Introduction to Spray Polyurethane Foam (SPF)

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Pennsylvania Housing Research Center

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Spray Polyurethane Foam Alliance v2.5

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Technical Director, Spray Polyurethane Foam Alliance

Rick is currently Technical Director for the Spray Polyurethane Foam Alliance. Prior to joining SPFA, he was the Senior Marketing Manager for Honeywell’s Spray Foam Insulation business from 2006 to 2008. From 1997 to 2006, he was the Global Program Director for CertainTeed/Saint-Gobain Insulation’s New Materials and Applications Portfolio. From 1989 to 1997 he was a Visiting Assistant Professor of Mechanical Engineering at Bucknell University. He holds a Ph.D. in Engineering Science and Mechanics from The Pennsylvania State University, MSME from Bucknell and a BSME from the University of Maryland. Rick is a Registered Professional Engineer in three states and is a certified BPI Building Analyst.
SPFA History

• **Spray Polyurethane Foam Alliance**
  
  – Originally founded as the Urethane Foam Contractors Association (UFCA) in 1975
  
  – In 1987 it became the Polyurethane Foam Contractors Division of the Society of the Plastics Industry (SPI)
  
  – Since 2003, it has been an independent trade association for contractors, manufacturers and distributors of polyurethane foam, equipment, protective coatings, inspections, surface preparations and other services.
  
  – Maintains strong relationship with the American Chemistry Council (ACC) and their Center for Polyurethanes Industry (CPI)
SPFA Programs and Activities

• **Education and Research**
  – Accreditation/Certification and Education programs
  – Technical Literature and Guidelines
  – "Hotline" for Technical questions (1-800-523-6154)
  – Industry Research Programs

• **Promotion and Awareness**
  – Regulatory and Legislative Activities
  – Promotional and Marketing Tools
  – Website [www.sprayfoam.org](http://www.sprayfoam.org)
  – Annual Spray Foam Conference and Exposition
  – *Spray Foam Professional* magazine
  – Directory and Buyers' Guide
SPFA Website

- www.sprayfoam.org
  - Key features of home page
    - Health and Safety
    - Technical
    - Membership
SPFA Publications

• Spray Foam Professional Magazine
  – Quarterly magazine through NACE Publishing
  – SPFA works with SFP editors at Naylor to develop and review content

www.naylornetwork.com/spfa/
Poll: Who’s Who?
Content

- History and products
- SPF chemistry and delivery methods
- Safety requirements
- Environmental impact
- Performance
- Applications
- Building codes
History of SPF in Buildings

SPF in construction for 50 years

- Late 60’s - Medium Density (agricultural and industrial)
- Mid 70’s - Roofing
  - Medium Density (general const.)
  - Sealants
- Mid 90’s - Low Density (residential)
Product Category

SPF: field-applied thermoplastic foam

BUILDING INSULATION

FOAM

INORGANIC

ORGANIC

THERMOSET

PIR

PUR

Phenolic

THERMOPLASTIC

EPS

XPS

XPE

POUR

LOW PRESS SPRAY

Sealant

MD-SPF (ccSPF)

HIGH PRESS SPRAY

LD-SPF (ccSPF)

MD-SPF (ccSPF)

Roofing SPF

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### Product Category

#### Four types of SPF in Construction

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Sealant</th>
<th>LD</th>
<th>MD</th>
<th>Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (lb/ft³)</td>
<td>0.6 – 1.8</td>
<td>0.5 - 1.4</td>
<td>1.5 - 2.3</td>
<td>2.5 - 3.5</td>
</tr>
<tr>
<td>Thermal Resistivity (R/in)</td>
<td>NR</td>
<td>3.6 - 4.5</td>
<td>6.2 - 6.8</td>
<td>6.2 - 6.8</td>
</tr>
<tr>
<td>Air Impermeable Material</td>
<td>*</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Integral Air Barrier System</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Integral Vapor Retarder</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Water Resistant</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cavity Insulation</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Continuous Insulation</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Low-Slope Roofing</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Structural Improvement</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Basic Chemistry

Reaction of 1:1 mixing of two liquids

• A-Side: Blend of monomeric and polymeric MDI
  (MDI=Methylene diphenyl diisocyanate)

• B-Side or Polyol
  – polyols
  – blowing agents
  – flame retardants
  – surfactants
  – catalysts

Proprietary blend of additives affect cell formation and foam performance

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**BLOW:** Expansion of liquid into a cellular structure
a. MDI + chemical blowing agent (H₂O) $\rightarrow$ CO₂ gas
b. Exothermic heating of polymerization transforms liquid physical blowing agent (HFC) into vapor

**SET:** Polymerization of liquid into solid polyurethane
a. MDI + polyols $\rightarrow$ polyurethane

Other additives are important:
• Catalysts control polymerization reaction time and temperature (speed)
• Surfactants control cell formation and structure
• Flame retardants embedded in PU provide built-in fire resistance
Basic Chemistry

B-Side Formulation:

- These are the five basic categories of B-side chemicals.
- Percentages will vary based on foam type (oc vs cc) and manufacturer.
- Some foam formulations contain small amounts of additional additives for appearance and added function, such as colorants and anti-microbial chemicals.
• Provide the hydroxyls (OH) that combine with MDI (NCO) to form polyurethane

• Petroleum polyols are polyester and/or polyether blends

• Some natural oil polyols, like soybean oils or sucrose-based polyols can be blended with petroleum polyols (20+45)

• Some products add brominated diols (polyols) to improve flame retardancy
Create the gas needed to expand the liquid polyurethane mixture

Physical blowing agents convert from liquid to a gas from the heat of the reaction (HFC-245fa)

Chemical blowing agents are gases created from chemical reactions. Water + MDI = CO$_2$

Some SPF uses blend of water and HFC-245fa

Non-flammable when used in SPF, No VOC

Without blowing agents to expand foam, solid polyurethane would result
Polyurethane foam is an organic material and is combustible.

Without fire retardants, foam plastics would not meet building code flame spread requirements.

No brominated FRs – (PBDE)
  • Some use Br-diols in polyol blend

Uses halogen-phosphorous FRs such as
  • TCPP – most common
  • TDCP – phasing out
  • TEP – increased interest

Flame retardants necessary for building fire safety
Amine catalysts are used to control the polyurethane reaction.

- Reactive
- Non-Reactive (odor-prone)

Metal catalysts may also be used.

To achieve proper desired foam properties, competing balance between BA expansion and polyurethane curing – stabilizing the foam.

**Basic Chemistry**

**B-Side Formulation: Catalysts**

- **Catalysts, 3%**
- **Surfactants, 2%**
- **Blowing Agents, 20%**
- **Polyols, 65%**
- **Flame Retardants, 10%**

*Catalysts control rise and cure of SPF*
Surfactants control cell formation rheology (flow properties) and degree of opening of panes inside each cell.

- Surfactants control cell structure
## Basic Chemistry

### Typical (generic) B-Side Formulations

<table>
<thead>
<tr>
<th>B-SIDE</th>
<th>RAW MATERIAL</th>
<th>B-Side WGT % (Generic)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.5 pcf</td>
</tr>
<tr>
<td>Polyols</td>
<td>Polyester</td>
<td>45.0%</td>
</tr>
<tr>
<td></td>
<td>Mannich</td>
<td>30.0%</td>
</tr>
<tr>
<td></td>
<td>Natural Oil (Soy)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compatibilizer</td>
<td>10.0%</td>
</tr>
<tr>
<td></td>
<td>Polyether</td>
<td>35.0%</td>
</tr>
<tr>
<td>Blowing Agents</td>
<td>Reactive (H₂O)</td>
<td>23.5%</td>
</tr>
<tr>
<td></td>
<td>Physical (HFC)</td>
<td>8.5%</td>
</tr>
<tr>
<td>Flame Retardants</td>
<td>TCPP</td>
<td>25.0%</td>
</tr>
<tr>
<td></td>
<td>TDCP</td>
<td></td>
</tr>
<tr>
<td>Catalysts</td>
<td>Amine</td>
<td>6.0%</td>
</tr>
<tr>
<td></td>
<td>Metal</td>
<td>0.5%</td>
</tr>
<tr>
<td>Surfactants</td>
<td>Silicone</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

*Generic formulations used for SPFA’s Life-Cycle Assessment (LCA)*
Basic Chemistry
Fundamental Cell Model

- **Closed-Cell Foam**: Essentially all panes are intact (>90% cc)
- **Open-Cell Foam**: One or more panes open (mostly oc)
- **Reticulated Foam**: All panes open, thick struts

*Cell structure and size affects density, flexibility, recovery as well as all other physical properties*
3. Basic Chemistry

OPEN CELL
~100x expansion
0.5 to 0.8 pcf
R-3.6 to R-4.5 per inch (air)

CLOSED CELL
~30x expansion
1.7-3.5 pcf
R-5.8 to R-6.8 per inch
(trapped low-k gas)
Delivery Methods

One-Component Low-Pressure Sealants

- 6-15 BF/min froth
- A and B pre-mixed; cured by contact with ambient moisture
- Low/high expansion
- Air-sealing of small cracks, gaps and holes
- Non-insulating

Retail DIY product for air sealing only
Delivery Methods

Two-Component Low-Pressure Foam

- 30-40 BF/minute froth
- A and B in separate pressurized cylinders
- Mechanical mixing
- Insulation and air sealing - small jobs

Professionally applied product used by weatherization contractors and by SPF contractors for small jobs or repair work
Delivery Methods

Two-Component High-Pressure SPF

- 100-500 BF/minute spray
- A and B in unpressurized drums or totes
- Chemicals heated and pressurized by proportioner
- Larger insulation jobs and all roofing applications
- Special training and capital investment

Professionally applied insulation and roofing SPF installed by trained contractors large jobs
Chemical Safety During Application

- Hazardous chemicals are used for SPF
  - A-side (Isocyanate) is reactive and can cause respiratory or dermal sensitization
  - B-side components (catalysts) can cause irritation
  - Delivery methods affect exposure
    - Low-pressure: gloves, eyes, APR
    - High-pressure: full-skin, eyes, APR or SAR
Chemical Safety During Application

• Chemical Safety Measures
  • PPE required during and just after installation
  • Isolate, contain and vent work zone
  • SPF contractor safety plan
  • www.spraypolyurethane.com
• No known chemical hazards for occupants
  • Safe MDI levels in 1-6 hours
  • 24 hour re-occupancy typical
  • Installed SPF is low-VOC (SPF is solvent-free)
    - GreenGuard Environmental Institute
    - CAN/ULC-S774 Saskatchewan Research Council
Environmental Impact

Raw Materials

• Petroleum vs. natural oil polyols
Environmental Impact
Raw Materials

- Fluorocarbon blowing agent evolution

<table>
<thead>
<tr>
<th>Years</th>
<th>Generation</th>
<th>SPF Blowing Agent</th>
<th>ODP</th>
<th>GWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960s -1993</td>
<td>1</td>
<td>CFC-11</td>
<td>1.0</td>
<td>4750</td>
</tr>
<tr>
<td>1993 - 2003</td>
<td>2</td>
<td>HCFC-141b</td>
<td>0.12</td>
<td>760</td>
</tr>
<tr>
<td>2003 - pres</td>
<td>3</td>
<td>HFC-245fa</td>
<td>0</td>
<td>1020</td>
</tr>
<tr>
<td>2012?</td>
<td>4</td>
<td>HFO/HFE</td>
<td>0</td>
<td>6 - 15</td>
</tr>
</tbody>
</table>
Environmental Impact

Raw Materials

• Phosphate flame retardants (no brominated)
  • No brominated FRs used
  • TEP, TCPP, TDCP are typical
  • Evaluated as potential carcinogen, mutagen, reproductive system, bio-toxicity, bio-accumulative
  • Low risk per EU EEC No. 793/93 Risk Assessment
Environmental Impact
Disposal and Recycling

- Landfill safe
- Mechanical grinding for fillers and packaging
- Chemical recycling
• Industry-wide LCA recently completed by SPFA
  • ISO-compliant to ISO 14040/14044
  • Third-party analysis and review
  • Transparent, credible review
  • Cradle-to-End-of-Life
  • SPF insulation and roofing
# Environmental Impact
## Life-Cycle Assessment

<table>
<thead>
<tr>
<th>Impact Category Characterization Factor</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global Warming Potential (GWP)</strong></td>
<td>A measure of greenhouse gas emissions, such as CO$_2$ and methane.</td>
<td>kg CO$_2$ equivalent</td>
</tr>
<tr>
<td><strong>Eutrophication Potential (EP)</strong></td>
<td>Eutrophication covers all potential impacts of excessively high levels of macronutrients, the most important of which nitrogen (N) and phosphorus (P)....</td>
<td>kg Nitrogen equivalent</td>
</tr>
<tr>
<td><strong>Acidification Potential (AP)</strong></td>
<td>The acidification potential is a measure of a molecule’s capacity to increase the hydrogen ion (H$^+$) concentration in the presence of water, thus decreasing the pH value.</td>
<td>mol H$^+$ equivalent</td>
</tr>
<tr>
<td><strong>Photochemical Ozone Creation Potential (POCP)</strong></td>
<td>A measure of emissions of precursors that contribute to ground level smog formation (mainly ozone O$_3$),</td>
<td>kg O$_3$ equivalent</td>
</tr>
<tr>
<td><strong>Ozone Depletion Potential (ODP)</strong></td>
<td>A measure of air emissions that contribute to the depletion of the stratospheric ozone layer.</td>
<td>kg CFC-11 equivalent</td>
</tr>
<tr>
<td><strong>Additional Inventory/Impact Category</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Primary Energy Demand (PED)</strong> [1]</td>
<td>A measure of the total amount of primary energy extracted from the earth, expressed in energy demand from non-renewable or renewable resources</td>
<td>MJ</td>
</tr>
</tbody>
</table>
Environmental Impacts from Production

Environmental Impacts Prevented during Use

>> 1

Primary Energy

47 to 73 ocSPF
93 to 144 ccSPF

Primary Energy investment is recovered in less than one year for ocSPF and less than two years for ccSPF

Using this many energy units to insulate a home with SPF (MJ)...

.... saves this many energy units (MJ) over a 60 year service life

14,000 Minneapolis
6,900 Richmond
3,000 Houston

Based upon SPFA's ISO-compliant Life Cycle Assessment study
Environmental Impact
Life-Cycle Assessment

environmental impacts prevented during use
environmental impacts from production

>> 1

Greenhouse Gases (GHGs)

2 to 4 ocSPF
27 to 42 ccSPF

Releasing this many units of GHG to insulate a home with SPF (1,000 kg of CO₂ eq.)...

GHG releases are recovered in less than nine months for ocSPF and less than eight years for ccSPF

... avoids these GHG emissions from energy savings over a 60 year service life

Based upon SPFA's ISO-compliant Life Cycle Assessment study
# Environmental Impact

## Life-Cycle Assessment

<table>
<thead>
<tr>
<th>Application</th>
<th>SPF Type</th>
<th>Ratio &amp; Payback</th>
<th>Houston</th>
<th>Richmond</th>
<th>Minneapolis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Energy</td>
<td>GHG</td>
<td>Energy</td>
</tr>
<tr>
<td>Residential Insulation</td>
<td>Low Density Open-Cell</td>
<td>Avoided/Embodied</td>
<td>64</td>
<td>92</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Payback (Yr)</td>
<td>0.9</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Medium Density Closed-Cell</td>
<td>Avoided/Embodied</td>
<td>32</td>
<td>7.6</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Payback (Yr)</td>
<td>1.9</td>
<td>7.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Commercial Roofing</td>
<td>Roofing R4 --&gt; R20</td>
<td>Avoided/Embodied</td>
<td>55</td>
<td>15</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Payback (Yr)</td>
<td>1.1</td>
<td>4</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Roofing R12 --&gt; R20</td>
<td>Avoided/Embodied</td>
<td>30</td>
<td>8.2</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Payback (Yr)</td>
<td>2</td>
<td>7.3</td>
<td>2.1</td>
</tr>
</tbody>
</table>

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SPF Performance

• Consistent Thermal Performance
• Air Impermeable
• Moisture Control
• Structural Enhancement
Several GHB studies show 15-30% better performance.

Why?
- Reduced internal convection
- Reduced air infiltration
- Consistent performance over range of operating temperatures
SPF Thermal Performance

Thermal Envelope Design

Energy Cost vs. R-value for Air Permeable Insulation

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SPF Thermal Performance
Thermal Envelope Design

Spray Foam Insulation
Air Permeable Insulation

Energy Cost

R-value

consistent R-value and air-sealing ~ 25% savings
SPF Thermal Performance

Thermal Envelope Design

- Spray Foam Insulation
- Air Permeable Insulation

**Consistent R-value and air-sealing ~ 25% savings**

**Better performance @ same R-value**

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SPF Thermal Performance

Thermal Envelope Design

- Spray Foam Insulation
- Air Permeable Insulation

consistent R-value and air-sealing ~ 25% savings

Same performance @ lower R-value

Better performance @ same R-value
Adoption of a **Thermal Metric** or **Wall Efficiency Rating** is key.
• **Materials**
  - Air-impermeable per ASTM E283 or E2178
  - air barrier material

• **Assemblies/Systems**
  - Low air leakage per ASTM E2357
  - SPF on opaque walls + sealant foams around fenestration creates air barrier system

• ABAA Spec for MD SPF
• Integral air-barrier
Poll: Head Count

Password for certificate of attendance: spfoam
### SPF Air Barrier Performance

#### Weatherization Case Studies

#### SPF Air Barrier Performance

<table>
<thead>
<tr>
<th>Home Size (SF)</th>
<th>Minimum Ventilation ($\text{ACH}_{50}$)</th>
<th>Initial Air-Leakage ($\text{ACH}_{50}$)</th>
<th>Foam Treatment</th>
<th>Final Air-Leakage ($\text{ACH}_{50}$)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2300</td>
<td>5.4</td>
<td>9.3</td>
<td>1” Attic floor</td>
<td>7.0</td>
<td>-25%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rim joist</td>
<td>6.3</td>
<td>-32%</td>
</tr>
<tr>
<td>2500</td>
<td>5.4</td>
<td>10.4</td>
<td>Rim joist</td>
<td>8.8</td>
<td>-15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100SF cantilevered floor</td>
<td>6.6</td>
<td>-37%</td>
</tr>
</tbody>
</table>

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• Open-cell SPF
  • Permeability 15-40 perm-inch
  • **Class III: semi-permeable at 6” or more**

• Closed-cell SPF
  — Permeability 2 perm-inch
  — **Class II: semi-impermeable at 2” or more**
  — Special considerations for extreme cold climates, high interior humidity loads, or low interior-temperatures
• MD SPF + vapor/air-permeable insulations to lower cost
• Air barrier performance?
• Vapor retarder plane
• SPFA Guideline under development
  – IECC Zones 1-3 guideline complete
  – IECC Zone 4 and above addressed in 2009 IRC Section 601.
SPF Structural Performance
Racking Strength Doubled by SPF

• Supported by numerous studies
SPF Structural Performance

Wind Uplift Resistance

Houses with damaged or missing roof sheathing in Florida
SPF Structural Performance

Wind Uplift Resistance

• **3x increase** (2008 Prevatt and Duncan, U of Florida)

![Graph Showing Failure Load (psf)]

- Baseline: 75 psf
- Fillet: 175 psf
- 3” Fill: 250 psf

130-140 psf load @ 150 mph zone 3

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Cathedralized Ceilings
Attic Floors
Rim-Band Joists / Sill Plates
Floors (Cantilevered)
Below Grade Walls
Below Slab
Basement Walls
Unvented Crawlspace
Exterior Walls
Interior Walls
Door and Window Sealing

Low-Expansion for windows and doors

High-Expansion for cracks and gaps
SPF Applications
Commercial

DOMED ROOFS
EXTERIOR WALLS
INTERIOR WALLS
LOW-SLOPE ROOFS
METAL BUILDINGS
FRAME WALLS
Other Applications
TEMPORARY STRUCTURES
TANKS AND VESSELS

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Exterior Walls
Exterior Walls
Low-Sloped Roofs

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Domed Roofs
Temporary Structures
Tanks and Vessels
• Code Sections
  – Separate from ‘traditional’ insulations
  – IBC: Ch 26, Section 2603 Foam Plastic Insulation
  – IRC: Ch 3, R316 Foamed Plastic

• Code Focus
  – Fire Protection
  – Thermal Performance
  – Moisture Control
**Fire Testing**

Surface Burning Characteristics

- **Steiner Tunnel Test** [IBC 2603.3 / IRC R316.3]
  - ASTM E84 / UL 723 Steiner Tunnel Test
    - Flame Spread Index (FSI)
    - Smoke Developed Index (SDI)
    - FSI/SDI is 0/0 for fiber-cement
    - FSI/SDI is 100/100 for red oak
    - Limited to 4” thickness
  - Class II – FSI ≤ 75, SDI ≤ 450
  - Class I – FSI ≤ 25, SDI ≤ 450
  - Roofing – FSI ≤ 75, SDI unlimited
  - **CHECK with manufacturer or ESR for testing >4”**
• Thermal Barrier Requirement [IBC 2603.4 / IRC R316.4]
  – Separates insulation from interior of building
  – Approved 15 minute thermal barrier
    • ½” gypsum wallboard is most commonly used
    • Others to be tested per ASTM E119 and/or full-scale fire tests
  – Exceptions to Thermal Barrier requirement...
Special Requirements for SPF in Type I-IV Construction

[IBC 2603.5]

- ASTM E119 or UL 263 required for fire-resistance rated wall assemblies
- Thermal barrier required
- NFPA 259 test data corresponding to SPF tested per NFPA 285
- Class I per ASTM E84 (<25 FS, <450 SD)
- NFPA 285 test data for each wall assembly
- Labelling of product
- NFPA 286 test data showing no sustained flaming
• Inside masonry or concrete walls [IBC 2603.4.1.1 / IRC R316.5.2]
• Cooler and freezer walls* [IBC 2603.4.1.2-3]
• Laminated metal wall panels-one story [IBC 2603.4.1.4]
• Roofing assembly* [IBC 2603.4.1.5 / IRC R316.5.2]
• Entry doors [IBC 2603.4.1.7-8 / IRC R316.5.5]
• Garage doors [IBC 2603.4.1.9 / IRC R316.5.6]
• Siding backer board [IBC 2603.4.1.10 / IRC R316.5.7]

* SPF applications
**Sill Plates and Headers**  [IBC 2603.4.1.13 / IRC R316.5.11]

- Limited to Type V construction
- Max thickness 3.25”
- Class I Foam (LD and MD)
• **Attics and Crawl Spaces** [IBC 2603.4.1.6 / IRC R316.5.3]
  
  – Entry is made only for service of utilities (no storage)
  
  – **Ignition barrier** is required separating attic/crawlspace space from foam
  
  – Thermal barrier required between attic/crawlspace and occupied space
• **Ignition Barrier**  [IBC 2603.4.1.6 / IRC R316.5.3]

  – Prescriptive:
    
    • 1.5” mineral fiber insulation
    • 0.25” wood structural panels
    • 0.375” particleboard
    • 0.25” hardboard
    • 0.375” gypsum board
    • Corrosion-resistant steel having base metal thickness of 0.016 “
    • 1.5” cellulose fiber insulation (IRC 2012 only)

  – **Alternative Assemblies by Special Approval Testing**
• **Special Approval Tests**  [IBC 2603.9 / IRC R316.6]
  
  – **NFPA 286** - Contribution of Wall and Ceiling Interior Finish to Room Fire Growth (with the acceptance criteria of Section 803.2/R315.4)
  
  – **FM 4880** - Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings, and Exterior Wall Systems
  
  – **UL 1040** - Safety Fire Test of Insulated Wall Construction
  
  – **UL 1715** – Fire test of interior finish material
  
  – *End-use fire tests*
Fire Safety

Ignition Barrier End-Use Fire Tests

• Special Approval for Foam In Attics and Crawlspaces
  – End-use fire tests...
    • Qualifies assembly (foam alone or foam with intumescent coating)
    • See AC-377 June 2009 for updated testing requirements

New modified NFPA 286 baseline test
Thermal and Moisture Code Requirements

• Thermal Performance, R-value
  
  [IBC 1301 → IECC 102.1.1 / IRC N1102.1 / 16CFR Part 460]
  
  – Measure per ASTM C 518 or C 177
  
  – At installed thickness or extrapolated from R-value at representative thickness per FTC rule; Refer to ESR
  
  – Must be aged R-value for SPF, as applicable

• Moisture Permeance [IECC 402.5 / IRC R318]
  
  – Measure per ASTM E 96 dry cup (method A)
  
  – Approximately 2 inches of closed-cell SPF provides ≤ 1 perm
• ICC-ES Acceptance Criteria
  – AC-12 for Foamed Plastic: XPS, EPS, PIR
  – AC-377 for Froth and Spray Polyurethane Foams:  -- NEW 3/1/08

• (A) ICC-ES Reports
  – Required Data
    • R-value, Surface Burning Characteristics (at thickness), Physical Properties
  – Optional Data
    • Air permeance, Water absorption, WVTR, Full-scale fire tests,...
  – Go to www.icc-es.org for full list of ESRs for SPF

• (B) Alternate Product Documentation
  – Code-compliance research reports, 3rd Party Test Data, Product Data Sheets also acceptable
On The Jobsite
Labelling and Certificates

• Product Labelling

[IBC 2603.2 / IRC R316.2]
– Containers on job site shall have mfg name, product ID, product listing, suitability for use

• Installation Certificate

[IECC 401.3 / IRC N1101.8]
– Provided by contractor to builder/homeowner
– Thickness, R-value and product listing or data sheet
– Placed on electric service panel or other conspicuous location

Get product data sheet, ESR and/or certification from builder/designer

[IRC N1101.8]
Quality Installation

SPFA Certification

• Establishes Clear Path to Professionalism
• Establishes Expectations
  • Among Industry Professionals
  • Among Customers
  • Among Partners (Arch / Design Build / GC / Etc)
• Standards-Driven (ANSI/ISO 17024)
• Uniform and Consistent Measures
• Consequences for Failure (Enforcement)
• Regular Continuing Education Required for Recertification
• Provides Further Market Differentiator for Company and Individuals
• Heavy Focus Upon H+S Throughout
Quality Installation

SPFA Accreditation / Certification

- Individual
- Inspector
- Contractor Firm
- Distributor
- Manufacturer
Summary

• Types of spray polyurethane foams
• Safety requirements
• Environmental impact
• Benefits
• Applications
• Building codes
• SPFA Accreditation Training
• SPFA Website and Annual Conference
• Formulators and Systems House Suppliers

SPFA Website: www.sprayfoam.org
Thank You!

Questions?

Next month’s webinar:
Building Science Primer
Tuesday, January 8, 1:00 PM
Register at: www.engr.psu.edu/phrc/Training/Webinars.htm