Engineering & Foam

Environmental Engineering

Control Systems

Hazmat Safety

Structural Engineering

Mechanical Engineering

Co-Generation of Fuels

WHAT IS SPRAY POLYURETHANE FOAM?

Spray polyurethane foam, commonly referred to as SPF, is a spray-applied insulating foam plastic that is installed as a liquid and then expands many times its original volume. SPF formulas can be tweaked to have many different physical properties depending on the use desired. For example, the same basic raw materials can make insulation foam that is semi-rigid and soft to the touch, also create a high density roofing foam that is resistant to foot traffic and water.

Specialized equipment is used to apply the SPF and proper technical training is important in order to get the best results.

SPF is the king of building material multi-tasking. In insulation, it can provide high levels of R-value, while providing air barriers and assistance in moisture control in buildings. In roofing, it insulates and eliminates thermal bridging through fasteners or gaps in decking, while providing a long-lasting roofing system that has a life that can be extended by re-coating an average of 15 years.

As a result SPF is used in a wide variety of applications including (but not limited to): roofing, air barriers, commercial and residential insulation in walls, ceilings, attics and basements, industrial insulation such as pipes and tank, cold storage facilities, freezers, walk-in coolers, climate controlled buildings such as mushroom farms or produce storage, clean rooms, flotation for boats, ships, barges, floating docks, etc. and much more. Higher density SPF systems have even been used to increase the structural strength of wings in airplanes.

So what is SPF? SPF is remarkable versatile material that provides proven solutions to a great range of challenges in construction and manufacturing.

IS SPRAY POLYURETHANE FOAM SAFE?

Yes, cured spray polyurethane foam is relatively inert and studies indicate that SPF does not release toxic gases or leach harmful chemicals into the soil.

However, during application, fumes and mist from the spraying process are created that can be harmful. The two basic chemical ingredients or compounds in all spray foam systems are dissocyantes (monomeric MDI and polymeric MDI) and polyol resins. Contact with these ingredients in vapor, liquid, or particle form can pose a number of health effects to your skin, eyes, and respiratory system. An overexposure to diisocyanates can also cause skin and respiratory sensitization.

Applicators and other person within a close proximity to the spray operation could be exposed to fumes beyond OSHA and NIOSH requirements and spills. Precautions should be made for applicators, helpers and building occupants to be protected from these fumes, mists and spills. Typically for the applicators this would include respirator, solvent resistant gloves and protective clothing. The zone where protective equipment is required can vary depending on the amount of open space and free ventilation. For example on a roof top, outside of a few feet the fumes dissipate rapidly, while in an enclosed room, fumes and mists can build. Each job should be assessed and a safety plan developed specific to the application

REGULATORY INFORMATION
SPFA Wins Positions at ICC-Code Hearings

Code Officials at the annual International Code Congress hearings held in Detroit, MI from September 28-October 2, 2005, approved positions supported by SPFA. The code changes affecting the SPF industry were in the International Energy Conservation Code and the International Residential Code and fell into 3 main topics.

1. Labeling and marking attic insulation
2. Total prescriptive R-values of wall and ceilings
3. Venting of attics and crawl spaces.

SPFA Positions:

1. Labeling and Marking Attic Insulation, International Residential Code: SPFA submitted a code change to exempt SPF from a new section that required depth markers for spray or blown-in insulation in attics. The new section was approved at the 2004 code hearings to address blown-in cellulose and fiberglass insulation value of blown-in cellulose and fiberglass insulation during a visual inspection. SPFA believes this section could be misinterpreted by building code officials to require depth markers for SPF applications. SPFA's position was that markers cannot accurately gauge the depth of SPF applications and since SPF does not settle over time, are unnecessary. The ICC Advisory Board agreed with SPFA's position and the code change was adopted without opposition.

2. Prescriptive R-values, International Energy Conservation Code: SPFA is in favor of performancebased evaluation of building energy performance in lieu of higher prescriptive R-values of wall and ceiling/roof assemblies. During the 2004 hearings a proposal from the Department of Energy was adopted with a modification that increased R-values in wall assemblies in some regions from R-13 to R-15 and in other regions from R-19 to R-21. SPFA opposed this increase and supported a building code change at the 2005 hearings that would roll back the R-values to the DOE proposed values. The change was initially recommended for disapproval by the ICC Advisory Board in an earlier hearing in Cincinnati. In order to overturn the Advisory Board recommendation, a 2/3 margin was required. The National Association of Home Builders coordinated a successful coalition of industry organizations that convinced the building code officials that the higher R-values "were not cost-effective and would not have provided significant energy savings to new buildings." The final vote was 271 to 68.

3. Venting of attics and crawl spaces International Residential Code and International Energy Conservation Code. A code change was proposed by the Asphalt Roofing Manufacturers Association to eliminate the section allowing unvented attics or cathedral ceilings. SPFA supports conditioned attics and unvented cathedral ceilings when using SPF in those applications. Experience demonstrates that SPF is most effective in controlling moisture within a building when venting is not included in the design. The code body approved the Advisory board's recommendation to keep this important section allowing unvented attics.

The hearings completed this 3 year cycle of code hearings and the new ICC codes will be published and in effect in 2006.

WHAT'S WRONG WITH HIGHER PRESCRIPTIVE R-VALUES?

Energy saving measures such as reducing thermal bridging, stopping air infiltration and reducing convective currents is not recognized effectively in the prescriptive code. The modification raising the prescriptive R values from 13 to 15 and from R-19 to R-21 would have potentially excluded the use of low density insulation in 2" x 4" constructions and 2" x 6" constructions and provided a poorer competitive position for medium density SPF as well. The fiberglass industry lobbied hard against the code proposal since they have a fiberglass batt that can achieve an R-15 within a 2" x 4" stud wall and an R-21 within a 2" x 6" stud wall.

RLC Engineering, LLC.
SPRAY-IN-PLACE POLYURETHANE FOAM INSULATION

An Opinion Paper by:
Craig DeWitt, PhD, PE
March 11, 2002

Expanding spray-in-place foam insulation products such as those based on a polyurethane formulation have several beneficial aspects over other forms of insulation. Spray foam insulation currently costs more than alternative insulation products, but this additional up-front cost can be overcome when the other benefits of spray foam are utilized and realized. These aspects include benefits associated with increased structural/strength properties, enhanced thermal insulation capabilities, and reduced air infiltration properties.

Structural benefits: Clemson University has been researching the use of spray foam as an enhanced attachment system for roofing. This research centers on how to retrofit or construct buildings to be more resistant to hurricane and other high wind events. Clemson's research shows that spray foam can significantly improve the attachment of roof sheathing to trusses and rafters, similar to the way construction adhesives help bond a floor system together. In a retrofit case, foam can be sprayed on one or both sides of the sheathing/rafter intersection from inside the finished roof. In new construction, spray foam can be applied to the entire roof system. The spray foam makes a significantly stronger roof than either nails or screws alone. More information on this research is available from Clemson University's Civil Engineering Department, or the 113 Calhoun St Project in Charleston, SC.

Thermal and air benefits: A second aspect of spray foam is the enhanced thermal insulation characteristics. The stated R-value, or thermal resistance value, of insulation is measured under laboratory conditions. Real-life in-use R-values are quite different. An R-13 rated insulation batt installed improperly may only provide R-9. Whole wall R-values may be even less because of voids, wood, headers, etc. in the wall. Spray foam can provide a higher whole-wall R-value because of its ability to better fill wall cavities around electrical, plumbing, and other obstructions within the wall. The Oak Ridge National Lab has tested several whole-wall R-values for various wall/insulation combinations. Some of their results have been published in publications such as Energy Design Update, and should be available on their web site soon.

The R-value of an insulation system also depends upon the lack of air movement through the insulation. Most insulation products use entrapped air as a barrier to heat transfer. Therefore, to get a high R-value, air cannot move within or through the insulation.

In a whole-house situation, part of the energy use is in infiltration air. Air flow retarder products such as house wraps were developed to reduce the amount of infiltration air. These air barriers help reduce infiltration as well as air movement through the insulation.

Typical loose fill or batt insulation works well if installed correctly, and if installed in conjunction with an air barrier. Good installation is difficult to do, however. The insulation is often packed too tight or too loose, cut too short or too long, gapped around plumbing and wiring, or left out because of access problems.

Spray foams claim a couple benefits. First, they fill gaps and voids better. Second, they perform well as air flow retarders. The result is a higher in-the-wall R-value. Infiltration is also reduced, so that component of a building's energy use is reduced. Both of these benefits result in raising the "effective" R-value of spray foam when compared to typically installed loose fill or batt insulation.

Spray foam products must still be sprayed correctly, and dense-pack blown cellulose can make some of the same claims. Spray foam is also self-supporting, which enables its use on the underside of roofs and floors.

Roof Benefits: Insulating the underside of a roof rather than a ceiling creates many other benefits as well. Historically, we ventilated roofs in an attempt to prevent moisture problems and reduce heat build-up.

Current research shows that much of the moisture in attics comes from damp basements or crawl spaces, as well as from the living space. Research also shows that if we address crawl space, basement, attic and living space moisture, we do not need to ventilate an attic. In fact, by ventilating an attic, we can often make a moisture problem worse.

Attic moisture problems are a result of moisture condensing on cold roof surfaces. Adding more vents causes the attic to be cooler, especially at night, which causes more condensation to form on the underside of the cold roof. Cutting a hole in the roof causes a bigger hole in the top of our "chimney", which makes the "chimney" draw better, pulling even more moisture upward. I have not seen any attic moisture problems solved by adding attic ventilation, with the exception of ice damming. (Ice damming is a "warm" attic phenomenon, and can better be addressed by reducing the amount of heat leaking into the attic.) Unfortunately, the building codes haven't kept up.

Ventilation to reduce summer heat build up in an attic has also been challenged recently by research done at the Florida Solar Research Center and the Building Research Council in Illinois. Much of the heat in an attic is from radiant heat transfer. The hot sheathing radiates heat to the ceiling or other objects in the attic. To cool an attic, outside air is vented through attic or insulation is added to the ceiling to prevent the attic heat from warming the living space. Research has shown that the ventilation rate would have to be quite large to make much difference in an attic temperature. In the summer, the best you could possibly achieve was outside temperature. With a very large fan using lots of energy, you might get close to outside temperatures. In winter, this would result in a colder attic as well.

Ceilings are usually insulated because of the ease of piling up cheap insulation. Recessed lights, outside walls, sloped or tray ceilings and knee walls all create a non-uniform thermal "cap" on the building and result in voids in the insulation. The real-life R-value of an insulated ceiling is very often less than the claimed R-value.

Ducts are often located in the attic, which exposes the coolest/warmest air in the house to the hottest/coldest environment in the house (depending upon the season). This does not create a very energy efficient situation. As much as 10% of the heat or AC can be lost by placing ducts in an unconditioned attic.

From an energy standpoint, ducts and air handlers should be located within the conditioned space. This reduces heat transfer to the outside, and reduces some concern of duct leakage. Recently, building researchers proposed making crawl spaces into unvented, conditioned plenums, which is now accepted by code. More recently, building researchers proposed making attics into conditioned space by eliminating ventilation and insulating the underside of the roof rather than the ceiling. As a building researcher, I fully support both concepts.

A roof system insulated with spray foam reduces energy several ways. Energy loss from ducts located in the attic is essentially eliminated. The top of the building is much tighter resulting in less infiltration and exfiltration, so excess moisture isn't pulled into the attic. Infiltration through the ceiling is also reduced. In addition, the attic temperature is lower, which further reduces energy loads.

In a standard insulation system, ceiling insulation reduces the transfer of heat from the attic to the living space (in the summer). Attic temperatures can often approach 140F during the day. Most of this heat enters the attic space through a multi-step process. First, solar energy warms the shingles and sheathing. The hot sheathing then transfers heat to the rest of the attic through conduction, convection and radiant heat transfer. The 140F temperature of the underside roof surface drives the heat transfer process

By insulating the roof surface with spray foam, the surface temperature exposed to the attic (the temperature driving the heat transfer) is reduced by as much as 40F. Both conduction and convection heat transfer are proportional to a temperature difference, so that heat transfer will be reduced proportional to a drop in surface temperature. Radiant heat transfer, though, is proportional the 4th power of the temperature difference. The reduction in radiant heat transfer resulting from an insulated roof can easily exceed conduction and convection reductions.

The benefits of including the attic in the insulated space are:

" Duct leakage and heat loss/gain from ducts is much less of an issue.
" Air sealing is easier in the roof that in the ceiling.
" Dust and loose insulation are less likely to migrate down to the living space.
" Tests show energy costs are lower when the attic is sealed.

Further information is available from ASHRAE (8700-527-4723) in a publication titled "Vented and Sealed Attics in Hot Climates".

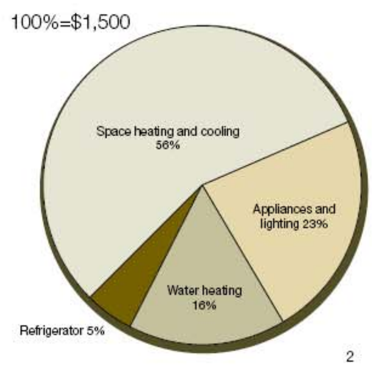
Crawl Spaces Benefits: Batt insulation is usually installed between the floor joists over a crawl space foundation. Problems associated with this installation technique include incomplete thermal barriers from obstructions such as wiring and plumbing, ductwork, and narrow or wide joist spacing. Batts are often compressed during installation due to the use of wire insulation hangers. Open web floor trusses create additional problems in that the open webs create pathways for air to move around the batts. During the summer, warm humid air can flow around the batts and create condensation, mold and decay problems in the floor system. In my opinion, open web floor trusses are impossible to adequately insulate with batts.

Spray foam circumvents floor insulation problems through its ability to completely fill voids and open spaces. Areas around wiring and plumbing as well as open webs of floor trusses can be completely filled, resulting in a complete, essentially uniform thermal barrier on the floor. Spray foam will also create an effective air flow retarder layer on the floor, which will reduce the house air by crawl space air.

In my opinion, spray foam insulation is a superior insulation product that overcomes several disadvantages of other insulation products. Spray foam can provide a more uniform, consistent thermal barrier as well as provide air flow retarder functions.
To best obtain spray foam's potential benefits, and overcome its higher initial costs, spray foam should be used in a systems approach to creating a better building. In a roof application, spray foam will increase the structure's ability to handle high winds as well as bring the attic into the conditioned space. A roof application of spray foam will reduce infiltration and reduce ceiling heat transfer and duct losses. Wall and floor applications will also create better thermal and air barriers, and make better use of engineered products. Spray foam insulation can result in less conductive, convective and radiant heat transfer, lower infiltration rates, less duct losses, a more structurally sound building and can result in significantly smaller-sized heating and cooling systems and better comfort levels for the occupants.
www.rlcengineering.com

The Importance of Insulation

Insulation helps create a living space that is comfortable, healthy and energy efficient



2

Air Flow

- Keep unconditioned air from leaking in
- Keep conditioned air from leaking out
- Prevent drafts within the structure

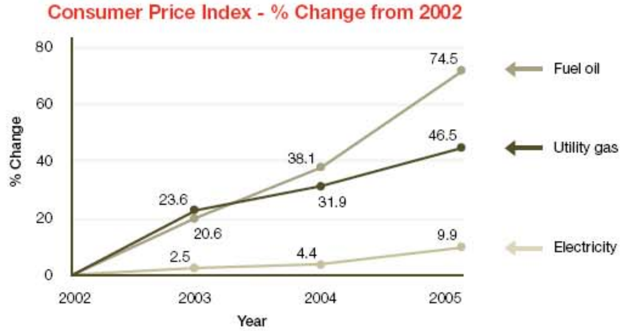
"Today, it is estimated that in residential and small commercial buildings, over 50% of the energy loss is associated with heat transfer and air leakage through building envelope components."
ORNL [1]

Heat Flow

- Keep heat in during winter
- Keep heat out during summer
- Maintain uniform temperature

"Heating and cooling (space conditioning) account for 50 – 70% of the energy used in the average American home."
DOE

Consumer Price Index - % Change from 2002



4

Water Flow

- Bulk
- Air
- Vapor

"Of all environmental conditions, moisture poses the biggest threat to structural integrity and durability, accounting for up to 89% of damage in building envelopes."
M.T. Bomberg [3]

The Building Envelope

- Insulation, working together with the roof, wall and foundation assemblies (as well as the related sub-elements of each assembly), forms the building envelope

- Among other functions, the building envelope must:
  - Keep wind and unconditioned air out
  - Keep the conditioned air in
  - Prevent drafts

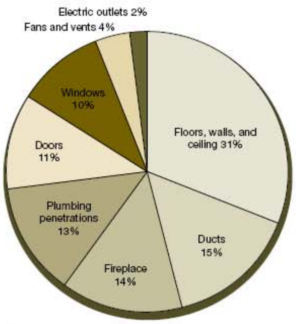
- Air movement (into and out of the house) has many detrimental effects:
  - Moisture within air impacts the long-term performance and structural integrity of the building
  - Introduction and distribution of pollutants and microbes
  - Thermal heat transfer [1]

- To address these concerns, many building scientists have concluded that houses should be as tight and seamless as possible [2]

- The American Lung Association also recommends that homes need to be as tight as practical [3]

- Random natural infiltration should be minimized and controlled mechanical ventilation should be employed [4]

Current Issues with Insulation & Air Control



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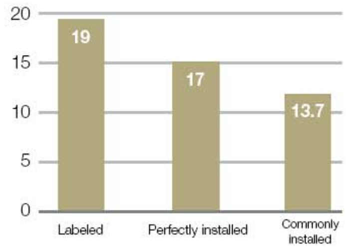


2 28% loss of R-value found in "commonly installed" insulation

How Does the Air Escape?

- Air moves in and out of your home through every hole, crack and seam
- About one third of this air infiltrates through openings in your ceilings, walls and floors

Traditional Fiberglass Insulation

- Even small voids in irregular framing or at the end of the batt of 1-2% of the insulation area can result in a 25-40% loss of R-value* [3]

Traditional Air Control

- A typical 2,500 sq. ft. home has more than ½ mile of cracks and crevices [4]
- These usually occur in:
  - Poorly fitted and flashed doors and windows
  - Plumbing/electrical outlets
  - Gaps in drywall and wall plates
  - Rim/framing joists
- With an average 8 mph wind, your home could lose up to 30% installed R-value [5]
- Most insulation materials do not block air and require an air barrier (an incremental cost when comparing installation costs) [6]

The Importance of Moisture Control

"Controlling moisture is key to preventing mold growth...When present in large quantities, mold can cause health problems, including allergic reactions, asthma episodes and respiratory problems." [1]

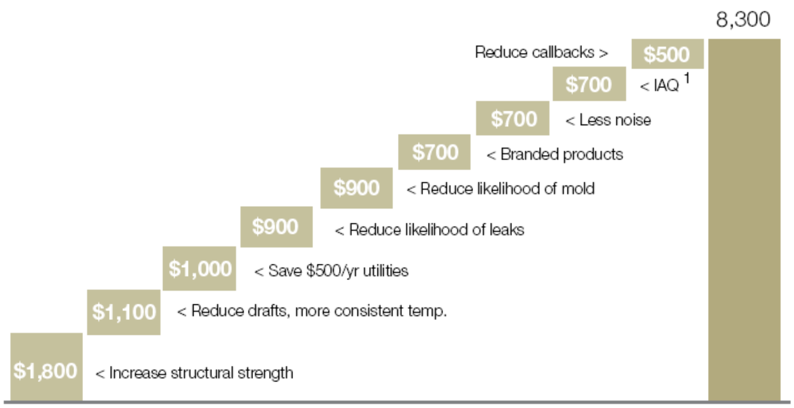
"Controlling rain and ground water are the most important factors in the design and construction of durable buildings and for the control of mold." [2]

FEMA Technical Bulletin 2-93 [3]

- Closed-cell foam is the only type of insulation classified as an "acceptable flood-resistant material" by FEMA.
- "Flood-resistant material" is defined as any building material capable of withstanding direct and prolonged contact with floodwaters without sustaining significant damage.
- Batt or blanket insulation types and all other insulation types are classified as "unacceptable".

Home Buyer Needs Analysis

How much would you be willing to pay to:



About the Research

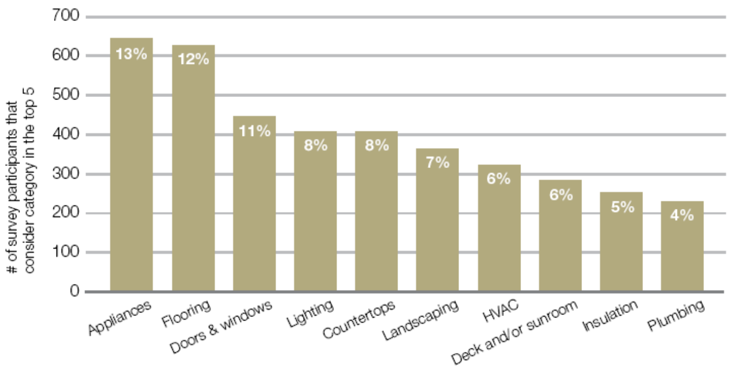
- 1,000 new home buyer respondents of 12,000 surveys sent
- Representative profile of U.S. new home buyers
- Strong demographics correlation with NAHB (e.g. age, income, purchase price, geography) and U.S. census data

> ***"I wish the temperatures in my home were more consistent."***
>
> **-Survey Respondent**

Home Buyer Spending Analysis

Top categories for upgrade dollars

Appliances, flooring, doors & windows, lighting and countertops were the most common categories for upgrade dollars. Insulation was listed as the ninth most likely category for upgrade dollars.

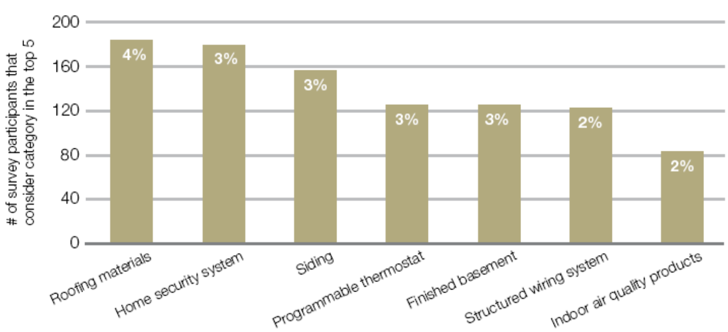


Insulation upgrades make the "top-ten" list for options spending

> 50% of the participants were highly satisfied with the upgrade options that they purchased

Homes > $500,000: top upgrade dollar spending was for countertops, flooring and doors & windows.

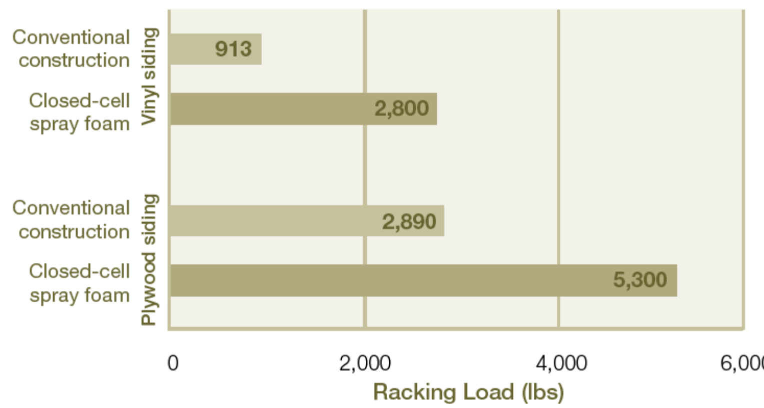
Categories with lower spending upgrade dollars



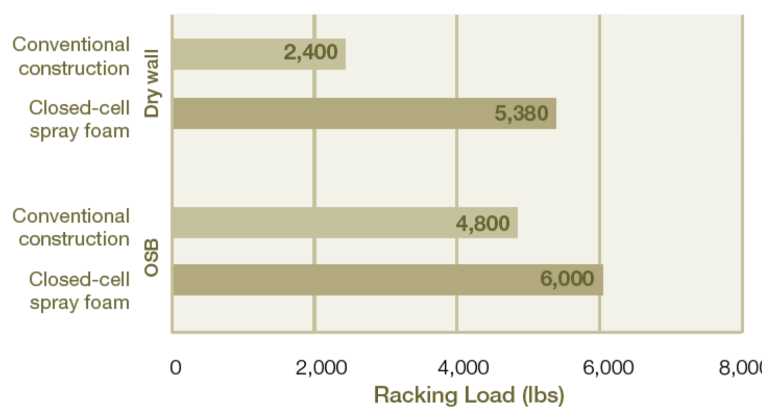
Structural Strength

"During a design racking event like a hurricane, there would be less permanent deformation of wall elements and possibly less damage to a structure that was braced with SPF [spray polyurethane foam] filled walls." [1]

Average Maximum Racking Load (structural resistance to wind) Supported by 16" On-Center Spruce-Pine-Fir 2x4 Stud Framing [1]

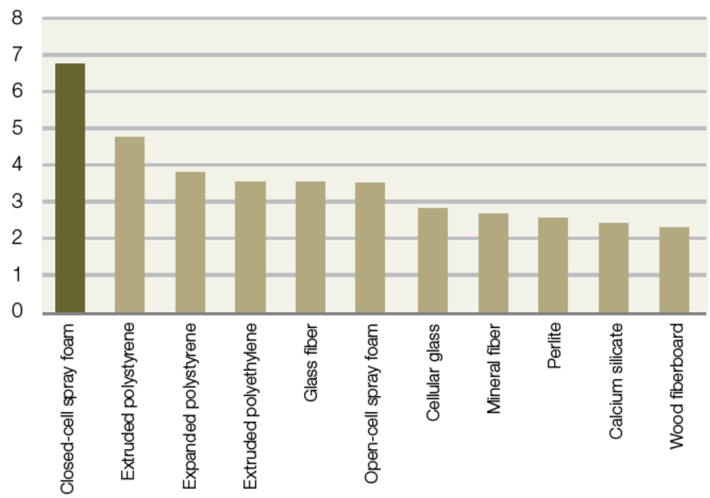


Maximum Racking Load (structural resistance to wind) for SPF vs Conventional R-19 Batts Supported by 24" On-Center 20-Gauge Light Structural Steel Framing [2]



Thermal Insulation/Draft Reduction

Typical R-values of Insulation Materials [1]

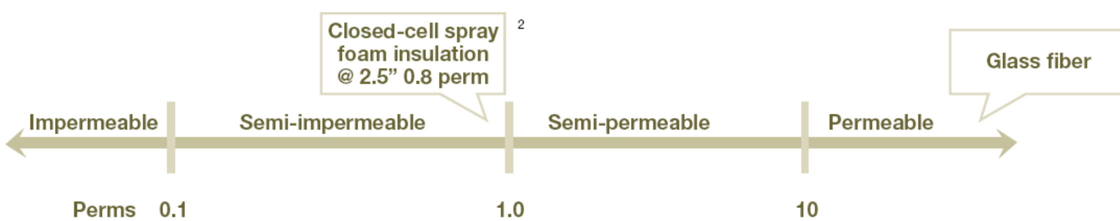


- Closed-cell spray foam provides the highest R-value of available insulation materials
- Closed-cell spray foam also provides the best defense against all six mechanisms of heat transfer
- Unlike other insulation materials, closed-cell spray foam seamlessly fills regular and irregular spaces [2]

Moisture Control

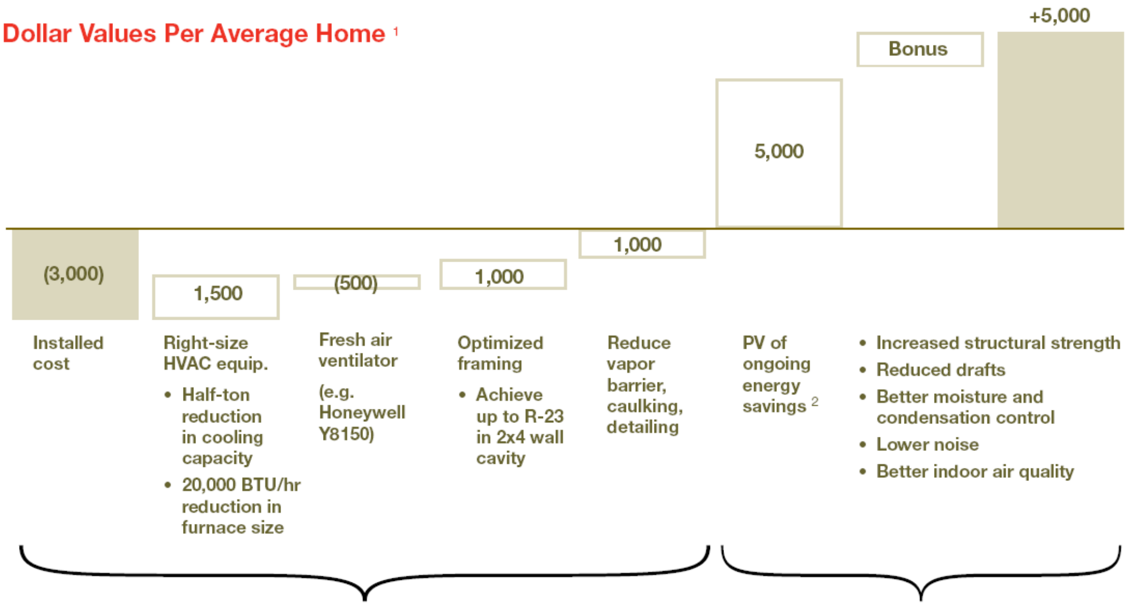
	1. Rain & ground water	2. Air infiltration	3. Vapor diffusion
How do you control	- Properly designed and constructed drainage planes - Use of repellent materials (building paper, house wrap, foam insulation) in the construction	- Seamless, continuous air barrier	- Vapor retardant materials - Optimal placement can change (from outside to inside or vice versa) depending on climate and weather differences
Closed-cell spray foam advantage	"SPF [spray polyurethane foam] can be applied within a building envelope to control heat, air and moisture transport by providing continuous and effective air barriers, rain screens, weather barriers, and thermal insulation... SPF also limits water movement within the building envelope since the water cannot flow within the SPF's closed cells, even if a hole is made in the SPF." (Mason Knowles, SPFA)	"SPF is an effective air barrier and weather barrier because of its ability to seamlessly fill irregular spaces and provide water resistance" Mark Bomberg, Ph.D, PE National Research Center of Canada, Construction Practice: Building Envelope and environmental Control	- Semi-impermeable, allows for controlled breathing and drying - Uniformity and consistency enables it to resist passage of vapor equally well in all directions (from David Frane, Journal of Light Construction) - Minimizes dew point problems and condensation (Mason Knowles, SPFA)

Classes of Materials Based on Permeance [1]



Closed-Cell Spray Foam Benefits

Dollar Values Per Average Home [1]



- **Higher installed cost per square foot for closed-cell spray foam insulation may be offset by savings in other areas**
- **Builders have a potential upsell opportunity based on benefits for homebuyers**

Upsell Potential

LEED® Credits Opportunity [3]

Credit	Points
Wall, floor, ceiling, crawl space insulation	1-2
Air infiltration	1-2
Local sources	3
Overall home Energy Star performance	16

LEED® Performance Levels

Certified	30 Points
Silver	50 Points
Gold	70 Points
Platinum	90 Points

Closed-Cell Spray Foam Features	Closed-Cell Spray Foam Benefits
• Structural strength • Air infiltration control • Moisture/condensation control • Thermal insulation (R-value)	• Energy savings • Improved indoor air quality • Improved comfort (draft reduction) • Problem solving tool - Ice dam - Rim joist - Pipe freeze - Tub enclosures - Unvented attics - Unvented crawl space - Leaky windows - Foundations - R-23 using 2x4 framing

Energy Comparisons

Case study #1	**Sacramento, CA** **Comparable single story 2,400 square foot homes** **Several addresses apart on same side of street** **Gas and electric bills Feb to Dec, 2003**	
Traditionally insulated home: • Utility bills - $2,239 electric - $477 gas - $2,716 total • Monthly average utilities - $247 • Average utility prices - Gas $0.95 per therm - Electric $0.17 per kWH	Closed-cell spray foam insulated: • Total gas and electric - $1,107 electric - $306 gas - $1,413 total • Monthly average utilities - $128 • Average utility prices - Gas $0.93 per therm - Electric $0.13 per kWH	Closed-cell spray foam energy savings: • 48% reduction in utility bills - $118 per month average savings - $1,422 per year; $42,645 over 30 years • How much extra financing could you afford on a 30 year mortgage with an extra $118 per month? - $19,758 at 6% - $17,805 at 8%

Case study #2	**Roanoke, VA** **2,240 square foot ranch** **Liquid propane gas heat** **Low fuel consumption got supplier's attention** **Monitored propane usage Aug '00 to Jul '01**	
Ten similar homes with traditional insulation: • Total propane consumption - Average was 769 gallons	Closed-cell spray foam insulated: • Total propane consumption - 321 gallons	Closed-cell spray foam energy savings: • 58% reduction in propane usage vs. average of ten comparable homes - 30% savings vs. next best home - 74% savings vs. worst home • Estimated savings - $896/yr with propane at $2 per gal - Mortgage value of $12,444 at 6%

Case study #3	**Atlanta, GA** **Comparable residences 1,800 sq. ft.** **Less than two miles apart** **Similar occupancy**	
Traditionally insulated home: • Monthly average utilities $143.76 • Cost of insulation $2,350	Closed-cell spray foam insulated: • Monthly average utilities $89.64 • Cost of insulation $5,200	Closed-cell spray foam energy savings: • 38% reduction in utilities - $54.12 per month average saving • Added mortgage cost $2,850 - $17.10 per month added mortgage payment at 6% interest • Extra cash in homeowner's pocket $37.02 per month

1. Oak Ridge National Labs
www.eere.energy.gov/consumer/tips/air_leakes.html
2. Department of Energy www.energystar.gov
3. Building Envelope and Environmental Control:Part 1-Heat,Air and Moisture Interactions by M.T. Bomberg and W.C. Brown, Originally published in "Construction Canada" 35(1) 1993, p. 15-18
4. Source: U.S. Department of Labor, Bureau of Labor Statistics, Average Price Data www.bls.gov

SPF Out Performs Fiberglass In Attic Insulation Performance Tests at Oak Ridge National Laboratories

For years SPF contractors have been frustrated by prescriptive building code requirements that mandated extremely high R-values in attics, particularly in cold climates. For example in Wisconsin, R-values of 49 are prescribed in attics. In order to provide more realistic evaluations of insulation systems, Oak Ridge National Laboratories developed a large scale, attic climate simulator that could provide data on how efficiently insulation systems rated R-values matched up to more real life performance.

In July, 2005, SPFA contracted with R & D Services to test low density, water blown SPF and 2lb density HFC 245fa blown insulation systems in an attic thermal performance climate simulator at Oak Ridge National Laboratories. The SPF assemblies were compared to a typical blown-in fiberglass insulation attic application.

Three attic insulation systems were tested in the LSCS for both Winter and Summer conditions. The thermal test section has dimensions 8x8 ft and area of 64 ft2.

Loose-fill fiberglass on floor of attic (depth 14")

Low-density foam between rafters on the underside of the roof desk (depth 5.5in)

Medium (2. lb) density foam between rafters on the underside of the roof deck (depth 4.0 in.)

Results:

The test results demonstrate that both density and medium (2lb) density SPF installed to the underside of the roof deck in attic assemblies maintain a much higher effective R-value at both low and high temperatures than the fiberglass insulation system. The SPF systems maintained 74% and 83% respectively of reported R-value at low outside temperatures compared to 46% for the fiberglass assembly, and 61% and 67% of reported R-value at high outside temperature compared to 51% for the fiberglass assembly. (table 1)

Attic temperatures of low density and medium density SPF assemblies averaged 77 to 78 degrees F at high outside temperature and 60-61 degrees F at low outside temperature compared to an average of 107 degrees at high outside temperature and 7 degrees at low outside temperature for the fiberglass assembly (table 5).

1. During low density SPF installation, application anomalies were noted by observers that may have affected R-value performance.

This statistic is important for buildings that have ducts and HVAC units in attics. The high and low attic temperatures require much more energy to heat & cool and contribute to wider temperature ranges between levels of the building (Table 2)

Table 1
Comparison of Tested R-Values and Labeled R-Values
Attic Thermal Testing at Oak Ridge National Laboratory

Insulation	**Test Number**	**Insulation Temperature**	**Labeled R-Value**	**Tested R- Value (C 1363)**	**% Labeled**
Blown Fiber Glass @ 14 inches	1a (low temp)	38.01	38	17.7	47
	1b (low temp)	38.03		17.7	47
	1c (avg temp)	51.75		29.0	76
	1d (high temp)	88.97		20.2	53
Low-Density SPF @ 5.5 inches	2a (low temp)	32.61	19.8	14.7	74
	2b (low temp)	32.73		14.7	74
	2c (avg temp)	48.49		13.6	69
	2d (high temp)	93.00		12.1	61
High Density SPF @ 4.0 inches	3a (low temp)	32.89	27	22.8	84
	3b (low temp)	33.01		22.7	83
	3c (avg temp)	48.79		19.8	73
	3d (high temp)	93.07		18.1	67

Table 2

Attic Air Temperatures Observed in ORNL LSCS Project

Attic air temperatures were recorded for each of the 12 measurements at locations six inches below the peak of the attic and 12 inches below the peak of the attic. This was done using thermocouples suspended in the attic air space. The temperatures are in F.

Test No.	**Interior Temp.**	**6-inches from peak**	**12-inches from peak**	**Exterior Temp**
1a	69.99	7.75	7.75	0.20
1b	69.98	7.54	7.44	0.09
1c	69.96	32.73	32.72	30.12
1d	70.06	108.14	107.75	109.93
2a	70.02	60.31	60.42	-0.21
2b	70.01	60.33	60.47	0.00
2c	69.99	64.04	64.18	30.15
2d	70.03	78.28	77.78	109.87
3a	70.03	61.39	61.45	0.10
3b	70.03	61.44	61.56	0.23
3c	70.01	64.80	64.90	29.99
3d	69.97	77.10	76.72	109.95

US Department of Energy
National Laboratory System
Science and Technology Information

The follow shows the equivalent "R" values of the most common types of insulation. When insulation collects moisture or any air is allowed to pass through it, the "R" value goes to zero.

Fiberglass Insulation	R3.2 per inch	32% Efficiency Rating

3 ½ inches in a 2x4 wall with a 32% ER is equivalent to R11.2

Collects Moisture

Cellulose Insulation	R3.5 per inch	36% Efficiency Rating

3 ½ inches in a 2x4 wall with a 34% ER is equivalent to R12.74

Collects Moisture

Open Cell Foam Insulation	R3.5 per inch	44% Efficiency Rating

3 ½ inches in a 2x4 wall with a 44% ER is equivalent to R13.72

Collects Moisture

Closed Cell Foam Insulation	R7 per inch	92% Efficiency Rating

3 ½ inches in a 2x4 wall with a 92% ER is equivalent to R63.7
2 inches in a 2x4 wall with a 92% ER is equivalent to R40.18
1 inch in a 2x4 wall with a 92% ER is equivalent to R20.09

Does Not Collect Moisture

WHAT IS FLAME SPREAD RATING?

A measure of the relative flame spread, and smoke development, from a material being tested. The flame spread rating is a single number comparing the flame spread of a material with red oak, arbitrarily given the number 100 and asbestos cement board with a flame spread of 0. Building codes require a maximum flame spread of 25 for insulation installed in exposed locations.

Fire Performance

What is flame spread and smoke developed? How does this relate to fireguard and class A?

Surface Burning Characteristics Rating (Formerly Flame Spread Rating)

The surface Burning Characteristics Rating of a material is a number, calculated from the results of a test, which indicates the relative relate at which flame will spread over the surface of the material as compared with flame spread on asbestos-cement board, which is rated 0, and on red oak, which is rated 100. Note that this rating is not the rate at which the flame actually spreads along the surface and is not at all an indication of the fire resistance of the material.

Test Method

The test used to obtain results from which a rating is calculated is called "Method of Test of Surface Burning Characteristics of Building Materials" (NFPA No. 255, ASTM E 84, UL No. 723). It is commonly known as the tunnel Test; the test equipment is referred to as the 25' tunnel. Although several small scale tests have been developed to predict flame spread ratings based on the tunnel test, these are primarily bench test for product development. The National fire Protection Association (NFPA) has not accepted any alternate methods for determining the flame spread characteristics of materials to be used in building; for this purpose, NFPA recommends only the Tunnel Test.

The sample of material to be tested (minimum 18" wide, 25' long) is installed beneath the removable top panel. A gas flame is applied at one end and regulated constant draft is directed through the tunnel from the flam end. The progress of the flame front along the sample is observed through side windows.

A flame spread rating is relative number. It has no direct relationship to a fire resistance rating, which is a rating in hours determined by an entirely different test, know as "Standard Methods of Fire Tests of Building Construction and Materials" NFPA No. 251, ASTM E 119, UL No. 263).The exposed surface (ceiling) of an assembly possessing very little fire resistance could both have a very low flame spread. There is not necessarily any correlation between the two rating.

There are numerous laboratories with 25 foot tunnels that do commercial testing.

Applying The Ratings

Relative figures on how fast fire will spread over the surface of the material allow fire protection engineers to deal with problems involving possibilities of (1) people being trapped within a building before orderly evacuation can be accomplished, and (2) rapid spread of fire through an entire building or an area of a building before the usual fire protection measures can be put into effect to control or extinguish the fire. Building codes generally group flame spread ratings into classifications as follows:

Class 25 or Class I or Class A = Flame Spread Ratings 0-25; class 75 or Class II or Class B – Flame Spread Rating 26-75; Class 200 or Class III or Class C – Flame Spread Rating 76-200; Class IV or class D = Flame Spread Rating 201-.

ASTM E=119 AND FIRE GUARD PRODUCTS

ASTM E-119 is an assembly test, not a product test. This is the test method (UL) used for fire resistance rated assemblies. UL does make note of this in the 2000 UL Fire Resistance Directory under INTRODUCTION. Therefore, any of our Fire Guard products have been tested according to this method

R314.1 GENERAL.
The provisions of this section shall govern the materials, design, application, construction and installation of foam plastic materials.

R314.2 LABELING AND INDENTIFICATION.
Packages and containers of foam plastic insulation and foam plastic insulation components delivered to the job site shall bear label of an approved agency showing the manufacturers' name, the product listing, product identification and information sufficient to determine that the end use will comply with the requirements.

R314.3 SURFACE BURNING CHARACTERISTICS.
Unless otherwise allowed in Section R314.5 or R314.6, all foam plastic or foam plastic cores used as a component in manufactured assemblies used in building construction shall have a flame spread index of not more than 75 and shall have a smoke-developed index of not more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E 84. Loose-fill type foam plastic insulation shall be tested as board stock for the flame spread index and smoke-developed index.

EXCEPTION: Foam plastic insulation more than 4 inches thick shall have a maximum
flame spread index of 75 and a smoke-developed index of 450 where tested at a minimum thickness of 4 inches, provided the end use is approved in accordance with Section R314.6 using the thickness and density intended for use.

R314.THERMAL BARRIER
Unless otherwise allowed in Section R314.5 or Section R314.6, foam plastic shall be separated from the interior of a building by an approved thermal barrier of minimum 0.5" (12.7mm) gypsum wallboard or an approved finish material equivalent to a thermal barrier material that will limit the average temperature rise of the unexposed surface complying with the ASTM E 119 standard time temperature curve. The thermal barrier shall be installed in such a manner that it will remain in place for 15 minutes based on NFPA 286 with the acceptance criteria of Section R315.4, FM 4880, UL 10410 or UL 1715.

R314.5.1 MASONRY OR CONCRETE CONSTRUCTION.
The thermal barrier specified in Section R314.4 is not required in masonry or concrete wall, floor or roof with the foam plastic insulation is separated from the interior of the building by a minimum 1-inch (25mm) thickness of masonry or concrete.

R314.5.2 ROOFING
The thermal barrier specified in Section R314.4 is not required when the foam plastic in a roof assembly or under a roof covering is installed in accordance with the code and the manufacturer's installation instruction and is separated from the interior of the building by tongue and groove wood plank or wood structural panel sheathing in accordance with Section R803, not less than 15/32" (11mm) thick bonded with exterior glue and identified as Exposure 1, with edges supported by blocking or tongue and groove joints or an equivalent material. The smoke-developed index for roof applications shall not be limited.

R314.5.3 ATTICS: The thermal barrier specified in Section 314.4 is not required where attic access is required where attic access is required by Section R807.1 and where the space is entered only for service of utilities and when the foam plastic insulation is protected against ignition using one of the following ignition barrier materials:

1. 1.5- inch-thick (38 mm) mineral fiber insulation;
2. 0.25-inch-thick (6.4mm) wood structural panels

3. 0.375-inch (9.5mm) particleboard
4. 0.25-inch (6.4 mm) hardboard
5. 0.375-inch (9.5mm) gypsum board; or
6. Corrosion-resistant steel having a base metal thickness of 0.016 inch 0.406mm).

The above ignition barrier is not required where the foam plastic insulation has been tested in accordance with Section R 314.6

R314.5.4 CRAWL SPACES; The thermal barrier specified in Section R314.4 is not required where crawlspace access is required by Section R408.3 and where entry is made only for service of utilities and the foam plastic insulation is protected against ignition using one of the following ignition barrier materials:

1. 1.5-inch-thick (38mm) mineral fiber insulation
2. 0.25-inch-thick (6.4mm) wood structural panels
3. 0.375-inch (9.5mm) particleboard
4. 0.25-inch (6.4mm) hardboard
5. 0.375-inch (9.5mm) gypsum board or
6. Corrosion-resistant steel having a base metal thickness of 0.016”(0.41mm)

The above ignition barrier is not required where the foam plastic insulation has been tested in accordance with section R314.6

R314.5.5 FOAM-FILLED EXTERIOR DOORS
Foam-filled exterior doors are exempt from the requirements of Sections R314.3 and R314.4

R314.5.6 FOAM-FILLED GARAGE DOORS
Foam-filled garage doors in attached or detached garages are exempt from the requirements of Section R314.3 and R314.4

R314.5.7. FOAM BACKER BOARD: The thermal barrier specified is Section R314.4 is not required where siding backer board foam plastic insulation has a maximum thickness of 0.5 (12.7 mm) and a potential heat of not more than 2000 Btu per square foot (22 0720 kJ/m2) when tested in accordance with NFPA 259 provided that:

1. The foam plastic insulation is separated from the interior of the building by not less than 2” (51 mm) of mineral fiber insulation or
2. The foam plastic insulation is installed over existing exterior wall finish in conjunction with re-siding
3. The foam plastic insulation have been tested in accordance with Section R314.6

R314.8.8 RE-SIDING
The thermal barrier is specified in Section R314.4 is not required where the foam plastic insulation is installed over existing exterior wall finish in conjunction with re-siding provided the foam plastic has a maximum thickness of 0.5” (12.7mm) and a potential heat of not more than 2000 Btu per square foot (22 720kJ/m2) when tested in accordance with NFPA 259.

R314.5.9 INTERIOR TRIM: The thermal barrier specified in Section R314.4 is not requires for exposed foam plastic interior trim, provided all of the following are met:

1. The minimum density is 20 pounds per cubic foot (320 kg/m3)
2. The maximum thickness of the trim is 0.5 inch (12.7mm) and the maximum width is 8 inches (204mm).
3. The interior trim shall not constitute more than 10 percent of the aggregate wall and ceiling area of any room or space.
4. The flame spread index does not exceed 75 when tested per ASTM E 84. The smoke-developed index is not limited.

R314.5.10 INTERIOR FINISH
Foam plastics shall be permitted as interior finish where approved in accordance with R314.6. Foam plastics that are used as interior finish shall also meet the flame spread and smoke-developed requirements of Section R315.

R314.5.11 SILL PLATES AND HEADERS: Foam plastic shall be permitted to be spray applied to a sill plate and header without the thermal barrier specified in Section R314.4 subject to all of the following:

1. The maximum thickness of the foam plastic shall be 3 ¼ inches (83
2. The density of the foam plastic shall be in the range of 1.5 to 2.0 pounds per cubic foot (24 to 32 kg/m3)
3. The foam plastic shall have a flame spread index of 25 or less and an accompanying smoke developed index of 450 or less when tested in accordance with ASTM E 84.

R314.5.12 SHEATHING
Foam plastic insulation used as sheathing shall comply with Section R314.3 and Section R314.4. Where the foam plastic sheathing is exposed to the attic space at a gable or knee wall, the provisions of Section R314.5.3 shall apply.

R314.6 SPECIFIC APPROVAL
Foam plastic not meeting the requirements of Sections R314.3 through R314.5 shall be specifically approved on the basis of one of the following approved tests: NFPA 286 with the acceptance criteria of Section R315.4, FM4880, UL 1040 or UL 1715, or fire tests related to actual to actual end-use configuration. The specific approval shall be based on the actual end use configuration and shall be performed on the finished foam plastic assembly in the maximum thickness intended for use. Assemblies tested shall include seams, joints and other typical details used in the installation of the assembly and shall be tested in the manner intended for use.

R314.7 TERMITE DAMAGE
The use of foam plastics in areas of “very heavy” termite infestation probability shall be in accordance with Section R320.4

Table 1

Reported Flame Spread Indices

Material	ASTM-E84 Flame Spread	Source	Material	ASTM E-84 Flame Spread	Source
LUMBER			**SOFTWOOD PLYWOOD (Exterior Glue)**		
Birch, Yellow	105-10	UL	Cedar 3/8"	70-95	APA
Cedar, Pacific Coast Yellow	78	CWC	Douglas Fir ¼"	150	APA
Cedar, Western Red	70	HPVA	Douglas Fir 5/16"	115-155	APA
Cedar, Western Red	73	CWC	Douglas Fir 3/8"	110-150	APA
Cherry ¾"	76	HPVA	Douglas Fir ½"	130-150	APA
Cottonwood	115	UL	Douglas Fir 5/8"	95-130	APA
Cypress	145-150	UL	Hemlock 3/8"	75-160	APA
Elm ¾"	76	HPVA	Southern Pine ¼"	95-110	APA
Fir, Douglas	70-100	UL	Southern Pine 3/8"	100-105	APA
Fir, Douglas ¾" flooring	83-98/	WEY	Southern Pine 5/8"	90	APA
Fir, Amabilis (Pacific Silver)	69	CWC	Redwood 3/8"	95	UL
Fir, White	65	HPVA2	Redwood 5/8"	75	UL
Gum, Red	140-155	UL			
Hem-Fir species Group	60	HPVA2			
Hemlock, West Coast	60-75	WEY-UL	**HARDWOOD PLYWOOD**		
Larch, Western	45	HPVA2	ASH ¾" – Particleboard core	134	HPVA
Maple (flooring)	104	CWC	Birch ¼" – Douglas Fir Veneer core	135-173	HPVA
Oak, Red or White	100	UL	Birch ¼" – Fuma Veneer core	127	HPVA
Oak, Red ¾"	84	HPVA2	Birch ¾" – Douglas Fir Veneer Core	114	HPVA
Oak, White ¾"	77	HPVA2	Birch ¾" - High Density Veneer Core	114	HPVA
Pecan ¾"	85	HPVA2	Birch ¾" – Particle Core	124	HPVA
Pine, Eastern White	85	CWC	Birch ¾" – MDF Core	134	HPVA
Pine, Idaho White	72	HPVA	Honduras Mahogany 3/4 " – Particleboard Core	105	HPVA

Pine, Idaho White	82	WEY	Lauan 11/64”	167	NIST
Pine, Lodgepole	98	WEY	Lauan ¼”	150	HPVA
Pine, Northern White	120-215	UL	Oak ¼” – Douglas Fir Veneer Core	153	HPVA
Pine, Ponderosa	105-230	UL	Oak ¾” – MDF Core	123	HPVA
Pine, Ponderosa	115	HPVA2			
Pine, Red	142	CWC	**PARTICLEBOARD**		
Pine, Southern Yellow	130-195	UL	3/16” (AROMATIC Cedar Flakeboard)	156	HPVA
Pine, Sugar	95	HPVA2	3/8”	200	UL
Pine, Western White	75	UL	½”	135	HPVA
Poplar, Yellow	170-185	UL	1/2’”	156	NIST
Redwood	70	UL	5/8”	153	NIST
Redwood 3/8”	102	UL	11/16”	168	UL
Spruce, Engelmann	55	HPVA2	¾”	145	UL
Spruce, Northern	65	UL	¾” (Exterior Glue)	88-98	APA2
Spruce, Sitka	74	CWC	**MEDIUM DENSITY FIBERBOARD – MDF**		
Spruce, Western	100	UL	3/8”	140	UL
Walnut	130-140	UL	7/16”	125	HPVA
Walnut ¾”	101	HPVA2	5/8”	120	HPVA
ORIENTED STRAND BOARD, WAFERBOARD (Exterior Glue)			**11/16”**	**140**	**UL**
5-16”	127-138	APA2	¾”	140	HPVA
7/16”	86-150	APA2	¾”	140	HPVA
½”	74-172	APA2	¾”	130	HPVA
¾”	147-158	APA2	1”	90	UL
			SHAKES AND SHINGLES		
			Western Red Cedar Shakes ½”	69	HPVA
			Western Red Cedar Shingles ½”	49	HPVA

TABLE 1 FOOTNOTES
1. Thickness of material tested is one-inch nominal except when indicated
2. The ASTM E-84 test method has been revised a number of times during the year's reference by the source reports. However, the E-84 test apparatus has changed little over this period. Slightly different flame spread indices, usually lower, result when recent E-84 flame spread calculation techniques are applied to older wood product data. The changes in flame spread indices are not sufficient to change the flame spread class for the wood products described in this report.
3.SOURCES: APA – APA- The Engineered Wood Association, Research Reports 128, August 1979. APA2 – APA – The Engineered wood Association Test Results CWC-Fire Safety Design in Buildings, Canadian Wood Council, 1996. HPVA – Hardwood Plywood and Veneer Association, Test Reports, 202,203,335,336,337,592, and 596; Special flame spread performance tests, Aug 1974;T9234,T9237,T9317,T9344,T9354, May 1995; T9422,T9430,T9431,T9453,T9665, Feb/July 1997. HPVA2 – Hardwood Plywood and Veneer Association, March/April 1995; October/December 2000. NIST – National Institute of Standards and Technology (formerly National Bureau of Standards), Technical Notes 879 and 945. UL-Underwriter's Laboratory, UL 527, May 1971; Subject 723, Assignment 71SC509, Mar 15 & 16, 1971; Assignment 84NK1898, File R10917, Mar 9,1984 WEY – Weyerhaeuser Fire Laboratory, 1973, 1987, January & February 1988.
4. Ave3rage of 18 tests was 154 with three values over 200.
5. The Hem-Fir Species Group represents six species: California Red Fir, Grand Fir, Nobel Fir, Pacific Silver Fir, Western Hemlock, and White Fir. The reported flame spread index represents a product containing a mixture of these species. When lumber is from a single species refer to the specific species flame spread index.
6. Exposure 1 or exterior.
7. Flame spread of plywood is affected by the species of the face veneer but can also be influenced by the species of the underlying core veneer. Various panel constructions involving certain core species show a relatively high degree of variability and potential to yield flame spread values above 200. Panel constructions involving cores of aspen, sumauma, yellow poplar and white fir have exhibited this behavior with average flame spread indices ranging from 78 to 259. Other factors, in addition to species, including material and process variables related to specific manufactures can also affect flame spread. Thus, for plywood panels with certain core species, test data from the actual manufacturer is particularly important in establishing the flame spread classification of the product.

TABLE 2	
REPORTED FLAME SPREAD INDICES OF FACTORY FINISHED PRODUCTS	
MATERIAL 1	**ASTM E-84 FLAME SPREAD**
PARTICLEBOARD	
5/32” Factory Finished Printed	
5/32” Paper Overlay	
5/32” Vinyl Overlay	
¼” Vinyl Overlay	
3/8” Vinyl Overlay	
½” Vinyl Overlay	
5/8” Vinyl Overlay	
MEDIUM DENSITY FIBERBOARD (MDF)	
3/16” Factory Finished Printed	
¼” Vinyl Overlay	
HARDBOARAD	
1/8” Paper Overlay	
1/8” Vinyl Overlay	
3/16” Vinyl Overlay	
HARDWOOD PLYWOOD	
Cherry 1/4” Factory Finished	
Elm ¼” Factory Finished Printed	
Hickory ¼” Factory Finished	
Lauan ¼” Factory Finished Printed	
Lauan 1/4” Vinyl Overlay	
Lauan 3.6mm Factory Finished Printed	
Lauan 3.6mm Vinyl Overlay	
Lauan 3.6mm Paper Overlay	
Maple ¼” Factory Finished	
Oak ¼” Factory Finished	
Pecan ¼” Factory Finished	
Pine ¼” Factory Finished	
Walnut ¼” Factory Finished	
SOFTWOOD PLYWOOD	
¼” Douglas Fir w/ Medium Density Overlay 2	
3/8” Douglas Fir w/Medium Density Overlay 3	
3/8” Douglas Fir w/High Density Overlay 3	
ORIENTED STRAND BOARD, WAFERBOARD (EXTERIOR GLUE4)	
7/16” Phenolic Paper Overlay3	

FOOTNOTES

1. **Source: Hardwood Plywood and Veneer Association Test Records, except as noted**
2. **Canadian Wood council, *Fire Safety Design in Buildings, 1996***
3. **APA – The Engineered Wood Association Test Results**
4. **Exposure 1 or exterior**

ELK APPROVED

SPRAY-IN-PLACE INSULATION SYSTEMS

Fact Sheet

Elk premium roofing products are approved for use over many non-vented* and vented specialty deck systems. These systems include applications over specific spray-in-place insulation applied to the underside of the roof deck.

We take this area of our business very seriously and we have approved some non-vented specialty deck since the early 1980's. In addition to our field experience with these systems, here are additional reasons why you should consider Elk premium roofing products for application over approved spray-in-place insulation systems:

- Elk has a state-of-the-art test facility at the Technology Center in Ennis, Texas, where we conduct our own testing and evaluation of specialty desks.
- Each specialty deck manufacturer is required to submit specific data, product specifications, guidelines, and MSDS for evaluation.
- All Elk products carry the full limited warranty over approved spray-in-place systems.
- Elk shingles are manufactured to perform in all climates and in all temperatures.
- Elk has 4 manufacturing plants located in California, Pennsylvania, Texas, and Alabama. Each plant has a technical services department and we have one specialist dedicated to provide technical assistance in the area of specialty decks.

Elk carrier a full line of roofing and accessory product including:

- Elk field shingles are offered in a wide range of looks for a wide variety of homes, including our Prestique® shingles with a visual depth and texture reminiscent of real wood. Prestique Grande' is 40% larger and brings a dramatic large-scale look to any roof. Domain® Winslow®'s large exposure gives a bold, wood-shake look and Capstone® has a distinctive slate-like appearance.
- Z ® Ridge and Seal-A-Ridge® Hip and Ridge Shingles
- VersaShield® Underlayment
- All-Climate Self-Adhered Underlayment
- Ventilation Products
- Roof Accessory Paint
- CrossTimbers ™ composite lumber is ideal for decks, patios, and fencing

For information regarding Elk premium roofing products, please contact the Elk location nearest you or visit our web sit at www.elkcorp.com. For information regarding specialty deck systems, please contact our Technical Services department at 866-355-8324, ext 6.

Spray polyurethane foam (SPF) and rigid foams made with polyurethane (Polyiso), extruded polystyrene (XPS) and expanded polystyrene (EPS) are growing solutions for insulation systems.

SPF conforms to the surface to which it is applied and forms a seamless layer of insulation, thus filling energy-wasting holes and gaps around pipes, outlets, windows and more. Since SPF fills in gaps and seams during application, it is increasingly being used as an air-barrier in buildings. The material -- cut into sheets, slabs or any desired design, as well as sprayed to meet specific building code requirements or custom designs -- serves as a durable design solution since it often arrives at the job site as a liquid, saving on transportation costs and reducing waste.

This beneficial 'air barrier' effect can be achieved by rigid polyurethane (Polyiso) foams installed properly with taped seams. Structural insulated Panels (SIPs) also demonstrate this same beneficial air barrier trait. SIPs can be made from Expanded polystyrene (EPS) or Extruded polystyrene (XPS). A SIP is two layers of 5/16th inch OSB with the expanded or extruded polystyrene encased between those two layers forming a rigid wall structure without normal 'studs' being needed. See the June issue of Modern Materials magazine for National Association of Home Builders wall performance tests showing how plastics building materials can outperform typical 'stick and batt' construction under real-world windy conditions.

Can SPF and rigid plastic foam insulations (SIPs, Polyiso, EPS and EPS) exhibit green characteristics? Yes. By inhibiting heat flow and helping create air barriers, plastic building products can help save energy heating and cooling the structure over time. This lessens the environmental 'footprint' of the building over time. Savings in manufacture of plastic building products have been validated as well, to show that plastic materials save approximately 467.2 trillion BTU of energy a year as compared to alternative materials. The energy saved is enough to meet the average annual energy needs of 4.6 million U.S. households. According to a 2000 study by Franklin Associates, for the entire country, the annual savings in energy cost would be $2.58 billion or $128.6 billion over 50 years if all houses were insulated with plastic foam insulation.

In commercial applications, SPF is typically applied over existing roof systems, which avoids scrap and waste while the product also provides exceptional energy savings through high R-values with no seams, longevity, resistance to leaks, and little degradation due to UV rays.

FREQUENTLY ASKED QUESTIONS

Building Envelope

Q: How does SPF reduce energy use in buildings?
A SPF provides a continuous air barrier.
SPF prevents moisture infiltration through air leakage.
SPF minimizes dew point problems and condensation.
SPF avoids thermal bridging
SPF resists heat movement in all directions
SPF provides reliable performance under varying conditions

Q: What is the difference between a vented and unvented attic
A Unvented (conditioned) attics use air-impermeable insulation as a barrier to prevent moisture condensation on the underside of roof decks. Vented attics minimize condensation by allowing the escape of moisture to the exterior by air flow.

Q: If you spray the underside of a roof deck with SPF insulation, should you vent the attic?
A No, the application of SPF insulation to the underside of the roof deck minimizes the potential for condensation. The SPF insulation develops a thermal and moisture gradient that avoids the development of dew point conditions in the attic. Because of this, moisture won't condense or accumulate and, therefore, does not need to be vented to the exterior.

Q: Do you need a vapor retarder or a vapor barrier with SPF insulation?
A It depends of the use of the building, the climate and the materials of construction. In normal occupancies and moderate climates, SPF insulation typically does require a vapor retarder. Extremes of climate and building use may require a vapor retarders/barrier. Check with your design professional for specific recommendations and refer to SPFA technical document, AY 118, Moisture Vapor Transmission for further information.

Q: Is SPF a good soundproofing material?
A Both low and medium (2lb/cubic/ft) density SPF effectively reduce noise from outside sources by sealing cracks and gaps that allow sound to travel through the walls, floors and ceilings into the building. They are less effective against noise caused by vibration.

Q: What is the difference between low density, open cell SPF and medium density closed cell SPF?
A ½ lb Spray Polyurethane Foam (SPF)
Low density, open cell SPF refers to a general spray polyurethane SPF that weighs between 0.4 to 0.6 lbs per cubic ft when fully cured. It is spray applied to a substrate as a liquid and expands about 100-150 times its original volume to form a semi-rigid/flexible, non-structural SPF insulation. The SPF has an R-value around 3.5 per inch and typically uses water as the blowing agent.

Medium Density, Closed Cell Spray Polyurethane Foam (SPF)

Medium density, closed cell SPF used in interior applications typically refers to generic spray polyurethane foam that weighs between 1.5 to 2 lbs per cubic ft when fully cured. It is also spray applied as a liquid to a substrate and expands about 35 to 50 times its original volume to form a rigid, structural SPF insulation with a compressive strength between 15 to 25 PSI. The SPF has an R-value of around 6.0 per inch (aged R-value) and uses high R-value blowing agents.

Similarities: Both products are excellent air barriers in buildings, provide great insulation, can assist in the control of condensation within buildings and have great environmental benefits.

For more detailed information on both SPF insulation products refer to the Modern Materials article Learning the Difference between ½ lb and 2 lb SPF, august 2005, page 11 or Spray Foam Magazine, Ask the Expert, Which SPF Insulation is Right for Me? August, 2005 page 11.

VAPOR DRIVE

Moisture flow by vapor diffusion is governed by the second law of thermodynamics (basic physics to. Some, not so basic to others). Moisture will flow by diffusion because of a concentration gradient as well as a temperature gradient (from “more to less” as well as “from warm to cold”). This means that it tends to go from the inside out up north and from outside in down south. In the middle of the country part of the year it goes from inside out and part of the year it goes from outside in.

Moisture moves TOWARD dry and/or cool conditions. The mechanics are a bit more complex than that for a building. For example, moisture generally first moves into the exterior finish materials by capillarity, or directly through a leak. It moves laterally and downward.

When a void or cavity is encountered, the relative humidity in the void or cavity is increased by the moisture intrusion. Now we get condensation. There is nothing to drive the moisture backward, so it is cumulative and progressively worsens unless the source is stopped.

The accumulated moisture then “attacks” the next dry area or cooler area. The same mechanics prevail and it will move to some other location, inward and downward. In the process, given reasonable conditions, mold will grow!