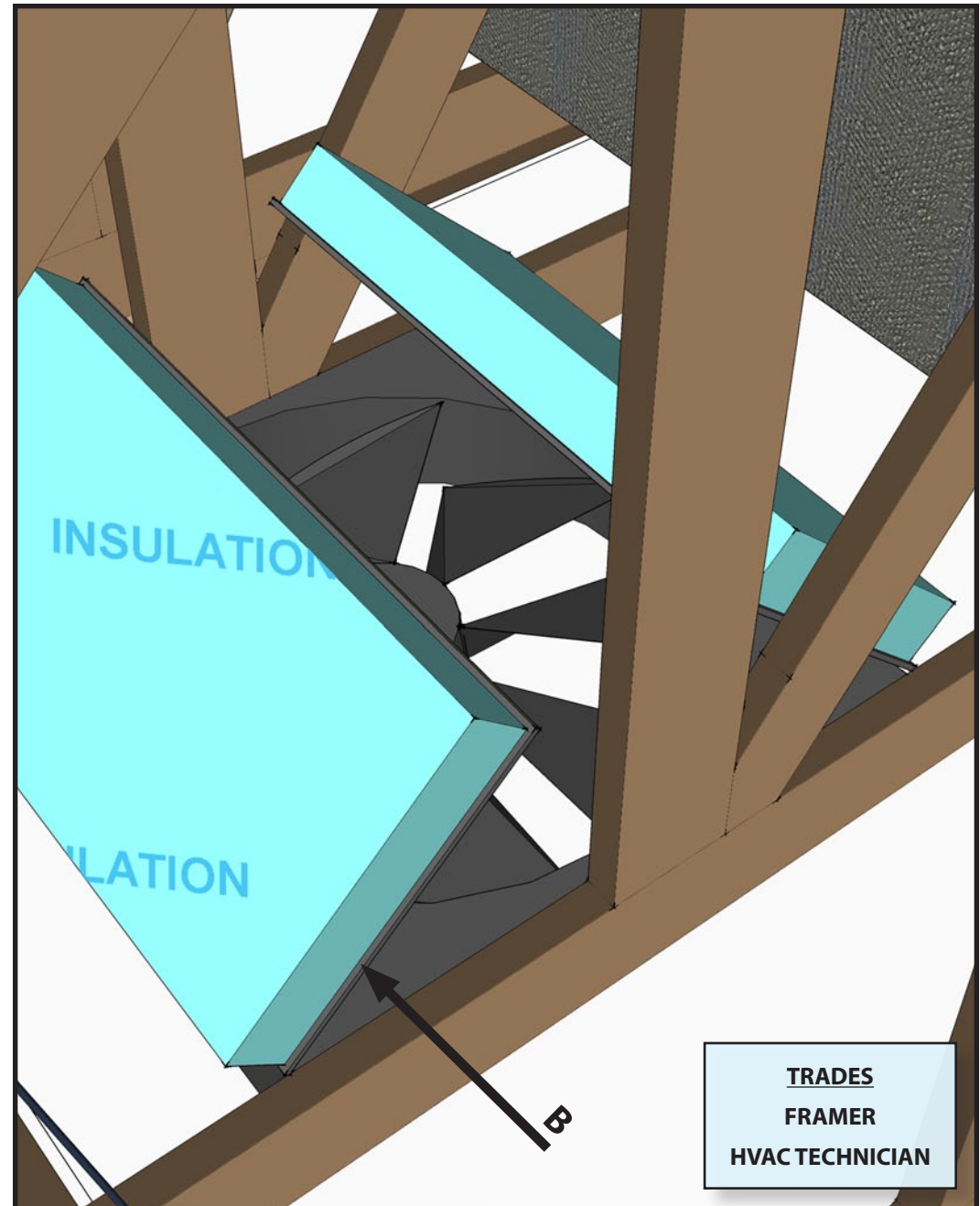
DETAIL 5.3.3 ²³

Whole-house fans equipped with a durable $\geq$ R-10 insulated cover that is gasketed and either installed on the house side or mechanically operated

- A. Install a whole-house fan that is equipped with an insulated cover to meet or exceed R-10.
- B. Install an insulated and gasketed cover on the house side or install one that is mechanically operated.
- C. Seal all gaps, and holes to unconditioned space with caulk or foam.
- D. Whole-house fans are most effective in climates with hot days, cool nights and relatively low humidity.

FOOTNOTES

23. Examples of durable covers include, but are not limited to, pre-fabricated covers with integral insulation, rigid foam adhered to cover with adhesive, or batt insulation mechanically fastened to the cover (e.g., using bolts, metal wire, or metal strapping).



THERMAL ENCLOSURE SYSTEM RATER CHECKLIST

5 AIR SEALING

3 OTHER OPENINGS



A. Whole house fan installed without an insulated cover.



GOOD PIC OF WHOLE HOUSE FAN WITH INSULATED COVER



BAD PIC OF WHOLE HOUSE FAN WITHOUT GASKET/ LOUVERS WITH GAPS FROM INSIDE HOUSE



GOOD PIC OF GASKETED WHOLE HOUSE FAN



C. Whole house fan installed with holes in surrounding platform that need to be air sealed.



GOOD PIC OF AIR SEALING WHOLE HOUSE FAN

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



ALL FOOTNOTES

1. At the discretion of the Rater, the builder may verify up to eight items specified in this checklist. When exercised, the builder's responsibility will be formally acknowledged by the builder signing off on the checklist for the item(s) that they verified.
2. For Prescriptive Path: All windows, doors, and skylights shall meet or exceed ENERGY STAR Program Requirements for Residential Windows, Doors, and Skylights – Version 5.0 as outlined at www.energystar.gov/windows. For Performance Path: All windows, doors and skylights shall meet or exceed the component U-factor and SHGC requirements specified in the 2009 IECC – Table 402.1.1. If no NFRC rating is noted on the window or in product literature (e.g., for site-built fenestration), select the U-factor and SHGC value from tables 4 and 14, respectively, in 2005 ASHRAE Fundamentals, Chapter 31. Select the highest U-factor and SHGC value among the values listed for the known window characteristics (e.g., frame type, number of panes, glass color, and presence of low-e coating). Note that the U-factor requirement applies to all fenestration while the SHGC only applies to the glazed portion. The following exceptions apply:
 - a. An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements;
 - b. An area-weighted average of fenestration products more than 50% glazed shall be permitted to satisfy the SHGC requirements;
 - c. 15 square feet of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above;
 - d. One side-hinged opaque door assembly up to 24 square feet in area shall be exempt from the U-factor requirements and shall be excluded from area-weighted averages calculated using a) and b), above;
 - e. Fenestration utilized as part of a passive solar design shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above. Exempt windows shall be facing within 45 degrees of true south and directly coupled to thermal storage mass that has a heat capacity $> 20 \text{ btu/ft}^3 \times ^\circ\text{F}$ and provided in a ratio of at least 3 sq. ft. per sq. ft. of south facing fenestration. Generally, thermal mass materials will be at least 2" thick.
3. Insulation levels in a home shall meet or exceed the component insulation requirements in the 2009 IECC – Table 402.1.1. The following exceptions apply:
 - a. Steel-frame ceilings, walls, and floors shall meet the insulation requirements of the 2009 IECC – Table 402.2.5. In CZ 1 and 2, the continuous insulation requirements in this table shall be permitted to be reduced to R-3 for steel-frame wall assemblies with studs spaced at 24" on center. This exception shall not apply if the alternative calculations in d) are used;
 - b. For ceilings with attic spaces, R-30 shall satisfy the requirement for R-38 and R-38 shall satisfy the requirement for R-49 wherever the full height of uncompressed insulation at the lower R-value extends over the wall top plate at the eaves. This exemption shall not apply if the alternative calculations in d) are used;
 - c. For ceilings without attic spaces, R-30 shall satisfy the requirement for any required value above R-30 if the design of the roof/ceiling assembly does not provide sufficient space for the required insulation value. This exemption shall be limited to 500 square ft. or 20% of the total insulated ceiling area, whichever is less. This exemption shall not apply if the alternative calculations in d) are used;
 - d. An alternative equivalent U-factor or total UA calculation may also be used to demonstrate compliance, as follows:
 - i. An assembly with a U-factor equal or less than specified in 2009 IECC Table 402.1.3 complies.
 - ii. A total building thermal envelope UA that is less than or equal to the total UA resulting from the U-factors in Table 402.1.3 also complies. The insulation levels of all non-fenestration components (i.e., ceilings, walls, floors, and slabs) can be traded off using the UA approach under both the Prescriptive and the Performance path. Note that fenestration products (i.e., windows, skylights, doors) shall not be included in this calculation. Also, note that while ceiling and slab insulation can be included in trade-off calculations, the R-value must meet or exceed the minimum values listed in items 4.1 through 4.3 of the checklist to provide an effective thermal break, regardless of the UA tradeoffs calculated. The UA calculation shall be done using a method consistent with the ASHRAE Handbook of Fundamentals

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



and shall include the thermal bridging effects of framing materials. The calculation for a steel-frame envelope assembly shall use a series-parallel path calculation method.

4. Consistent with the 2009 IECC, slab edge insulation is only required for slab-on-grade floors with a floor surface less than 12 inches below grade. Slab insulation shall extend to the top of the slab to provide a complete thermal break. If the top edge of the insulation is installed between the exterior wall and the edge of the interior slab, it shall be permitted to be cut at a 45-degree angle away from the exterior wall.
5. Where an insulated wall separates a garage, patio, porch, or other unconditioned space from the conditioned space of the house, slab insulation shall also be installed at this interface to provide a thermal break between the conditioned and unconditioned slab. Post-tensioned slabs with integrated porch foundations are exempted from this requirement in all homes, as are post-tensioned slabs with integrated garage foundations in multi-family buildings, until feasible architectural details can be developed.
6. 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 $\geq 5.5"$ or $1.5"$, 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 $\geq 1"$ 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 ≥ 6 mil.
7. Band joists are currently exempt from interior air barrier requirement in Climate Zones 4 through 8, but highly encouraged by EPA as a best practice.
8. Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate thermal fins, wing walls, masonry fireplaces, or similar architectural details.
9. Examples of supports necessary for permanent contact include staves for batt insulation or netting for blown-in insulation. Batts that completely fill a cavity enclosed on all six sides may be used to meet this requirement without the need for supports, even though some compression will occur due to the excess insulation, as long as the compressed value meets or exceeds the required insulation level. Specifically, the following batts may be used in six-sided floor cavities: R-19 batts in 2x6 cavities, R-30 batts in 2x8 cavities, R-38 batts in 2x10 cavities, and R-49 batts in 2x12 cavities. For example, in a home that requires R-19 floor insulation, an R-30 batt may be used in a six-sided 2x8 floor cavity.
10. Fully-aligned air barriers may be installed at the exterior surface of the floor cavity in all Climate Zones if the insulation is installed in contact with this exterior air barrier and the perimeter rim and band joists of the floor cavity are also sealed and insulated to comply with the fully-aligned air barrier requirements for walls.
11. Sloped attics shall meet the air barrier requirements for walls and are defined as sloped surfaces separating conditioned attics from ambient conditions. In contrast, sloped ceilings shall meet the air barrier requirements for ceilings and are defined as sloped surfaces separating conditioned house space from ambient conditions (e.g., sloped ceiling at the perimeter of a bedroom).
12. The minimum designated R-values must be achieved regardless of the trade-offs determined using an equivalent U-factor or UA alternative calculation. Note that if the minimum designated values are used, they must be compensated with higher values elsewhere using an equivalent U-factor or UA alternative calculation in order to meet the overall insulation requirements of the 2009 IECC. Also, note that these requirements can be met by using any available strategy, such as a raised-heel truss, alternate framing that provides adequate space, and/or high-density insulation. In Climate Zones 1 through 3, one option that will work for most homes is to use 2x6 framing, an R-21 high-density batt, and a wind baffle that only requires 0.5" of clearance.
13. Insulated sheathing rated for water protection can be used as a water resistant barrier if all seams are taped and sealed. If the insulated sheathing is not rated for water protection, it shall be attached directly over a water-resistive barrier and sheathing. In addition, it shall provide the required R-value as demonstrated through either testing in accordance with ASTM C 1363 or by attaining the required R-value at its minimum thickness. If non-insulated structural sheathing is used at corners, advanced framing details listed under requirement 4.4.5 shall be met for those wall sections. Rigid insulation, if used, may be installed on either the interior or exterior side of the wall.
14. Steel framing shall meet the reduced thermal bridging requirements by complying with item 4.4.1 of the checklist.

THERMAL ENCLOSURE SYSTEM RATER CHECKLIST



15. Double-wall framing is defined as any framing method that ensures a continuous layer of insulation covering the studs to at least the R-value required in Section 4.4.1 of the checklist, such as offset double-stud walls, aligned double-stud walls with continuous insulation between the adjacent stud faces, or single-stud walls with 2x2 or 2x3 cross-framing. In all cases, insulation shall fill the entire wall cavity from the interior to exterior sheathing except at windows, doors, and other penetrations.
16. All exterior corners shall be constructed to allow access for the installation of $\geq$ R-6 insulation that extends to the exterior wall sheathing. Examples of compliance options include standard-density insulation with alternative framing techniques, such as using three studs per corner, or high-density insulation (e.g., spray foam) with standard framing techniques.
17. Headers shall be minimum R-3 for Climate Zones 1 through 4 and R-5 for Climate Zones 5 through 8 using continuous rigid insulation sheathing, SIP headers, other prefabricated insulated headers, single-member or two-member headers with insulation either in between or on one side, or an equivalent assembly, except where a framing plan provided by the builder, architect, designer, or engineer indicates that full-depth solid headers are the only acceptable option. The Rater need not evaluate the structural necessity of the details in the framing plan to qualify the home. Also, the framing plan need only encompass the details in question and not necessarily the entire home. R-value requirement refers to manufacturer's nominal insulation value.
18. Framing at windows shall be limited to a maximum of one pair of king studs and one pair jack studs per window opening to support the header and window sill. Additional jack studs shall be used only as needed for structural support and cripple studs only as needed to maintain on-center spacing of studs.
19. Insulation shall run behind interior/exterior wall intersections using ladder blocking, full length 2"x6" or 1"x6" furring behind the first partition stud, drywall clips, or other equivalent alternative.
20. Vertical framing members shall either be on-center or have an alternative structural purpose (e.g., framing members at the edge of pre-fabricated panels) that is apparent to the Rater or documented in a framing plan provided by the builder, architect, designer, or engineer. The Rater need not evaluate the structural necessity of the details in the framing plan to qualify the home. Also, the framing plan need only encompass the details in question and not necessarily the entire home. No more than 5% of studs may lack an apparent or documented structural purpose, which is equivalent to one vertical stud for every 30 linear feet of wall, assuming 16" o.c. stud spacing.
21. Light tubes that do not include a gasketed lens are required to be sealed and insulated $\geq$ R-6 for the length of the tube.
22. In Climate Zones 1 through 3, stucco over rigid insulation tightly sealed to windows and doors shall be considered equivalent to sealing rough openings with caulk or foam.
23. Examples of durable covers include, but are not limited to, pre-fabricated covers with integral insulation, rigid foam adhered to cover with adhesive, or batt insulation mechanically fastened to the cover (e.g., using bolts, metal wire, or metal strapping).

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