POLARIS
HIGH PERFORMANCE HOMES

Spray Foam Technical Briefing

About the Author — Cameron Caja is the owner of Polaris High Performance Homes, a custom residential homebuilder. He is a Licensed General Contractor, a Certified Passive House Consultant (CPHC), Expert-in-Residence for the Reimagine Buildings Collective, and the Phius Alliance Representative for Arkansas, Missouri, Oklahoma, and Kansas. Cameron is also a Principal and consultant at Positive Energy, a Building Science and MEP engineering firm headquartered in Austin, Texas. His work focuses on enclosure durability, moisture control, indoor air quality, and risk-based specification decisions for high-performance residential projects.

Scope and Intent — This briefing is written for AEC professionals evaluating SPF as part of a high-performance residential enclosure strategy. It focuses on common field installation risks, durability outcomes, and serviceability constraints associated with both open-cell and closed-cell SPF in typical roofline and wall applications. While SPF can perform well when installed correctly under controlled conditions, the decision to specify it should be based on an honest assessment of field variability, inspection limitations, and long-term risk tolerance.

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1. Health, Exposure Pathways, and Indoor Air Quality Risk

Bottom line: SPF introduces chemical exposure pathways that are difficult to verify, difficult to remediate, and ethically hard to justify in housing where occupants do not meaningfully consent to those risks.

Owners and project teams increasingly treat indoor air quality as a primary performance objective, not a secondary comfort feature. Spray foam assemblies raise recurring concerns because they combine high chemistry complexity, high field variability, and limited post-install verification. The following issues represent the most common health-related risk signals that AEC professionals should take seriously before specifying SPF in residential construction.

Flame Retardant Additives (Including TCPP and Related Compounds)

Many SPF products rely on additive flame retardants to meet fire-related requirements. These chemistries are a major concern for teams pursuing low-toxin interiors because they can introduce persistent indoor contaminants that migrate into settled dust over time. A second concern is that the real-world benefit of these additives is difficult for project teams to evaluate: even when a material tests as compliant, it does not change the fact



that SPF remains a high fuel-load material that can contribute to severe smoke toxicity in a fire scenario.

Off-Ratio Chemistry and Long-Lived Exposure Risk

SPF installation is a high-sensitivity chemical process performed in the field, often under schedule pressure, variable substrate conditions, and inconsistent jobsite controls. When foam is mixed off-ratio or applied outside manufacturer conditions, it can leave behind unreacted components and byproducts (including isocyanate-related compounds and amines) that may persist as odors and irritants long after installation.

The key issue for residential projects is not whether most installs are "fine." The issue is that when it goes wrong, the health consequences can be severe, the diagnosis is difficult, and the remediation often involves invasive removal that most homeowners never budgeted for.

Fire Smoke Toxicity and Downstream Harm

In the event of a structure fire, SPF contributes to a smoke profile that can include highly hazardous compounds. This affects not only occupant survivability but also amplifies exposure risk for firefighters operating in already dangerous conditions. From a risk ethics standpoint, specifying petrochemical foam in homes increases the severity of worst-case outcomes, without offering a corresponding improvement in long-term durability or repairability.

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2. Durability, Risk, and Hidden Cost

Bottom line: SPF can deliver thermal performance, but it reduces inspection tolerance and amplifies the consequences of field variability.

High Cost per Unit Performance

SPF is often sold on high nominal R-value and air-sealing potential, but it comes at a premium relative to more conventional assemblies. Closed-cell SPF is typically the highest-cost insulation option used in residential construction. In many projects, that budget premium reduces flexibility elsewhere (airtightness detailing, better windows, mechanical design, ventilation strategy, and QA/QC), while simultaneously increasing performance risk tied to installer execution.

Installation Sensitivity and Long-Term Continuity Risk

SPF performance is highly dependent on field conditions and installer technique. Overheating, off-ratio mixing, elevated ambient humidity, and excessive substrate moisture can lead to voids, bubbles, friable foam, shrinkage, or pull-away from framing and sheathing. These defects degrade air control continuity and increase uncontrolled heat and moisture transport. In mixed-humid climates (including much of Arkansas), discontinuities can become sites of localized condensation and elevated wood moisture content, increasing mold and decay risk over time.

In residential work, the issue is not whether SPF can work, it's whether it reliably performs in the field often enough to justify the downside risk to the people living inside.

Fire Risk, Insurance Cost, and Financing Friction

SPF increases fire and smoke risk exposure relative to many fibrous insulation options, and it introduces additional code-driven requirements (ignition barriers, thermal barriers, detailing discipline). More importantly: when insurers increase premiums, restrict coverage, or when mortgage lenders treat SPF assemblies as undesirable, we should treat that as a professional warning, not an inconvenience. Those industries exist to price probability and severity of loss. If they are signaling elevated risk, project teams should learn from it. In residential construction, this is not a theoretical concern: a significant failure or loss event is not merely possible, it is plausibly probable across enough installations to justify avoiding SPF as a default specification.

Additionally, improper lift thickness and uncontrolled exotherm are a known risk in SPF application. Overly thick applications can overheat, degrade adjacent materials, and create latent defects that may not be visible at closeout, including damage to wiring insulation that creates delayed fire risk.

Concealed Moisture Accumulation and Reduced Leak Detectability

Both open-cell and closed-cell SPF can reduce a project's ability to detect and manage incidental water. Closed-cell SPF can function as a vapor retarder and can conceal roof deck wetting from interior view, delaying leak discovery until damage is advanced. Open-cell SPF is more vapor-open but can absorb and retain bulk water at leaks or condensation sites, increasing the duration of wetting against susceptible materials. In both cases, the dominant issue is not "spray foam causes leaks," but that it can reduce drying potential and reduce early warning signals, two properties that enclosures need in order to survive real-world events.



SPF can remove the two things that save buildings in practice: drying capacity and discoverability.

Inspection Limitations for Pest Management (Including Carpenter Ants)

In termite-prone regions, foam-insulated assemblies can reduce visibility for routine inspection and treatment, especially when SPF conceals key framing interfaces. Termites and carpenter ants can exploit concealed pathways, and SPF can hide mud tubes, galleries, and trails such that significant infestation progresses without obvious visual signals. In the worst cases, the result is not cosmetic damage but catastrophic structural degradation that is discovered late and corrected at extreme cost.

Because inspection access is central to many pest-control warranties and treatment strategies, some providers include exclusions or limitations when framing members are not observable due to foam coverage. For long-term durability risk management, this is not a side issue, it is a serious operational and liability concern.

Low Serviceability and High Remediation Cost

SPF is difficult and expensive to remove once installed. That means mistakes, whether foam-related (coverage, adhesion, defects) or unrelated (missed wiring, flashing errors, concealed leaks), often become higher-cost problems simply because the assembly is no longer accessible. In high-performance projects where we value verification and repairability, reduced serviceability should be considered a primary downside of SPF, not an afterthought.

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3. Worker Welfare, Field Safety, and Local Economic Resilience

Bottom line: SPF shifts risk onto installers and occupants, while renewable/biogenic insulation options tend to support safer trades and stronger regional value chains.

Safety and Health

Biogenic and mineral insulation options are generally less hazardous to install and easier to handle on a jobsite, which supports a safer work environment for trades. This contrasts with petrochemical SPF systems, which carry meaningful exposure risk during installation and can create long-term indoor air quality liabilities when something goes wrong. A safer jobsite is not just a “nice-to-have”, it means fewer health hazards, fewer medical costs, fewer career-ending exposures, and fewer projects where the trades absorb the consequences of a risky spec.

We are already facing a severe labor shortage in construction. As specifiers and builders, we should not normalize assemblies that treat workers as expendable.

Supporting Local Workers

Plant-based and regionally produced insulation products (cellulose, hemp, wood fiber, wool, etc.) are more likely to rely on local or domestic supply chains, especially in timber- and agriculture-rich regions like Arkansas. That translates to more resilient job opportunities for loggers, mill workers, farmers, processors, and installers. When we specify materials that can be sourced and produced closer to the jobsite, more of the project's insulation budget becomes local payroll instead of remote extraction.

Economic Circulation

A significant portion of the value of biogenic insulation stays closer to the region where it is installed, through harvesting, processing, distribution, and installation labor. In contrast, petrochemical-based products often route a larger share of value upstream to multinational oil and chemical manufacturers. That wealth extraction weakens local economic stability and increases exposure to global price volatility. When the market shifts toward renewable, regionally produced materials, it supports secondary economic benefits as well, transportation, warehousing, equipment, and processing capacity, which strengthens regional economic health.

Reducing Dependency on Oil-Based Supply Chains

When project teams choose cellulose, hemp, wood fiber, and wool, they are also reducing exposure to oil-driven material volatility and petrochemical supply disruptions. In practical terms, insulation choices can either deepen dependence on global petrochemical markets, or help shift residential construction toward more stable, domestic, and renewable material systems.

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4. Environmental Impact and Lifecycle Liability

Bottom line: SPF can deliver high thermal and air-sealing performance, but so can other assemblies with far lower environmental cost. When high-performance outcomes are achievable without petrochemical foam, SPF becomes difficult to defend on climate and lifecycle grounds.

Many owners and project teams now evaluate insulation assemblies not only for thermal performance, but also for embodied carbon, supply chain resilience, and end-of-life outcomes. SPF is frequently marketed as a sustainability upgrade due to operational



energy savings, but that framing often ignores the immediate emissions profile of petrochemical foam and the lifecycle waste it creates.

High Embodied Carbon

Petrochemical spray foam carries a high embodied carbon burden compared to many fibrous and biogenic alternatives. In particular, some SPF systems rely on HFC blowing agents, which have global warming potentials thousands of times higher than CO_2. Compare that to insulation strategies like recycled cellulose, which can be low-carbon and may even represent a net carbon storage benefit depending on sourcing, methodology, and accounting boundaries.

Carbon Payback Time and the Reality of Near-Term Harm

Even when SPF contributes to operational energy savings, it does so with an extremely high upfront carbon load. That matters because the climate impact of emissions is not evenly distributed across time: carbon released today amplifies the current crisis, while "paying it back" decades later does not undo near-term consequences.

In practical terms, specifying high-carbon insulation in housing can create a payback timeline that is long enough to be environmentally irrational, especially when there are lower-carbon insulation strategies that can deliver comparable performance without the same upfront emissions penalty.

Supporting Sustainable Agriculture and Forestry

Renewable insulation materials can fund healthier forestry and agricultural practices, especially in timber-rich regions. When sourced and managed responsibly, these systems create a continuous cycle of growth, harvest, and renewal that supports ecosystems, stabilizes rural jobs, and can store carbon within durable building products.

End-of-Life Waste and Loss of Material Reuse

SPF bonds aggressively to substrates and is extremely difficult to separate during renovation or demolition. In practice, this can downgrade otherwise reusable materials, framing, sheathing, metal components, into contaminated waste streams. That outcome undermines circular economy goals and increases landfill burden.

Put plainly: SPF turns potentially recoverable building materials into permanent trash.

For AEC professionals pursuing low-carbon, serviceable housing, SPF is a difficult material to defend. It front-loads emissions, increases health risks, limits repair pathways, and leaves behind waste that is structurally difficult to undo.

5. Conclusion: A Risk-Based Spec Decision

Spray foam insulation can achieve high performance on paper, but residential construction is not performed in a controlled environment. It is executed across variable crews, changing schedules, imperfect substrates, inconsistent supervision, and uneven quality control. When SPF is specified, the project team is betting that chemistry, field conditions, and installer execution align closely enough, every time, for the building enclosure to remain durable, healthy, and serviceable for decades.

For AEC professionals, that is not a neutral bet. It shifts risk onto trades, owners, and occupants while reducing the ability to verify, inspect, and repair the assembly after the fact. And when SPF fails, the outcomes tend to be expensive, invasive, and late-discovered, exactly the failure profile we should design out of housing.

High-performance homes do not require spray foam. We can meet or exceed thermal, airtightness, and durability targets using assemblies that are lower-toxicity, more serviceable, more repairable, and more ethically defensible. In residential work, where real people live, sleep, and breathe, SPF should be treated as a last-resort material, not a default upgrade.

Specifier Checklist (If SPF Is Being Proposed)

- What problem is SPF solving that cannot be solved with lower-risk assemblies?
- How will the assembly be inspected and verified after installation?
- What is the remediation plan if defects, odor, or moisture are discovered?
- Who holds liability if the foam is off-ratio or fails prematurely?
- What occupant health protection and ventilation protocols are being used during and after installation?

Supplemental Reading

This supplemental reading list is provided for AEC professionals who want to review primary sources and go deeper on the technical, environmental, and health-risk implications of spray polyurethane foam (SPF) and high-GWP blowing agents.

1. High-GWP Blowing Agents (HFCs) and Regulatory Context

- U.S. EPA — Technology Transitions GWP Reference Table — Includes 100-year GWPs for common HFCs, blends, and substitutes used for rule implementation.
- U.S. EPA — Regulatory Actions for Technology Transitions — Rulemaking history and updates for the Technology Transitions Program.

2. Worker Health, Exposure Pathways, and Chemical Risk

- U.S. CDC — Issues Related to Occupational Exposure to Isocyanates, 1989 to 2002 — 14 years of isocyanate-related HHEs on 46 sites including schools and offices.
- OSHA — Weather Insulating/Sealing: Chemical Hazards - SPF/Isocyanates — OSHA identified hazards in industries using SPF
- U.S. EPA (Archived) — Health Concerns about Spray Polyurethane Foam (Safer Choice) — Summary of known hazards and exposure pathways (isocyanates, sensitization, asthma risk, and related concerns).