XPS TECH TALK

XPS . . . THE BEST CHOICE FOR COMMERCIAL ROOF INSULATION APPLICATIONS

Setting the Record Straight …

XPS is the "Cadillac" of insulations because of its high, stable, long-term R-value coupled with high compressive strength and second-to-none moisture-resistance properties. Lightweight, yet durable, these properties combine to make XPS foam an efficient, effective choice for commercial roofing insulation – whether new or retrofit. The superior weather-resistance properties of XPS allow it to be installed either under (in conventional roofs) or over the membrane (in Protected Membrane Roof Applications—PMR) to protect the roof from damage and weather. In fact, when it comes to PMR applications—XPS is really your only choice in today's marketplace.

When hearing or reading information infused with scare tactics designed to confuse you about the properties of XPS insulation, be sure to call the author on it! The information is mostly fictional, resulting in "MythUnderstandings" for the uninformed target reader. This bulletin will help you debunk these and enable you to separate fact from fiction.

So, don't believe competitive industry rhetoric without checking out the facts. Instead, join the many in the roofing industry who understand these facts and conclude that XPS insulation is superior to polyiso in roof applications. The XPS industry prides itself on providing accurate and reliable information about the stable, sustainable, long-term R-value intrinsic to XPS insulation boards. These qualities are recognized by an array of Underwriters Laboratories (UL) and Factory Mutual (FM) listings, as well as in the International Family of Building Codes and their respective Evaluation Service agency approvals for a wide variety of XPS insulation products, which combined make XPS the best choice for roof insulation.

We do agree with industry competitors on one thing: *"… the request for, and use of alternate insulation materials (i.e., alternative to polyiso) is increasing."*[1] The reasons for switching from polyiso to XPS are driven by the present high-cost, product unavailability, and service factors of polyiso roof insulation.

XPSA is confident a true and accurate comparison between XPS and polyiso roof insulation products will lead the roof specialist to the conclusion that when it comes to roof insulation . . .

XPS Covers Everything!™

[1] John Mansville "Marketing Bulletin", Number M04-093, December 14, 2004, page 1, paragraph 1.

XPSA
EXTRUDED POLYSTYRENE FOAM ASSOCIATION
4223 Dale Boulevard ♦ Woodbridge, VA 22193 ♦ tel 703.731.1601 ♦ email: office@xpsa.com

QUICK FACTS

FACT: Extruded polystyrene foam (XPS) insulation boards have met—and continue to meet—all International Building Code (IBC) and International Fire Safety Code (IFS) requirements for roof applications, including direct-to-metal deck systems.

FACT: XPS is approved for application directly over metal roof deck without an underlying thermal barrier layer in many situations. Thus, the direct-to-deck application was accepted under the 2003 International Building Code when thermoplastic polystyrene foam insulation products successfully passed Part 1 of "UL 1256-98 with 2000 Revisions" test standard. This UL standard is specifically referenced in the IBC—without any limitations regarding sprinklers or re-roofing. Thus, per the IBC, a product and construction assembly passing the test as designated in Part 1 of UL 1256 allows for the use of foam plastics in direct-to-metal-deck roof applications without a thermal barrier.

- XPS roof system approvals are based on listings by Underwriters Laboratories (UL), as detailed in UL's Roof Deck Construction Numbers: 440 and 457. These listings are not unlike any other industry's products in that the listings are specific to a set of materials and a specific construction technique used during the test.

- XPS roof insulation products passed code-referenced FM 4880 with wet sprinklers. These systems are currently listed in the "FM Specification Tested Products Guides" section of the current edition of FM's Approval Guide.

- XPS roof insulation products meet Factory Mutual Class 1 requirements when installed with an approved thermal barrier, such as ½" gypsum.

FACT: In contrast, what the polyiso industry is <u>not</u> talking about is that its own industry—not the XPS industry—currently has fire-related issues with some of its products. Some polyiso listings have been pulled by UL due to failure in meeting ASTM E 108 and UL 790 test criteria. As a roof insulation customer, it is important to verify that polyiso roof systems actually meet UL and IBC Code requirements by passing ASTM E 108 and UL 790.

FACT: Long-term ramifications of making short-term decisions must be based on the entire property performance portfolio of attributes, especially thermal performance. After all, these are "insulation" products we are talking about. XPS has not changed its blowing agent, and its stable, long-term R-value is 5 per inch—results that are verified by actual long-term use—not just laboratory tests.

FACT: XPS insulation does not rely on a facer to give it its superior property performance and it does not require a coverboard to perform adequately when subjected to foot and roof equipment traffic. All property performance values are not dependant on keeping the facer intact to perform. This means the roof specialist can count on the properties to continue to perform over the service life of the product without worrying about delamination problems.

"MythUnderstandings" . . . Separating Fact from Fiction[2]

"MythUnderstanding" 1

The abbreviation for Extruded Polystyrene Foam is "ExPS" and has the same physical property characteristics as Molded Expanded Polystyrene Foam (EPS).

FACT: The commonly used abbreviation for extruded polystyrene is "XPS"—not "ExPS"—which distinguishes extruded polystyrene (XPS) from molded expanded polystyrene (EPS) foam insulation. The two types of polystyrene insulation are manufactured very differently and have different properties. Therefore, discussion of properties and applications for the two types should not be blended together, as is done to confuse the reader by enticing them to think that the stated properties of EPS are the same for XPS. Simply stated—they are not!

"MythUnderstanding" 2

EPS and XPS Manufacturers can achieve a UL Class A rating for exterior fire … but must use an approved coverboard and a fire-rated membrane to do so.

FACT: The reference made to Underwriters Laboratories (UL) Class A exterior rating is not relevant to XPS direct to deck acceptance. Acceptance of direct to deck XPS at UL is based on an interior fire exposure, tested in accordance with Part 1 of the UL Standard 1256. "Class A" ratings are obtained from successfully passing the test procedure ASTM E 108. ASTM E 108 involves a fire test exposure on the top side of the roof. Thus, direct-to- deck approval tests and "Class A" fire ratings are both important, but are separate fire specification tests to evaluate separate fire scenarios. In either case, XPS has successfully passed both of these fire specification tests and as a result hold current listings as IBC and IFS code-compliant systems. **It is the polyiso industry which currently has a problem passing the Class A fire rating test** (i.e., ASTM E 108), which caused UL to withdraw certain polyiso product listings. NRCA recommends that polyiso roof insulation should use a coverboard in certain situations.[3] Regarding a fire-rated membrane, any roof system listed in UL must state the components necessary upon which the listing is granted.

"MythUnderstanding" 3

Polystyrene foam can pass ASTM E 84 tests, but these test results are misleading because polystyrene melts and drips into the building and could cause a fire in the building's interior.

FACT: First, the 2003 International Building Code (IBC)[4] states that test procedures, UL 1256 and FM 4450, must be used to evaluate roof deck assembly constructions—not ASTM E 84. Second, XPS products meet building code requirements for flame spread when tested in accordance with ASTM E 84. However, it is important to understand that the ASTM E 84 test has absolutely nothing to do with evaluating interior fire exposure scenarios of roofs. As such, it is not the code-required test standard used to evaluate the performance of roof assembly systems in a direct-to-metal deck application.

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[2] Most of these "MythUnderstandings" (XPSA's metaphor for misleading and fictional information) are alleged by John Mansville in its *Marketing Bulletin, Number M04-093*, December 14, 2004 and by inaccurate or misleading information contained in the Polyisocyanurate Insulation Manufacturers Association (PIMA) Advisory, "Polyiso Foam Roof Insulation: It's More than R-value, It's Meeting the Codes", February 2005, found online at http://www.pima.org/advisories/021505-codememo.htm.

[3] NRCA Technical Bulletin, 2000-3, "Use of Coverboards Over Polyisocyanurate Roof Insulation", March 2000.

[4] International Building Code, Section 2603.4.1.5 Roofing, which states, " … A thermal barrier is not required for foam plastic insulation that is part of a Class A, B or C roof-covering assembly, provided the foam plastid insulation satisfactorily passes FM 4450 or UL 1256."

Some currently-distributed information confuses the applicability and scope of fire tests, like ASTM E 84, with building code standards, such as that contained in Section 2603 of the IBC. The bottom line is that E 84 test results are **irrelevant** to actual performance of direct-to-deck systems.

ASTM E 84 is a small-scale test for evaluating flame spread (i.e., burning) across the surface of an individual material. The E 84 test, and its results, should not be confused with direct-to-deck approval, which is gained through a "systems approach" test such as Part 1, UL 1256, which is also known as the "White House" test. The White House test is a more real-world, large-scale test assembly and was the granddaddy benchmark test that was used to develop and validate the much smaller-scale FM 4450 test apparatus and protocol. The 2003 International Building Code (IBC)[5] states that UL 1256 and FM 4450 are used to evaluate roof deck assembly constructions.

Although not required by building codes, XPS thermoplastic foam[6] was tested extensively in large-scale, intermediate-scale and small-scale test assemblies to evaluate the possibility of spreading fire via melting and dripping. It was found not to be a concern by each regional model code evaluation service agency that examined the data (e.g., ICBO, BOCA and SBCCI). All three subsequently issued evaluation service reports that accepted the use of XPS in direct-to-deck applications. All three agencies thoroughly investigated the melt and drip phenomenon, and approved the application in spite of fierce market-driven pressure by competitive industries.

It is important to understand that underdeck fire spread testing assumes that a large scale fire is in progress inside the building, started and fueled by the building contents. The purpose of the test is to determine if the roof insulation will become involved in the already-existing fire, contribute significantly to its growth, and spread the fire away from it's point of origin. Extensive testing demonstrated that flaming drops of polystyrene occur only where the existing interior fire, fueled by the building contents, is present to ignite them. In this 'flash over' fire zone, building contents are lost and human survival is not possible, all due to the originating fire of the building's contents. Away from the interior fire, flaming drops do not occur. All building code groups examined the XPS melting/dripping data and approved XPS direct to deck.

Factory Mutual (FM) tested and listed direct to deck in the 2002, 2003 and 2004 FM Approval Guides as a Class 2 assembly with sprinkler protection. FM, in 2005, is in the process of changing the listing from the "Approval Guide" to the "Specification Tested Guide". When asked in writing by XPSA members what new data FM possessed that provoked the change, FM responded in writing, "…we do not require any outside stimulus (to change) our requirements … FM added that "specific information that we have … if any, would be confidential." XPSA also wrote in December 2003 for an explanation of why the testing we were promised would lead to a bona-fide FM approval was being denied only after the huge expense of the testing program was incurred and paid to FM. To date, XPSA has not received even the courtesy of a response to its December 2003 letter. Further, XPSA members have not received any information from any source regarding a hazard created from melting XPS in an actual roof fire scenario.

FACT: BOCA Evaluations Service (now merged into the ICC structure, along with the other former regional code-bodies: ICBO and SBCCI) was very sensitive to this competitively-motivated attack and was very thorough in its process to analyze test data and results—including the "melt and drip" phenomenon. In a letter to BOCA during this thorough review process, internationally-renown fire expert, Jesse Beitel of Hughes Associates stated, "IBC Code-approved standard for evaluating fire spread across a roof assembly UL 1256, Part 1 tests demonstrate that thermoplastic insulation used in roof assemblies allow for heat energy and combustible gases to escape through the roof. If contained, this combination of

[5] International Building Code, Section 2603.4.1.5 Roofing, which states, " … A thermal barrier is not required for foam plastic insulation that is part of a Class A, B or C roof-covering assembly, provided the foam plastid insulation satisfactorily passes FM 4450 or UL 1256."

[6] Thermoplastic materials are made from resin polymers that when exposed to heat, soften and melt. XPS is a thermoplastic foam.

energy and gases are critical to underdeck fire spread inside a building. Polystyrene foam insulation is a thermoplastic material composed of more than 90% air. This means when exposed to flame, it shrinks, then melts. And at temperatures greater than 850 degrees Fahrenheit, it *self*-ignites." Continuing on, Mr. Beitel explained, "While polystyrene droplets may fall into the already-developed fire below, they do not ignite unless there is ***direct*** flame contact. White House tests clearly show that even though most of the polystyrene roof insulation will melt over the area of the 100'-long test structure—only the material falling directly into the fire plume below will burn.

FACT: Table I. Thermal Decomposition of FR-Treated Polystyrene

Performance	Approximate Temperature (F°)
Foam begins to shrink	**210**[7]
Foam begins to liquify	**250**
Onset of Volatilization	**455**
Max. Volatilization	**622**
Total Volatilization	**743**
Flash Ignition	**750**
Self Ignition	**>800**

"MythUnderstanding" 4

ICBO requires a building with direct-to-deck XPS roof applications to be completely sprinklered. ICC is considering adopting a similar policy.

FACT: ICBO Acceptance Criteria AC 142 no longer exists. It was originally developed as an "alternative equivalent" to the Uniform Building Code to govern the acceptance and use of direct-to-deck foam plastic in roof applications for jurisdictions primarily located in the western half of the United States,. ICBO ES is now merged into the ICC structure and no longer enforces this criteria because it has been superceded by IBC code acceptance of the UL 1256, Part 1 test criteria.

FACT: If ICC is considering adopting a similar policy for direct-to-deck assemblies, the XPS industry has not been contacted to explore the policy in any peer-review, consensus-making process. Further, ICC has not submitted any public code-change proposals at the recent hearings in Cincinatti, OH. If ICC were considering this, the time was most ripe to do it here at its code-development forum. This is simply wishful thinking.

FACT: It is true that the code bodies in general have always expressed concern about the sprinkler "trade-off" code issues … but these concerns relate to a large set of various construction systems and buildings and are not limited or focused on direct-to-deck assemblies.

[7] It is important to note that human life cannot be sustained at temperatures of 212°F. Thus, even if droplets begin to appear, the hazard was already sufficient enough to cause death. Thus, the flaming droplets do not pose a safety hazard to human life. This argument is simply a red herring.

FACT: All large scale, UL 1256 Part I XPS tests (i.e., the White House test) were conducted and passed at accredited laboratories without sprinklers. ICBO ES only imposed the requirement for sprinklers after it was proposed by the XPS industry as a means to end the seemingly-endless opposition to the direct to deck concept put forth by the polyisocyanurate industry and FM. This industry's position is, "Who can be against sprinklers?"

FACT: In 2005, ICBO became a defunct code, and the criteria that once existed (AC 142) that required sprinklers is also defunct. The current 2003 International Building Code (IBC) is fully updated and includes the revised UL 1256 standard, thus fully adopting large scale testing (Part I) that was passed without sprinklers. That test standard was not in the old ICBO code which enabled the negotiation process that resulted in "sprinklers". Section 2603.3.4.1.4 of the 2003 IBC states that a thermal barrier is not required in a Class A, B or C roof assembly that also passes FM 4450 **or** UL 1256. The requirement to pass FM 4450 or UL 1256 was in ICBO and all of the old codes. It is not new. The IBC says nothing about the use of sprinklers in conjunction with direct to deck, and, there are presently no proposals in the code change process to change that fact.

FACT: FM 4450 is a smaller-scale test also conducted on an assembly of roof materials. There are assemblies, with thermal barriers, containing EPS or XPS that pass FM 4450. The fact that the direct-to-deck concept is tested using UL 1256, Part I, not FM 4450, is a well-known and code-accepted fact. UL 1256 Part I is a very large scale test, conducted outdoors, capable of replicating large-scale fire performance. Such fire performance cannot be measured using the small-scale, in laboratory, test standard FM 4450, or, UL 1256 Part II, also a smaller scale test. All listings, both FM and UL, are very specific regarding the brand of components including all types of foam plastic insulation, XPS, EPS and polyisocyanurate alike.

"MythUnderstanding" 5

It is very difficult to prevent hot asphalt from flowing between joints of the coverboard on a polystyrene foam roof application. Polystyrene will melt when it comes in contact with hot asphalt…" or solvents in adhesives can penetrate through the coverboard and melt the underlying polystyrene insulation.

FACT: XPS is used with hot asphalt systems and with solvent-based, fully adhered systems. As with all roofing systems, proper installation procedures must be followed. It is well-known that hot asphalt and solvent-based adhesives can damage polystyrene roof insulation. When proper cover boards are used, joints are taped as necessary, adhesives are applied at the proper coverage rates, materials are handled and stored properly on the jobsite. This results in XPS roof insulation that has been, and is still, used successfully in hot and fully-adhered roofing systems.

"MythUnderstanding" 6

Mechanical fasteners should not be used in direct contact with polystyrene due to it's 'cold flow' properties. These properties cause the polystyrene to flow away from the pressure of the mechanical fastener and plate and will cause the fastener to 'sit high' in the board…"

FACT: This is yet another "red herring" allegation. There have not been any complaints from the field regarding "cold flow". The physical properties of XPS products comply with the industry's material standard, ASTM C 578. XPS insulation have been used in mechanically attached roofing systems for over two decades directly under suitable single ply membranes and in direct contact with stress plates without one complaint of "cold flow" behavior. For the past several years, it has been very common for XPS to be installed under TPO membranes with only a fire slip-sheet separating the two materials.

In addition to extensive field experience, laboratory testing conducted by Owens Corning and shared with the Single Ply Roofing Institute (SPRI) demonstrated that the density, compressive strength, and the ability of XPS to maintain pressure on stress plates is well-suited for mechanically-attached roofing systems. The testing involved long-term mechanical fastener and stress plate loading, and the results showed it retained pressure measurements long-term. These allegations regarding XPS in mechanically-attached roofing systems are unfounded and contrary to the extensive in-service record of XPS roof insulation used in these systems.

"MythUnderstanding" 7

In order to achieve FM/UL approval, the polystyrene insulation must be installed over a thermal barrier…A layer of 2.5" polyiso has an R-value of 15.3. A comparable system would require a 3.5" layer of EPS with an R-value of 14.59 … (Extra labor, materials, handling, longer fasteners)…renders the polystyrene insulation system more expensive than polyiso."

FACT: R Values for EPS (molded expanded polystyrene foam) are much lower inch-for-inch, than those for XPS (extruded polystyrene foam). For example, an XPS direct to deck system with 3" of foam thickness would yield a long-term R-Value of 15. As explained in preceding sections, both UL and FM have successfully tested the direct-to-deck application of XPS and issued reports and/or listings that detail those results. In many, many situations, a thermal barrier layer is not required. Thus, this is a cost that can, and is being, eliminated for many roof and re-roof systems. A cost factor not mentioned by the polyiso industry is the need for a coverboard in many of its roof assemblies. This is a recommendation of the National Roof Contractors Association due to delamination problems witnessed in the field.

FACT: Regarding R-value, XPSA recommends the use of long-term, aged R-value—a concept that is much confused and long-abused by the polyiso industry. The XPS industry has long-recommended the use of long-term aged R-value of 5 per inch measured at a mean temperature of 75^{o}F for XPS. (This is the temperature required to report per the cellular polystyrene foam insulation industry standard, ASTM C 578). Thus, a reliable, long-term, water resistant, R-15 can be achieved with 3" of XPS. (For more information on long-term R-Value, please ask for a copy of the XPS Tech Talk Bulletin on Sustainable R-Value or check LTTR information contained on XPSA's website, www.XPSA.com.)

R-value can be measured at different mean temperatures and using different techniques/test procedures for "aging" the samples. For example, XPS measured at a mean temperature of 40^{o}F has a value of R-5.4 per inch compared to R-5 per inch at 75^{o}F. Aged R-values measured in accordance with the procedures defined by the standard CAN/ULC S770 yield results for XPS products ranging from R-5 to R-5.5 per inch when measured at 75^{o}F, depending on the sample thickness (i.e., a total of 1", 2", 3", or 4" thick). XPSA recommends that specifiers use R-5 per inch as the long-term R-value for XPS insulation products. These results have been verified by actual field samples and by the ASTM C 1303 test method. It remains to be seen whether the long-term R-values currently being reported by the polyiso industry will stand the test of time—for now these are simply laboratory results from a Canadian standard test.

"MythUnderstanding" 8

The physical properties and thermal performance of polyiso is superior to that of expanded polystyrene … with the implication that XPS and EPS have identical properties.

Although XPS properties have not been published by competitors in their allegations about polystyrene foam insulation used in direct-to-deck roof systems, the reader may infer that EPS and XPS share identical properties.

It is important to understand that XPS has superior properties to both polyiso and expanded polystyrene foam (EPS) in the following ways:

Compressive Strength: XPS compressive strengths range from 15 psi to 100 psi, with 18 and 25 psi used most often in traditional insulation located below the membrane in conventional roofing applications. Polyiso is often specified as an 18 psi compressive strength material. The difference is that polyiso must rely on a facer to achieve this property. XPS does not.

Water Moisture: At least one polyiso manufacturer has published a bulletin that shows polyiso products with a water absorption rate as <1.5% compared to EPS at 3.0% or 4.0%. The table fails to clarify that polyiso, when tested in accordance with ASTM C 209, has a much less severe exposure than the water absorption test, ASTM C 272, used to test polystyrene foam insulation products per its material standard, ASTM C 578. Even under the more severe test exposure conditions of ASTM C 272, XPS has a water absorption value of 0.3% (that is "point 3 percent"). Therefore, the XPS value for moisture absorption rate is five (5) times **less** than that of polyiso even though XPS is measured and tested under much more rigorous absorption conditions and does not require a facer to achieve this property.

These comparisons become more amazing when one considers that polyiso is tested using a less rigorous test procedure on a product with a facer intact to assist in its ability to resist absorption—a facer that can, and does, delaminate in real-world roof applications. In contrast, XPS is tested without any facer or laminate.

Summary

XPS roof products are superior to polyiso in many, many ways. The reliable, long-term and stable R-value claims for XPS, high moisture resistance, high compressive strength and the array of UL, FM and code approvals for XPS, have always made XPS the best choice for roof insulation. As stated by JM in the opening paragraph of their bulletin, "…the request for and use of alternate (to polyiso) insulation materials is increasing." The reasons for switching from polyiso to XPS are only partly related to the present unfavorable cost and service factors in the polyiso. XPSA is confident that many in the roofing and construction industry are re-examining the facts—especially the comparison between XPS and polyiso roof insulation choices. After such reflection, we hope you will join the many who have already concluded that XPS roof insulation truly has the best life-cycle value, and will remain XPS consumers in the future.