QUICK GUIDE
Foam Plastic Applications for Better Building

2024 IECC Thermal Bridging Requirements & Foam Plastic Insulating Sheathing (FPIS) Continuous Insulation (ci)

INTRODUCTION

Modern energy codes, such as ASHRAE 90.1-2022 and the 2024 IECC, feature prescriptive requirements for continuous insulation (ci) in essentially all climate zones. Among other benefits, ci helps to prevent thermal bridging caused by framing as visualized in **Figure 1**. Without ci, the wall's cavity insulation is only 45% to 85% effective[1] for steel and wood framing respectively. Ci also compliments the thermal mass of concrete and masonry walls, especially in cold climates where thermal mass effects are significantly diminished. It also plays a key role in other building applications such as roofs, foundations, and various retrofit or remodeling projects.

The conventional practice of addressing thermal bridges only within building assemblies is not the end of the story. Other major types of thermal bridges occur at building assembly and component intersections as shown in **Figure 2**. If not mitigated, a building thermal envelope's actual performance (effective R-value) can be decreased by typically 20-70% or more depending on the building materials, structural details, and insulation detailing (or lack thereof).

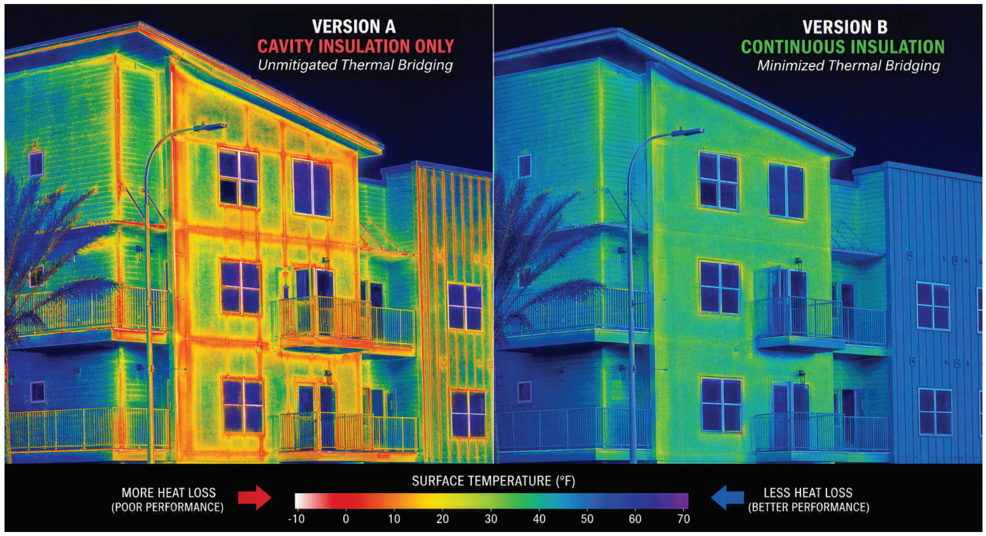
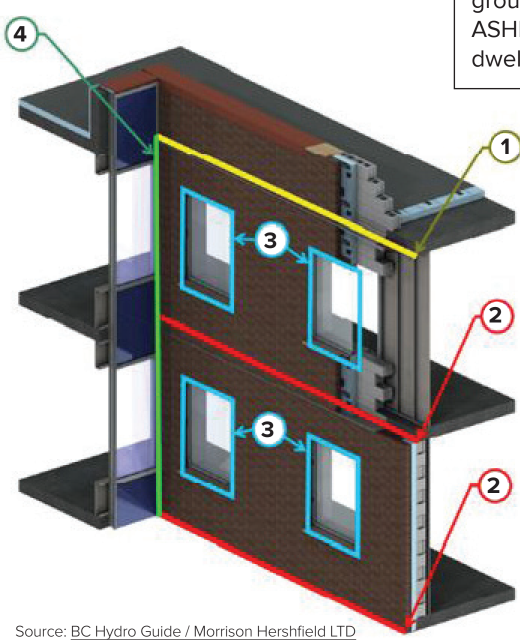


Figure 1. Thermal image illustration of (A) unmitigated thermal bridges with only cavity insulation between framing members and (B) use of continuous insulation and structural thermal breaks to minimize thermal bridging.

NEW CODE REQUIREMENTS ARE HERE!

While major thermal bridges at assembly interfaces (see Figure 2) have been overlooked in past U.S. energy codes and in practice, the IECC 2024 (Section C402.7) and ASHRAE 90.1-2022 (Section 5.5.5) have introduced new prescriptive requirements to identify and mitigate these "assembly interface" thermal bridges. This Quick Guide focuses on the IECC 2024. For ASHRAE 90.1-2022, refer to a forthcoming guide produced by DOE/PNNL.

These new requirements apply only to buildings and structures within the scope of the commercial building provisions of the 2024 IECC covering all commercial building use groups and residential multifamily (Group R) buildings greater than three stories (same as ASHRAE 90.1). These requirements are not applicable to residential one- and two-family dwellings in the 2024 IECC (or IRC Chapter 11).



Source: BC Hydro Guide / Morrison Hershfield LTD

- **Clear field thermal bridges:** Repetitive framing members, cladding supports (e.g., Z-furring), and fasteners distributed relatively uniformly throughout a building assembly surface.[2]
- **Linear thermal bridges:** Roof-to-wall, floor-to-wall, window-to-wall, and wall-to-wall intersections that are linear in pattern of intensified heat flow (e.g., slab floor edges and projecting balconies, shelf-angles, parapets, etc.).

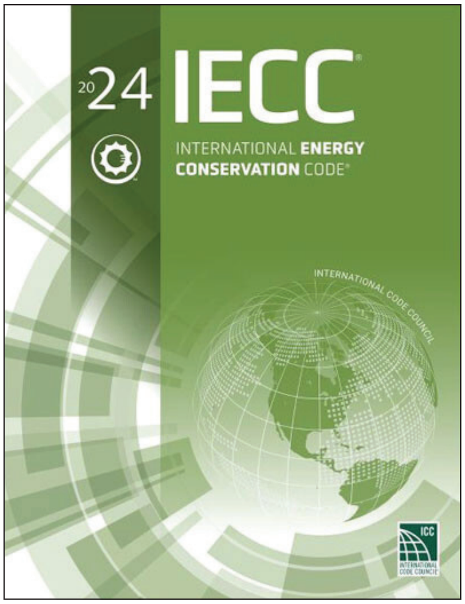
See colored lines in figure:
1 (yellow) = roof-to-wall linear thermal bridge
2 (red) = floor-to-wall linear thermal bridge
3 (blue) = window-to-wall linear thermal bridge
4 (green) = wall-to-wall linear thermal bridge

- **Point thermal bridges:** Thermal bridges that occur at a discrete point on the surface area of the building thermal envelope assembly, such as a beam or column penetration.

Figure 2. Types of thermal bridges in building assemblies and assembly interfaces.

[1] Effective Insulation R-Values in Steel vs. Wood Framing, Building Enclosure Online, May 29, 2017.

[2] According to the IECC and ASHRAE 90.1 definition of continuous insulation, the only permitted penetrations through continuous insulation are fasteners and service openings. Other penetrations, such as metal Z-furring (when not placed over the ci and fastened through it) are not permitted unless the impact on the assembly U-factor is accounted for.



KEY CONCEPTS

The main concept behind the new thermal bridging provisions involves detailing at assembly interfaces (roof-to-wall, windows-to-wall, and floor-to-wall intersections) to reasonably maintain continuity of the building thermal envelope. In particular, this involves the appropriate use and placement of continuous insulation, such as FPIS ci, at these assembly interfaces. In most cases, some degree of thermal bridging is unavoidable, so the goal of these new code provisions is to practically minimize or mitigate thermal bridging with cost-effective detailing. This more comprehensive approach to building envelope design ensures that the overall building envelope is not compromised by unabated thermal "leaks" that can substantially degrade the investment in and performance of a building's thermal envelope (see Introduction). Therefore, the concept of mitigating thermal bridges is one of smartly addressing the "small details with a large impact."

To demonstrate compliance with the 2024 IECC (and similar for ASHRAE 90.1-2022), two prescriptive pathways and one performance pathway are available to address thermal bridges:

1. **Prescriptive compliance** using Section C402.7.
2. **Prescriptive compliance** using the component performance alternative method in Section C402.1.4. Commonly known as the Total UA method, this pathway allows trade-offs between thermal envelope assemblies and thermal bridging details.
3. **Performance compliance** using Simulated Building Performance as outlined in Section C407.

1. PRESCRIPTIVE COMPLIANCE PER SECTION C402.7

GENERAL

Section C402.7 of the 2024 IECC contains all of the prescriptive thermal bridging requirements addressing detailing and placement of insulation at building thermal envelope assembly intersections. It is not exhaustive, but focuses on key types of thermal bridges. There are also important exceptions to consider first to determine if these provisions even apply to a given building project (see **Exceptions** at right).

The charging language of Section C402.7 gives two options to demonstrate compliance:

1. Compliance with the provisions (subsections) of Section C402.7,
 —OR—
2. Compliance demonstrated by an approved design.

An approved design requires approval of the local building official responsible for enforcing the locally-adopted energy code. Such approved designs would typically provide an alternative equivalent solution for a particular thermal bridging condition addressed in one of the subsections of Section C402.7. This allows for use of a special or standard detail that may differ from the limited prescriptive solutions described in the code provided it is shown to have equivalent (or better) performance (kind of like using an assembly U-factor to justify an equivalent alternative R-value and placement of insulation materials). It also allows use of proprietary thermal bridging devices with manufacturer data used to verify performance equivalency. For approved design alternatives that involve the entire building thermal envelope, including all regulated thermal bridges (i.e., those identified in Section C402.7), compliance is typically demonstrated by using the component performance alternative (Section C402.1.4) or the performance path (Section C407) of the 2024 IECC. Both are addressed in later sections of this QuickGuide.

IMPORTANT!

Exceptions to C402.7

1. Any building or structure in Climate Zones 0 through 3.
   - ➔ Only buildings or structures in Climate Zones 4 through 8 are required to comply with Section C402.7.
2. Any thermal bridge composed of a material having a thermal conductivity of not greater than 3.0 Btu-in/h-ft-F.
   - ➔ Relatively "low" thermal conductivity materials like wood or engineered wood composites and plastics, such as fiberglass brackets, are exempt. Consequently, typical commercial or multifamily buildings of all wood-frame construction do not need to comply with Section C402.7.
3. All blocking, coping, flashing, and other similar materials for attachment of roof coverings.
   - ➔ Roof covering systems must be attached in accordance with manufacturer approved or listed details to ensure adequate securement (e.g., prevent blow-off in high wind) and the ability to alter such details to address thermal bridging may be limited.
4. All thermal bridges accounted for in the U-factor or C-factor for a building thermal envelope assembly.
   - ➔ This exception prevents "double-counting" of the impact of thermal bridges (such as repetitive framing members) already required to be accounted for in complying with the energy code's prescribed R-values and U-factors for clear-field assemblies.

BALCONIES & FLOOR DECKS

Section C402.7.1 opens with a general requirement that balconies and floor decks not penetrate the building thermal envelope (see **Exceptions** below). This includes floor edges supported on exterior walls (see **Figure 3**) and balconies (see **Figure 4**). Consequently, floor edges that do not extend beyond the wall may be addressed by extending the exterior wall's continuous insulation across the floor-wall-intersection. Balconies must be separately supported or be supported by intermittent structural attachments (i.e., point connections such as shear tabs and strut/tie anchors as shown in **Figure 4**) that "minimize thermal bridging through the building thermal envelope."

These two options align with the **KEY CONCEPTS** outlined above. In this case, the linear thermal bridge at the floor-balcony-to-wall intersection is not eliminated, but it is substantially mitigated by turning a continuous linear thermal bridge (e.g., balcony slab projection) into a series of point thermal bridge connections that better interrupt the heat-flow path through the insulated building thermal envelope.

IMPORTANT!

Exceptions to C402.7.1

The following are alternative approaches for floor edges and balconies that allow the floor edge or balcony to completely penetrate the building thermal envelope with appropriate compensation or mitigation:

1. An area-weighted U-factor is used for above-grade wall compliance that includes a U-factor of 0.8 Btu/h-F-ft2 for the area of the above-grade wall penetrated by a concrete floor deck.

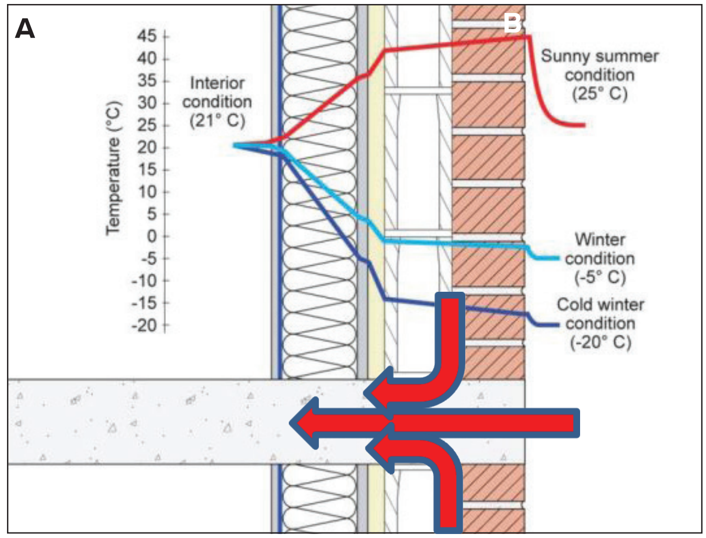
   ➔ This exception allows the impact of a slab floor edge or balcony to be area-averaged with the remainder of the above-grade wall opaque area to determine an area-weighted U-factor for the overall wall assembly of a building. To comply, additional insulation may need to be added to the opaque wall areas or the wall overall U-factor may need to be traded off with other building envelope assemblies per Section C402.1.4 (addressed later).

2. An approved structural thermal break device installed at the slab/wall intersection with a minimum of R-10 insulation located at that juncture.

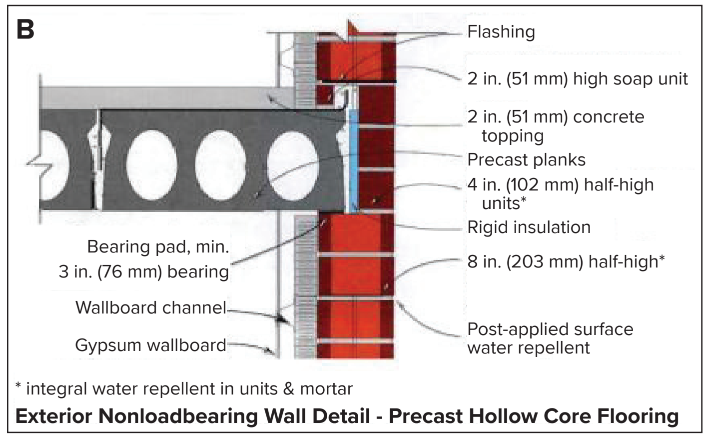
   ➔ Typically, such devices are proprietary and require code official approval as an equivalent alternative design using the manufacturer's thermal data. This exception simply legitimizes that option.

3. An approved design where the above-grade wall U-factor used for compliance accounts for all balcony and concrete floor deck thermal bridges.

   ➔ This exception is similar to Exception 1 but broader in scope. For example, a project-specific thermal modeling of a floor slab condition (or standard detail) at an exterior wall may justify a different U-factor than given as a "default" value in Exception 1. This can then be used to demonstrate compliance in the same manner as Exception 1.



Source: Development of Thermal Bridging Factors for Use in Energy Models, US Army Corps of Engineers, Fig 4-2



Source: NCMA TEK 5-15 (2008), p. 3

Figure 3. Floor slab edge with unmitigated (A) and mitigated (B) linear thermal bridge.

NOTE: The rigid insulation at the floor edge shown in Figure 3B reduces but does not eliminate the floor edge thermal bridge because some thermal bridging pathways around the slab edge insulation remain. Thus, it can result in a somewhat lower floor edge U-factor than provided as a default for floor edges in Exception 1 and can be used an approved design alternative per Exception 3. Where feasible, applying continuous insulation on or in the exterior wall assembly and continuously across the floor-wall intersection will provide much better performance.

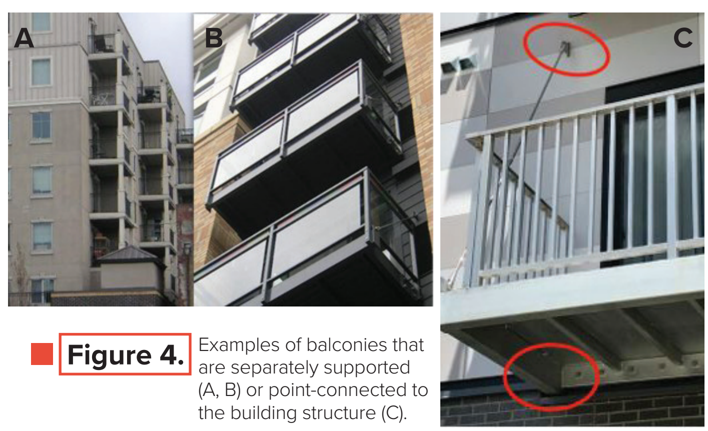


Figure 4. Examples of balconies that are separately supported (A, B) or point-connected to the building structure (C).

Source: Thomas Culp, Ph.D.

CLADDING SUPPORTS

Section C402.7.2 requires that cladding linear support elements (like a masonry veneer shelf angle and furring or rail elements) be offset from the surface of the wall by a sufficient amount to allow exterior continuous insulation to pass behind them. This requires the use of point connections (e.g., "shear tabs") for those elements that create the offset from the structural wall. Examples of offset cladding supports are shown in **Figure 5**.

For many cladding types (depending on weight or ci thickness), however, fasteners can be used directly through FPIS ci to support the cladding or furring system, which avoids the need to comply with Section C402.7.2 (see **Figure 6**). The following resources provide more details about the code-compliant use of cladding connections (fasteners) through FPIS ci, which complies with the code definition of continuous insulation (see below):

- **Quick Guide:** Cladding Connections to Steel Frame Walls with FPIS ci
- **Quick Guide:** Cladding Connections to Wood Frame Walls with FPIS ci
- **Web Resource:** Cladding Connections
- **Code References:** 2024 IBC Section 1404.5 or 2024 IRC Sections R703.15, R703.16, and R703.17

IMPORTANT!

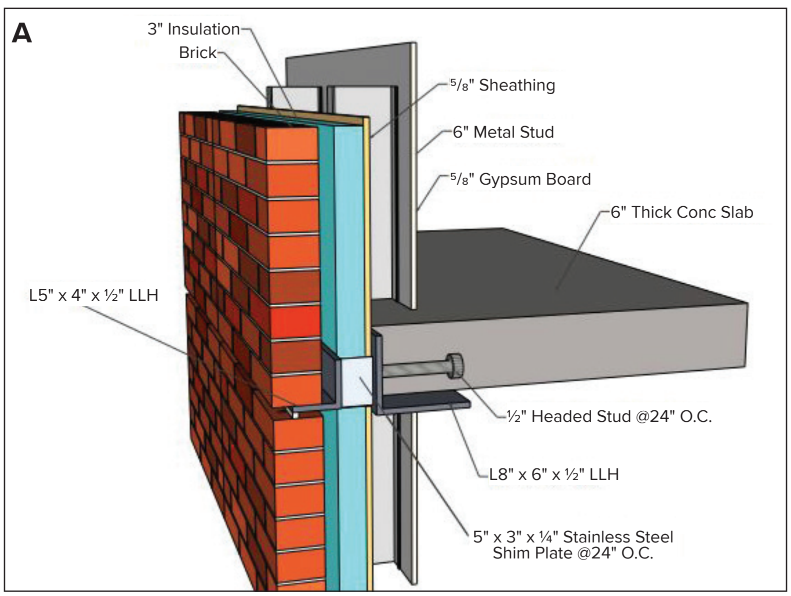
Exceptions to C402.7.2

1. An approved design where the above-grade wall U-factor used for compliance with the energy code thermal envelope requirements accounts for the impact of the cladding support element thermal bridge.

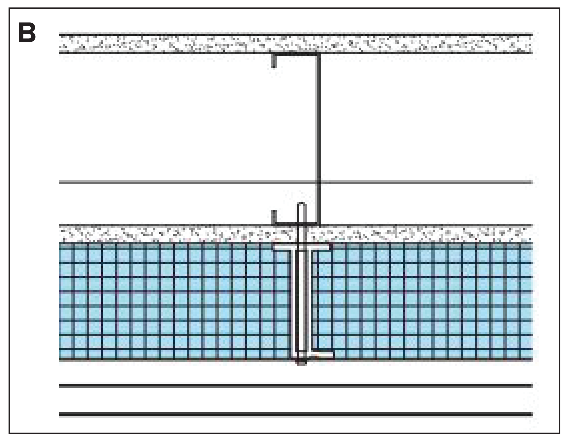
   ➔ This exception provides for flexibility in solutions that may be used to demonstrate compliance (and in some cases may allow for no additional thermal bridging mitigation).

2. Anchoring for curtain wall and window wall systems where such systems comply with Section C402.7.4 of the 2024 IECC.

   ➔ This exception recognizes that curtain walls and window walls do not need to comply with cladding support requirements (even though they are serving as the cladding of a building) provided they comply with Section C402.7.4 (addressed below).



Source: Thermal Bridging Solutions: Minimizing Structural Steel's Impact on Building Envelope Energy Transfer, SEI/AISC, p. 11

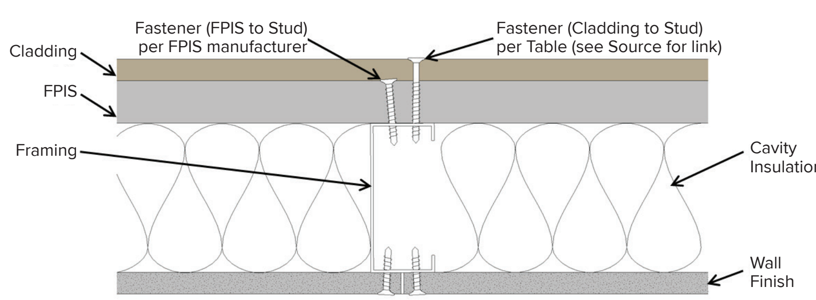


Source: Thermal Performance of Façades: 2012 AIA Upjohn Grant Research Initiative, Payette/AIA, p. 8a

Figure 5. Offset shelf angle for masonry veneer support (A) and offset furring for cladding attachment (B).

DEFINITIONS MATTER!

Continuous Insulation (ci). Insulating material that is continuous across all structural members without *thermal bridges* other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the *building thermal envelope.*



Source: Ci Quick Guide: Cladding Connections to Steel Frame Walls with FPIS ci, Fig 3A

Figure 6. Direct cladding (or furring) attachment through FPIS ci to wall framing.

STRUCTURAL BEAMS & COLUMNS

Section C402.7.3 requires structural beams and columns penetrating the building thermal envelope to be encapsulated with not less than R-5 insulation for a distance of not less than two feet beyond the interior or exterior surface of the building thermal envelope. Examples of this requirement are shown in **Figure 7**. As the beam may be "cold" (below dew-point temperature of building indoor air) in the wintertime, it is also important to consider how to prevent condensation or moisture accumulation in the insulation material (e.g., lower vapor permeance insulation materials or an air-tight vapor retarder over the surface of the insulation are recommended for this application).

IMPORTANT!

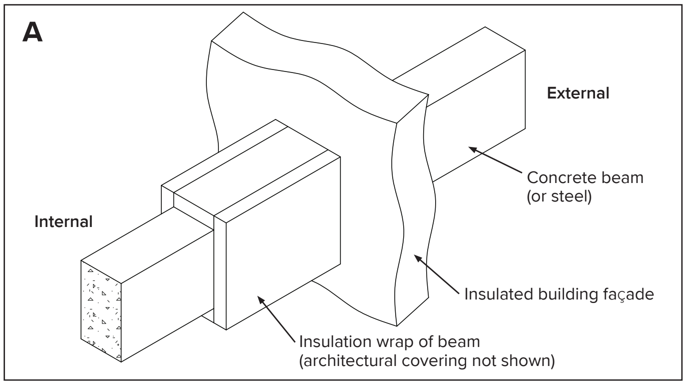
Exceptions to C402.7.3

1. Use of an approved structural thermal break device installed per manufacturer instructions.

   ➔ This allows use of manufactured structural thermal break devices based on manufacturer data to demonstrate thermal performance at least equivalent to the R5 insulation encapsulation method of Section C402.7.3.

2. An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or column thermal bridge.

   ➔ This exception allows for broad use of equivalent designs that may include a special or standard detail that has been demonstrated to be at least equivalent to the method prescribed in Section C402.7.3, or use of an unmitigated (uninsulated) beam or column detail.



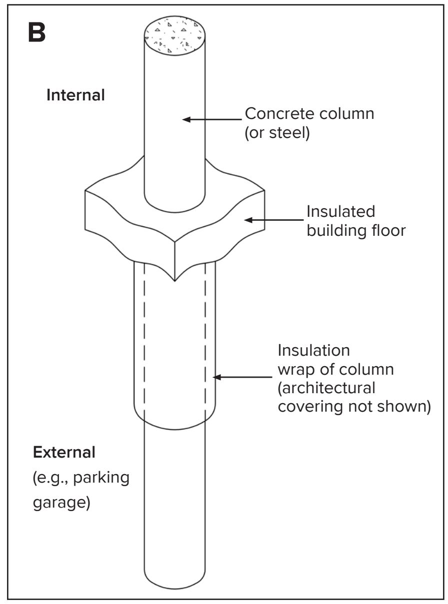


Figure 7. Examples of a concrete beam (A) and a concrete column (B) penetrating building thermal envelope and encapsulated with minimum R-5 insulation material (steel similar).

NOTE: Structural fire protection is not shown; must be coordinated with code requirements as applicable.

VERTICAL FENESTRATION

Section C402.7.4 requires that vertical fenestration intersections with the above-grade wall comply with one of the following four options as applicable to the location of the fenestration relative to insulation materials in the wall assembly. The key concept is to mitigate (reduce) thermal bridging by maintaining reasonable alignment of the fenestration's thermal resistance plane with the thermal insulation in or on the wall assembly (see **Figure 8**).

1. Walls with continuous insulation: The plane of the exterior glazing layer or, for metal frame fenestration, a nonmetal thermal break in the frame shall be positioned within 2 inches of the interior or exterior surface of the continuous insulation.
2. Walls without continuous insulation: The plane of the exterior glazing layer or, for metal frame fenestration, a nonmetal thermal break in the frame shall be positioned within the thickness of the integral or cavity insulation (located inside the wall assembly).
3. Where #1 or #2 are not achieved, the surface of the rough opening, not covered by the fenestration frame shall be insulated with insulation of not less than R-3 material or covered with a wood buck that is not less than 1.5 inches thick.
4. For the intersection between vertical fenestration and opaque spandrel in a shared framing system, manufacturer's data for the spandrel U-factor shall account for thermal bridges.

IMPORTANT!

Exceptions to C402.7.4

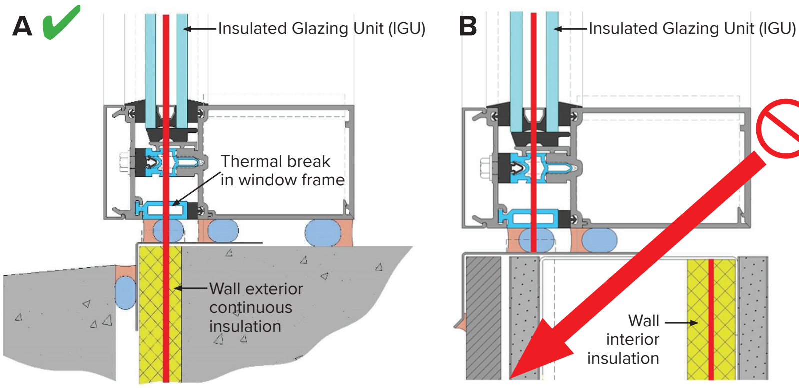
1. Where an approved design for the above-grade wall U-factor used for compliance accounts for the thermal bridges at the intersection with the vertical fenestration.

   ➔ This exception gives broad latitude to implement an alternative detail or to not mitigate the window-wall interface thermal bridge provided the overall above-grade wall U-factor (accounting for the thermal bridge) complies with the code.

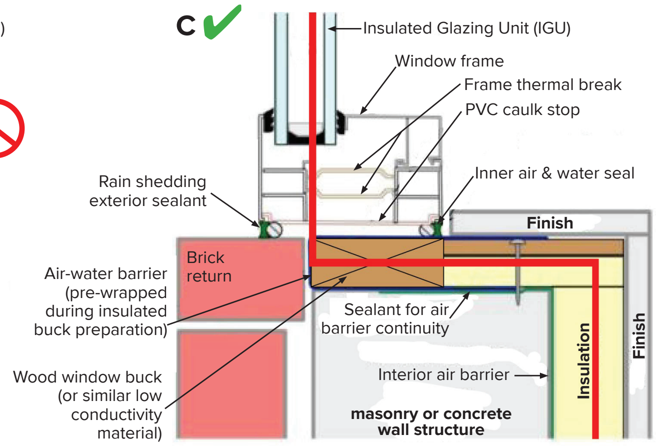
2. Doors.

   ➔ While doors may be considered fenestration, they are exempted. Skylights are not mentioned in Section C402.7 but Section C402.2.1.2 does require that skylight curbs be insulated with a minimum R-5 insulation to mitigate fenestration-roof interface thermal bridging (same as ASHRAE 90.1-2022).

NOTE: Spandrels are considered to be part of the opaque wall (by definition) and, when area-weighted with other opaque wall areas on the building, must comply with the energy code's maximum U-factor for above grade walls. However, C402.1.4 or C407 may be used to justify a higher U-factor by appropriate documentation of trade-offs in the overall building thermal envelope (C402.1.4) or in the overall whole building system (C407). Typical spandrel panels have much higher U-factors than required for opaque walls in general.



Modified based on National Glass Association, Thermal Bridging Design Guide DG03-22



KEY: Red Line = Location of plane of thermal resistance of wall and fenestration unit
Red Arrow = Thermal bridge (discontinuity of thermal resistance at window-to-wall intersection)

Modified based on Fig 6-7 in Development of Thermal Bridging Factors for Use in Energy Models, US Army Corps of Engineers.

Figure 8. Thermal bridging and its mitigation at the window-to-wall interface: (A) Perfect alignment of window and wall thermal resistance with no thermal bridge, (B) misalignment of window and wall thermal resistance (unmitigated thermal bridge), and (C) rough opening insulated to mitigate misaligned window and wall thermal resistance.

NOTE: Figure 8A is an example of perfect alignment per Option 1 (not using the allowance for up to 2 inches of misalignment). Figure 8B is an example of what is **disallowed** per Option 1 or 2 (i.e., more than 2 inches misalignment with wall insulation). Figure 8c is an example that complies with Option 3 using a 2x wood buck under the window frame and also using minimum R-3 insulation to cover the remainder of the rough opening to maintain continuity of thermal resistance, although the wood buck could extend the entire width of the rough opening.

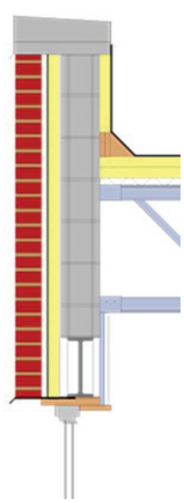
PARAPETS

Section C402.7.5 addresses thermal bridging at parapets (i.e., the roof-to-wall intersection where the wall extends above the roof surface). It provides the following five prescriptive options as applicable to the wall and roof insulation conditions described:

1. Wall with continuous insulation on exterior side and roof with continuous insulation entirely above deck (see Figure 9).
   a. The continuous insulation shall extend up both sides of the parapet not less than 2 feet or to the top of the parapet.
   b. Parapets that are required to be fire-resistance rated assemblies shall maintain such ratings in accordance with the building code.
2. Wall with continuous insulation on the exterior side, but roof insulation is below deck.
   a. The continuous insulation shall extend up the exterior side of the parapet to not less than the top surface of the roof assembly.
   ➔ Normally, the continuous insulation would extend to the top of the parapet to avoid a step in the exterior wall thickness. Also, the roof/ceiling insulation should be extended as tight as possible to the exterior wall, including air sealing to prevent indoor air movement into the parapet or roof assembly (this recommendation applies to all parapet construction cases).
3. Wall does not have exterior continuous insulation and the roof is insulated with insulation above deck.
   a. In this case, the wall cavity or integral insulation shall extend into the parapet up the level of the exterior face of the roof insulation.
   b. Alternatively, equivalent insulation R-value shall be installed on the underside of the roof deck and extended not less than 2 feet inward from the wall.
4. Wall does not have exterior continuous insulation and the roof insulation is below deck.
   a. In this case the roof and wall insulation components are simply required to be adjacent to each other (essentially abutting) at the roof-ceiling-wall intersection.
5. As an alternative to options 1-4, a thermal break device shall be permitted with not less than R-10 insulation material aligned with the above-grade wall and roof insulation. Installation shall be in accordance with the manufacturer's instructions.
   ➔ This fifth case would also allow for a designed standard detail that has the same function and equivalent performance.

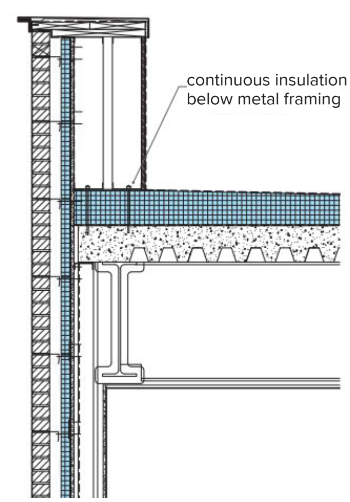
> **IMPORTANT!**
> ### Exceptions to C402.7.5
> The only exception gives broad latitude for "an approved design where the above-grade wall U-factor used for compliance accounts for the parapet thermal bridge."
> ➔ Use of this exception will require combining the parapet linear thermal bridge effect (Psi-factor) with the wall area's (U-factor) to provide an adjusted or weighted U-factor with which to determine compliance.

A



Source: FPIS: One Multifunctional Product for Many Applications

B



Source: Thermal Performance of Façades: 2012 AIA Upjohn Grant Research Initiative, Payette/AIA, p. 97a

Figure 9. A parapet complying with (A) Option 1 and (B) Option 5 of Section C402.7.5.

2. PRESCRIPTIVE COMPLIANCE PER SECTION C402.1.4

Section C402.1.4 is called the component performance method (previously known as the “Total UA Method” or commonly referenced as the “envelope trade-off method”). For the most part, when complying with the prescriptive detailing options of Section C402.7 (as addressed in the previous section) you don’t need to do any math or know what a “Psi-factor” or “Chi-factor” is (see **DEFINITIONS**). You just follow the prescriptive detailing instructions and execute a design accordingly for the indicated types of thermal bridges. Where using Section C402.1.4 as the prescriptive means of demonstrating overall building envelope compliance, it’s not that simple: There is math involved and it requires use of building assembly thermal transmittance data (e.g., U-factors, C-factors, F-factors, Chi-factors, and Psi-factors). But, for the added work, it gives the advantage of being able to make performance trade-offs between different envelope assemblies and also with thermal bridging details. Thus, one could leave a particular thermal bridge unmitigated (i.e., not compliant with Section C402.7) and make up for it by better insulating the wall, floor, roof, and/or foundation assembly, or by specifying higher performance fenestration. Alternatively, a proposed thermal bridge detail could be improved above that which is required in Section C402.7 and then used to trade-off other building thermal envelope components. It gives useful flexibility to fine-tune or optimize an overall building envelope.

Typically, this process is executed by using a free online design tool (administered by DOE) known as COMcheck. However, Section C402.1.4 specifies a “math” approach that can be implemented relatively easily on a spreadsheet. The math that is required is represented by Eq. 4-1 of Section C402.1.4. It simply requires that the thermal conductance of an overall proposed building envelope (including any trade-ups and trade-downs between envelope components) is equal to or less than the thermal conductance of an identical “baseline” building that has all envelope components complying exactly with the maximum tabulated prescriptive U-factors, C-factors, F-factors, and Psi-factors.

The purpose of this Quick Guide is not to demonstrate how to use Section C402.1.4 but rather to bring awareness to the fact that it also incorporates the ability to consider alternatives to the thermal bridging prescriptions of Section C402.7. The Psi- and Chi-factors used for this purpose are found in Table Section C402.1.4. That table lists both “complaint” and “non-compliant” (i.e., unmitigated) Psi- and Chi-factors. The “compliant” values are equivalent to the performance of thermal bridging details prescribed in Section C402.7. Therefore, the “compliant” Psi- and Chi-factors also can be used to as the basis to substitute a different thermal bridging detail when complying with Section C402.7 provided it is shown to have equivalent performance (i.e., an equivalent or lower value than the tabulated “compliant” Psi- or Chi-factors). ASHRAE 90.1-2022 provides guidance on determining Psi- and Chi-factors in Section A10 of its Appendix A. Generally, it requires thermal testing or modeling of a thermal bridge detail.

DEFINITIONS MATTER!

Thermal Bridge. An element or interface of elements that has higher thermal conductivity than the surrounding *building thermal envelope*, which creates a path of least resistance for heat transfer.

Chi-Factor (χ-Factor). The heat loss factor for a single thermal bridge characterized as a point element of a *building thermal envelope* (Btu/h × °F) [W/k].

Psi-Factor (Ψ-Factor). The heat loss factor per unit length of a *thermal bridge* characterized as a linear element of a *building thermal envelope* (Btu/h × ft × °F) [W/(m × K)].

***U*-Factor (Thermal Transmittance).** The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h × ft2× °F) [W/(m2× K)].

***F*-Factor (Thermal Transmittance).** The perimeter heat loss factor per unit perimeter length of slab-on-grade floors (Btu/h × ft × °F) [W/(m × K)].

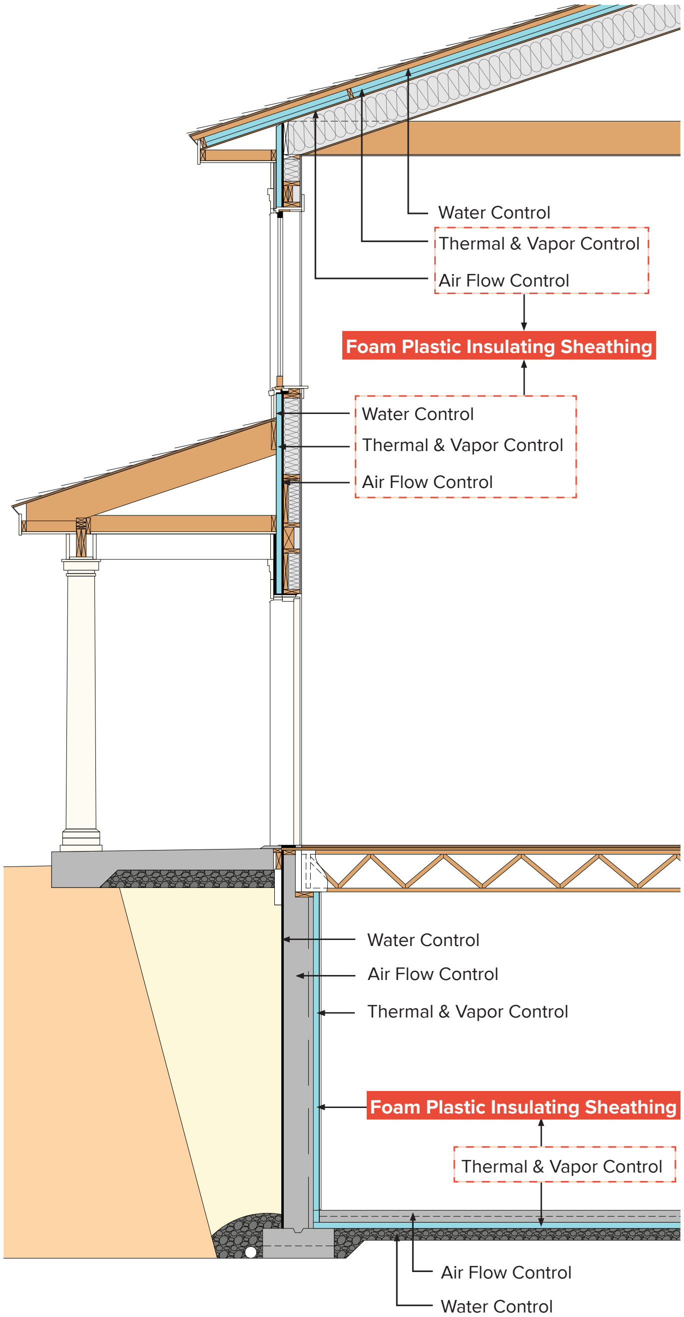
C-Factor (Thermal Conductance). The coefficient of heat transmission (surface to surface) through a building component or assembly, equal to the time rate of heat flow per unit area and the unit temperature difference between the warm side and cold side surfaces (Btu/h × ft2× °F) [W/(m2× K)].

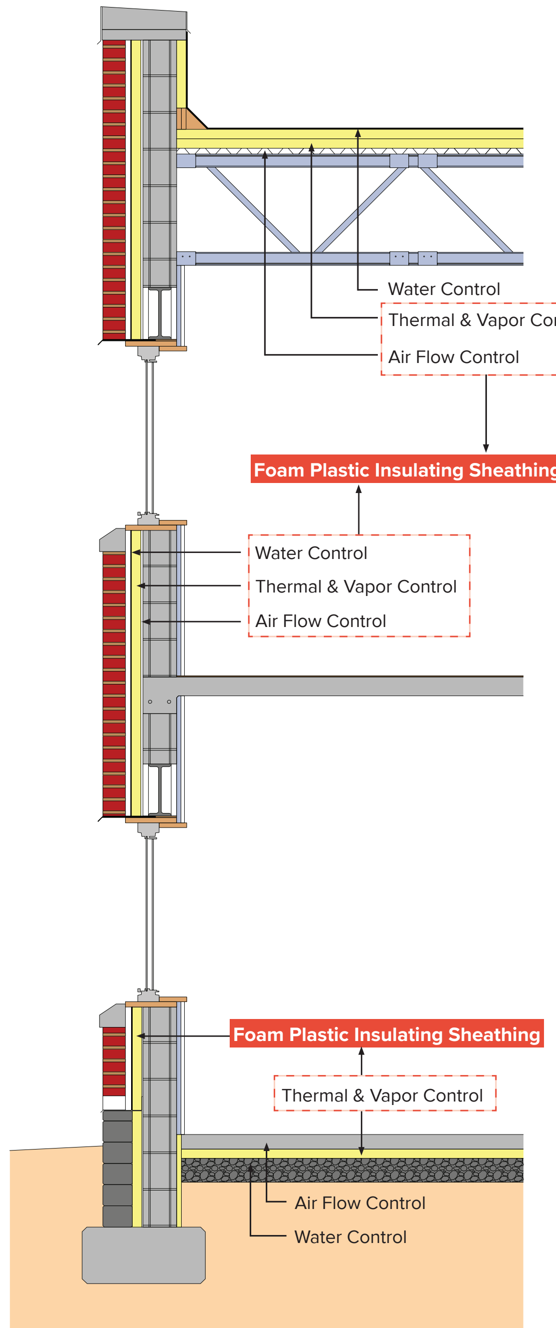
3. PERFORMANCE COMPLIANCE PER SECTION C407

Section C407 addresses a whole-building compliance method known as the “simulated building performance” path. It gives the greatest flexibility in addressing thermal bridging details and all other building envelope components as well as building systems such as heating and ventilation systems. However, it requires the use of a qualified whole building energy modeling software and a knowledgeable energy designer to properly develop and run the whole building simulation. It is beyond the scope of this Quick Guide to provide guidance on energy modeling of whole buildings. For information on how to adjust building assembly U-factors (as inputted in a simulation model) to account for the types of thermal bridges addressed in Section C402.7, refer to Appendix A10 (Sections A10.1 and A10.2) of ASHRAE 90.1-2022.

EXAMPLE APPLICATIONS OF FPIS ci

The following are example details used to mitigate thermal bridges at roof-to-wall, floor-to-wall, window-to-wall, and foundation conditions in both residential and commercial applications.





ADDITIONAL RESOURCES

Major thermal bridges at assembly interfaces have gone overlooked in past U.S. energy codes and practice. This is no longer the case in the 2024 IECC and ASHRAE 90.1-2022 standard for commercial buildings. The following resources provide guidance for code compliance and best practices to mitigate thermal bridges:

WEB RESOURCES

- Thermal Bridging Prevention
- Cladding Connections

EDUCATION

- Thermal Bridging: Small Details with a Large Impact
- 2024 IECC Commercial Envelope

DESIGN GUIDE/DETAILS/DATA

- Building Envelope Thermal Bridging (BETB) Guide
- Development of Thermal Bridging Factors for Use in Energy Models
- Thermal Performance of Façades
- BSI-081 Zeroing In and Construction Plans
  (high performance zero energy building continuous insulation)
- BSI-132 More on Continuous Exterior Insulation...
  (detailing cladding support fastening through ci)

What about exterior flame spread and thermal bridging details?

For materials like FPIS ci used on Type I, II, III, or IV buildings, an entire two-story wall/floor assembly and fenestration detailing must be tested in accordance with NFPA 285. There are many code-compliant assembly details available through manufacturer test data complying with NFPA 285 and the building code requirements found in Section 1402.5 and Section 2603.5 of the International Building Code (IBC). This is a case where the energy code, including thermal bridging detailing, and building code compliance must be coordinated.

For additional information on this topic, refer to:

- FACTS Sheet: Fire Safety & Moisture Protection for Wall Assemblies
- FPIS Design Guide (Fire Safety Code Compliance): CFS Frame Walls | Wood-Frame Walls
- Web Resource: Fire Performance


FACTS | Foam Plastic Applications for Better Building

Content originally produced for continuousinsulation.org with support from ACC's Foam Sheathing Committee.

Fire Safety & Moisture Protection for Wall Assemblies
Advantages for Code-Compliant Use of Foam Plastic Insulating Sheathing (FPIS) as Continuous Insulation (ci)

Fire safety and the control of water in its various forms are crucial to the creation of a wall assembly that is durable, safe, and code compliant. When using foam plastic insulating sheathing (FPIS) as continuous insulation (ci) for energy code compliance, two key wall performance considerations for building code compliance include **Fire Safety** and **Moisture Protection**.

FIRE SAFETY FIRST!

The combustibility of a specified continuous insulation material is not the sole factor that determines the fire performance of a building, its exterior wall system, or its exterior wall covering assembly. **Simply put, specifying a non-combustible insulation material does not ensure code-compliant fire safety.** This is why building codes comprehensively address fire-safety in an integrated manner for materials, assemblies, and building systems as a whole.

For foam plastic insulation materials, like FPIS, strict regulations have been in place since 1976. Current requirements for FPIS used in exterior walls for commercial buildings of Type I, II, III, and IV construction are covered in Section 2603.5 of the International Building Code (IBC). Additional requirements for use of combustible materials in exterior wall coverings are found in Section 1405. These provisions represent some of the most comprehensive, stringent, and effective fire-safety requirements for use of a combustible material on exterior walls of buildings of any height.

A key component of IBC Section 2603.5 is a full-scale, two-story wall fire test method known as the NFPA 285 standard. Many exterior wall assemblies including FPIS have successfully passed this test and are listed here. NFPA 285 has proven to be an effective indicator of acceptable fire performance since 1988. As evidenced by exterior fire events reported internationally, there is an absence of adverse life-safety protection consequences for buildings properly designed and constructed with (1) sprinklers and (2) either NFPA 285 or IBC Chapter 26 compliant exteriors using foam plastics or non-combustible exteriors. **Using NFPA 285-tested assemblies when specifying FPIS ci on buildings of Type I, II, III, and IV construction is a code requirement and it provides confidence in successful assembly performance consistent with actual experience.**

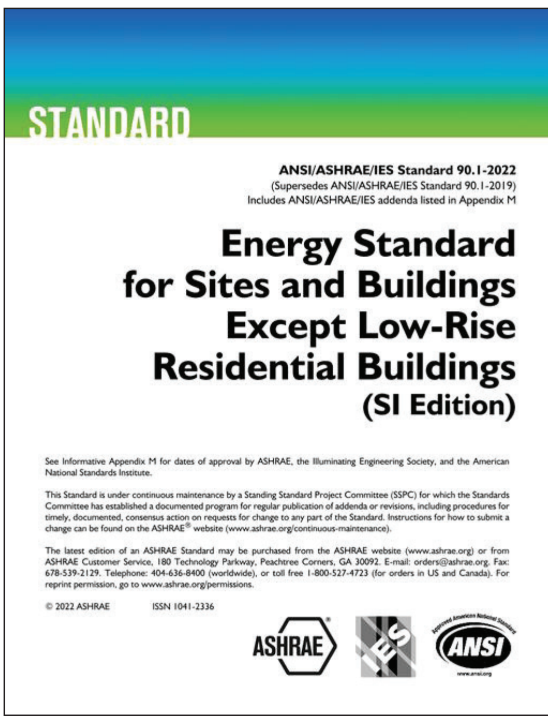
For all building types (including Type V buildings and homes of combustible wood frame construction that do not require NFPA 285-tested wall assemblies), FPIS products must comply with code-required maximum flame spread and smoke-developed indices in accordance with the long-standing ASTM E84 test method. Additional fire-safety features required by code include the use of thermal barriers (e.g., gypsum wall board) or ignition barriers to protect foam plastics from exposure to an interior fire or ignition source – the primary sources of fire risk for buildings. Manufacturers also are required to conduct full-scale fire tests for special approval of applications or conditions of use that are not specifically addressed by the code.

Source: Fire Safety & Foam Sheathing Use

Learn more: FIRE PERFORMANCE

For more information, visit continuousinsulation.org

FS5_FireMoisture_06.2022_rev12.2024 • Page 1 of 2


STANDARD

ANSI/ASHRAE/IES Standard 90.1-2022
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2019)
Includes ANSI/ASHRAE/IES addenda listed in Appendix M

Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings (SI Edition)

See Informative Appendix M for dates of approval by ASHRAE, the Illuminating Engineering Society, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 180 Technology Parkway, Peachtree Corners, GA 30092. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2022 ASHRAE ISSN 1041-2336

www.ansi.org

How do the ASHRAE 90.1-2022 thermal bridging provisions differ from those in the 2024 IECC?

There are three major differences. First, the 2024 IECC provisions may be considered a simplified method with flexibility achieved through use of approved design alternatives. Second, ASHRAE 90.1-2025 requires essentially the same thermal bridging conditions to be specifically addressed, but also includes a broad “other thermal bridges” category that creates a scope limit to the use of prescriptive compliance (that requires calculations to determine). Third, the inclusion of “other thermal bridges” increases the scope of thermal bridging conditions required to be modeled in the performance path (whole building modeling).

For more information on specific thermal bridging provisions of ASHRAE 90.1, refer to the following two resources:

- ASHRAE 90.1-2022 Standard (Section 5.5.5, Section 5.6 & Appendix C, Appendix A, Chapter 12, and Appendix G)
- PNNL/DOE “Envelope Thermal Bridges in ASHRAE 90.1-2022” (pending)

Contact us.

Owned and operated by the Applied Building Technology Group with support from the Foam Sheathing Committee (FSC) of the American Chemistry Council, **continuousinsulation.org** provides informational resources intended to assist the foam plastic insulating sheathing industry, using sound science to develop research supporting the reliable, efficient, and economic design and installation of foam sheathing.