
WHITE PAPER

SIP Foam Core Thermal Performance

R-Value Comparison by Foam Type, Panel Thickness, and Temperature

A Technical Reference for Architects, Builders, and Energy-Conscious Clients

1. Executive Summary

Structural Insulated Panels (SIPs) are available with three principal foam core materials: Expanded Polystyrene (EPS), Graphite-Enhanced Polystyrene (GPS), and Polyurethane (PUR). Each core type delivers meaningfully different R-values at a given panel thickness — and each responds differently to temperature change. This white paper presents tested system R-values at three ASTM C518 mean temperatures (75°F, 40°F, and 25°F), compiles data from multiple panel manufacturers, identifies ranges where source data diverges, and draws key observations relevant to building design and specification in cold climates.

All R-values reported here are system R-values — measured through the complete panel assembly including both 7/16" OSB skins — not the raw foam insulation R-value alone. Ranges are shown where manufacturer data differs; single figures indicate agreement across sources.

2. Methodology & Data Sources

R-value data in this white paper was compiled from:

- ▶ Published technical specification sheets from SIP manufacturers offering EPS, GPS (BASF Neopor®), and PUR foam cores
- ▶ BASF's published material data for Neopor® GPS Type VIII Expanded Polystyrene Foam (ASTM C578)
- ▶ Cross-referenced manufacturer R-value tables providing data at multiple mean temperatures (75°F, 40°F, and 25°F)

All system R-values are based on ASTM C518 testing methodology. The 40°F mean temperature is particularly relevant for New England and Mid-Atlantic applications, as it more accurately reflects the mean temperature across a wall or roof assembly during the heating season. The 25°F mean temperature represents performance under severe winter conditions.

Where two sources report different values for the same panel thickness, a range is shown (e.g., "47–48"). Where only one data set covers a given thickness or temperature, that value is reported directly.

3. Foam Core Materials Overview

3.1 Expanded Polystyrene (EPS)

EPS is the most widely used SIP foam core. It consists of air-filled closed-cell polystyrene beads fused under steam. Type I EPS (1.0 lb/cu.ft. nominal density) is the standard SIP core grade, delivering approximately 3.84 R per inch at 75°F. EPS is chemically stable and dimensionally consistent — its R-value does not degrade over time, as the insulating medium is air rather than a proprietary blowing agent gas.

3.2 Graphite-Enhanced Polystyrene (GPS) — BASF Neopor®

GPS is produced by integrating high-purity graphite particles into the EPS polymer matrix during manufacturing. The graphite acts as an infrared reflector, impeding radiant heat transfer through the foam and increasing thermal resistance. BASF markets this product under the Neopor® brand; the SIP-grade material is classified as ASTM C578 Type VIII at 1.25 lb/cu.ft. nominal density.

BASF's published material data reports a per-inch R-value of 4.70 at 75°F and 5.0 at 40°F for Neopor® Type VIII. Published system R-values from SIP manufacturers using Neopor® cores are consistent with the 4.70/inch rate at 75°F. The effective per-inch rate at 40°F — derived from published system R-values — falls in the range of 4.8–5.0 per inch, broadly consistent with BASF's specification, with minor variation attributable to OSB skin contribution and measurement rounding.

Key Note on GPS Per-Inch Rate:
*BASF publishes Neopor® Type VIII at 4.70 R/inch @ 75°F and 5.0 R/inch @ 40°F.
System R-values reported by panel manufacturers are consistent with the 4.70/inch baseline at 75°F.
At 40°F, back-calculated per-inch rates from system data range from 4.8–5.0/inch — consistent with BASF's specification within the precision of these measurements.*

3.3 Polyurethane (PUR) Closed-Cell Foam

Closed-cell polyurethane foam achieves the highest R-value per inch of any commercially used SIP core material, at approximately 6.9 R per inch at 75°F. PUR SIPs are available in a narrower range of thicknesses than EPS or GPS panels, typically from 4-5/8" to 6-5/8" overall. The foam is injection-molded in place between the OSB skins, with no adhesive lamination required.

The PUR panels referenced in this white paper use Honeywell HFO (hydrofluoroolefin) as the liquid blowing agent — a next-generation, low global-warming-potential formulation replacing legacy HFC and HCFC blowing agents. This is a meaningful environmental differentiator compared to older PUR formulations.

4. EPS Core — System R-Values by Thickness

The following table presents system R-values for EPS-core SIP panels at three mean test temperatures. Single values indicate agreement across sources; ranges indicate minor divergence between manufacturer data sets.

Panel Thickness	Foam Core Thickness	System R @ 75°F	System R @ 40°F	System R @ 25°F
4-5/8"	3-3/4"	15	16	17
6-1/2"	5-5/8"	23	24–25	26

Panel Thickness	Foam Core Thickness	System R @ 75°F	System R @ 40°F	System R @ 25°F
8-1/4"	7-3/8"	29–30	32	33
10-1/4"	9-3/8"	37	40	42
12-1/4"	11-3/8"	45	48–49	51
15"	14-1/8"	55	60	—

Table 1. EPS Core SIP System R-Values. Type I EPS, 1.0 lb/cu.ft. nominal density, 3.84 R/inch. OSB skins: 7/16" Exposure-1 on both faces. Values at 25°F not available for the 15" panel from current sources.

EPS panels deliver consistent, predictable R-value performance across temperatures — both 40°F and 25°F values show modest improvement over the 75°F baseline, reflecting the temperature-stable nature of air-filled closed cells. The R-value reported on installation day is the R-value that will be present decades later.

5. GPS (Neopor®) Core — System R-Values by Thickness

GPS panels using BASF Neopor® Type VIII foam deliver approximately 20% higher system R-values than EPS panels at equivalent thickness. Importantly, GPS R-values improve as temperatures drop — an inherent characteristic of graphite-enhanced foam that is particularly advantageous in cold climates.

Panel Thickness	Foam Core Thickness	System R @ 75°F	System R @ 40°F	System R @ 25°F
4-5/8"	3-3/4"	18	19	20
6-1/2"	5-5/8"	28	29	30
8-1/4"	7-3/8"	36	37–38	39
10-1/4"	9-3/8"	45	47–48	49
12-1/4"	11-3/8"	55	57–58	59
15"	14-1/8"	67	72	—

Table 2. GPS Core SIP System R-Values. BASF Neopor® Type VIII, 1.25 lb/cu.ft. nominal density, 4.70 R/inch @ 75°F. OSB skins: 7/16" Exposure-1 on both faces. Ranges shown where manufacturer data differs by 1 R-value unit. Values at 25°F not available for the 15" panel from current sources.

The 12-1/4" GPS panel reaches a system R-value of 57–58 at 40°F — among the highest values achievable in a standard SIP panel format. At 15" overall thickness, the GPS panel achieves R-72 at 40°F, making it well-suited to high-performance and net-zero projects requiring exceptional envelope performance.

6. Polyurethane Core — System R-Values by Thickness

PUR panels achieve the highest R-value per inch of any available SIP core, enabling high thermal performance within a thinner overall wall section. However, PUR panels are available in fewer thickness options than EPS or GPS, and their long-term R-value performance is subject to a phenomenon known as thermal drift, addressed in Section 8.

Panel Thickness	Foam Core Thickness	System R @ 75°F	System R @ 40°F	Notes
4-5/8"	3-11/16"	27	29	Initial rating
5-5/8"	4-11/16"	34	37	Initial rating
6-5/8"	5-11/16"	41	44	Initial rating

Table 3. PUR Core SIP System R-Values. Closed-cell polyurethane, 2.2 lb/cu.ft. nominal density, 6.9 R/inch @ 75°F. Honeywell HFO blowing agent. OSB skins: 7/16" Exposure-1 on both faces. Values shown are initial (as-manufactured) rated values. See Section 8 for thermal drift considerations.

PUR panels show meaningful improvement at 40°F over the 75°F baseline — the 4-5/8" panel moves from R-27 to R-29, and the 6-5/8" from R-41 to R-44. The 40°F values represent the effective real-world performance during typical heating season conditions.

7. Comparative Summary at 40°F

The following table compares system R-values across all three foam types at 40°F mean temperature — the most practically relevant test condition for cold-climate building applications. Where thickness options do not align exactly, the nearest available panel thickness is used for comparison.

Panel Thickness	EPS @ 40°F	GPS @ 40°F	GPS Gain vs. EPS	PUR @ 40°F	PUR Gain vs. EPS
4-5/8"	16	19	+19%	29	+81%
5-5/8" / 6-1/2"	24–25	29	+16–21%	37	+48–54%
6-5/8" / 8-1/4"	32	37–38	+16–19%	44	+38%

Table 4. Cross-Core R-Value Comparison at 40°F Mean Temperature. GPS gain calculated against EPS at equivalent panel thickness. PUR gain calculated against the nearest EPS thickness. Percentages are approximate.

Key Takeaway — R-Value per Inch at 40°F:

EPS: ~3.9–4.1 R/inch (system, including OSB skins)

GPS: ~4.8–5.0 R/inch (system, including OSB skins) — approximately 20% higher than EPS

PUR: ~6.9–7.1 R/inch (system, initial rated value) — approximately 75–80% higher than EPS

8. Key Observations & Technical Takeaways

8.1 Temperature Dependence — All Foam Types Improve in Cold

All three SIP foam core types deliver higher R-values at lower mean temperatures, consistent with the physics of heat transfer through closed-cell foam. This is an important contrast to fiberglass and cellulose insulation, which can lose performance in cold conditions due to convective air movement. Specifying R-values at 40°F rather than 75°F better reflects actual heating-season performance in cold climates.

- **EPS:** Improvement from 75°F to 40°F is modest — typically 1–5 R-value units across the standard thickness range. Performance is extremely stable over time.

- ▶ **GPS (Neopor®):** Improvement from 75°F to 40°F is consistent and meaningful — typically 1–5 R-value units, with a larger absolute gain at greater thicknesses. The graphite particles provide enhanced infrared reflection at lower temperatures, contributing to greater improvement than plain EPS.
- ▶ **PUR:** Improvement from 75°F to 40°F is 2–3 R-value units at standard thicknesses. PUR also outperforms EPS and GPS in absolute R-value at any given thickness.

8.2 GPS Per-Inch Rate — Source Variance

Two distinct per-inch R-value rates appear in the available GPS data:

- ▶ 4.70 R/inch at 75°F — the value published by BASF for Neopor® Type VIII and consistently reflected in panel manufacturer system R-value data
- ▶ 5.0 R/inch at 40°F — the value published by BASF for Neopor® Type VIII at 40°F mean temperature

Back-calculating from published system R-values at 40°F yields effective per-inch rates in the 4.8–5.0 range, consistent with BASF's specification. Some manufacturer marketing materials round to "R-5 per inch" as a general figure — this approximation is reasonable for 40°F conditions but should not be applied at 75°F, where 4.70 R/inch is the correct baseline.

8.3 Polyurethane — Thermal Drift

PUR foam achieves its high initial R-value in part because the closed cells are initially filled with blowing agent gas, which has a lower thermal conductivity than air. Over time — typically within the first 2–5 years — this gas gradually diffuses out and is replaced by air, causing the R-value to decrease. This phenomenon is known as thermal drift or off-gassing.

The magnitude of thermal drift depends on the specific blowing agent used. Modern HFO-blown PUR foams (such as those using Honeywell HFO) are formulated to minimize drift compared to legacy HFC and HCFC blowing agents. Independent research (Oak Ridge National Laboratory) has found that the long-term R-value of PUR and GPS/EPS panels converge to within a narrower band after 5+ years of service than initial ratings suggest. Specifiers should evaluate whether the higher initial R-value of PUR panels or the long-term R-value stability of GPS panels better serves the project's performance goals.

PUR Thermal Drift — Practical Guidance:

Use initial rated values for code compliance documentation.

For energy modeling and long-term performance projections, consult the manufacturer's Long-Term Thermal Resistance (LTTR) or aged R-value data, which accounts for blowing agent off-gassing. HFO-blown PUR foams have lower drift than legacy formulations.

8.4 OSB Skin Contribution

Both 7/16" OSB skins contribute a combined R-value of approximately 0.44 to the system total (0.22 per skin). This is included in all system R-values reported in this document. Specifying thicker OSB skins (5/8" or 3/4") provides a modest additional R-value contribution and may be required for structural reasons in certain applications, but the thermal impact is minor.

9. Conclusion

SIP panels offer a highly capable thermal envelope solution across a wide range of R-value requirements, with three foam core options suited to different performance and budget goals:

- ▶ **EPS Core:** Reliable, cost-effective, and stable over time. Ideal for projects where long-term R-value consistency and budget efficiency are priorities.
- ▶ **GPS Core (BASF Neopor®):** Approximately 20% higher R-value than EPS at the same thickness, with performance that increases as temperatures drop. The preferred choice for high-performance and net-zero applications. Long-term R-value is stable.
- ▶ **PUR Core:** Highest R-value per inch of any standard SIP core, enabling superior thermal performance within a thinner wall section. Best suited to applications where cross-section depth is constrained. Long-term R-value stability should be verified against LTTR data.

IECC Table R402.1.2 — U-Factor and R-Value Reference

The table below summarizes the maximum assembly U-factors for Wood Frame Walls and Ceilings (roofs) from IECC Table R402.1.2 (2021 edition), along with their R-value equivalents. SIP panels — which deliver essentially their rated R-value with minimal thermal bridging — can be specified directly against the U-factor column without the framing-fraction deductions required for conventional stud walls.

Climate Zone	Wood Frame Wall Max U-Factor	Wood Frame Wall R-Equiv.	Ceiling (Roof) Max U-Factor	Ceiling (Roof) R-Equiv.
0	0.084	R-12	0.035	R-29
1	0.084	R-12	0.035	R-29
2	0.084	R-12	0.026	R-38
3	0.060	R-17	0.026	R-38
4 exc. Marine	0.045	R-22	0.024	R-42
5 & Marine 4	0.045	R-22	0.024	R-42
6	0.045	R-22	0.024	R-42
7 & 8	0.045	R-22	0.024	R-42

Table 5. IECC 2021 Table R402.1.2 — Maximum assembly U-factors for Wood Frame Walls and Ceiling/Roof assemblies by climate zone, with R-value equivalents ($R = 1/U$, rounded). SIP panels comply via the U-factor path. Consult local jurisdiction for adopted code version.

NorthEast SIPs help our clients select the appropriate SIPs needed to achieve the optimal envelop for the projects. Working our manufacturing partners we design, engineer, fabricate and deliver panels to project-specific R-value, structural, and dimensional requirements across all three core types. Contact us to discuss the optimal specification for your project.

Disclaimer: R-values reported in this document are based on published manufacturer specification sheets and material data sheets current as of August 2026. System R-values are measured per ASTM C518 at stated mean temperatures. Actual field performance may vary based on installation quality, air sealing, and building assembly details. Specifications are subject to change by manufacturers without notice. This document is provided for informational and specification support purposes only and does not constitute a warranty of performance. NorthEast SIPs recommends verifying current manufacturer data sheets prior to final specification.

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