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MAKE A DIFFERENCE.


An Objective Comparison of Rigid Polystyrene Insulations - EPS and XPS

Provider K 031
Course EPS 104, 1 LU HSW/SD

AIA Continuing Education

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- Questions related to specific materials, methods and services will be addressed at the conclusion of this presentation.

Learning Objectives

- Define and understand the similarities and differences between how Expanded Polystyrene (EPS) and Extruded Polystyrene (XPS) are manufactured
- Learn about the environmental features and benefits of polystyrene insulation including recyclability, LEED, thermal performance, energy efficiency, reducing global warming and mold resistance
- Understanding ASTM C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
- Review physical property data of both EPS and XPS: Compressive Strength, Long Term Moisture Retention and Sustainable R-Value

What is Expanded Polystyrene (EPS)?

- Expanded polystyrene (EPS) is a durable, rigid foam plastic material that is specified as an effective insulator. It is manufactured in large block form in a variety of strengths and cut to order based on the project specifications.
- EPS also possesses a tremendous strength to weight ratio and the cellular structure is well suited to resist compression under the most demanding dead/live load applications.
- The same fundamental chemistry has been used to manufacturer EPS since the 1950’s
- There have been great advancements in manufacturing equipment and quality control in the last 20 years that make EPS much more predictable and attractive rigid insulation.

EPSMA – EPS Alliance
Expanded Polystyrene Molders Association

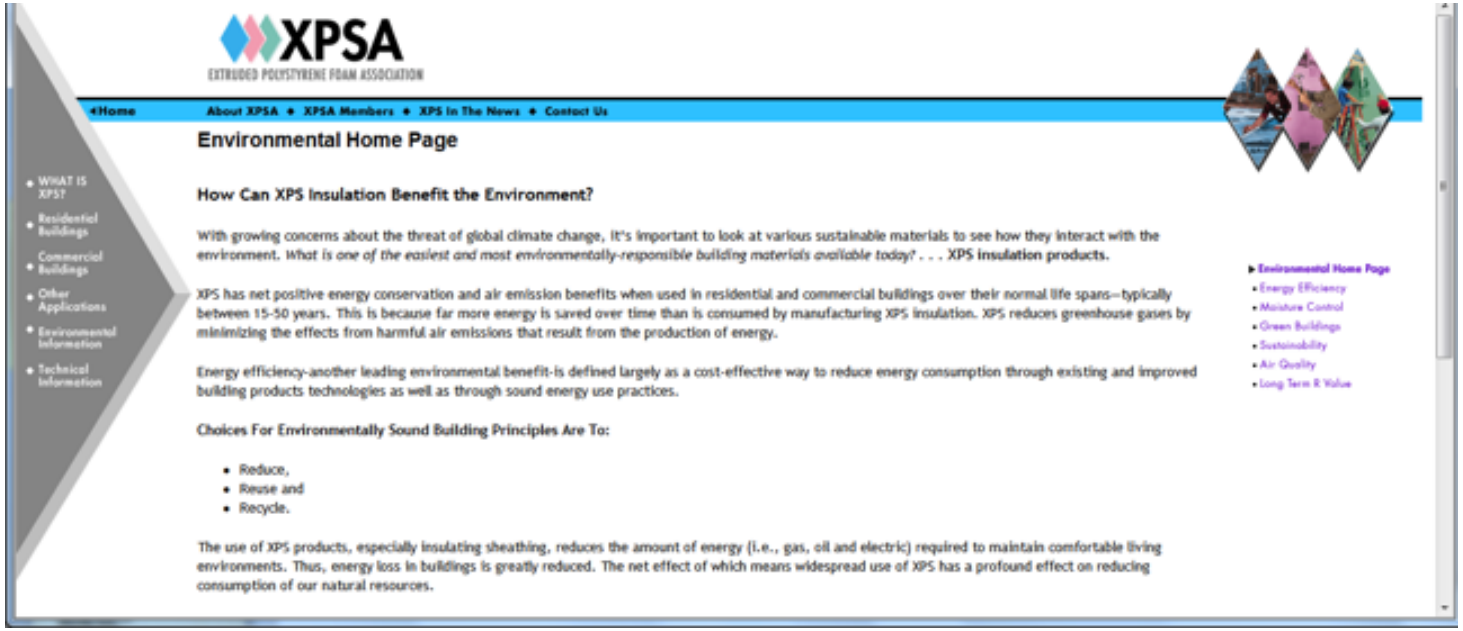
www.epsindustry.org

- Insulfoam
- Cellofoam
- Atlas
- Plasti-Fab
- Carpenter
- ACH
- Numerous local and regional companies

What is Extruded Polystyrene (XPS)? aka Styrofoam*

- Extruded polystyrene (XPS) foam insulation is durable, rigid foam plastic insulation that is manufactured in sheet form in a variety of strengths through an extrusion process and is typically available up to 3” thick in ½” increments
- XPS also possesses a tremendous strength to weight ratio and the cellular structure is well suited to resist compression under the most demanding dead/live load applications.
- Its excellent resistance to moisture, imperviousness to rot, mildew and corrosion, controlled compressive strength and ability to maintain insulating power make it a heavily specified product for the construction industry.
- XPS is typically supplied as blue, pink, green or yellow colored boards in 2’x 8’ or 4’x 8’ panels

XPSA
Extruded Polystyrene Manufacturers Association



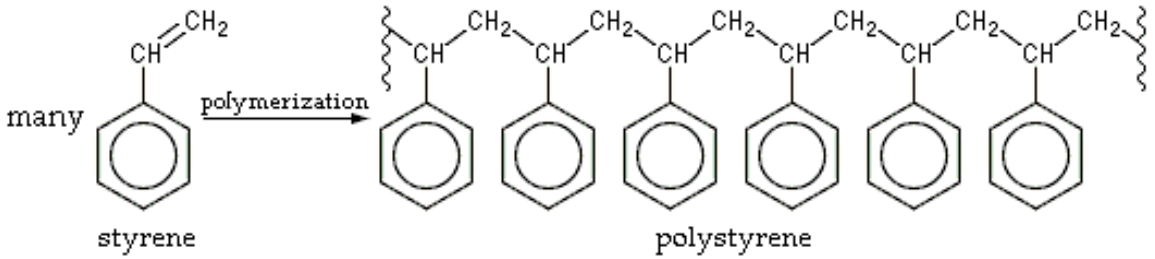
www.XPSA.com

PACTIV

OWENS CORNING

DOW Styrofoam Building Materials

Key Raw Material



Both XPS & EPS are manufactured from a polystyrene resin…

- Modified and unmodified
- Varying pentane contents
- Varying Sizes
- Different blowing agents

EPS Manufacturing

Pre-Expansion

Block Molding

Cutting

Laminating

Finished Goods

XPS Manufacturing

Manufacturing Comparison

EPS

- Block-molded into large billets and then cut to job-specific sizes
- Virtually no limitations on product size
- Standard offering in 7 different compressive strengths
- 75+ different manufacturers

XPS

- Continuously extruded through a die by thickness and then cut to length
- Limited thicknesses and panel sizes
- Standard offering in 3 different compressive strengths
- 4 different manufacturers

Sustainability and Environmental Benefits

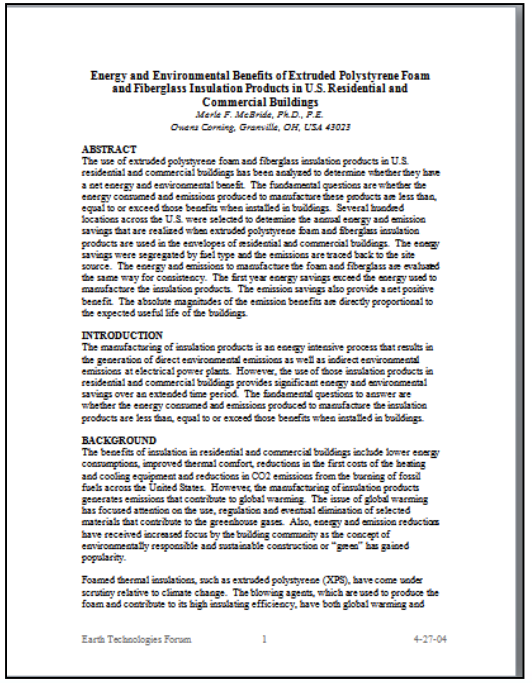
- Environmentally friendly; Conserves energy
- Contains no ozone depleting blowing agents; contains formaldehyde
- 100% recyclable from jobsites
- May contain recycled content
- Reduces global warming
- Contributes towards LEED Certification credits

Recyclability

- EPS and XPS can be removed off jobsites and may be used in future manufacturing as long as it is not contaminated
- Can be introduced into the manufacturing of new product or returned to a styrene resin

Polystyrene Insulations Reduce Global Warming

Insulation can return up to 200 times the amount of energy required to produce it, and reduce emissions by up to 100 times the volume produced during the manufacturing process



Energy and Environmental Benefits of Extruded Polystyrene Foam and Fiberglass Insulation Products in U.S. Residential and Commercial Buildings

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ABSTRACT

The use of extruded polystyrene foam and fiberglass insulation products in U.S. residential and commercial buildings has been analyzed to determine whether they have a net energy and environmental benefit. The fundamental questions are whether the energy consumed and emissions produced to manufacture these products are less than, equal to or exceed those benefits when installed in buildings. Several hundred locations across the U.S. were selected to determine the annual energy and emission savings that are realized when extruded polystyrene foam and fiberglass insulation products are used in the envelopes of residential and commercial buildings. The energy savings were segregated by fuel type and the emissions are traced back to the site source. The energy and emissions to manufacture the foam and fiberglass are evaluated the same way for consistency. The first year energy savings exceed the energy used to manufacture the insulation products. The emission savings also provide a net positive benefit. The absolute magnitudes of the emission benefits are directly proportional to the expected useful life of the buildings.

INTRODUCTION

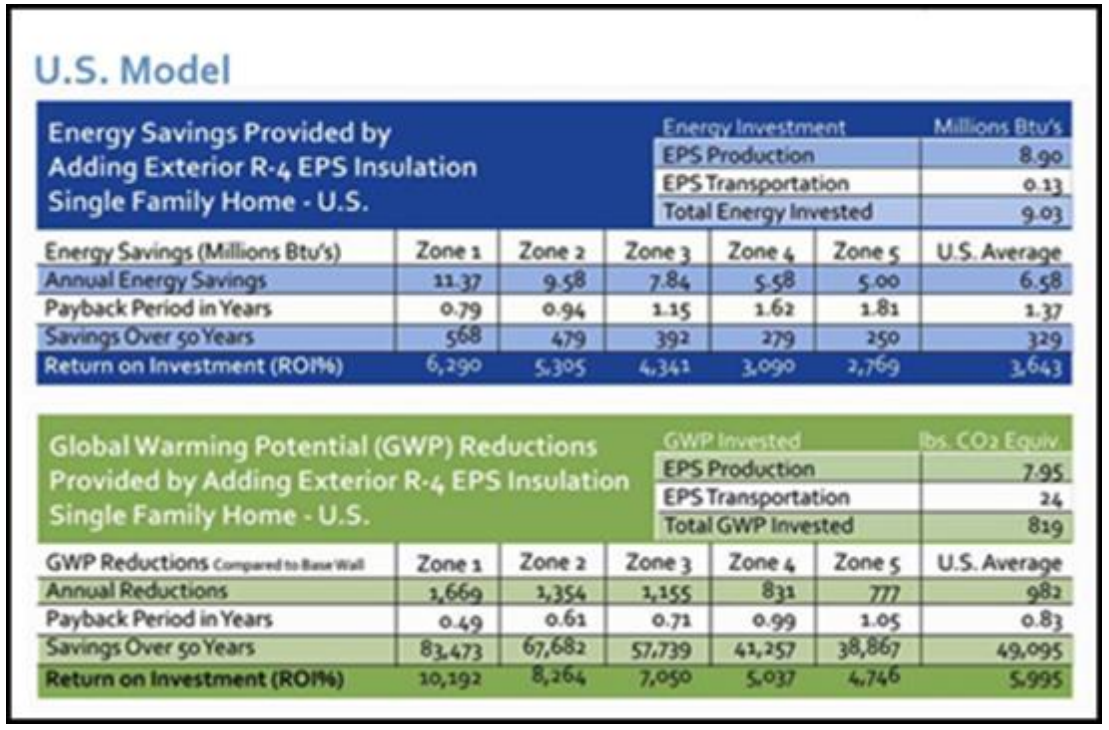
The manufacturing of insulation products is an energy intensive process that results in the generation of direct environmental emissions as well as indirect environmental emissions at electrical power plants. However, the use of those insulation products in residential and commercial buildings provides significant energy and environmental savings over an extended time period. The fundamental questions to answer are whether the energy consumed and emissions produced to manufacture the insulation products are less than, equal to or exceed those benefits when installed in buildings.

BACKGROUND

The benefits of insulation in residential and commercial buildings include lower energy consumptions, improved thermal comfort, reductions in the first costs of the heating and cooling equipment and reductions in CO_2 emissions from the burning of fossil fuels across the United States. However, the manufacturing of insulation products generates emissions that contribute to global warming. The issue of global warming has focused attention on the use, regulation and eventual elimination of selected materials that contribute to the greenhouse gases. Also, energy and emission reductions have received increased focus by the building community as the concept of environmentally responsible and sustainable construction or "green" has gained popularity.

Foamed thermal insulations, such as extruded polystyrene (XPS), have come under scrutiny relative to climate change. The blowing agents, which are used to produce the foam and contribute to its high insulating efficiency, have both global warming and

Polystyrene Insulations Reduce Global Warming



U.S. Model

Energy Savings Provided by Adding Exterior R-4 EPS Insulation Single Family Home - U.S.

Energy Investment	Millions Btu's
EPS Production	8.90
EPS Transportation	0.13
Total Energy Invested	9.03

Energy Savings (Millions Btu's)	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	U.S. Average
Annual Energy Savings	11.37	9.58	7.84	5.58	5.00	6.58
Payback Period in Years	0.79	0.94	1.15	1.62	1.81	1.37
Savings Over 50 Years	568	479	392	279	250	329
Return on Investment (ROI%)	6,290	5,305	4,341	3,090	2,769	3,643

Global Warming Potential (GWP) Reductions Provided by Adding Exterior R-4 EPS Insulation Single Family Home - U.S.

GWP Invested	lbs. CO_2 Equiv.
EPS Production	7.95
EPS Transportation	24
Total GWP Invested	819

GWP Reductions Compared to Base Wall	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	U.S. Average
Annual Reductions	1,669	1,354	1,155	831	777	982
Payback Period in Years	0.49	0.61	0.71	0.99	1.05	0.83
Savings Over 50 Years	83,473	67,682	57,739	41,257	38,867	49,095
Return on Investment (ROI%)	10,192	8,264	7,050	5,037	4,746	5,995

- The use of foam insulation on a building significantly increases the R-Value of walls to save energy
- Lower residential energy use translates into fewer emissions and reduced GWP

USGBC and LEED

Materials and Resources (MR Credits)

- MR Credit 2.1 and 2.2 - Construction Waste Management:
  - Divert 20% or 75% from Disposal, 2 points possible
- MR Credit 3.1 & 3.2 - Materials Reuse: 5% or 10%, 2 points possible
- MR Credit 4.1 & 4.2 - Recycled Content: 10% or 20%, 2 points possible
- MR Credit 5.1 & 5.2 - Regional Materials, 2 points possible

Sustainable Sites (SS Credits)

- SS Credit 7.2 – Heat Island Effect Roof, 1 point possible

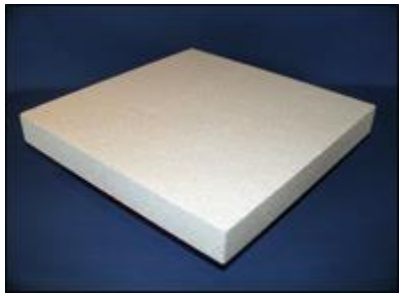
Energy and Atmosphere (EA Credits)

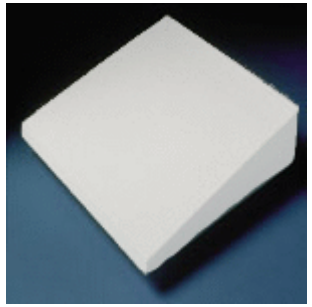
- EA Credit 1 - Optimize Energy Performance, 10 points possible
- EA Credit 5 – Measurement & Verification, 1 point possible

EPS Products

Product Features:

- Standard 10 - 60 psi compressive strength at 10% strain
- Long-term R-value of 3.85 to 4.6 per inch
- Any thickness from 3/8” to 48”
- Available in panels, blocks & custom shapes
- Tapered Panels available 0-40”, any slope
- T&G, bevel or straight-cut edges
- Specialty & Architectural shapes





Product Benefits:

- 100% recyclable
- Job specific sizes and performance requirements
- Minimal waste and material handling
- Moisture resistant
- Most R-value per dollar
- No thermal drift

EPS Products: Skinned & Composites

Factory-laminated Facers:

- Polymeric facers – printed, white and silver
- Reflective films – low emissivity
- Fiber glass reinforced facers

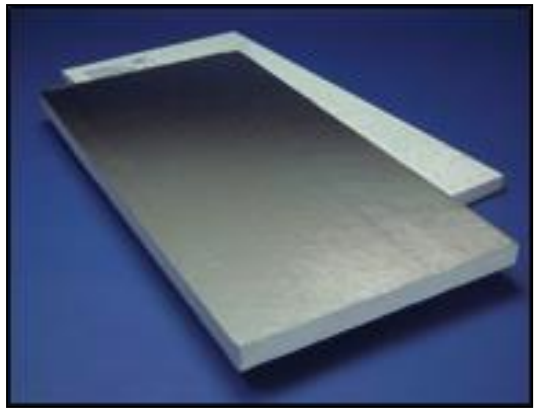
Composites:

- Wood fiber & perlite
- OSB & Plywood
- Gypsum & DensDeck®
- High-Density and Standard Iso

Benefits:

- Improved handling & durability
- Fanfold capabilities
- Eliminate compatibility concerns
- Improved moisture absorption
- Enhanced performance and code approvals

DensDeck® is a registered trademark of Georgia Pacific



EPS
Physical Properties

Typical Physical Properties							
Property	**Type I**	**Type VIII**	**Type II**	**Type IX**	**Type XIV**	**Type XV**	**Test Method**
Nominal Density (pcf)	1.0	1.25	1.5	2.0	2.50	3.0	ASTM C303
C-Value (Conductance) BTU/(hr•ft²•°F)							ASTM C518 or ASTM C177
@ 25° F	.230	.220	.210	.200	0.198	0.196	
(per inch) @ 40° F	.240	.235	.220	.210	0.206	0.198	
@ 75° F	.260	.255	.240	.230	0.222	0.217	
R-Value (Thermal Resistance) (hr•ft²•°F)/BTU							ASTM C518 or ASTM C177
@ 25° F	4.35	4.55	4.76	5.00	5.05	5.10	
(per inch) @ 40° F	4.17	4.25	4.55	4.76	4.85	5.05	
@ 75° F	3.85	3.92	4.17	4.35	4.50	4.60	
Compressive Strength (psi, 10% deformation)	10 - 14	13 - 18	15 - 21	25 - 33	40	60	ASTM D1621
Flexural Strength (min. psi)	25	30	35	50	60	75	ASTM C203
Dimensional Stability (maximum %)	2%	2%	2%	2%	2.0	2.0	ASTM D2126
Water Vapor Permeance (max. perm., 1 inch)	5.0	3.5	3.5	2.0	2.5	2.5	ASTM E96
Water Absorption (max. % vol.)	4.0	3.0	3.0	2.0	2.0	2.0	ASTM C272
Capillarity	none	none	none	none	none	none	–
Flame Spread	< 20	< 20	< 20	< 20	< 20	< 20	ASTM E84
Smoke Developed	150 - 300	150 - 300	150 - 300	150 - 300	150-300	150-300	ASTM E84

*Properties are based on data provided by resin manufacturers, independent test agencies and Insulfoam.

EPS Construction Applications

- Below Grade Insulation
- Below/Between Slab Insulation
- Radiant Heat Floors
- Roof & Wall Insulation
- Plaza Deck
- Block-outs & Concrete Forming
- EIFs & Cavity Wall
- Landscape and Structural Void Fill
- Siding Underlayment
- Pre-cast Wall Panels

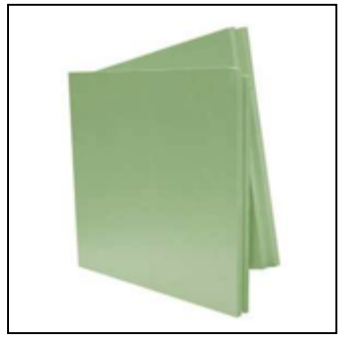


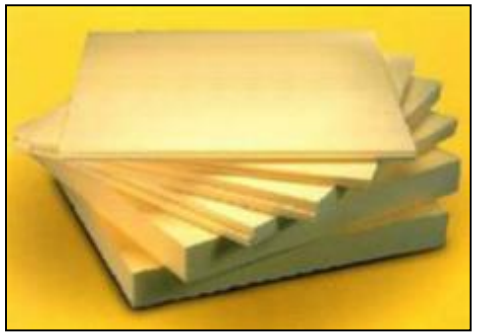



XPS Products

Product Features:

- Standard 25, 40 & 60 psi compressive strength at 10% strain
- 100 psi available as a special order
- R-value of 5 per inch
- Thicknesses from ½” to 3” in ½” increments
- Standard panels of 2’x 8’ or 4’x 8’; other special order sizes available
- T&G or straight-cut edges





Product Benefits:

- Typically contains recycled content
- 100% recyclable
- Several standard compressive strengths
- Moisture resistant
- Durable & Lightweight

XPS Physical Properties

XPSA
EXTRUDED POLYSTYRENE FOAM ASSOCIATION

◆ WHAT IS XPS?
◆ Residential Buildings
◆ Commercial Buildings
◆ Other Applications
◆ Environmental Information
◆ Technical Information

Title

ASTM C 578-08b

"Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation"—This standard has been approved for use by agencies of the Department of Defense.

This table is recreated, in part, to show only XPS information listed on the more complete table, ASTM C 578-08b. The standard is copyrighted, so please obtain the actual standard from ASTM for more complete information pertaining to this table and the test methods used tto derive these values.

Type	Product *	Density pcf	R-Value @ 75 degrees F	Compressive Strength (psi)	Flexural Strength (psi)	Water Vapor Permeance (perm)	Water Moisture Absorption (%)	Dimensional Stability (%)	Oxygen Index (%)	** E 84 Flame Spread	** E 84 Smoke Development
IV	XPS	1.55	5	25	50	1.1	0.3%	2	24	< 75	< 450
V	XPS	3	5	100	100	1.1	0.3%	2	24	< 75	< 450
VI	XPS	1.8	5	40	60	1.1	0.3%	2	24	< 75	< 450
VII	XPS	2.2	5	60	75	1.1	0.3%	2	24	< 75	< 450
X	XPS	1.3	5	15	40	1.5	0.3%	2	24	< 75	< 450
XII	XPS	1.2	4.6	15	40	1.5	0.3%	2	24	< 75	< 450

XPS Construction Applications

- Below Grade Insulation
- Below/Between Slab Insulation
- Radiant Heat Floors
- Roof & Wall Insulation
- Plaza Deck
- Block-outs & Concrete Forming
- EIFs & Cavity Wall
- Landscape and Structural Void Fill
- Siding Underlayment
- Pre-cast Wall Panels

Product Comparisons

EPS

- Wide variety of compressive strengths available
- 1/8” – 48” thickness available
- Boards can be custom fabricated to any length
- Made to order; short lead times; job-lot quantities
- Tapered

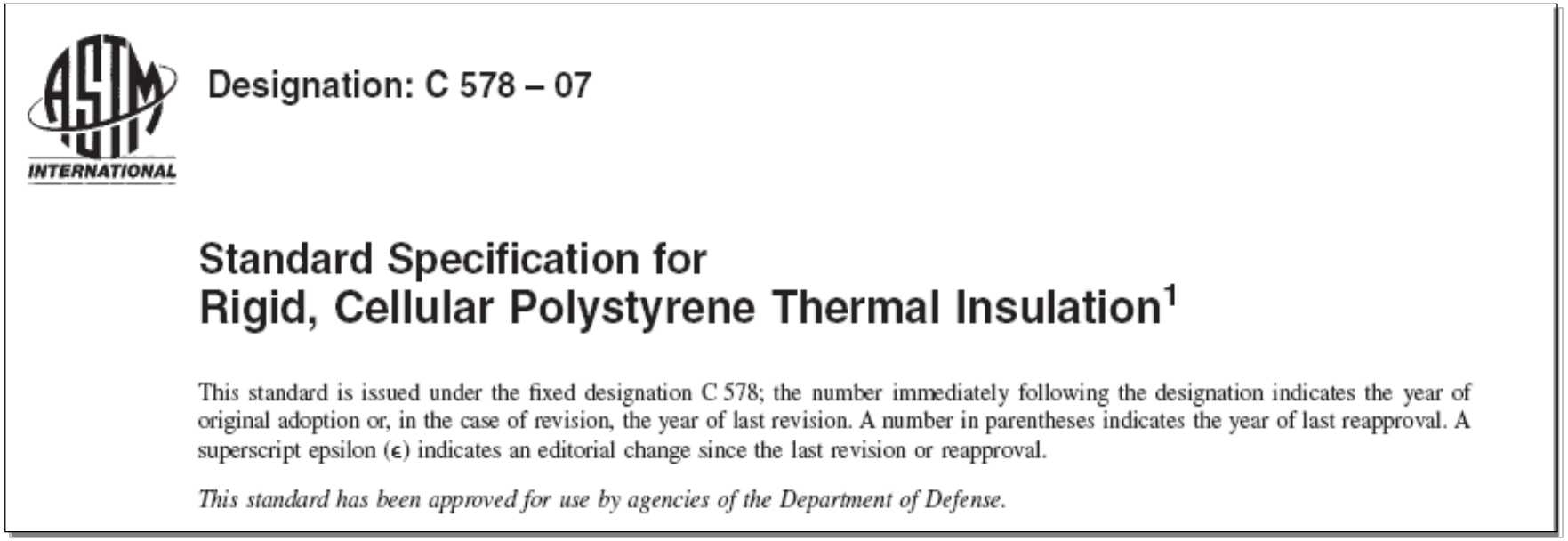
XPS

- 3 standard compressive strengths available
- Limited thickness available – 3” max
- Limited to standard lengths – 8’ and 9’
- Standard sizes; special orders require lengthy lead times; full pallets only; larger minimum orders
- No tapered

EPS and XPS
Codes and Compliances

- FM
- UL
- ASTM
- ICC-ES
- IBC
- Miami Dade
- State of Florida, FBC
- Various State Approvals

ASTM C578



Designation: C 578 – 07

Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation[1]

This standard is issued under the fixed designation C 578; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

- The industry's consensus standard for Expanded and Extruded polystyrene
- Establishes the minimum physical properties requirements

ASTM C 578

Classification	Type XI	Type I	Type VIII	Type II	Type IX	Type XIV	Type XV	Type XII	Type X	Type XIII	Type IV	Type VI	Type VII	Type V
Compressive resistance at yield or 10 % deformation, whichever occurs first (with skins intact), min, psi (kPa)	5.0 (35)	10.0 (69)	13.0 (90)	15.0 (104)	25.0 (173)	40.0 (276)	60.0 (414)	15.0 (104)	15.0 (104)	20.0 (138)	25.0 (173)	40.0 (276)	60.0 (414)	100.0 (690)
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, F·ft²h/Btu (K·m²/W) Mean temperature: 75 6 2°F (24 6 1°C)	3.1 (0.55)	3.6 (0.63)	3.8 (0.67)	4.0 (0.70)	4.2 (0.74)	4.2 (0.74)	4.3 (0.76)	4.6 (0.81)	5.0 (0.88)	3.9 (0.68)	5.0 (0.88)	5.0 (0.88)	5.0 (0.88)	5.0 (0.88)
Flexural strength, min, psi (kPa)	10.0 (70)	25.0 (173)	30.0 (208)	35.0 (240)	50.0 (345)	60.0 (414)	75.0 (517)	40.0 (276)	40.0 (276)	45.0 (310)	50.0 (345)	60.0 (414)	75.0 (517)	100.0 (690)
Water vapor permeance of 1.00-in. (25.4-mm) thickness (See Note 5.), max, perm (ng/Pa·s·m²)	5.0 (287)	5.0 (287)	3.5 (201)	3.5 (201)	2.5 (143)	2.5 (143)	2.5 (143)	1.5 (86)	1.5 (86)	1.5 (86)	1.5 (86)	1.1 (63)	1.1 (63)	1.1 (63)
Water absorption by total immersion, max, volume %	4.0	4.0	3.0	3.0	2.0	2.0	2.0	0.3	0.3	1.0	0.3	0.3	0.3	0.3
Dimensional stability (change in dimensions), max,%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Oxygen index, min, volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Density, min, lb/ft³ (kg/m³)	0.70 (12)	0.90 (15)	1.15 (18)	1.35 (22)	1.80 (29)	2.40 (38)	2.85 (46)	1.20 (19)	1.30 (21)	1.60 (26)	1.55 (25)	1.80 (29)	2.20 (35)	3.00 (48)

EPS options

XPS options

Compressive Strengths

EPS

- 7 standard types available
- 5 psi – 60 psi
  - 5 psi for packaging or compressible inclusions
- Any thickness or sheet size available in all strengths
- Recommend right density based on actual project loading conditions

XPS

- 3 standard types available
- 15 psi – 100 psi
  - 15 and 100 psi products are special order only
- Typical recommendation of 15 psi for residential & wall applications only
- 25 – 100 psi for commercial applications

Plaza Parking Deck

ASTM D6817

Specification for Rigid Cellular Polystyrene Geofoam

Improves Design Predictability

- 1st published in 2002
- Establishes additional physical properties to aid Engineers in designing projects where Polystyrene will act as a structural void fill material & will bear the weight of concrete slabs, soil overburden, pavement and heavy truck traffic
- 1% deformation values published for EPS and XPS
  - Considered as the conservative Elastic Limit Stress (σ)
- Material will NOT exhibit post construction creep or plastic deformation as long the combined dead/live loads do not exceed the 1% strain values identified in ASTM D6817

The Strength That Really Counts
Design within the Elastic Range

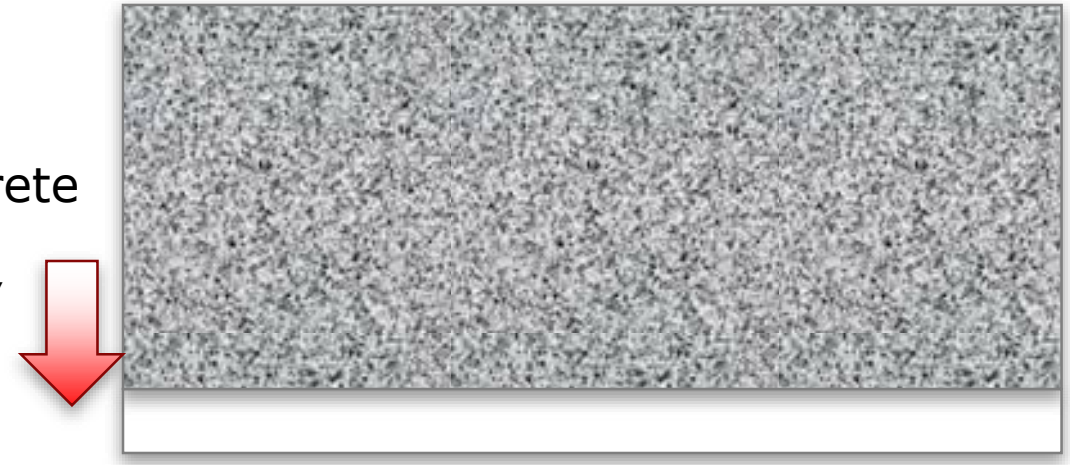
Type I EPS can bear a minimum of 518 psf @ 1% strain (σ)
- 10 psi @ 10% strain

Concrete weighs 150 pcf

Divide elastic limit stress (1% strain value) of foam type
- by weight of overburden material
- 518 psf / 150 pcf = 3.45 feet

3.45 feet (41”) of concrete

1% strain of 6” = 0.06”
Less than 1/16”
compression



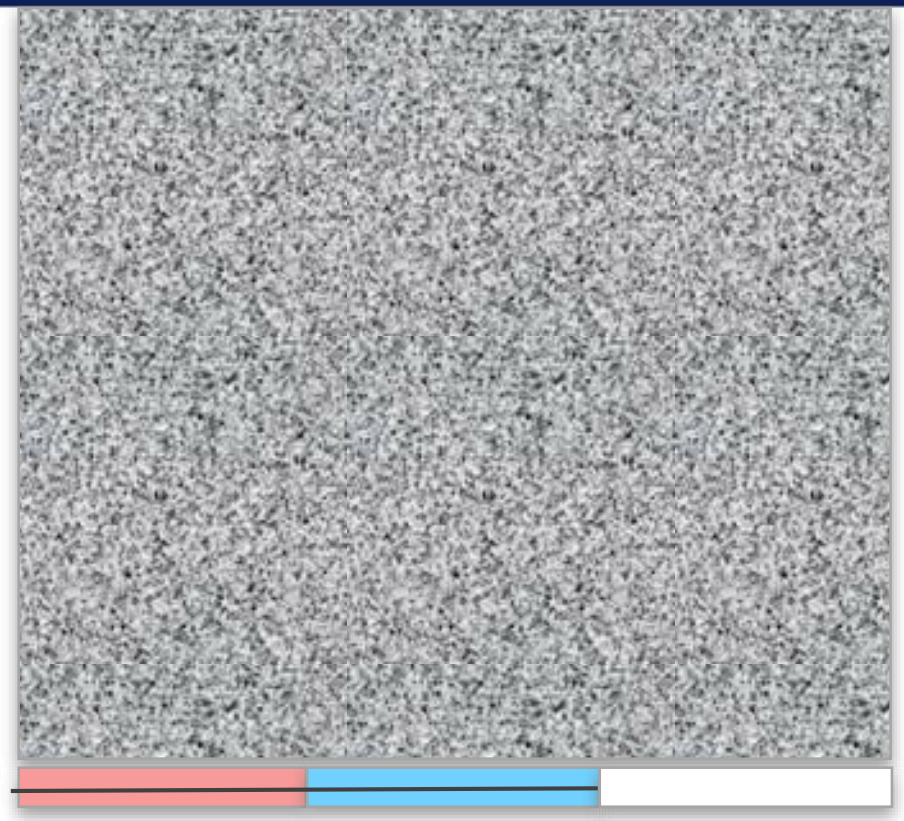
6” of Type I EPS

XPS Manufacturers Say: 25 psi Minimum Under Slab

- Type IV XPS can bear a minimum of 1,569 psf @ 1% strain
  - 25 psi @ 10% strain
- Type IX EPS can also bear a minimum of 1,569 psf @ 1% strain
  - 25 psi @ 10% strain
- 1569 psf / 150 pcf = 10.45 feet

10.45 feet (125”) of concrete

1% strain of 6” =0.06”
Less than 1/16” compression



6” of Type IV XPS or Type IX EPS

The Right Choice for your Project?

- Concrete weighs 150 pcf
  6” slab weighs 75 psf
- Soil weighs 120 pcf
  2’ of soil weighs 240 psf

- Most concrete parking garages and structural roof decks are designed to withstand 100-200 psf total dead/live loads
- Pedestrian foot traffic loads are typically 50-75 psf
- Heavy semi-truck traffic loads are typically 100-200 psf

Actual Project: Cost of Over Specifying

100 psi XPS specified as tiered void filler sandwiched between a structural deck and 6” thick concrete slab with pedestrian traffic San Diego, CA: 10,000 cubic feet

EPS

- 518 psf or 3.6 psi @ 1% or 10 psi @ 10% strain
- Cost per cubic foot : $3.00

XPS

- 5,846 psf or 40.6 psi @ 1% or 100 psi at 10% strain
- Cost per cubic foot: $25

Total loads: 175 psf (75: slab + 100: live)

Total savings to use EPS: $220,000

Water Absorption Test
ASTM C272

24-hour Full Submersion Test

XPS	EPS
0.3%	2 - 4%

Long-Term Moisture Retention

EPS Below Grade Series 103
November 2008

Technical bulletin

15-Year In-Situ Research Shows EPS Outperforms XPS in R-Value Retention

Studies show that as much as 25% of energy loss from a structure can be attributed to a lack of insulation on below-grade foundations, crawl spaces and under slabs. Insulation R-value is directly correlated to maximum energy efficiency in a building envelope: higher R-values translate into increased savings. In below grade applications, foam insulation is exposed to moisture and could lose r-value over time if this moisture is absorbed.

As shown in an independent, third-party test program expanded polystyrene (EPS) maintains its R-value even after long-term exposure in cold, wet climates. A competing insulation material, extruded polystyrene (XPS) was shown to have lost R-value over time. The results of this test program demonstrate that EPS insulation is a perfect choice to reduce energy loss.

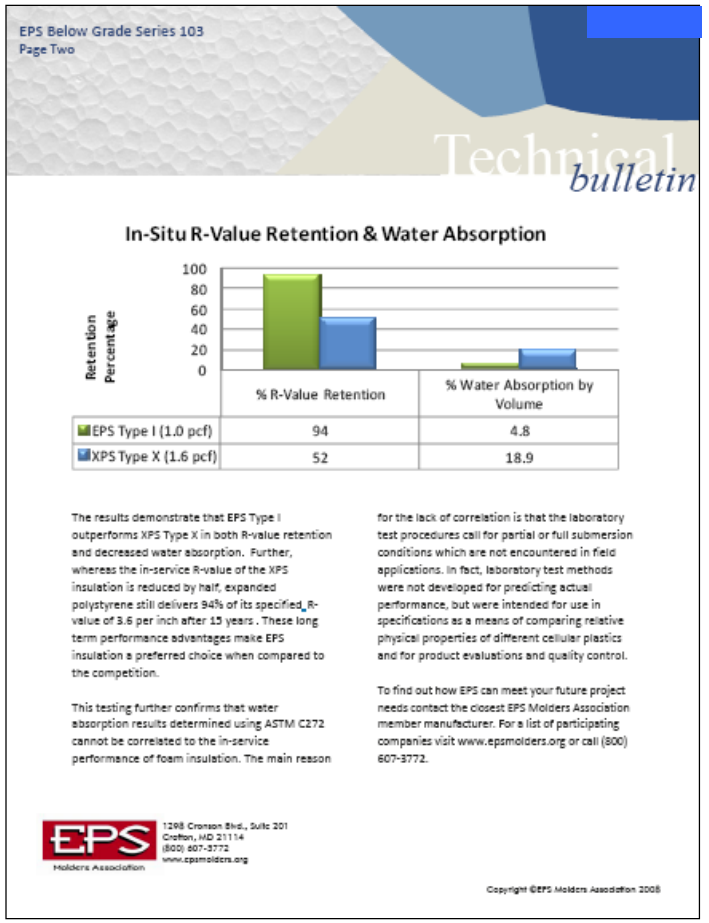
IN-SITU TEST RESULTS

In August 2008, independent testing[1] evaluated the field performance of EPS and XPS insulation in a side-by-side, below grade application following a continuous 15-year installation period. EPS Type I and XPS Type X test samples were excavated from the exterior of a commercial building in St. Paul, MN at a depth of approximately 6 feet below grade.

Specimens were tested for thermal resistance using ASTM C518 *"Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus"* immediately after excavation. Moisture content was determined by measuring the sample weight at the time of removal and again after being oven dried.

Excavation Site Minneapolis, MN Climate Zone 1

Side-by-Side Installation



Technical bulletin

In-Situ R-Value Retention & Water Absorption

	% R-Value Retention	% Water Absorption by Volume
EPS Type I (1.0 pcf)	94	4.8
XPS Type X (1.6 pcf)	52	18.9

The results demonstrate that EPS Type I outperforms XPS Type X in both R-value retention and decreased water absorption. Further, whereas the in-service R-value of the XPS insulation is reduced by half, expanded polystyrene still delivers 94% of its specified R-value of 3.6 per inch after 15 years. These long term performance advantages make EPS insulation a preferred choice when compared to the competition.

This testing further confirms that water absorption results determined using ASTM C272 cannot be correlated to the in-service performance of foam insulation. The main reason for the lack of correlation is that the laboratory test procedures call for partial or full submersion conditions which are not encountered in field applications. In fact, laboratory test methods were not developed for predicting actual performance, but were intended for use in specifications as a means of comparing relative physical properties of different cellular plastics and for product evaluations and quality control.

To find out how EPS can meet your future project needs contact the closest EPS Molders Association member manufacturer. For a list of participating companies visit www.epsmolders.org or call (800) 607-3772.

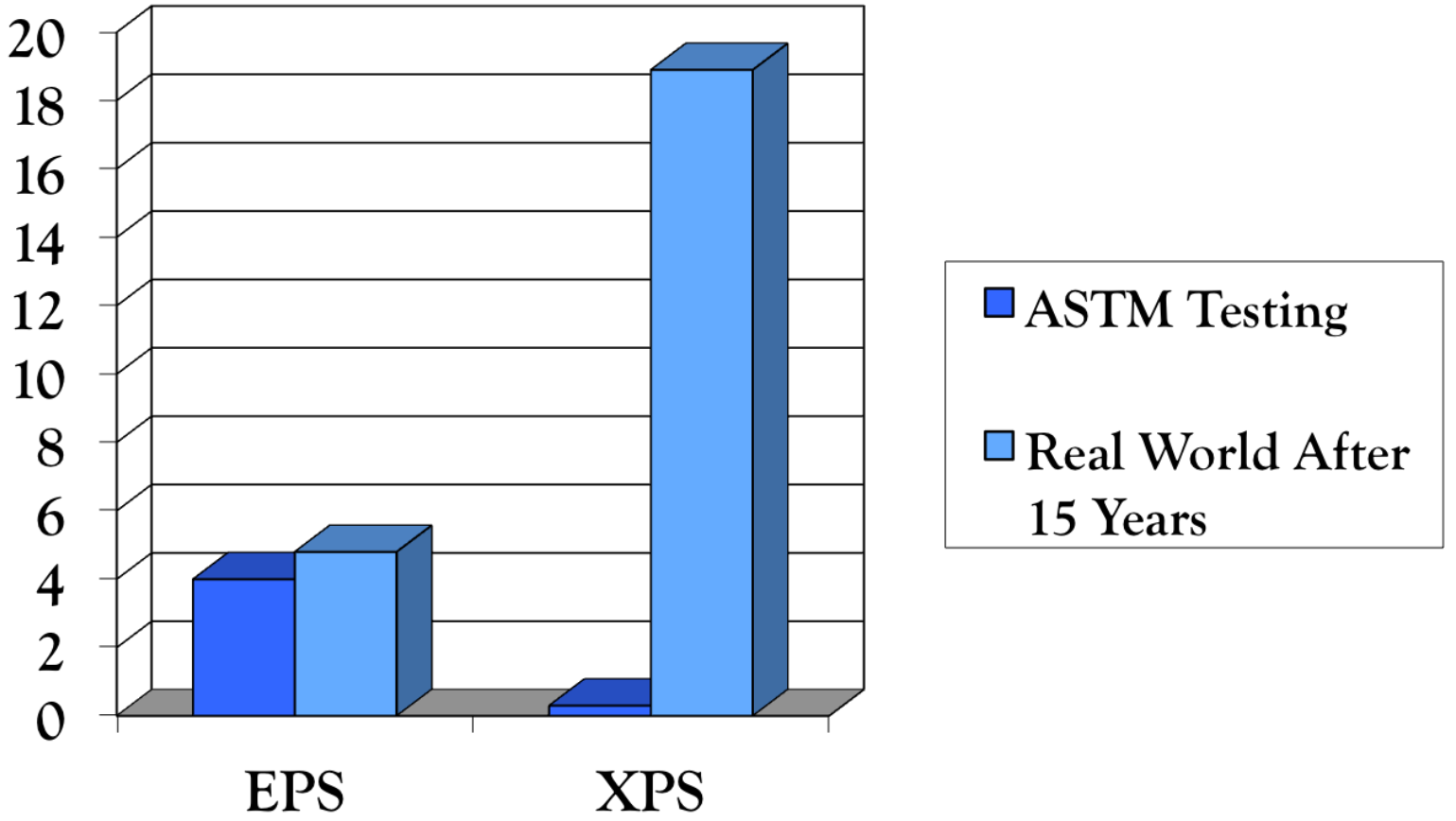
EPS Molders Association
1298 Cronson Blvd., Suite 201
Crofton, MD 21114
(800) 607-3772
www.epsmolders.org

Compare Moisture Retention After 15 years in service

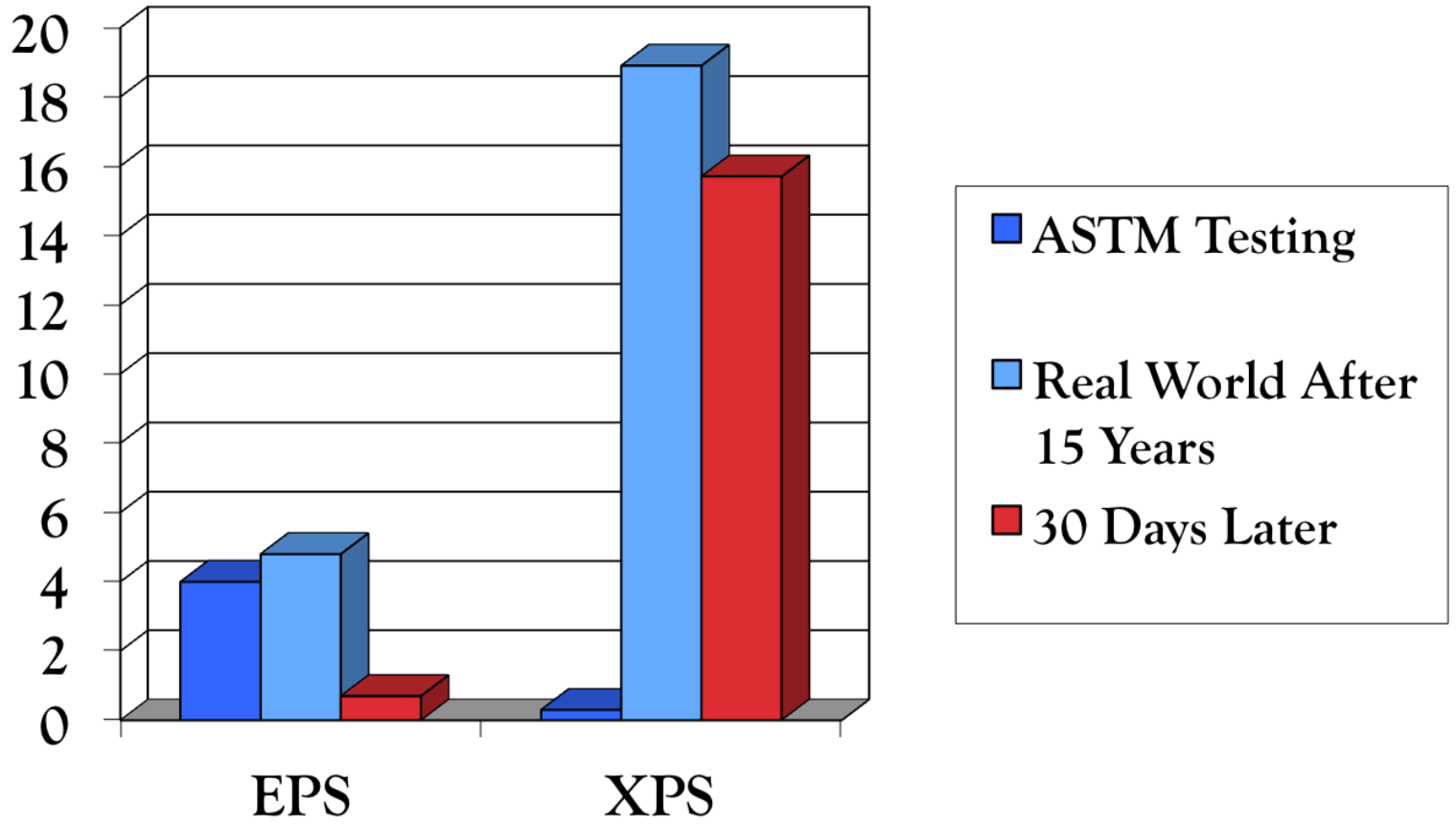
	15 Yr. In-situ Test Results				ASTM C578 Values	
	Results Upon Extraction		Results after 30 days @ 72° F & 50% R.H.			
	EPS	XPS	EPS	XPS	EPS	XPS
R-Value/inch	3.4	2.6	3.7	2.8	3.6	5.0
Moisture Content (Volume %)	4.8	18.9	0.7	15.7	4.0	0.1

Unlike other Type I EPS, when exposed to dry conditions for four weeks, the XPS did not approach values expected per ASTM 578 *Standard Specification for Rigid Polystyrene Thermal Insulation*

Water Absorption Percentage



Water Absorption Percentage



Published R-Values

EPS

- 3.85 - 4.6 per inch @ 75° F
- R–Value increases as temperature decreases
- 40° and 25° F values available
  - Higher per inch
  - Base on local climate

XPS

- 5 per inch @ 75° F
- R–Value increases as temperature decreases
- 40° and 25° F values available
  - Higher per inch
  - Base on local climate

Life Sciences: U of A, Fairbanks, Alaska

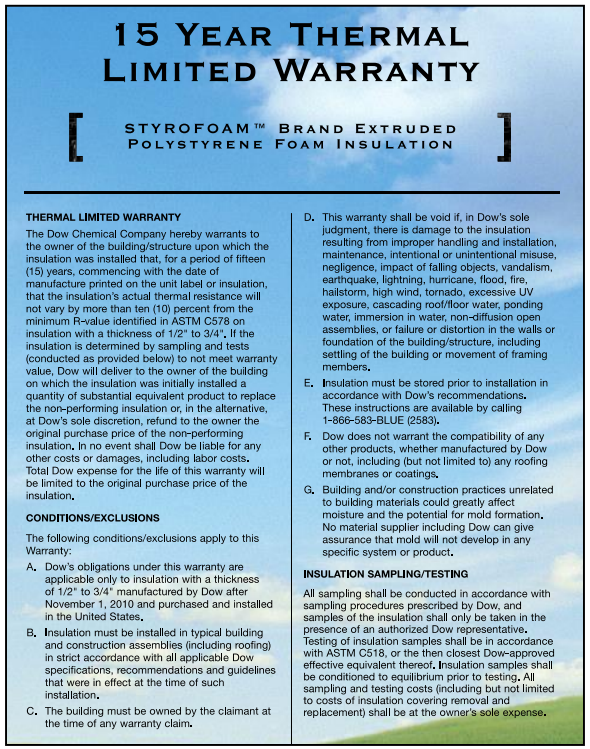
Thermal Drift Reduces Long Term R-Value

- Thermal Drift is defined as loss of insulating power over time as trapped low conductivity blowing agent used to manufacture XPS escapes out of the foam and is replaced with air.
- R-Value of XPS starts higher and then irreversibly decreases over time.
- EPS does not experience thermal drift because there is no blowing agent trapped in between the cells (just air).

Warranted R-Values

EPS

- 100% of published value



15 YEAR THERMAL LIMITED WARRANTY

[STYROFOAM™ BRAND EXTRUDED POLYSTYRENE FOAM INSULATION]

THERMAL LIMITED WARRANTY

The Dow Chemical Company hereby warrants to the owner of the building/structure upon which the insulation was installed that, for a period of fifteen (15) years, commencing with the date of manufacture printed on the unit label or insulation, that the insulation's actual thermal resistance will not vary by more than ten (10) percent from the minimum R-value identified in ASTM C578 on insulation with a thickness of 1/2" to 3/4". If the insulation is determined by sampling and tests (conducted as provided below) to not meet warranty value, Dow will deliver to the owner of the building on which the insulation was initially installed a quantity of substantial equivalent product to replace the non-performing insulation or, in the alternative, at Dow's sole discretion, refund to the owner the original purchase price of the non-performing insulation. In no event shall Dow be liable for any other costs or damages, including labor costs. Total Dow expense for the life of this warranty will be limited to the original purchase price of the insulation.

CONDITIONS/EXCLUSIONS

The following conditions/exclusions apply to this Warranty:

A. Dow's obligations under this warranty are applicable only to insulation with a thickness of 1/2" to 3/4" manufactured by Dow after November 1, 2010 and purchased and installed in the United States.

B. Insulation must be installed in typical building and construction assemblies (including roofing) in strict accordance with all applicable Dow specifications, recommendations and guidelines that were in effect at the time of such installation.

C. The building must be owned by the claimant at the time of any warranty claim.

D. This warranty shall be void if, in Dow's sole judgment, there is damage to the insulation resulting from improper handling and installation, maintenance, intentional or unintentional misuse, negligence, impact of falling objects, vandalism, earthquake, lightning, hurricane, flood, fire, hailstorm, high wind, tornado, excessive UV exposure, cascading roof/floor water, ponding water, immersion in water, non-diffusion open assemblies, or failure or distortion in the walls or foundation of the building/structure, including settling of the building or movement of framing members.

E. Insulation must be stored prior to installation in accordance with Dow's recommendations. These instructions are available by calling 1-866-583-BLUE (2583).

F. Dow does not warrant the compatibility of any other products, whether manufactured by Dow or not, including (but not limited to) any roofing membranes or coatings.

G. Building and/or construction practices unrelated to building materials could greatly affect moisture and the potential for mold formation. No material supplier including Dow can give assurance that mold will not develop in any specific system or product.

INSULATION SAMPLING/TESTING

All sampling shall be conducted in accordance with sampling procedures prescribed by Dow, and samples of the insulation shall only be taken in the presence of an authorized Dow representative. Testing of insulation samples shall be in accordance with ASTM C518, or the then closest Dow-approved effective equivalent thereof. Insulation samples shall be conditioned to equilibrium prior to testing. All sampling and testing costs (including but not limited to costs of insulation covering removal and replacement) shall be at the owner's sole expense.

XPS

- Typical, 90% of published value
  - 10% decrease in writing
- R- 5 per inch published
  - Thermal Drift Occurs

= **R- 4.5 per inch warranted**

EPS is viable alternative to XPS

- Stable, long term R-Value that won’t drift
- Compressive strengths to match with loading requirements of job
- Low long-term moisture retention with no detrimental structural effect on physical properties

Learning Objectives

- Define and understand the similarities and differences between how Expanded Polystyrene (EPS) and Extruded Polystyrene (XPS) are manufactured
- Learn about the environmental features and benefits of polystyrene insulation including recyclability, LEED, thermal performance, energy efficiency, reducing global warming and mold resistance
- Understanding ASTM C578: *Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*
- Review physical property data of both EPS and XPS: Compressive Strength, Long Term Moisture Retention and Sustainable R-Value

INSULFOAM
A CARLISLE COMPANY

INSULATION ENGINEERED TO
MAKE A DIFFERENCE.



Thank You for Your Time!

Questions?