

WHITE PAPER

Structural Insulated Panels and the IECC U-Factor Compliance Path

Why SIPs Outperform Conventional Framing — Even With Spray Foam Climate Zone 5 under the 2021 and 2024 IECC

Revised October 2026

1. Executive Summary

The International Energy Conservation Code (IECC) sets the thermal envelope requirement for residential construction in a table of maximum whole-assembly U-factors. It then offers a table of minimum insulation R-values as an alternative. Most builders work from the R-value table out of habit. For Structural Insulated Panel (SIP) construction that is the wrong table.

The reason is thermal bridging. Conventional framing — whether insulated with fiberglass batt, mineral wool, or closed-cell spray polyurethane foam — loses heat through the wood framing members themselves. Those thermal bridges cut the effective whole-wall R-value of a framed assembly by 20 to 40 percent against its nominal cavity value. The R-value table does not see that loss. The U-factor table does.

This paper sets out what the code actually requires in Climate Zone 5, under both the 2021 and the 2024 IECC; shows which SIP thicknesses clear those numbers and which do not; and is explicit about the one thing a SIP does not eliminate, which is the lumber at its edges.

The headline: in Climate Zone 5 a 6-1/2 in. EPS SIP at R-23 satisfies the U-factor requirement for walls. A 2×6 stud wall needs R-21 cavity insulation plus R-5 continuous exterior insulation — R-26 of material — to reach the same place.

2. The Two Compliance Paths — What the Code Actually Says

Section R402.1 of the IECC is commonly described as offering two co-equal prescriptive paths. That understates the position. The two tables are not presented as equals, and the order matters.

2.1 Table R402.1.2 — the requirement

Section R402.1.2 is titled Insulation and Fenestration Criteria. Its text reads: “The building thermal envelope shall meet the requirements of Table R402.1.2, based on the climate zone specified in Chapter 3.” Table R402.1.2 is a table of maximum assembly U-factors — the thermal transmittance of the complete assembly, framing, sheathing, finishes and all.

2.2 Table R402.1.3 — the alternative

Section R402.1.3 is titled R-Value Alternative. Its text reads: “Assemblies with R-value of insulation materials equal to or greater than that specified in Table R402.1.3 shall be an alternative to the U-factor in Table R402.1.2.”

The code names the U-factor table as the requirement and the R-value table as the alternative to it. This wording is identical in the 2021 and 2024 editions. A designer electing the U-factor path is not asking for an exception; they are complying with the section the code puts first.

The U-factor path is a whole-assembly measurement. It captures what the wall actually does — including the degrading effect of thermal bridges — rather than the performance the cavity insulation would deliver if nothing interrupted it.

2.3 Climate Zone 5 requirements, 2021 and 2024 compared

The two editions differ in one envelope component that matters to SIP construction. The ceiling requirement was relaxed in 2024, returning to the 2018 level. Walls, floors and basement walls are unchanged.

Component	2021 IECC max U	2024 IECC max U	Equivalent assembly R
Ceiling / roof	U-0.024	U-0.026	R-41.7 / R-38.5
Wood frame wall	U-0.045	U-0.045	R-22.2
Floor	U-0.033	U-0.033	R-30.3
Basement wall	U-0.050	U-0.050	R-20.0
Crawl space wall	U-0.055	U-0.055	R-18.2

Under the R-value alternative, Zone 5 walls require R-30 cavity, or R-20 plus R-5 continuous, or R-13 plus R-10 continuous, or R-20 continuous — the same in both editions. The Zone 5 ceiling requirement fell from R-60 in the 2021 IECC to R-49 in the 2024 IECC, a change that applies across Climate Zones 4 through 8.

Two notes on reading these numbers. The equivalent assembly R in the right-hand column is the simple reciprocal of the U-factor and is shown for orientation only; it is not a cavity insulation value and should not be compared against one. And a U-factor requirement is a maximum — lower is better — which is the opposite convention to R-value.

3. Which Edition Applies to Your Project

The Northeast is not on one edition. Three states enforce the 2024 IECC today; the rest do not. As of October 2026:

State	Energy code in force	Basis
Connecticut	2022 Connecticut State Building Code	2021 IECC
Maine	Maine Uniform Building and Energy Code	2021 IECC
Massachusetts	State energy code, base	2021 IECC
New Hampshire	State energy code	2018 IECC
New Jersey	Uniform Construction Code 2024 energy subcode, adopted 17 August 2026	2024 IECC
New York	2025 ECCCNY, effective 31 December 2025	2024 IECC
Pennsylvania	State code effective 1 January 2026	2021 IECC, amended
Rhode Island	State energy code, effective 1 December 2025	2024 IECC
Vermont	2020 or 2024 RBES, by election	2018 or 2021 IECC

Rhode Island was first in the region, effective 1 December 2025. New York followed on 31 December 2025 with no transition period, so any application submitted on or after that date is reviewed against the 2025 ECCCNY. New Jersey adopted the 2024 IECC as its energy subcode in August 2026, with a grace period for work already authorized under lawful permits.

Connecticut remains on the 2022 code. A 2026 Connecticut State Building Code adopting the 2024 IECC has been drafted and its public comment period closed in October 2025, but it awaits approval by the Legislative Regulation Review Committee and its effective date has been delayed past the originally intended 1 July 2026.

Three states need a closer look. Pennsylvania amends the table rather than adopting it as written: its Zone 5 wood frame wall maximum is U-0.051, not U-0.045, and the ceiling is U-0.026. Pennsylvania also does not require the Section R408 additional efficiency package, and a separate alternative path published by the Pennsylvania Housing Research Center permits a reduced wall R-value where the framing factor is 19 percent or less — unusually explicit code recognition of the calculation discussed in Section 6.3.

Vermont is a naming trap. Its 2024 Residential Building Energy Standards are built on the 2021 IECC, not the 2024 IECC, and a September 2025 executive order reinstated the 2020 standards alongside them, so a project may comply with either. Massachusetts layers a Stretch Energy Code and an opt-in Specialized Code over its base code, and most of the Commonwealth's municipalities have adopted one of them. Those codes route compliance through performance modeling rather than the prescriptive envelope tables, so the analysis in this paper applies to the Massachusetts base code only.

Maine and Vermont sit largely in Climate Zone 6 rather than Zone 5. Confirm the zone-specific row of Table R402.1.2 for any project outside Zone 5, and confirm the adopted edition and any state amendments with the authority having jurisdiction before relying on a prescriptive U-factor submission.

There is no 2026 IECC. The next edition is the 2027 IECC, with a final draft targeted for 1 December 2026.

4. The Thermal Bridging Problem in Conventional Framing

4.1 What is a thermal bridge?

A thermal bridge is any part of an assembly that conducts heat faster than the material around it. In a wood-framed wall the studs are the bridge. Wood runs about R-1.25 per inch against the R-3.5 to R-6.5 per inch of common cavity insulations.

In a 2×6 wall framed at 16 in. on center, framing occupies roughly 15 to 25 percent of the wall area once studs, plates, headers and corners are counted. Every one of those members is a conductive path from the warm side to the cold side that bypasses the insulation entirely.

4.2 The effect on effective R-value

The ASHRAE zone method and the parallel path method both account for heat flowing through insulation and framing at the same time. Typical results:

Wall assembly	Nominal cavity R	Effective whole-wall R	Loss
2×4 @ 16 in. o.c.	R-13 batt	R-9 to R-10	25–30%
2×6 @ 16 in. o.c.	R-21 batt	R-14 to R-15	25–30%
2×6 @ 16 in. o.c.	R-20 batt	R-13 to R-14	30–35%
2×6 @ 24 in. o.c. (advanced framing)	R-21 batt	R-16 to R-17	18–24%

These are approximations for illustration. A specific wall should be calculated from its own framing takeoff. The degradation itself is not a defect — it is what interrupted insulation does — and it is the reason the prescriptive R-value table specifies numbers well above what the physics alone would require. The code writers know nominal R overstates delivered performance.

5. Why Spray Foam Does Not Solve It

5.1 What spray foam does well

Closed-cell spray polyurethane foam (SPF) is a genuinely better cavity insulation than batt. It seals air leakage paths, adheres to framing, and delivers R-6 to R-6.5 per inch against R-3.5 for fiberglass. None of that is in dispute.

5.2 What it does not do

Spray foam insulates the cavity. It does not remove the framing. Consider a 2×6 wall filled with closed-cell SPF:

- ▶ Closed-cell SPF in the cavity: R-6.5/in. × 5.5 in. ≈ R-35 nominal
- ▶ Wood stud at the same location: ≈ R-6.9 through the full 5.5 in. depth
- ▶ Effective whole-wall R after parallel-path calculation: ≈ R-20 to R-23
- ▶ Degradation from nominal: ≈ 34 to 43 percent

The better the cavity insulation, the sharper its contrast with the wood beside it — so the fractional loss gets larger, not smaller. A 2×6 wall at a nominal R-35 of spray foam lands at roughly R-22 as an assembly, which is a U-factor of about 0.045. That is exactly at the Zone 5 limit, with no margin.

5.3 Continuous insulation, and what it costs

The standard fix is continuous insulation: rigid foam or mineral wool outboard of the framing, uninterrupted. The code recognizes it explicitly — R-20+5ci, R-13+10ci and R-20ci are all listed Zone 5 wall options. It works. It also adds thickness, longer fasteners throughout, and new detailing problems at every window, door and penetration, each of which costs time on site.

6. How SIPs Perform Under the U-Factor Path

6.1 The panel

A SIP is an engineered sandwich: two structural facings, typically 7/16 in. OSB, bonded under factory conditions to a rigid foam core — Type I expanded polystyrene (EPS), graphite-enhanced polystyrene (GPS), or polyurethane (PUR/PIR). The core is both the structure and the insulation. Across the field of the panel there is no framing member penetrating its depth, which is why a SIP's published system R-value tracks its delivered performance far more closely than a framed wall's nominal R-value tracks its own.

6.2 Murus system R-values and U-factors

Murus publishes system R-values for its panels, tested at a mean temperature of 75°F. The U-factor shown is the reciprocal of the published panel R-value. Section 6.3 explains what that figure does and does not include.

EPS core — expanded polystyrene

Panel thickness	System R @ 75°F	U-factor
4-5/8 in.	R-15	0.067
6-1/2 in.	R-23	0.043
8-1/4 in.	R-29	0.034
10-1/4 in.	R-37	0.027
12-1/4 in.	R-45	0.022
15 in.	R-55	0.018

GPS core — graphite-enhanced polystyrene (BASF Neopor®)

Panel thickness	System R @ 75°F	U-factor
4-5/8 in.	R-18	0.056
6-1/2 in.	R-28	0.036
8-1/4 in.	R-36	0.028
10-1/4 in.	R-45	0.022
12-1/4 in.	R-55	0.018
15 in.	R-67	0.015

PUR core — polyurethane closed-cell foam

Panel thickness	System R @ 75°F	U-factor
4-5/8 in.	R-27	0.037
5-5/8 in.	R-34	0.029
6-5/8 in.	R-41	0.024

PUR gives the highest R per inch of the three cores and reaches R-27 in a 4-5/8 in. panel. One caveat worth knowing: Murus publishes EPS and GPS performance at reduced mean temperatures as well as at 75°F, and both improve as it gets colder — a real cold-climate advantage. Published low-temperature data for PUR is not offered on the same basis. Where cold-weather performance is the deciding factor, ask for the test data at the temperature that matters rather than extrapolating from the 75°F figure.

6.3 What a SIP does not eliminate

It would be convenient to claim a SIP has no thermal bridges at all. It is not true, and a plans examiner who has read a panel manufacturer's own technical guidance will know it is not true.

Real panels carry lumber: top and bottom plates, corner posts, window and door bucking, headers, king studs, floor-deck connections, and solid splines where spans need reinforcement. Foard Panel's Technical Bulletin 82 puts the resulting framing factor at 5 to 25 percent for structural SIP walls and 0 to 8 percent for structural SIP roofs, and notes that a SIP therefore does not strictly meet the code definition of continuous insulation.

Two corrections pull in opposite directions. A code submission may add the interior finish and the inside and outside air films to the panel R-value, worth roughly R-1.3, which helps. It must also account for the framing factor, which hurts. At typical thicknesses these partly offset, but not reliably, and not in the same proportion at every thickness.

The honest statement is this. A panel comfortably inside the limit stays inside it once framing is counted. A panel sitting within a few percent of the limit must be calculated from the actual building, not assumed from a catalog figure. NorthEast SIPs will run that calculation for a specific project.

7. Code Compliance Comparison — Climate Zone 5

The tables below compare assemblies against the Zone 5 requirements. SIP rows use the published panel U-factor from Section 6.2, without the air-film credit and without a framing deduction. Framed rows use approximate effective R-values from parallel-path calculation.

7.1 Wall assemblies — maximum U-0.045, both editions

Wall assembly	Basis	U-factor	R-value path (R402.1.3)	U-factor path (R402.1.2)
2×6 + R-21 batt	≈ R-15 effective	≈ 0.067	Fail	Fail
2×6 + R-21 batt + R-5ci	≈ R-22 effective	≈ 0.045	Pass (R-20+5ci)	At the limit
2×6 + closed-cell SPF (R-35 nom.)	≈ R-22 effective	≈ 0.045	Pass (R-30 cavity)	At the limit
2×6 + SPF + R-5ci	≈ R-27 effective	≈ 0.037	Pass	Pass
4-5/8 in. EPS SIP	R-15 panel	0.067	Fail	Fail
6-1/2 in. EPS SIP	R-23 panel	0.043	Fail	Pass
8-1/4 in. EPS SIP	R-29 panel	0.034	Fail	Pass
4-5/8 in. GPS SIP	R-18 panel	0.056	Fail	Fail
6-1/2 in. GPS SIP	R-28 panel	0.036	Fail	Pass
4-5/8 in. PUR SIP	R-27 panel	0.037	Fail	Pass
5-5/8 in. PUR SIP	R-34 panel	0.029	Fail	Pass

One regional exception to the number at the head of this table: Pennsylvania amends its Zone 5 wall maximum to U-0.051, which gives every panel listed here more margin than shown. Every other state in Section 3 uses U-0.045.

Three things to take from this table. The thinnest panels do not pass in Zone 5 — a 4-5/8 in. EPS or GPS wall panel fails the U-factor requirement and should not be specified here on thermal grounds. A 6-1/2 in. EPS panel passes, but by about four percent, which is inside the range where the framing calculation in Section 6.3 decides the question. And every SIP row fails the R-value path while passing the U-factor path, which is precisely the point: the R-value table is asking about cavity insulation in a wall that has no cavity.

7.2 Roof and ceiling assemblies

This is where the 2021 and 2024 editions diverge. The maximum is U-0.024 under the 2021 IECC and U-0.026 under the 2024 IECC.

Roof assembly	Basis	U-factor	2021 (U-0.024)	2024 (U-0.026)
Vented attic, R-49 blown	R-49	≈ 0.020	Pass	Pass
Vented attic, R-60 blown	R-60	≈ 0.017	Pass	Pass
Cathedral, 2×12 + ccSPF	≈ R-33 effective	≈ 0.030	Fail	Fail
8-1/4 in. EPS SIP	R-29 panel	0.034	Fail	Fail
10-1/4 in. EPS SIP	R-37 panel	0.027	Fail	Fail
12-1/4 in. EPS SIP	R-45 panel	0.022	Pass	Pass
15 in. EPS SIP	R-55 panel	0.018	Pass	Pass
8-1/4 in. GPS SIP	R-36 panel	0.028	Fail	Fail
10-1/4 in. GPS SIP	R-45 panel	0.022	Pass	Pass
12-1/4 in. GPS SIP	R-55 panel	0.018	Pass	Pass
6-5/8 in. PUR SIP	R-41 panel	0.024	Fail	Pass

The 6-5/8 in. PUR roof panel is the clearest illustration of why the edition matters. At R-41 its U-factor is 0.0244, which is over the 2021 limit of 0.024 and under the 2024 limit of 0.026. The same panel fails in Connecticut today and passes in New York today. Nothing about the panel changed.

The 10-1/4 in. EPS roof panel at R-37 does not meet the Zone 5 ceiling requirement under either edition. For a Zone 5 SIP roof on the prescriptive U-factor path, 12-1/4 in. EPS or 10-1/4 in. GPS is the practical starting point.

It is also worth noting what the table shows about the competition. A cathedral ceiling framed in 2×12s and filled with closed-cell spray foam does not reach the Zone 5 ceiling requirement on a whole-assembly basis, while a 12-1/4 in. SIP roof does — more simply, and without the air-sealing variability of a foam application in a framed cavity.

8. What Else Changed in the 2024 IECC

Two changes in the 2024 edition affect how this argument is made, and both are already live in New York.

8.1 The additional efficiency package — Section R408

The 2024 IECC adds a requirement that did not exist in 2021. Section R408 requires a dwelling to earn a minimum of ten additional efficiency credits from Table R408.2, using at least two separate measures. Dwellings with more than 5,000 sq. ft. of living space above grade plane must earn fifteen.

This is not a footnote. Meeting the envelope tables is no longer sufficient on its own, and the credit table rewards exactly the things a SIP building does well — envelope performance above the minimum, and measured airtightness. Designers coming to SIPs from the 2021 code should expect to document R408 compliance as a separate exercise.

8.2 The R-20 wall option — Section R408.2.9

Section R408.2.9 allows wood frame walls in Climate Zones 4 and 5 to be reduced to a maximum U-factor of 0.060 — effectively an R-20 wall — where the additional efficiency requirements are met. Expect this to be the route a stick-frame competitor takes to avoid continuous insulation.

It is worth being clear-eyed about it. The trade is a measurably worse envelope bought with credits earned elsewhere, often in mechanical equipment with a fifteen-year life, against a wall assembly that will stand for the life of the building. That is a legitimate argument to make to a client. It is not an argument that the wall performs better.

8.3 Other changes worth knowing

- ▶ Ceiling R-value under the R-value alternative dropped from R-60 to R-49 in Climate Zones 4 through 8, matching the 2018 level.
- ▶ Prescriptive air leakage tightened to 2.5 ACH50 in Climate Zones 6 through 8. Zones 3 through 5 remain at 3 ACH50.
- ▶ Window U-factor in Climate Zones 5 and 6 tightened to 0.28.
- ▶ The Total UA Alternative was renamed the Component Performance Alternative (R402.1.5). The calculation method is unchanged.
- ▶ Slab edge insulation depth in Climate Zones 4 and 5 was reduced from 4 ft. to 3 ft.

9. Making the Submission

9.1 The U-factor path is the requirement, not a favor

Section R402.1.2 states that the thermal envelope shall meet the requirements of Table R402.1.2. Section R402.1.3 offers the R-value table as an alternative to it. A building official reviewing a correctly documented U-factor submission is reviewing compliance with the primary section of the adopted code.

Insisting on the cavity R-value table instead would impose a requirement the adopted code does not contain. That said, the argument is won with a complete submission, not with a citation. Give the reviewer the arithmetic and the supporting reports and the question usually does not arise.

9.2 Documentation checklist

- ▶ The manufacturer's published system R-value data, with the test standard and mean temperature stated
- ▶ The current ICC-ES evaluation report — for Murus panels this is ESR-4696, reissued April 2026 and subject to renewal April 2027
- ▶ A compliance table setting each assembly U-factor against the Table R402.1.2 maximum for the climate zone, citing the edition the jurisdiction has adopted
- ▶ A framing-factor calculation for any assembly within roughly ten percent of the limit
- ▶ An explicit statement that compliance is elected under Section R402.1.2
- ▶ For projects under the 2024 IECC, the Section R408 additional efficiency credits, shown separately

One scope note on the evaluation report. ESR-4696 covers the 2021, 2018 and 2015 editions of the IBC and IRC. Where a jurisdiction has moved to the 2024 I-Codes, confirm the current report status before submission.

10. Conclusion

The IECC asks for whole-assembly performance first and offers a cavity R-value table as an alternative. SIPs are built for the first question and read badly against the second, which is why a SIP submission on the R-value path looks worse than the building is.

Framed walls are limited by the lumber in them. Batt, blown or closed-cell spray foam, the bridges remain and take 20 to 40 percent of the nominal value with them. Continuous insulation fixes it and adds cost and detailing. A SIP arrives with the insulation already continuous across the field of the panel.

That is not the same as claiming a SIP has no thermal bridges. It has lumber at its plates, corners and openings, and an honest submission counts it. What a SIP does is start from a much better place and need far less correction to get to compliance — and in Climate Zone 5 the panels that get there are 6-1/2 in. and up for walls, and 12-1/4 in. EPS or 10-1/4 in. GPS and up for roofs.

NorthEast SIPs is an independent SIP dealer providing design, engineering review, fabrication, delivery, framing takeoffs and on-site installation consulting through its manufacturing partners. To discuss a project, contact Trevor Huffard, President, at trevor@nesips.com or 203-293-5404.

11. References

- ▶ 2021 International Energy Conservation Code, Sections R402.1.2 and R402.1.3 and Tables R402.1.2 and R402.1.3. International Code Council.
- ▶ 2024 International Energy Conservation Code, Sections R402.1.2, R402.1.3, R402.1.5 and R408. International Code Council. Published 14 August 2024.
- ▶ 2025 Energy Conservation Construction Code of New York State, effective 31 December 2025. New York State Department of State, Division of Building Standards and Codes.
- ▶ 2022 Connecticut State Building Code, adopted pursuant to CGS § 29-252. Connecticut Department of Administrative Services, Office of the State Building Inspector.
- ▶ National Association of Home Builders, “Significant Changes to the 2024 IECC.”
- ▶ ICC-ES Evaluation Report ESR-4696, The Murus Company, Inc., Structural Insulated Panels. Reissued April 2026.
- ▶ Murus Company published R-values for PUR, EPS and GPS structural insulating panels, tested at a mean temperature of 75°F. murus.com/products/r-values
- ▶ Foard Panel, Inc., Technical Bulletin 82, “SIPs and the IECC-’21,” and SIP Properties at Standard Thicknesses.
- ▶ Premier Building Systems, Technical Bulletin BC-1, “IECC Insulation U-Factor Requirements.”
- ▶ ASHRAE Handbook of Fundamentals, Chapter 27, Heat, Air, and Moisture Control in Building Assemblies.
- ▶ Oak Ridge National Laboratory, Whole-Wall Thermal Performance research series.

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