MPS No. 1001

Subject: **Understanding Thermal Design Terms**

Date: **January 2008 (Revised January 2019)**

R-value (Thermal Resistance)

R-value, or thermal resistance, is a measure of a material's or a construction's ability to retard heat flow. A higher R-value provides better thermal insulation performance. R-values of materials in series can be added to determine a construction's total thermal resistance.

Although not normally written, the units of R-values are $\frac{hr \cdot ft^2 \cdot {}^oF}{Btu}$ or $\frac{m^2 \cdot {}^oC}{W}$

U-value (Thermal Transmittance)

U-value is a measure of a material's or a construction's ability to allow heat to pass through itself. A lower U-value provides better thermal insulation performance. It is the reciprocal of a construction's R-value.

U-values include air film resistances. The units of U-value are $\frac{Btu}{hr \cdot ft^2 \cdot {}^oF}$ or $\frac{W}{m^2 \cdot {}^oC}$

C-value (Thermal Conductance)

C-value is a measure of a material's or a construction's ability to allow heat to pass through itself. It is the same as U-value but without air film resistances. A lower C-value provides better thermal insulation performance.

The units of C-values, just like U-values, are $\frac{Btu}{hr \cdot ft^2 \cdot {}^oF}$ or $\frac{W}{m^2 \cdot {}^oC}$

K-value (Thermal Conductivity)

K-value is a measure of a homogeneous material's ability to allow heat to pass through itself, independent of its thickness. A lower K-value provides better thermal insulation performance. If we multiply a material's C-value by its thickness, we have its K-value.

$$K = \frac{1}{R} \cdot t = \frac{t}{R}$$

The units of K-value are $\frac{Btu \cdot in}{hr \cdot ft^2 \cdot {}^oF}$ or $\frac{W}{m^2 \cdot {}^oC}$

Example

	Component R-value
Inside Air Film	0.7
1/2" Gypsum Wallboard	0.5
R-19 Fiberglass	19.0
1" Hawaii Construction Foam 250	4.8
Wood Siding	0.8
Outside Air Film	0.2
Wall R-value	26.0

Using the example:

$$U = \frac{1}{R} = \frac{1}{26.0} = 0.038$$

From the example, the wall's R-value without air films is 26.0 minus 0.9 (0.7 + 0.2) or 25.1.

$$C = \frac{1}{R} = \frac{1}{25.1} = 0.040$$

PAP 1001-08/20

Hawaii Construction Foam

Tech Bulltin

MPS No. 1002

Subject: **R-value and Long Term R-value – Background**

Date: **January 2008 (Revised January 2019)**

The blowing agents used in extruded polystyrene, polyisocyanurate, and polyurethane foams provide for an initial high R-value. During the life of the foam, air from the atmosphere diffuses into the cells of the foam and reduces the R-value. In addition, the blowing agents themselves diffuse out of the foam, further reducing the R-value.

Two test methods have been developed to help provide information and standardize the reporting of R-value for materials with blowing agents other than air. The following test methods have been developed:

ASTM C1303 Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation.

CAN/ULC-S770 Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Insulating Foams.

Both test methods provide a similar method to predict the Long Term Thermal Resistance (LTTR) or long term R-value of insulations.

Diffusion theory for gases establishes that the diffusion of gases in foam is mathematically dependent upon the thickness. Each of the methods involves cutting thin sections approximately 10 mm (3/8") from a sample of thicker insulation such as 100 mm (4"). Due to the relative size of the thin samples, diffusion of air into the foam and blowing agents out of the foam is quicker than for the original thick sample. The measurement of thermal resistance for the thin samples along with mathematical relations allows for the prediction of the LTTR or long term R-value. However, in each method long term is defined only as 5 years.

ASTM C1303 excerpt: "The values produced by the Prescriptive Method correspond to the thermal resistance at an age of five years"

CAN/ULC-S770 excerpt: "This procedure defines the long-term thermal resistance (LTTR) of a foam product as the value measured after 5-year storage..."

As noted above, the LTTR value commonly published from testing to ASTM C1303 or CAN/ULC-S770 is a prediction for the R-value of the insulation after 5 years.

Many insulation manufacturers are promoting LTTR without providing a clear understanding that LTTR is a prediction for the R-value of the material after only 5 years. The concept of a 5 year R-value being equal to the "time-weighted 15 year average" is also often used by Polyiso and XPS manufacturers. This approach assumes that the higher R-value established in years 1-4 is weighted by the inevitably lower R-value of the insulation in years 6-15.

Neither the 5 year R-value, nor the time-weighted 15 year average approach is appropriate for use in building design. This is due to the fact that the R-values of Polyiso and XPS continue to decline below the LTTR published 5 year numbers. Starting in year 5 and for the remaining life of the insulation, the R-values of Polyiso and XPS are below LTTR published R-values.

Most insulation users are interested in a true long-term thermal R-value for their insulations. A 50 year R-value is a more suitable long-term R-value for use in building design. The 50 year R-value can easily be determined using the existing protocol described in ASTM C1303 or CAN/ULC-S770.

Specify a 50 year R-value for a reliable long-term R-value for building design.

PAP 1002-08/20

MPS No. 1003

Subject: **R-Value and Long Term R-Value – Polyisocyanurate Insulation**

Date: **January 2008 (Revised January 2019)**

Manufacturers of Polyisocyanurate insulation are promoting the use of the long term R-value techniques in ASTM C1303 and CAN/ULC S770. The Polyisocyanurate Insulation Manufacturers Association, PIMA, is promoting using some form of time weighted average over 15 years[1]. Their literature states that "using techniques in ASTM C1303, CAN/ULC S770" provides the following long term R-values for some Polyisocyanurate insulations.

Average LTTR Values for Polyiso with Hydrocarbon Blowing Agents[1]	
POLYISO THICKNESS (inches)	**LTTR R-VALUE**
1	6.0
2	12.1
3	18.5
4	25.0

The exact variations from the standard test methods are not described. As is well known, deviations from standard test methods make the results unreliable for comparison.

Although this is a step forward for the Polyisocyanurate insulation industry to recognize that estimates of long term R-value, the use of their 'modified' test method only allows for Polyisocyanurate insulation manufacturers to compare performance among Polyisocyanurate insulations. The use of the modified PIMA method DOES NOT provide for determination of a long term R-value, such as after 50 years. The PIMA method only provides for the determination of the R-value after 5 years.

The R-value published by polyisocyanurate insulation manufacturers is ONLY for 5 years.

The long term R-value for polyisocyanurate insulations is LOWER than that represented by the PIMA published information.

[1] Refer to Polyiso Performs - PIMA (Polyisocryanurate Insulation Manufacturers Association) - 2002

PAP 1003-08/20

MPS No. 1004

Subject: **Mold**

Date: **January 2008 (Revised January 2019)**

The building industry is continually learning about the growth of mold. Homeowners and building professionals are concerned over the potential for mold growth and the impact on the living environment. This bulletin is designed to provide a basic overview of mold in structures.

Mold problems in structures are normally directly related to a moisture problem. Common moisture problems are the result of water leaks and/or the lack of attention to flashing and building details.

Molds are a type of fungi in the same family as mushrooms and yeasts. Molds need the right conditions to grow. This is typically a temperature between 40 and 100 degrees Fahrenheit and 20% moisture content in the product they are attacking. Thus, an area of a building with a water problem is an ideal environment for mold growth. Under warm and humid conditions, they can quickly multiply and spread over wall surfaces and building materials.

Molds are an essential part of the world with the function of breaking down the basic components of plants and other natural organic materials. The molds of concern to the building industry get their nutrients from the starches and sugars in wood and paper products.

Hawaii Construction Foam insulation does not contain the starches or sugars as found in wood or paper products.

Hawaii Construction Foam insulation provides no nutrient value to plants, animals, or microorganisms. Therefore, bacteria and fungi (mold) do not multiply due to the presence of insulation.

If a mold problem is encountered in a structure, a building professional should be consulted.

PAP 1004-08/20

MPS No. 1005

Subject: Soundproofing

Date: January 2008 (Revised January 2019)

Design of wall, floor, or roof elements may require special attention to the sound transmission performance. Sound Transmission is measured by ASTM E-90, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions." The test measures the sound transmission loss for sound with frequencies from 125-4000 Hz. This range is the most important part of the hearing range. The results of the test are further classified into a Sound Transmission Class (STC) which is useful in comparing different building systems. The significance of STC ratings can be seen by a review of the following information on STC ratings.

STC rating

25 Normal speech can be understood quite clearly.

30 Loud speech can be understood fairly well.

35 Loud speech audible but not intelligible.

42 Loud speech audible as a murmur

45 Must strain to hear loud speech.

48 Some loud speech barely audible

50 Loud speech not audible

The design of systems which have high STC ratings relies on passive absorption, barriers, and proper construction details.

Passive Absorption

When sound passes through materials, the energy of the sound is reduced by absorption. Acoustically absorptive materials force sound to change directions many times and travel long distances before the sound passes through. Each time a sound wave changes direction, some energy of the sound wave is lost.

Barriers

Since sound is a form of energy, barriers can be used to reduce sound transmission. An effective barrier has a high mass (weight and density) and a low resonant frequency to stop (or reflect) this energy.

Construction Details

Building components designed to have a high STC rating rely on proper construction. It is critical that details must be followed to eliminate any cracks or air gaps. Sound will find its way through the smallest crack.

Hawaii Construction Foam insulation can be used in the design of walls having specific STC ratings when constructed with various components, such as gypsum board, sound channels, and sound insulation. The use of Hawaii Construction Foam insulation in sound walls should be verified by testing in accordance with ASTM E-90.

PAP 1005-08/20

Hawaii Construction Foam

Tech Bulltin

MPS No. 1006

Subject: Low Temperature R-Values

Date: January 2008 (Revised January 2019)

The following chart has been assembled to aid in the design of Hawaii Construction Foam insulation applications in low temperature conditions.

Hawaii Construction Foam	Temperature			
	40°F (4.4°C)	25°F (-3.9°C)	0°F (-17.8°C)	-25°F (-31.7°C)
100	4.2	4.4	4.5	4.7
130	4.4	4.6	4.7	4.8
150	4.6	4.7	4.8	5.0
250	4.8	5.0	5.1	5.3

PAP 1006-08/20

HAWAII CONSTRUCTION FOAM

TECH BULLTIN

MPS No. 1007

Subject: **Mold Resistance**

Date: **January 2008 (Revised January 2019)**

Hawaii Construction Foam insulation was subjected to accelerated moisture/mold exposure testing to gauge its degree of mold resistance. Testing was based upon ASTM D3273-00, "Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber." This testing involves exposing the Hawaii Construction Foam insulation to mold in an high humidity environment, approximately 90% RH. In addition to the testing of Hawaii Construction Foam insulation sample, samples of southern yellow pine were tested as a control. At the end of the 3 month test, the growth of mold (Trichoderma and Aspergillus) was obvious on the southern yellow pine. NO mold growth was present on the Hawaii Construction Foam insulation. Please also refer to Technical Bulletin MPS no. 1004.

Southern Yellow Pine with Mold Growth

Molded Polystyrene insulation with NO Mold Growth

PAP 1007-08/20

MPS No. 1009

Subject: **Building Green and LEED Credits**

Date: **January 2008 (Revised January 2019)**

The United States Green Building Council (USGBC) publishes the Leadership in Energy and Environmental Design (LEED) rating system. The latest LEED, version v4, includes new market sector adaptations for data centers, warehouses and distribution centers, hospitality, existing schools, existing retail and mid-rise residential projects

LEED v4 establishes requirements for design components that impact sustainable design. Credits or points are earned for meeting specific milestones in various categories. These categories include Location and Transportation (LT), Sustainable Sites (SS), Water Efficiency WE), Energy and Atmosphere (EA), Materials and Resources (MR), Indoor Environmental Quality (EQ) , Innovation (IN), and Regional Priority (RP). A minimum number of available points are required to achieve a LEED Certified rating. Silver, Gold, and Platinum levels are also available by meeting higher point thresholds.

Hawaii Construction Foam insulation is an ideal insulation choice for inclusion into LEED certified building designs. The key benefit of using Hawaii Construction Foam insulation is a reduction in energy consumption. The following are the key categories associated with the use of Hawaii Construction Foam insulation in LEED certified building.

Materials & Resources

Environmental Product Declarations

Hawaii Construction Foam Insulation is a molded polystyrene insulation and an industry wide Environmental Product Declaration (EPD) is available to understand environmental impacts.

Material Ingredients

A material ingredients disclosure for Hawaii Construction Foam Insulation is available to provide information on the ingredients contained in Hawaii Construction Foam Insulation.

Energy & Atmosphere

Minimum Energy Performance

Hawaii Construction Foam insulation helps reduce the environmental and economic harms of excessive energy use by achieving a minimum level of energy efficiency for the building and its systems.

(required)

Optimized Energy Performance

Hawaii Construction Foam insulation is a key building envelope component to achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic harms associated with excessive energy use.

PAP 1009-08/20

MPS No. 1010

Subject: **ASTM Standard**

Date: **January 2008 (Revised January 2019)**

Hawaii Construction Foam insulation is a rigid cellular molded polystyrene material that is used for building insulation, geotechnical applications (geofoam), as a component of structural insulated panels, as a component of exterior insulation finish systems, and a number of other applications. Molded polystyrene in each of these end use applications requires different performance properties upon which a product selection would be made.

In order to promote uniformity of specification for expanded polystyrene in these various applications, ASTM has developed multiple standard specifications for polystyrene foam. This bulletin describes the three main ASTM standard specifications that cover foam products.

ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation

ASTM C578 is the standard that is referenced in the design and applicability of molded polystyrene materials for general insulation needs. This specification covers the types, physical properties, and dimensions of cellular polystyrene intended for use as thermal insulation.

Hawaii Construction Foam insulation is available in 7 different "Types" as specified in ASTM C578. These are Type XI, I, VIII, II, IX, XIV, and XV. In addition to thermal properties, such as R-value; physical properties such as compressive resistance, flexural strength, water vapor permeance, and water absorption are requirements of ASTM C578. The performance requirements for the various Types of Hawaii Construction Foam insulation can be seen in the tables attached to this bulletin.

ASTM E2430 Standard Specification For Expanded Polystyrene ("EPS") Thermal Insulation Boards For Use In Exterior Insulation and Finish Systems ("EIFS")

ASTM E2430 is a standard for boards used in Exterior Insulation and Finish Systems ("EIFS"). The specification covers requirements for board dimensions and manufacturing requirement specific to the EIFS industry. The boards are specified to be 2' in width and 4' in length, the standard size required for the EIFS industry. Boards in compliance with ASTM E2430 must fully comply with the Type I requirements of ASTM C578. No additional material properties are required by ASTM E2430. Thus, the Type I referenced properties from ASTM C578 are applicable to molded polystyrene manufactured in conformance with ASTM E2430.

ASTM D6817 Standard Specification for Rigid Cellular Polystyrene Geofoam

The title for ASTM D6817 is clear that this specification is for Geofoam applications. Geofoam is the commonly accepted term for lightweight foam materials used in geotechnical applications. ASTM D6817 specifically defines geofoam as a "block or planar rigid cellular foam polymeric material used in geotechnical engineering applications." ASTM D6817 is the definitive standard that should be referenced in the design and applicability of molded polystyrene materials for geotechnical applications. This specification covers the types and physical properties of cellular polystyrene intended for use as Geofoam.

Hawaii Construction Foam Geofoam is available in 7 different "Types" as specified in ASTM D6817. These are Type EPS12, EPS5, EPS19, EPS22, EPS29, EPS39, and EPS46. The key material property specified by ASTM D6817 is the compressive resistance at 1% deformation. This is the normally accepted design load for geofoam.

In addition to compressive resistance at 1% deformation, compression resistance at 5% and 10% is also available. The compression resistance at these higher percentage of compression are applicable to the very specific design and use of molded polystyrene in compressible application. Flexural strength, a key quality control measure, is also included. The performance requirements for the various Types of Hawaii Construction Foam Geofoam are shown in the tables attached to this bulletin. Please also refer to Hawaii Construction Foam Geofoam technical bulletin no. 5001.

The standards referenced in this bulletin are copyrighted by ASTM. If you require of any of the above reference standards, please visit ASTM at their website, www.astm.org to purchase a copy.

This table outlines a few key physical properties of Hawaii Construction Foam molded polystyrene insulation in accordance with ASTM C578, “Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation” compared to Hawaii Construction Foam Geofoam in accordance with ASTM D6817, “Standard Specification for Rigid Cellular Polystyrene Geofoam”.

PRODUCT		Insulation 50	Insulation 100	Insulation 130	Insulation 150	Insulation 250	Insulation 400	Insulation 600	Geofoam 12	Geofoam 15	Geofoam 19	Geofoam 22	Geofoam 29	Geofoam 39	Geofoam 46
ASTM C578[2] Compliance, Type		XI	I	VIII	II	IX	XIV	XV							
ASTM D6817[1] Compliance, Type									EPS12	EPS15	EPS19	EPS22	EPS29	EPS39	EPS46
Density[1,2], min., ASTM C303	lb/ft³ (kg/m³)	0.70 (12)	0.90 (15)	1.15 (18)	1.35 (22)	1.80 (29)	2.40 (38)	3.0 (48)	0.70 (11)	0.90 (15)	1.15 (18)	1.35 (22)	1.80 (29)	2.40 (38)	2.85 (46)
Compressive Strength @10%[2], min., ASTM D1621	psi (kPa)	5 (35)	10 (69)	13 (90)	15 (104)	25 (173)	40 (276)	60 (414)							
Compressive Resistance @1% deformation[1], min., ASTM D1621	psi (kPa)								2.2 (15)	3.6 (25)	5.8 (40)	7.3 (50)	10.9 (75)	15.0 (103)	18.6 (128)
R-value[2], Thermal Resistance, per inch, ASTM C518	°F·ft²·h/Btu (°K·m²/W)	3.2 (0.56)	3.9 (0.68)	3.9 (0.69)	4.2 (0.73)	4.4 (0.77)	4.4 (0.77)	4.5 (0.78)							
Flexural Strength[1,2], min. ASTM C203	psi (kPa)	10 (69)	25 (173)	30 (208)	35 (242)	50 (345)	60 (414)	75 (517)	10 (69)	25 (172)	30 (207)	35 (240)	50 (345)	60 (414)	75 (517)
Oxygen Index[1,2], min.	vol. %	24	24	24	24	24	24	24	24	24	24	24	24	24	24

[1] Please refer to ASTM D6817 specification for complete information.
[2] Please refer to ASTM C578 specification for complete information.

PAP 1010-08/20

MPS No. 1013

Subject: **Environmental Cycling**

Date: **April 2008 (Revised January 2019)**

Molded polystyrene has a proven track record of performance in below grade applications. Molded polystyrene is a closed cell material with excellent resistance to moisture, freeze-thaw cycles, and the rigors of below grade use.

The successful performance of molded polystyrene insulation used as below-grade insulation material has been demonstrated by a two-year exposure to a below-grade foundation application[1]. Key performance issues highlighted during the project were:

- The molded polystyrene insulation was directly exposed to high moisture content soil conditions; however, the moisture content after the two-year exposure period was found to be less than 0.5% by volume on average.
- The in-situ thermal performance of the molded polystyrene insulation was monitored over the two-year exposure period and found to remain constant - i.e., there was no loss in thermal resistance value exhibited based upon field monitoring.
- Samples taken from the field exposure were subjected to laboratory testing to confirm thermal performance and durability. Test results indicated there was no change in material properties after the two-year field exposure.
- The research project included development of a durability test protocol to provide a means of assessing performance of all types of insulation subjected to extreme thermal gradient and environmental cycling. Testing confirmed that all types of molded polystyrene insulation retained their specified material properties even after being subjected to freeze-thaw cycling.

The below-grade research[1] led to the development of ASTM C1512, "Standard Test Method for Characterizing the Effect of Exposure to Environmental Cycling on Thermal Performance of Insulation Products". This standard provides a laboratory method to characterize the performance of insulations used in below grade applications.

The method exposes test specimens initially to moisture for 28 days to intentionally increase moisture content.

After this period, the samples are exposed to freeze-thaw cycles. The specimens divide two environments during the freeze-thaw cycling: 75°F 90%RH and an environment that cycles every 12 hours between 5°F and 60°F for 20 days. This exposure simulates the performance of building insulation in cold climates. The 75°F is similar to the interior of the building and the cycling between 5°F and 60°F is to simulate the changing exterior environment.

Hawaii Construction Foam 100, 150, and 250 samples have been tested in accordance with ASTM C1512[2]. The samples were tested for compressive strength and thermal resistance (R-value) before and after the environmental cycling. The moisture condition was also measured after the cycling.

AFTER ASTM C1512 Environmental Cycling

Hawaii Construction Foam	Compressive Strength, psi.	R-value, °F-ft²-h/btu	Moisture Content, volume %
100	13.7	3.7	2.7
150	21.6	4.0	1.7
250	32.0	4.4	1.6

After testing, the compressive strength and R-value for the molded polystyrene samples still meet the requirement of ASTM C578, "Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation". In addition the moisture contents are below the values for moisture absorption presented in ASTM C578.

The ASTM C1512 test results clearly show that molded polystyrene samples are not affected by the type of environmental conditions that is typical of building insulation.

[1] Research program conducted by the National Research Council of Canada/Expanded Polystyrene Association of Canada and the Expanded Polystyrene Industry Alliance.

[2] Research conducted by the Expanded Polystyrene Industry Alliance.

PAP 1013-08/20

MPS No. 1015

Subject: **Properties - Shear and Tensile Strength**

Date: **September 2008 (Revised January 2019)**

Hawaii Construction Foam insulation is manufactured in compliance with ASTM C578, "Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation". This standard covers the minimum requirements for flexural strength, compressive strength, and other physical properties of molded polystyrene foam. Some engineered systems such as Structural Insulated Panels (SIPs), insulated concrete forms (ICF's) and exterior insulation and finish systems rely on Hawaii Construction Foam insulation as a key component to resist shear and/or tensile loads.

Hawaii Construction Foam has conducted extensive tests to determine the shear strength and tensile strength of Hawaii Construction Foam insulation Shear strength of Hawaii Construction Foam insulation was evaluated in accordance with ASTM C273, "Standard Test Method for Shear Properties of Sandwich Core Materials". Tensile strength was evaluated in accordance with ASTM C297, "Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions".

PRODUCT		Hawaii Construction Foam					
		100	130	150	250	400	600
Shear Strength, min. ASTM C273	psi (kPa)	12 (83)	15.5 (107)	18 (124)	24 (166)	30 (208)	35 (242)
Tensile Strength, min. ASTM C297	psi (kPa)	20 (138)	25 (173)	30 (208)	40 (276)	50 (345)	60 (414)

Note: The values are based upon testing Hawaii Construction Foam insulation at laboratory conditions (72F/50%RH) under short term load durations as specified by the ASTM test methods.

PAP 1015-08/20

MPS No. 1016

Subject: **Water Absorption**

Date: **October 2008 (Revised January 2019)**

Architects, Engineers, Contractors, and Building Owners are all concerned with the performance of their insulation. The long term performance of insulation is critical to ensuring the energy savings the insulation was specified to provide.

Hawaii Construction Foam insulation has been subjected to a 15 year moisture absorption study to demonstrate the performance of molded polystyrene in a below grade application. The basic premise of the study was that Hawaii Construction Foam insulation be subjected to a real world application and not a short term laboratory test.

Samples of molded polystyrene insulation were installed as perimeter below grade insulation on a building in St. Paul, MN. The insulation was placed below grade in 1993 (15 years of exposure as vertical wall insulation separating the heated building foundation from soil). Samples were removed from the exterior foundation of a St. Paul, MN building in the summer of 2008 (see Figures 1 and 2).

In addition to the removal of the molded polystyrene molded polystyrene samples, extruded polystyrene (XPS) samples were removed. The XPS samples were immediately adjacent to the molded polystyrene and were also on the foundation wall for 15 years (see Figure 3). At the time of excavation the soil in contact with the insulation was dry and no abnormal conditions were observed.

The samples were brushed clean (see Figure 4) and tested immediately upon removal from the foundation wall for R-value. The results of the R-value testing at the time of removal and after an additional 28 days of conditioning at 72F/50% RH are shown in Table 1. In addition to R-value, the water absorption of the samples was measured and are shown in Table 2.

Table 1

Thermal Resistance		
Sample	R-Value/in. upon removal	Conditioned[1] R-Value/in.
Molded polystyrene	3.4	3.7
XPS	2.6	2.8

[1] Four weeks after removal and in a laboratory at 72° F, 50% RH conditioning.

Table 2

Moisture Content		
Sample	Moisture Content volume% upon removal	Conditioned[1] Moisture Content volume%
Molded polystyrene	4.8	0.7
XPS	18.9	15.7

[1] Four weeks after removal and in a laboratory at 72° F, 50% RH conditioning.

The results of the independent testing are dramatic. The molded polystyrene insulation maintained 94% of its stated R-value of 3.6 after the 15 year time period and had a moisture content of 4.8%. However, the XPS retained only 52% of its stated R-value of 5.0. The loss in R-value for the XPS is quite dramatic and can be explained very simply by the 18.9% of moisture absorption over the 15 years of use.

It is apparent that moisture that migrates through the soil, insulation, and foundation system is trapped in the cell structure of XPS. In contrast to the XPS, molded polystyrene is maintaining an equilibrium condition with the adjacent soil and is not accumulating water over the life of the building.

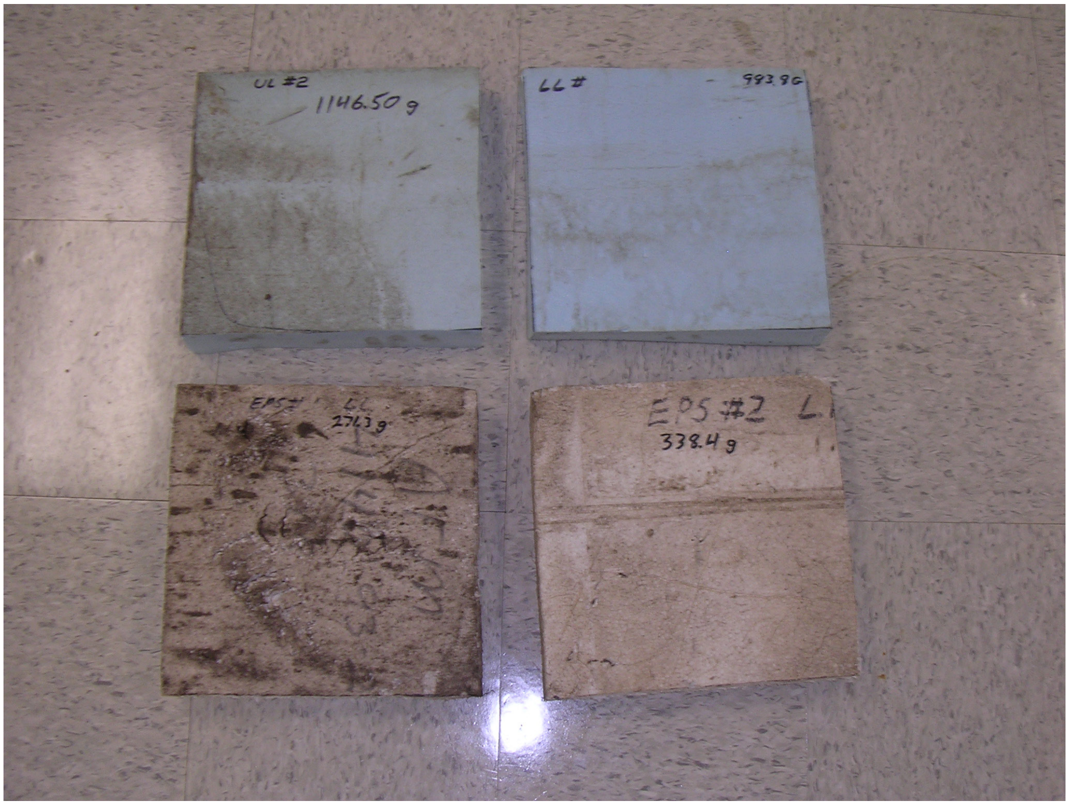
A letter from Stork Testing concerning this testing is attached to this bulletin.

Figure 1. Excavation of insulation samples after 15 years

Figure 2. XPS and molded polystyrene below grade insulation

Figure 3. XPS and molded polystyrene were installed adjacent to each other

Figure 4. Samples cleaned and ready for testing



PAP 1016-08/20

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November 14, 2008

To Whom It May Concern:

Stork Twin City Testing has recently completed below grade insulation testing for AFM Corporation of Burnsville, MN. The results from the testing are documented in a Stork project report 95863.5 dated October 31, 2008 provided to AFM Corporation.

Stork has reviewed the Foam-Control EPS Water Absorption Facts literature provided by AFM Corporation with control number FC09 dated 10/08 and the Foam-Control EPS Technical Bulletin no. EPS 1016 dated October 2008. The results tabulated in these publications are consistent with the results contained in the proprietary report prepared by Stork for AFM Corporation.

Stork has no comment, implied or otherwise, on the other claims contained in the above reference publications.

Regards,

William Stegeman

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MPS No. 1017

Subject: **Environmental Payback**

Date: **November 2008 (Revised January 2019)**

Hawaii Construction Foam insulation has long been recognized as a leader in the foam insulation industry with respect to environmental benefits. Hawaii Construction Foam insulation helps make your construction projects environmentally friendly.

Lower energy consumption reduces carbon dioxide emissions.

Is inert and stable.

Does not produce contaminating leachates.

Has never contained CFC, HCFC or HFC, all of which are harmful to the earth's ozone layer.

100% recyclable.

A recent study by the American Plastic Council confirms the environmental benefits of using molded polystyrene insulation on typical wood frame construction. The study consisted on analyzing the energy savings resulting from the application of insulation and comparing this against the energy used to produce the insulation. A comparison of these values provides a time period in which the environmental impact of producing the insulation is paid back by the energy savings.

The energy payback from the installation of insulation is under 2 years.

An executive summary of the study is attached for reference.

PAP 1017-08/20

EXECUTIVE SUMMARY

ENERGY AND GREENHOUSE GAS SAVINGS USING RIGID FOAM SHEATHING OR SPRAY FOAM APPLIED TO EXTERIOR WALLS OF SINGLE FAMILY RESIDENTIAL HOUSING IN THE U.S. AND CANADA

Prepared for
American Plastics Council
Washington, DC
By
FRANKLIN ASSOCIATES
A Division of ERG

May 16, 2008

INTRODUCTION

This analysis is a case study that examines energy savings and subsequent greenhouse gas emission reductions resulting from the addition of rigid plastic foam or spray foam sheathing to the exterior walls of single family housing in the United States and Canada. The widespread use of rigid plastic foam sheathing and, more recently, spray foam sheathing on exterior walls has become common in new housing construction. Energy conservation awareness was first recognized in the energy crisis of the 1970's. However, in the past 5 years, energy conservation has again become a very high priority for most North Americans.

Foam insulation possesses excellent structural and insulating characteristics and is considered to be cost effective by most homebuilders today. Its use significantly increases the insulation R-value of walls and therefore saves energy and reduces greenhouse gas (GHG) emissions.

GOAL/SCOPE

Four foam insulations were considered in this analysis – Expanded Polystyrene (EPS) boardstock foam, Polyurethane (PUR) foam sprayed in place, Extruded Polystyrene (XPS) boardstock foam and Polyisocyanurate (PIR) boardstock foam. The goal of this analysis is not to focus on each insulation type individually, but to show that the use of these foam insulations in residential housing provides an offset to the energy use and greenhouse gas emissions associated with their production.

An average size U.S. new construction house in 2006 was just under 2,500 square feet, and had 2,006 square feet of wall area. Typical building practices were wood frame construction with fiberglass batt insulation and wood siding. Energy savings were modeled between this house and one with 1 inch of foam sheathing under the wood siding. Only savings due to thermal conduction were included. Additional savings due to the air and vapor barrier qualities of the foam insulations are not calculated; therefore the final results are likely lower than actual energy savings.

RESULTS

The range of total energy requirements for producing the foam insulations for use in the U.S. are shown in the following table, along with the payback time and total energy savings over 50 years. The foams do not all have the same production energy requirements or the same payback time. Averaged across the entire country, however, every foam pays back the energy required for production in one to two years; over the assumed 50 year lifespan, more than 320 million Btu's of energy are saved in an average home.

ENERGY SAVINGS FROM USING EXTERIOR FOAM SHEATHING ON A U.S. AVERAGE 2006 NEW CONSTRUCTION HOUSE*

	Energy (Million Btu)
Energy Savings	
Annual	6.5 - 9.0
50 years	323 – 451
Foam Production Energy	7.41 - 14.0
Energy Payback (years)	1.15 - 1.79*

*National average of climate

The two main sources of greenhouse gases are fossil fuel combustion and the release of certain blowing agents. When the global warming potential of these blowing agents was not included, the greenhouse gas savings align with the energy savings. Payback times are slightly shorter for greenhouse gases than for energy – less than 1.5 years for a U.S. average. Although they make up only a small percentage of the weight of the foam insulation, the blowing agents will be entirely released to the atmosphere over the lifetime of the foam. Today, the effect of some blowing agents increases the greenhouse gas payback time significantly. In 2010, when the use of some blowing agents with high global warming potentials (GWP) will be restricted by Title IV of the Clean Air Act and as insulation producers shift to blowing agents that have lower global warming potential (GWP) than current blowing agents, the GHG payback time will decrease correspondingly.

Although Canadian results were included in the full report, they are not included in this Executive Summary. Results for Canadian homes do not differ significantly from those in the U.S. and show an energy payback of one to two years.

HAWAII CONSTRUCTION FOAM

TECH BULLETIN

MPS No. 1018

Subject: **Long Term Performance of Molded Polystyrene - 30 Year Old Field Samples**

Date: **February 2009 (Revised January 2019)**

The R-value of insulation over a service life of 50 years is a critical factor to consider when specifying an insulation product today. Insulation should be selected and designed based upon its warranted R-value at an age of at least 50 years old to ensure that energy savings calculations can be relied upon for the life of the structure.

Hawaii Construction Foam insulation is manufactured by a process in which the R-value for the insulation is stable for the life of the product. Hawaii Construction Foam insulation is warranted to maintain its R-value for 50 years.

Some foam plastic insulation board manufacturers provide an estimate of thermal resistance due to the fact that their products outgas blowing agents and as a result lose R-value over time. The test procedure used by these manufacturers for estimating R-value is often called LTTR or long term thermal resistance. LTTR provides an estimate of R-value after 5 years and not the future R-value. Therefore, **it is essential to specify the actual R-value of an insulation after 50 years of service life**. Also, you must specify that the insulation manufacturer provide a copy of their warranty to ensure they warrant of the R-value of their insulation for 50 years.

In the fall of 2008, a church school in Fond du Lac, Wisconsin was re-roofed to replace an aging 30 year old roof membrane. Molded polystyrene was used for insulation at the time of the original installation. Random samples of the 30 year old molded polystyrene were selected and sent to a third party independent test laboratory to determine the R-value of the molded polystyrene that was removed from the building.

Molded Polystyrene Properties				
Insulation	Density lb/ft^3	R-Value @ 75 ^oF $^oF.ft^2.h/Btu$	Compressive Strength @10% strain, psi	Flexural Strength, psi
30 Year Old Hawaii Construction Foam **100 Samples**	0.91	4.0	11.2	32.5
ASTM C578 Type I min. Requirement	0.90	3.6	10.0	25.0

Independent testing has confirmed that Hawaii Construction Foam 100, even after working on a roof for 30 years, still maintains its original claimed R-value. The R-value of the 30 year old Hawaii Construction Foam 100 exceeds the minimum R-value requirement of ASTM C578. Other foam board insulations which lose blowing agents over time would not be able to meet their LTTR R-value after 30 years.

In addition to R-value, the 30 year old Hawaii Construction Foam 100 samples were tested to determine their compressive and flexural strength. Again, the 30 year old Hawaii Construction Foam 100 samples exceeded the minimum physical properties stated in the ASTM C578 standard.

A copy of the Thermal Resistance Testing of the Hawaii Construction Foam 100 (Type I Molded polystyrene) Insulation from Stork Testing is attached to this bulletin.

PAP 1018-08/20

662 Cromwell Avenue
Saint Paul, MN 55114
USA

Telephone :(651) 645-3601
Toll Free :(888) 645-TEST
Telefax :(651) 659-7348
Website :www.storktct.com

JOB NUMBER: 30160 08-99583
PAGE: 1 of 3
DATE: October 7, 2008

THERMAL RESISTANCE TESTING OF TYPE I EPS INSULATION

Prepared for:
AFM Corporation
Attn: Dr. Todd Bergstrom
211 South River Ridge Circle
Suite 102A
Burnsville, MN 55337-1699

Prepared By:

Steven R. Miller

Steven R. Miller
Laboratory Supervisor
Product Evaluation Department

Reviewed By:

William Stegeman

William Stegeman
Advanced Materials Dept. Mgr.
Phone: 651-659-7230

The test results contained in this report pertain only to the samples submitted for testing and not necessarily to all similar products.

THERMAL RESISTANCE TESTING OF TYPE I EPS INSULATION

INTRODUCTION:

This report presents the results of Thermal Resistance Tests conducted on samples of Type I EPS Insulation. The testing was authorized by Dr. Todd Bergstrom of AFM Corporation on October 1, 2008. The testing and data analysis were completed on October 6, 2008.

The scope of our work was limited to conducting thermal resistance tests on the samples submitted and reporting the results.

SUMMARY OF RESULTS:

Thermal Resistance

Sample	R Value
# 1	3.96
# 2	3.94

SAMPLE IDENTIFICATION:

The samples were identified as Type I EPS supplied by M.W. Tighe Roofing of Fond du Lac, Wisconsin. The samples were reported to be removed from Sacred Heart Catholic School of Fond du Lac, Wisconsin on September 17, 2008. The material was reported to be installed originally during 1978.

TEST METHOD:

The specimen was allowed to condition at standard laboratory conditions of 72 ± 4°F and 50 ± 5% relative humidity for at least 40 hours prior to testing. The thermal resistance testing was conducted using ASTM Standard C518-04, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus" as a procedural guide. The specimen was placed in a Netzsch Heat Flow Meter; model HFM 436/3/1 ER. Steady-state heat flux measurements were made at a mean temperature of approximately 75°F using a hot face temperature of approximately 100°F and a cold face temperature of approximately 50°F. Specimen thermal resistance and thermal conductivity were determined by comparing the heat flux measurements of the specimen to measurements made on a known Standard Reference Material. Resistance values obtained from the Heat Flow Meter are best utilized for homogenous specimens.

Test Method	Test Method Title	Deviations from Method
ASTM C518-04	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus	None

JOB NUMBER: 30160 08-99583 **PAGE:** 3 of 3
DATE: October 7, 2008

CALIBRATED TEST EQUIPMENT:

Netzsch Heat Flow Meter, model HFM 436/3/1 ER, S# 284A-1107-606000788, calibrated 12/07
Mitutoyo Calipers, model 505-645-50, ID MM160-008, calibrated 9/08
Mitutoyo Digimatic Indicator, MM160-083, calibrated 11/07
Sartorious Balance, MM170-004, calibrated 7/08

UNCALIBRATED TEST EQUIPMENT:

Neslab Chiller, model RTE-110, S# 89CML91040-7

TEST DATA:

Parameter	Sample #1	Sample #2
Thickness, in	1.031	1.021
Density lbs/ft^3	0.91	0.91
TEST CONDITIONS:		
Temperature Gradient °F/in	48.27	48.59
Mean Temperature, °F	74.95	74.08
Temperature Range, °F	49.75	49.63
RESULTS:		
Thermal Conductivity, Btu·in/(h·ft^2·°F)	0.260	0.260
Thermal Conductance, Btu/(h·ft^2·°F)	0.253	0.254
Thermal Resistivity, °F·ft^2·h/Btu/in	3.84	3.85
Thermal Resistance, °F·ft^2·h/Btu	3.96	3.94

REMARKS:

The test materials will be retained for 14 days from the date of this report and then discarded unless we receive written notification requesting otherwise.

F:\Product\123FILES\08-Data\99583 AFM\99583 AFM Rpt.doc

Hawaii Construction Foam

Tech Bulletin

MPS No. 1019

Subject: **Fire Retardants**

Date: **March 2009 (Revised January 2019)**

Hawaii Construction Foam insulation is a key component to help reduce the use of energy in buildings. The energy reduction from using Hawaii Construction Foam insulation translates into important savings of carbon dioxide emissions to the environment over the entire life of the building. Hawaii Construction Foam insulation is recognized to achieve Green Building initiatives when used in foundation, wall, and roof insulation systems.

In addition to important energy reduction, compliance with fire and life safety is a first priority issue when using Hawaii Construction Foam insulation. The use of foam plastic insulation in buildings is regulated by building codes across North America. The most widely adopted building code is the International Building Code (IBC) published by the International Code Council (ICC). The IBC provides a series of requirements for the use of materials in buildings. For foam plastics, the typical requirements are:

1. The packages and containers display a third party (approved agency) label showing compliance with IBC requirements.

2. The foam plastic shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested in the maximum thickness for use in accordance with ASTM E84.

3. The foam plastic is separated from the interior of the building with 1/2" gypsum board.

Molded polystyrene can be manufactured without flame retardants, but the resulting product would not meet the fire performance required by the IBC. The use of a flame retardant in molded polystyrene is essential to ensure compliance with the IBC, provide for a safe building environment, and to protect lives and property from the risk of fire. **Hawaii Construction Foam insulation is always manufactured with flame retardants to ensure compliance with the fire requirements of the IBC.**

PAP 1019-08/20

MPS No. 1020

Subject: **ANSI/ASHRAE/IES Standard 90.1-2010 Insulation Requirements**

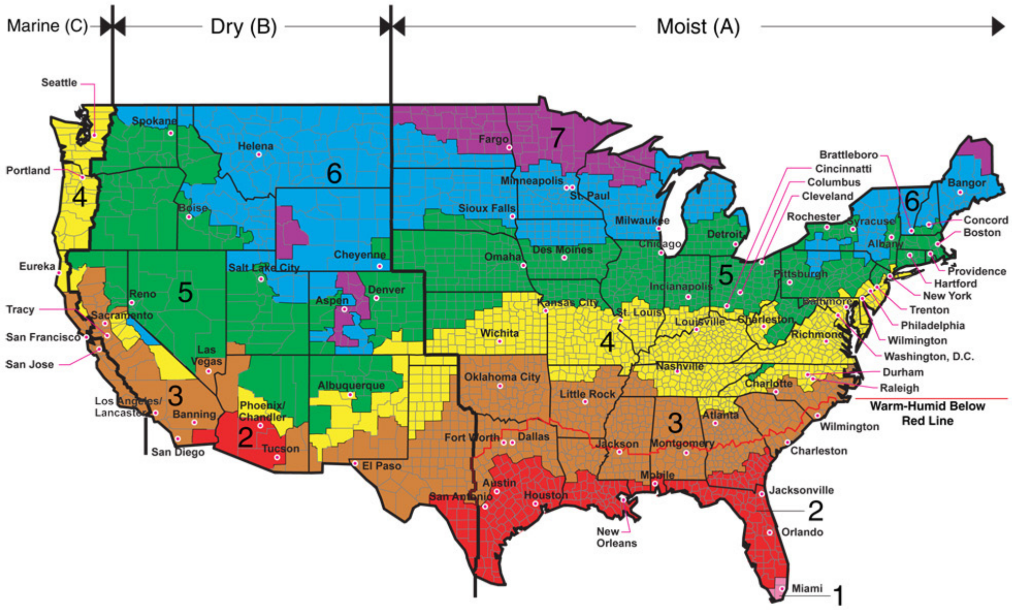
Date: **April 2012 (Revised January 2019)**

Hawaii Construction Foam insulation is a versatile insulation material which is suitable for installation in all areas of buildings. Hawaii Construction Foam insulation is available in a wide range of types and sizes to ensure that building owners are able to meet the most advanced energy code requirements, such as those published by the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE). This bulletin provides a summary of the prescriptive insulation requirements of the 2010 edition of ASHRAE Standard 90.1, "Energy Standard for Buildings Except Low-Rise Residential Building". Please refer to ASHRAE Standard 90.1 for detailed information.

ASHRAE Standard 90.1 is applied to commercial buildings and multistory residential buildings and is often adopted as a code requirement at the State level. State adoption of ASHRAE 90.1 may also be to the prior versions of ASHRE90.1 issued in 2001, 2004, and 2007.

The tables included with this bulletin provide the minimum prescriptive insulation requirements of ASHRAE90.1-2010. Alternative paths for conformance through detailed analysis are also available within the standard. Insulation requirements vary according to Climate Zone.

Climate Zones



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dellingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

Walls, Above Grade

ASHRAE Standard 90.1 provides prescriptive insulation requirements for above grade walls of heated buildings constructed with wood framing, steel framing, metal buildings, and mass (concrete, CMU, or stone) systems. The first number in the table below is the requirement for cavity insulation and the second number is for continuous insulation (ci). Continuous insulation minimizes heat loss since the insulation is installed continuously across the wall without thermal bridges other than fasteners and service openings.

ASHRAE 90.1-2010 Prescriptive R-value								
Walls, above grade								
	Wood-Framed		Steel-Framed		Metal-Framed		Mass	
Zone	Nonresi-dential	Residential	Nonresi-dential	Residential	Nonresi-dential	Residential	Nonresi-dential	Residential
1	13	13	13	13	16	16	NR	5.7ci
2	13	13	13	13+7.5ci	16	16	5.7ci	7.6ci
3	13	13	13+3.8ci	13+7.5ci	19	19	7.6ci	9.5ci
4	13	13+3.8 ci	13+7.5ci	13+7.5ci	19	19	9.5ci	11.4ci
5	13+3.8ci	13+7.5ci	13+7.5ci	13+7.5ci	13+5.6ci	13+5.6ci	11.4ci	13.3ci
6	13+7.5ci	13+7.5ci	13+7.5ci	13+7.5ci	13+5.6ci	13+5.6ci	13.3ci	15.2ci
7	13+7.5ci	13+7.5ci	13+7.5ci	13+15.6ci	13+5.6ci	13+5.6ci	15.2ci	15.2ci
8	13+15.6ci	13+15.6ci	13+15.6ci	13+18.8ci	19+5.6ci	19+5.6ci	15.2ci	25.0ci

ci = continuous insulation

Wall, Below Grade

ASHRAE Standard 90.1 provides prescriptive insulation requirements for below grade walls of heated buildings. Continuous insulation minimizes heat loss since the insulation is installed continuously across the wall without thermal bridges other than fasteners and service openings.

ASHRAE 90.1-2010 Prescriptive R-value		
Walls, below grade		
Zone	Nonresidential	Residential
1	0	0
2	0	0
3	0	0
4	0	7.5ci
5	7.5ci	7.5ci
6	7.5ci	7.5ci
7	7.5ci	10.0ci
8	7.5ci	12.5ci

ci = continuous insulation

Floor and Slabs

ASHRAE Standard 90.1 provides the prescriptive insulation requirements for mass floors and slab on grade floors of heated and unheated building.

ASHRAE 90.1-2010 Prescriptive R-value						
Floors						
	Mass		Slab-On-Grade Heated		Slab-On-Grade UnHeated	
Zone	Nonresidential	Residential	Nonresidential	Residential	Nonresidential	Residential
1	NR	NR	R-7.5 for 12 in.	R-7.5 for 12 in.	NR	NR
2	6.3ci	8.3ci	R-7.5 for 12 in.	R-7.5 for 12 in.	NR	NR
3	6.3ci	8.3ci	R-10 for 24 in.	R-10 for 24 in.	NR	NR
4	8.3ci	10.4ci	R-15 for 24 in.	R-15 for 24 in.	NR	R-10 for 24 in.
5	10.4ci	12.5ci	R-15 for 24 in.	R-15 for 24 in.	NR	R-10 for 24 in.
6	12.5ci	14.6ci	R-15 for 24 in.	R-20 for 48 in.	R-10 for 24 in.	R-15 for 24 in.
7	12.5ci	16.7ci	R-20 for 24 in.	R-20 for 48 in.	R-15 for 24 in.	R-15 for 24 in.
8	14.6ci	16.7ci	R-20 for 48 in.	R-20 for 48 in.	R-15 for 24 in.	R-20 for 24 in.

ci = continuous insulation

Roof Insulation

ASHRAE Standard 90.1 provides the prescriptive insulation requirements for continuous roof insulation above roof decks.

ASHRAE 90.1-2010 Prescriptive R-value		
Roof		
Above Deck		
Zone	Nonresidential	Residential
1	15ci	20ci
2	20ci	20ci
3	20ci	20ci
4	20ci	20ci
5	20ci	20ci
6	20ci	20ci
7	20ci	20ci
8	20ci	20ci

ci = continuous insulation

PAP 1020-08/20

TECH BULLETIN

HAWAII CONSTRUCTION FOAM

MPS No. 1021

Subject: **2012 IECC Insulation Requirements**

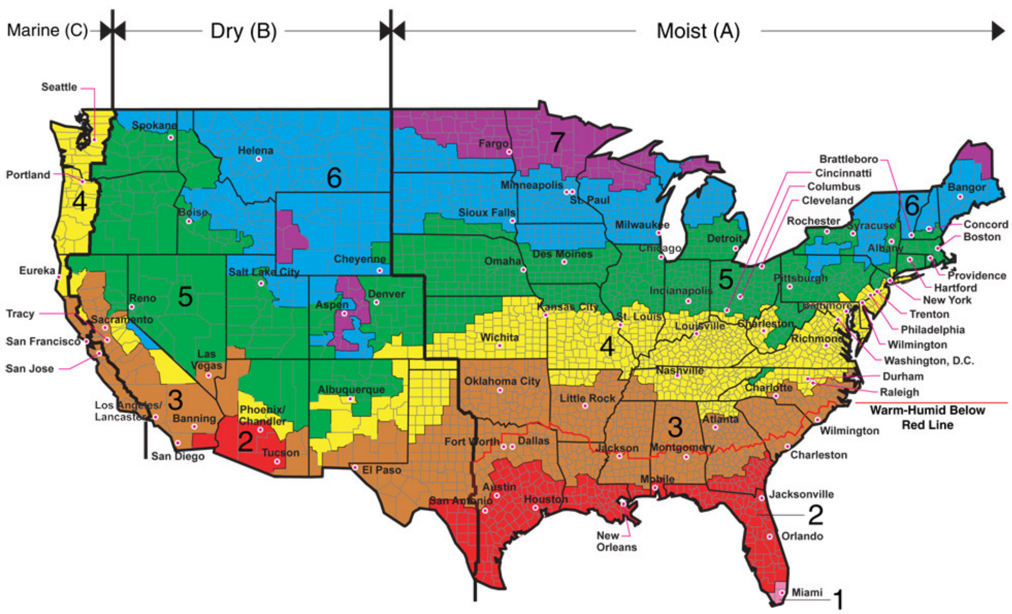
Date: **April 2012 (Revised January 2019)**

Hawaii Construction Foam insulation is a versatile insulation material which is suitable for installation in all areas of buildings. Hawaii Construction Foam insulation is available in a wide range of types and sizes to ensure that building owners are able to meet the most advanced energy code requirements, such as those published by the International Code Council (ICC). This bulletin provides a summary of the prescriptive insulation requirements of the 2012 edition of International Energy Conservation Code (IECC) published by ICC. Please refer to the 2012 IECC for detailed information.

The IECC is a leading energy code that is applicable to both commercial and residential buildings and is often adopted as a code requirement at the State level. State adoption of IECC may also be to the prior versions of the IECC issued in 2006 and 2009.

The tables included with this bulletin provide the minimum prescriptive insulation requirements of IECC-2012. Alternative paths for conformance through detailed analysis are also available within the standard. Insulation requirements vary according to Climate Zone.

Climate Zones



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dellingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

Residential

The IECC provides prescriptive insulation requirements for residential buildings. The first number in the table below is the requirement for cavity insulation and the second number is for continuous insulation (ci).

IECC-2012 Prescriptive R-value Residential							
Zone	**Wood-Framed[1] Wall**	**Mass[2] Wall**	**Basement Wall[3]**	**Slab[4] Wall**	**Floor**	**Crawl Space**	**Ceiling**
1	R-13	R-3/4	0	0	R-13	0	R-30
2	R-13	R-4/6	0	0	R-13	0	R-38
3	R-13+5ci or R-20	R-8/13	R-5/13	0	R-19	R-5/13	R-38
4 except Marine	R-13+5ci or R-20	R-8/13	R-10/13	R-10	R-19	R-10/13	R-49
5 and 4 Marine	R-13+5ci or R-20	R-13/17	R-15/19	R-10	R-30	R-15/19	R-49
6	R-13+10ci R-20+5ci	R-15/20	R-15/19	R-10	R-30	R-15/19	R-49
7	R-13+10ci R-20+5ci	R-19/21	R-15/19	R-10	R-38	R-15/19	R-49
8	R-13+10ci R-20+5ci	R-19/21	R-15/19	R-10	R-38	R-15/19	R-49

ci = continuous insulation
1 = First value is cavity insulation, second is continuous insulation, so “13+5” means R-13 cavity insulation plus R-5 continuous insulation.
2 = The second R-value applies when more than half the insulation is on the interior of the mass wall.
3 = “15/19” means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. “10/13” means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.
4 = Depth of the slab insulation is 2 ft in zone 4/5 and 4 ft in zones 6/7/8.

Commercial Walls, Above Grade

The IECC provides prescriptive insulation requirements for above grade walls of heated buildings constructed with wood framing, steel framing, metal buildings, and mass (concrete, CMU, or stone) systems. The first number in the table below is the requirement for cavity insulation and the second number is for continuous insulation (ci). Continuous insulation minimizes heat loss since the insulation is installed continuously across the wall without thermal bridges other than fasteners and service openings.

IECC-2012 Prescriptive R-value Commercial								
Walls, above grade								
	Wood-Framed		**Metal-Framed**		**Metal-Building**		**Mass**	
Zone	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**
1	R-13+3.8ci or R-20	R-13+3.8ci R-20	R-13+5ci	R-13+5ci	R-13+6.5ci	R-13+6.5ci	R-5.7ci	R-5.7ci
2	R-13+3.8ci or R-20	R-13+3.8ci R-20	R-13+5ci	R-13+7.5ci	R-13+6.5ci	R-13+13ci	R-5.7ci	R-7.6ci
3	R-13+3.8ci or R-20	R-13+3.8ci R-20	R-13+7.5ci	R-13+7.5ci	R-13+6.5ci	R-13+13ci	R-7.6ci	R-9.5ci
4 except Marine	R-13+3.8ci or R-20	R-13+3.8ci R-20	R-13+7.5ci	R-13+7.5ci	R-13+13ci	R-13+13ci	R-9.5ci	R-11.4ci
5 and 4 Marine	R-13+3.8ci or R-20	R-13+7.5ci R-20+3.8ci	R-13+7.5ci	R-13+7.5ci	R-13+13ci	R-13+13ci	R-11.4ci	R-13.3ci
6	R-13+7.5ci or R-20+3.8ci	R-13+7.5ci R-20+3.8ci	R-13+7.5ci	R-13+7.5ci	R-13+13ci	R-13+13ci	R-13.3ci	R-15.2ci
7	R-13+7.5ci or R-20+3.8ci	R-13+7.5ci R-20+3.8ci	R-13+7.5ci	R-13+15.6ci	R-13+13ci	R-13+19.5ci	R-15.2ci	R-15.2ci
8	R-13+15.6ci or R-20+10ci	R-13+15.6ci R-20+10ci	R-13+7.5ci	R-13+17.5ci	R-13+13ci	R-13+19.5ci	R-25.0ci	R-25.0ci

ci = continuous insulation

Commercial Walls, Below Grade

The IECC provides prescriptive insulation requirements for below grade walls of heated buildings. Continuous insulation minimizes heat loss since the insulation is installed continuously across the wall without thermal bridges other than fasteners and service openings.

IECC-2012 Prescriptive R-value Commercial		
Walls, below grade		
Zone	**All other**	**Group R**
1	NR	NR
2	NR	NR
3	NR	NR
4 except Marine	R-7.5ci	R-7.5ci
5 and 4 Marine	R-7.5ci	R-7.5ci
6	R-7.5ci	R-7.5ci
7	R-10.0ci	R-10.0ci
8	R-10.0ci	R-12.5ci

ci = continuous insulation

Commercial Floors and Slabs

The IECC provides the prescriptive insulation requirements for mass floors and slab on grade floors of heated and unheated building.

IECC-2012 Prescriptive R-value Commercial						
Floors						
	Mass		Slab-On-Grade Heated		Slab-On-Grade UnHeated	
Zone	All other	Group R	All other	Group R	All other	Group R
1	NR	NR	R-7.5 for 12 in.	R-7.5 for 12 in.	NR	NR
2	R-6.3ci	R-8.3ci	R-7.5 for 12 in.	R-7.5 for 12 in.	NR	NR
3	R-10ci	R-10ci	R-10 for 24 in.	R-10 for 24 in.	NR	NR
4 except Marine	R-10ci	R-10.4ci	R-15 for 24 in.	R-15 for 24 in.	R-10 for 24 in.	R-10 for 24 in.
5 and 4 Marine	R-10ci	R-12.5ci	R-15 for 36 in.	R-15 for 36 in.	R-10 for 24 in.	R-10 for 24 in.
6	R-12.5ci	R-12.5ci	R-15 for 36 in.	R-20 for 48 in.	R-10 for 24 in.	R-15 for 24 in.
7	R-15ci	R-16.7ci	R-20 for 24 in.	R-20 for 48 in.	R-15 for 24 in.	R-15 for 24 in.
8	R-15ci	R-16.7ci	R-20 for 48 in.	R-20 for 48 in.	R-15 for 24 in.	R-20 for 24 in.

ci = continuous insulation

Commercial Roof Insulation

The IECC provides the prescriptive insulation requirements for continuous roof insulation above roof decks.

IECC-2012 Prescriptive R-value Commerical		
Roof		
Above Deck		
Zone	All other	Group R
1	R-20ci	R-20ci
2	R-20ci	R-20ci
3	R-20ci	R-20ci
4 except Marine	R-25ci	R-25ci
5 and 4 Marine	R-25ci	R-25ci
6	R-30ci	R-30ci
7	R-35ci	R-35ci
8	R-35ci	R-35ci

ci = continuous insulation

PAP 1021-08/20

MPS No. 1022

Subject: **Compatible Adhesives**

Date: **June 2012 (Revised January 2019)**

Hawaii Construction Foam insulation is often applied to various substrates with the use of adhesives. Adhesives provide a convenient method for installation of Hawaii Construction Foam insulation products, however, the use of adhesives which are specifically designed for use with polystyrene foams must be used. Some adhesives contain solvents or other additives which can damage polystyrene foams.

The following adhesive manufacturers recommend specific products for use with polystyrene foam. Please contact the manufacturers directly for installation recommendations.

DAP® Beats The Nail

DAP Inc.

(888)DAP-TIPS

www.dap.com

ENERBOND™ Foam Adhesive

Dow Building Solutions

(866)-583-2583

www.dowbuildingsolutions.com

GREAT STUFF PRO Wall & Floor Adhesive

Dow Building Solutions

(866)-583-2583

www.dowbuildingsolutions.com

3M™ Polystyrene Foam Insulation 78 Spray Adhesive

3M

(800)362-3550

www.3M.com/adhesives

OSI QB-300

Henkel Corporation

(800)624-7767

www.henkel.com

Sonneborn 200 Adhesive

BASF Corporation Building Systems

(800)433-9517

www.buildingsystems.BASF.com

The list is provided only as a courtesy to Hawaii Construction Foam insulation users and is not necessarily exhaustive.

No warranty with respect to the suitability of the above

PAP 1022-08/20

MPS No. 1023

Subject: **Cladding Attachment**

Date: **January 2016 (Revised January 2019)**

The International Building Code (IBC) and International Residential Code (IRC) have stringent requirements for the energy use of new buildings. Historically, wall insulation has primarily been cavity insulation placed between wood or steel framing members. However, the loss of energy from the framing members can be significant. Therefore, the use of continuous insulation is now specified in the latest building codes to reduce the loss of heat through walls.

Builders must understand the fastener requirements for installing cladding over foam plastic continuous insulation. The 2015 IBC and 2015 IRC address this issue for builders by providing prescriptive tables for the attachment of cladding over foam plastics, such as Hawaii Construction Foam insulation. The tables in this bulletin are a summary of the information contained in 2015 IBC Table 2603.12.1 and 2015 IRC Table R703.15.1. For additional detailed information, please refer to the 2015 IBC and IRC.

CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

CLADDING FASTENER THROUGH FOAM SHEATHING	CLADDING FASTENER TYPE AND MINIMUM SIZE[b]	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[c] (inches)					
			16” o.c. Fastener Horizontal Spacing			24” o.c. Fastener Horizontal Spacing		
			Cladding Weight:			Cladding Weight:		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Wood Framing (minimum 1-1/4 inch penetration)	0.113” diameter nail	6	2	1	DR	2	0.75	DR
		8	2	1	DR	2	0.5	DR
		12	2	0.5	DR	2	DR	DR
	0.120” diameter nail	6	3	1.5	0.5	3	0.75	DR
		8	3	1	DR	3	0.5	DR
		12	3	0.5	DR	2	DR	DR
	0.131” diameter nail	6	4	2	0.75	4	1	DR
		8	4	1.5	0.5	4	0.75	DR
		12	4	0.75	DR	2	0.5	DR
	0.162” diameter nail	6	4	4	1.5	4	2	1
		8	4	3	1	4	1.5	0.75
		12	4	2	0.75	4	1	DR

DR = Design Required; o.c. = on center.
a. Wood framing shall be Spruce-Pine-Fir or any wood species with a specific gravity of 0.42 or greater in accordance with AWC NDS.
b. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.
c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]								
CLADDING FASTENER THROUGH FOAM SHEATHING INTO;	CLADDING FASTENER TYPE AND MINIMUM SIZE[b]	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[c] (inches)					
			16" o.c. Fastener Horizontal Spacing			24" o.c. Fastener Horizontal Spacing		
			Cladding Weight:			Cladding Weight:		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Steel Framing (minimum penetration of steel thickness plus 3 threads)	#8 screw into 33 mil steel or thicker	6	3	3	1.5	3	2	DR
		8	3	2	0.5	3	1.5	DR
		12	3	1.5	DR	3	0.75	DR
	#10 screw into 33 mil steel	6	4	3	2	4	3	0.5
		8	4	3	1	4	2	DR
		12	4	2	DR	3	1	DR
	#10 screw into 43 mil steel or thicker	6	4	4	3	4	4	2
		8	4	4	2	4	3	1.5
		12	4	3	1.5	4	3	DR

DR = Design Required; o.c. = on center.
a. Steel framing shall be minimum 33 ksi steel for 33 mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.
b. Screws shall comply with the requirements of AISI S200.
c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

PAP 1023-08/20

MPS No. 1024

Subject: **Furring Attachment**

Date: **January 2016 (Revised January 2019)**

The International Building Code (IBC) and International Residential Code (IRC) have stringent requirements for the energy use of new buildings. Historically, wall insulation has primarily been cavity insulation placed between wood or steel framing members. However, the loss of energy from the framing members can be significant. Therefore, the use of continuous insulation is now specified in the latest building codes to reduce the loss of heat through walls.

The use of furring attached over foam plastic insulation is a method builders commonly employ when attaching cladding products. Builders must understand the fastener requirements for installing furring over foam plastic continuous insulation. The 2015 IBC and 2015 IRC address this issue for builders by providing prescriptive tables for the attachment of furring over foam plastics, such as Hawaii Construction Foam insulation. The tables in this bulletin are a summary of the information contained in 2015 IBC Table 2603.12.2 and 2015 IRC Table R703.15.2. For additional detailed information, please refer to the 2015 IBC and IRC.

FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a,b]

FURRING MATERIAL	FURRING MEMBER	FASTENER TYPE AND MINIMUM SIZE	MINIMUM PENETRATION INTO WALL FRAMING (inches)	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[d] (inches)					
					16" o.c. Furring[e]			24" o.c. Furring[e]		
					Siding Weight:			Siding Weight:		
					3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Minimum 1x Wood Furring[c]	Minimum 2x Wood Stud	0.131" diameter nail	1-1/4	8	4	2	1	4	1.5	DR
				12	4	1.5	DR	3	1	DR
				16	4	1	DR	3	0.5	DR
		0.162" diameter nail	1-1/4	8	4	4	1.5	4	2	0.75
				12	4	2	0.75	4	1.5	DR
				16	4	1.5	DR	4	1	DR
		No. 10 wood screw	1	12	4	2	0.75	4	1.5	DR
				16	4	1.5	DR	4	1	DR
				24	4	1	DR	3	DR	DR
		1/4" lag screw	1-1/2	12	4	3	1	4	2	0.5
				16	4	1.5	DR	4	1.5	DR
				24	4	1.5	DR	4	0.75	DR

DR = Design Required; o.c. = on center.

a. Wood framing and furring shall be Spruce-Pine-Fir or any wood species with a specific gravity of 0.42 or greater in accordance with AWC NDS.

b. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.

c. Where the required cladding fastener penetration into wood material exceeds 3/4 inch and is not more than 1-1/2 inches, a minimum 2X wood furring or an approved design shall be used.

d. Foam sheathing shall have a minimum compressive strenth of 15 psi in accordance with ASTM C578 or ASTM C1289.

e. Furring shall be spaced not more than 24 inches on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.

FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

FURRING MATERIAL	FURRING MEMBER	FASTENER TYPE AND MINIMUM SIZE[b]	MINIMUM PENETRATION INTO WALL FRAMING (inches)	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[d] (inches)					
					16" o.c. Furring[e]			24" o.c. Furring[e]		
					Cladding Weight:			Cladding Weight:		
					3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Minimum 33 mil Steel Furring or Minimum 1x Wood Furring[c]	33 mil steel stud	#8 screw	Steel thickness plus 3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR
				24	2	DR	DR	2	DR	DR
		#10 screw	Steel thickness plus 3 threads	12	4	2	DR	4	1	DR
				16	4	1.5	DR	3	DR	DR
				24	3	DR	DR	2	DR	DR
	43 mil or thicker steel stud	#8 screw	Steel thickness plus 3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR
				24	2	DR	DR	2	DR	DR
		#10 screw	Steel thickness plus 3 threads	12	4	3	1.5	4	3	DR
				16	4	3	0.5	4	2	DR
				24	4	2	DR	4	0.5	DR

DR = Design Required; o.c. = on center.

a. Wood furring shall be Spruce-Pine-Fir or any softwood species with a specific gravity of 0.42 or greater. Steel furring shall be minimum 33 ksi steel. Steel studs shall be minimum 33 ksi steel for 33 mil and 43 mil thickness and 50 ksi steel for 54 mil steel or thicker.

b. Screws shall comply with the requirements of AISI S200.

c. Where the required cladding fastener penetration into wood material exceeds 3/4 inch and is not more than 1-1/2 inches, a minimum 2-inch nominal wood furring shall be used or an approved design.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

e. Furring shall be spaced not more than 24 inches on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.

PAP 1024-08/20

MPS No. 1025

Subject: **Chemical Exposure**

Date: **June 2017 (Revised January 2019)**

Hawaii Construction Foam insulation is used in a wide variety of applications. There may be instances in applications where Hawaii Construction Foam insulation is subjected to chemical exposure. This can be by either direct exposure to the chemicals or to their chemical vapors. Exposure to chemicals most commonly occurs during the installation process or as the result of exposure after the Hawaii Construction Foam insulation is in place.

The attached table provides general guidance for the resistance of Hawaii Construction Foam insulation to a number of chemicals. The table is intended to provide a preliminary guide, but does not guarantee long term performance of Hawaii Construction Foam insulation when in contact with the listed or any other chemicals.

It is recommended that laboratory tests modeled to represent chemical exposure in end use conditions be conducted to assure efficacy of the Hawaii Construction Foam insulation.

When the exposure of Hawaii Construction Foam insulation to any harmful chemicals is a possibility or in doubt, the protection of Hawaii Construction Foam insulation by means of an appropriate barrier material is required.

Rating: Overall chemical exposure performance is noted by a rating symbol.

S = Satisfactory M = Marginal* U = Unsatisfactory*

Chemical	Rating
Acetic Acid (5%)	S
Acetic Acid (10%)	M
Acetone	U
Ammonia	S
Benzene	U
Butly Alcohol	S
Citric Acid (10%)	S
Citric Acid (20%)	M
Detergents	M
Diesel Fuel	U
Ethyl Acetate (98%)	U
Ethyl Alcohol (95%)	M
Ethylene Glycol	S
Gasoline	U
Hexane	U
Hydrocloric Acid (10%)	S
Hydrocloric Acid (38%)	M
Hydrocloric Acid (100%)	U
Hydrogen Peroxide (30%)	S
Isopropyl Alcohol	M

Chemical	Rating
Kerosene	U
Methyl Alcohol	M
Methyl Ethyl Ketone	U
Mineral Oil	S
Motor Oil	M
Nitric Acid (20%)	U
Paint Thinner	U
Petroleum Jelly	S
Potassium Hydroxide (%30)	S
Propyl Alcohol	M
Propylene Glycol	S
Sodium Chloride (saturated)	M
Sodium Hypochlorite (15%)	S
Sodium Hydroxide (40%)	S
Sulphuric Acid (50%)	S
Sulphuric Acid (96%)	S
Toluene	U
Turpentine	U
Water (salt/sea)	S
Xylene	U

This information contained herein is provided for general purposes only. By providing this information, your Hawaii Construction Foam insulation supplier makes no guaranty or warranty, and does not assume any liability with respect to the accuracy or completeness of such information, and hereby expressly disclaims any implied warranties of fitness of the use of Hawaii Construction Foam insulation for a particular purpose.

PAP 1025-08/20

MPS No. 1026

Subject: **Labeling Foam-Plastic for Code Compliance**

Date: **July 2017 (Revised January 2019)**

Hawaii Construction Foam insulation products are manufactured in a wide range of material properties to meet the varying demands of building insulation applications. All Hawaii Construction Foam insulation products are manufactured to meet ASTM C578 "Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation", International Building Code (IBC), and International Residential Code (IRC) requirements. The following are critical considerations when selecting and specifying insulation products for building applications.

1. Labeling and identification. Packages and containers of foam plastic insulation and foam plastic insulation components delivered to the job site shall bear the label of an approved agency showing the manufacturer's name, product listing, product identification and information sufficient to determine that the end use will comply with the code requirements.

   Hawaii Construction Foam 100, 130, 150, 250, 400, and 600 for use in building applications are all labeled and identified with a UL label to meet this requirement.

2. Surface-burning characteristics. Foam plastic insulation shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested in the maximum thickness intended for use in accordance with ASTM E84 or UL 723.

   Hawaii Construction Foam 100, 130, 150, 250, 400, and 600 for use in building applications are all labeled and identified with a UL label to meet this requirement.

3. Roofing. Above deck molded polystyrene board shall comply with ASTM C578.

   Hawaii Construction Foam 100, 130, 150, 250, 400, and 600 for use in building applications are all labeled and identified with a UL label to meet this requirement.

The Hawaii Construction Foam UL label is most commonly provided in the form of a UL Certificate. Alternatively, UL recognition can be found in the UL Online Certificate Directory. UL recognition for ASTM E84/UL723 is shown under the UL requirement Category Code BRYX and UL recognition for ASTM C578 is shown under the UL Category Code QORW.

The use of evaluation reports or code reports are an additional method to meet building code requirements. Hawaii Construction Foam insulation products are recognized in evaluation reports from both UL and ICC-ES.

When selecting and specifying insulation products for your building application, please ensure that the specific ASTM Type you are specifying has complete third party recognition.

Manufacturer's literature and/or technical information does not meet the requirement of the building codes for a label of an approved agency. A label from an approved agency with ASTM E84/UL723 recognition and ASTM C578 compliance for the specific type used on your project is required.

The verification of the label from an approved agency should be a part of the submittal review process. A UL Certificate, UL Evaluation Report, or ICC-ES Evaluation Report should be required as part of any submittal package.

PAP 1026-08/20

Hawaii Construction Foam

Tech Bulletin

MPS No. 1027

Subject: **Elastic Modulus**

Date: **January 2018 (Revised January 2019)**

Hawaii Construction Foam insulation is manufactured in compliance with ASTM C578, "Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation". This standard covers the minimum requirements for flexural strength, compressive strength, and other select properties of polystryene foam. Some engineered systems such as Structural Insulated Panels (SIPs), insulated concrete forms (ICF's) and exterior insulation and finish systems rely on Hawaii Construction Foam as a key structural component.

Hawaii Construction Foam has conducted extensive tests to determine the elastic modulus of Hawaii Construction Foam products. Elastic modulus was determined in accordance with ASTM D1621, "Standard Test Method for Compressive Properties of Rigid Cellular Plastics".

PRODUCT		Hawaii Construction Foam					
		100	130	150	250	400	600
Elastic Modulus, typical ASTM D1621	psi (kPa)	360 (2500)	580 (4000)	730 (5000)	1090 (7500)	1500 (10300)	1860 (12800)

Note: The values are based upon testing at laboratory conditions (72F/50%RH) under short term load durations as specified by the ASTM test method.

PAP 1027-08/20

HAWAII CONSTRUCTION FOAM

TECH BULLETIN

MPS No. 1028

Subject: **Exposure to Moisture**

Date: **November 2018 (Revised January 2019)**

Hawaii Construction Foam is a molded polystyrene insulation with high compressive strength, high R-value, and superior moisture resistance. Hawaii Construction Foam insulation is a closed cell foam manufactured to resist moisture absorption in wetting conditions and release absorbed moisture quickly during drying periods.

Hawaii Construction Foam, like all insulation, may be exposed to challenging moisture conditions in building insulation applications. The behavior of any insulation when exposed to moisture is critical to understanding the potential impact of water absorption on the insulation's R-value.

The exposure of insulation to moisture varies widely in the most common building insulation applications:

- Roof insulation is protected by a membrane and is not exposed to rain
- Wall insulation is protected by a weather resistive barrier and is not exposed to rain
- Below Grade insulation installed with ground sloping away from the foundation and drainage at footings experiences little moisture exposure

The insulation industry for years has conducted water absorption testing as a means of quality control. ASTM C578[1] has very specific requirements for testing the water absorption of polystyrene insulation following ASTM C272[2]. The ASTM C272 test method involves placing a 1 in. x 12 in. x 12 in. sample of polystyrene insulation under water for 24 hours. After 24 hours the sample is taken out of the water, surface water on the sample is removed, and a determination of the water absorption by volume is made. The ASTM C578 requirements for this quality control test are as follows:

Hawaii Construction Foam	100	130	150	250	400	600
Water Absorption max., volume %, ASTM C272	4.0	3.0	3.0	2.0	2.0	2.0

Some building industry representatives have long referenced these ASTM C578 short-term quality control test results and inappropriately considered the values as the expected water absorption in building applications.

Researchers from Dow Chemical[3] as early as 1983 concluded "that moisture gain in perimeter insulation cannot be predicted accurately by any one laboratory test". More recently, building science professionals rely on complex software, such as WUFI[4], to attempt to predict the transient heat and moisture transport in buildings.

More useful information on the performance of Hawaii Construction Foam insulation when subjected to the normal wetting and drying conditions of building applications is now available.

Hawaii Construction Foam insulation samples which completed 24 hours of submersion in water in accordance with ASTM C272 testing were stored for an additional 24 hours in 50% RH air immediately upon removal from the water. This additional time period provides critical insight into the full cycle of Hawaii Construction Foam insulation wetting and drying behavior.

Hawaii Construction Foam	100	130	150	250	400	600
Water Absorption max., volume %, ASTM C272 & additional 24 hour in 50% RH air.	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3

The results above from the full cycle of a 24 hour under water exposure followed by a 24 hour air exposure clearly demonstrates Hawaii Construction Foam insulation resists moisture absorption in wetting conditions and releases absorbed moisture quickly during drying periods, which means Hawaii Construction Foam insulation will maintain R-value performance under the most demanding building applications.

Reference: [1] ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation. ASTM.

[2] ASTM C272, Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions. ASTM.

[3] Laboratory Methods for Determining Moisture Absorption of Thermal Insulations. II: Comparison of Three Water Absorption Test Methods with Field Performance Data. Journal of Thermal Insulation Vol. 7, 128-137. (1983). A.O. Forgues, Dow Chemical Canada Inc.

[4] WUFI®. WUFI is a family of software products that allows realistic calculation of the transient coupled one- and two dimensional heat and moisture transport in walls and other multi-layer building components exposed to natural weather. www.wufi.de/en/

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