Thermal and Ignition Barrier Requirements for SPF Sorting through the Confusion

Paul Duffy, M.A.Sc., P.Eng.
Vice President, Engineering
Icynene Inc.
Note:

Portions of this presentation are extracted from SPFA’s AIA Presentation

Used with permission of Rick Duncan
Technical Director
Spray Polyurethane Foam Alliance
Objectives

• Why Do Codes Require Thermal or Ignition Barriers?
• Fire Testing Basics
• What is a Thermal Barrier? Where is it required?
• What is an Ignition Barrier? Where is it required?
• Why is there confusion?
• How can you protect yourself?
Why Do Codes Require Ignition and Thermal Barriers?

- SPF, like most organic materials, is combustible
  - Unprotected SPF will ignite when exposed to fire
  - Smoke and combustible gases can accumulate in interior spaces during fire conditions and lead to flashover
  - Flame retardants added to slow flame spread
  - Flame spread measured under controlled conditions (ASTM E84), not representative of actual fire conditions
Why Do Codes Require Ignition and Thermal Barriers?

• Required by ICC Model Building Codes (I-codes)
  – Delays combustion and ignition of SPF
  – Provide extra time needed for worker and occupant egress
  – Requirements for Foam Plastics
    • IBC Chapter 26, Section 2603
    • IRC Chapter 3, Section R316
Fire Testing Basics

• Three categories
  • Surface Burning Characteristics (materials)
  • Room Tests (assemblies)
  • Structural Integrity Tests

• Testing standards from...
  • American Society for Testing of Materials (ASTM)
  • Underwriters Laboratories (UL)
  • National Fire Protection Association (NFPA)
  • Factory Mutual (FM)
Fire Testing Basics: Surface Burning

• ASTM E84 (UL 723) Tunnel Test
  • 25’ x 2’ x 2’ Steiner tunnel
  • Req’d for most interior building products
  • Material suspended on tunnel ceiling and ignited by gas burner at one end
    • Speed of flame front → Flame Spread Index (FSI)
    • Optical smoke density at outlet → Smoke Developed Index (SDI)
  • FSI/SDI baseline:
    • 0/0 for fiber-cement
    • 100/100 for red oak
  • 4” material thickness limitation
Fire Testing Basics: Surface Burning

• ASTM E84 (UL 723) Tunnel Test
  • 25’ x 2’ x 2’ Stiener tunnel
  • Req’d for most interior building products
  • Material suspended on tunnel ceiling and ignited by gas burner at one end
    • Speed of flame front → Flame Spread Index (FSI)
    • Optical smoke density at outlet → Smoke Developed Index (SDI)
  • FSI/SDI baseline: 0/0 for fiber-cement,

Surface Burning Test results are for comparative purposes only and not related to real-world fire conditions
Fire Testing Basics: Surface Burning

• Requirements for Foam Plastics (<4”) [IBC 2603.3 / IRC R316.3]
  • Class B is a mandatory requirement
    • FSI ≤ 75  and SDI ≤ 450
  • Class A is an optional requirement (achieved by most SPF insulations) that may be mandatory in certain applications
    • FSI ≤ 25 and SDI ≤ 450
  • Different requirement on low-slope roofs
    • FSI ≤ 75 but no limit on SDI
    • Roof assembly must pass  FM4450 or UL1256
Fire Testing Basics: Surface Burning

• Requirements for Foam Plastics (<4”) [IBC 2603.3 / IRC R316.3]
  • Class B is a **mandatory requirement**
    • FSI ≤ 75 and SDI ≤ 450
  • Class A is an **optional requirement** (achieved by most SPF insulations) that may be mandatory in certain applications
    • FSI ≤ 25 and SDI ≤ 450

• Different requirement on low-slope roofs

**NOTE:** Surface Burning Test limited to 4” material thickness. Additional testing required for foam plastics to be installed >4”
Fire Testing Basics: Surface Burning

• Requirements for Foam Plastics (>4”)
  • SPF greater than 4” thick to meet certain R-values
  • ASTM E84/UL 723 limited to 4” sample thickness
  • To qualify assemblies greater than 4” thick, special approval testing is permitted [IBC 2603.9 / IRC R316.6]

• Special approval testing is performed on assembly
  • Using one of four large-scale corner fire tests
  • ½” gypsum board between foam and fire source
  • Determines maximum foam thickness intended for use
Fire Testing Basics: Surface Burning

- ASTM E970 Critical Radiant Heat Flux Test Apparatus
  - 1m long test panel
  - Used to qualify combustible insulations on attic floor
  - Flame should not progress more than 1 m under minimum heat flux of 0.12 W/m² from suspended gas burner
  - No material thickness limitation
Fire Testing Basics: Room-Corner

• Room Corner Test Procedure
  • Room constructed using typical wall and ceiling assemblies
  • Controlled fire source placed in corner
    • Wood crib or gas burner
  • Fire source ignited and observations recorded
    • Heat Release Rate
    • Temperatures at Ceiling
    • Heat Flux
    • Target Ignition
    • Flame-Over
Fire Testing Basics: Room-Corner

Figure 2. Room-corner fire test geometry.
Fire Testing Basics: Room-Corner
Fire Testing Basics: Room-Corner
Fire Testing Basics: Room-Corner
What is a Thermal Barrier?

• Thermal Barrier Requirement  [IBC 2603.4 / IRC R316.4]
  • Separate foam plastics from all interior spaces with approved 15-minute thermal barrier
What is a Thermal Barrier?

• Two recognized thermal barrier coverings
  • ½” gypsum board [IBC 2603.4 / IRC R316.4]
    • Prescriptive for walls and ceilings
    • >95% of thermal barrier applications
  • nominal ¾” (19/32”) plywood [IBC Table 721.6.2(1)]
    • Not prescriptive but generally accepted for floors

• Non-prescriptive (equivalent) Thermal Barriers must be approved by large-scale fire testing
What is a Thermal Barrier?

- **Approved Thermal Barriers**  [IBC 2603.4 / IRC R316.4]
  1. **Prescriptive Thermal Barrier** is ½” gypsum wallboard
  2. **Equivalent Thermal Barrier** is a coating or covering that must pass two large-scale fire tests:
     - Average temperature rise of the unexposed surface less than 250°F (120C) after 15 minutes of fire exposure per ASTM E 119 or UL 263
     - Remain in place 15 minutes during specified large-scale fire tests such as NFPA 286, UL 1715, UL 1040 or FM 4880
       -- OR --
     - Comply with NFPA 275 (both test above)
What is a Thermal Barrier?

• Special Approval / Alternate Assemblies [IBC 2603.9 / IRC R316.6]

3. **Alternate Assemblies** (e.g. Exposed SPF or SPF with a protective covering) must:
   • Remain in place 15 minutes during specified large-scale fire tests such as NFPA 286, UL 1715, UL 1040 or FM 4880
   • Does not need to comply with requirements of IBC 2603.4.
   • Product-Specific Assemblies must be tested:
     • Thermal Barrier Brand A on Foam Brand B
     • Protective coverings may include cementious, fibrous and other proprietary products
What is a Thermal Barrier?

• **No thermal barrier required:**
  - Inside masonry or concrete walls  [IBC 2603.4.1.1 / IRC R316.5.2]
  - **Cooler and freezer walls (< 400 SF floor space)***  [IBC 2603.4.1.2-3]
  - Laminated metal wall panels-one story  [IBC 2603.4.1.4]
  - **Roofing assembly*** passing UL 1256  [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

* ICYNENE®
What is a Thermal Barrier?

- **No thermal barrier required:**
  - Sill Plates and Headers [IBC 2603.4.1.13 / IRC R316.5.11]
    - Limited to Type V construction
    - Max thickness 3.25”
    - Class A Foam (LD and MD)
What is a Thermal Barrier?

- **No thermal barrier required:**
  - Certain Attics and Crawl Spaces
    - Entry is made only for service of utilities
      - [IBC 2603.4.1.6]
    - Entry is made for repairs and maintenance
      - [IRC R316.5.3]
    - No storage
    - Thermal barrier required between attic/crawlspace and occupied space
  - **Ignition barrier** is required separating foam from certain attic/crawlspace
What is an Ignition Barrier?

- **Ignition Barrier** [IBC 2603.4.1.6 / IRC R316.5.3]
  - Fire protection requirements can be reduced from 15-minute thermal barrier to ignition barrier in limited-access spaces (certain attics and crawlspaces)
  - Six prescriptive ignition barriers include:
    - 1 ½” mineral fiber insulation
    - ¼” wood structural panels
    - ⅜” particleboard
    - ¼” hardboard
    - ⅜” gypsum board
    - corrosion-resistant steel having a base metal thickness of 0.016”
  - **Alternative Ignition Barrier Assemblies by Special Approval Testing**
What is an Ignition Barrier?

• Special Approval Tests for Alternative Ignition Barrier Assemblies
  [IBC 2603.9 / IRC R316.6]
  • Same four large-scale corner burn tests as thermal barrier
    • NPFA 286, UL1715, FM4880 or UL1040
  • Special end-use fire tests per AC-377
    • Equivalent performance to ¼” plywood
    • AC-377 Appendix X Test for SPF in crawlspaces and under roof decks
      in unvented attics since June 2009
    • ASTM E970 Radiant Heat Flux Test for SPF on attic floors since June 2011
Ignition Barrier Performance

**PASS**  
with intumescent coating  
[IB_pass.wmv]

**FAIL**  
without intumescent coating  
[IB_fail.wmv]

AC-377 Appendix X (modified NFPA286 Room Corner) Test for Ignition Barriers
Ignition Barrier Performance

**PASS**
with intumescent coating

**FAIL**
without intumescent coating

Even if building codes are not applicable in your jurisdiction or for a specific project, (e.g., retrofit insulation), **always** use the ignition barrier system recommended by the foam manufacturer.

AC-377 Appendix X (modified NFPA286 Room Corner) Test for Ignition Barriers
Fire Testing: Commercial Buildings

• **Additional requirements for SPF in Type I-IV Construction**  
  [IBC 2603.5]
  
  – Labelling of product
  
  – Thermal barrier required
  
  – Class A per ASTM E84 (<25 FS, <450 SD)
  
  – NFPA 259 test data corresponding to SPF tested per NFPA 285
  
  – NFPA 286 test data showing no sustained flaming
  
  – NFPA 285 test data for each wall assembly
  
  – ASTM E119 or UL 263 required for fire-resistance rated wall assemblies
Inspection and Verification

- Alternative Fire Assembly Test Results
  - Test performed by accredited 3rd-party lab
  - Sometimes difficult to interpret

- Evaluation Report
  - Test performed by accredited 3rd-party lab
  - Test results independently evaluated
  - Report defines installation
    - Product identification
    - Maximum thickness for foam
    - Alternative ignition barrier assemblies (if any)
Inspection and Verification

• Evaluation Service Reports
  • Majority of SPF insulation products have current ESRs
  • Available from manufacturer or ICC-ES websites
  •Eliminates need for contractors and inspectors to interpret test data
  • Defines product-specific requirements for thermal and ignition barriers based on fire testing
Application Examples

Unvented Attic and Crawlspace

- SPF insulation under roof deck separated from attic space with approved ignition barrier.
  - Prescriptive or per AC-377 Appendix X.

- Limited access attic separated from interior space with approved 15-minute thermal barrier.

- SPF insulation in walls separated from interior space with approved 15-minute thermal barrier.

- Limited access crawlspace separated from interior space with approved 15-minute thermal barrier.

- SPF insulation on walls separated from crawl space with approved ignition barrier.

- Limited access unvented attic space (no storage).

- ¾" subfloor.

- ½" gypsum board walls and ceilings.

- Interior space.

- Limited access unvented crawlspace (no storage).

- ICYNENE®
Application Examples

Unvented Attic and Crawlspace – w/ Storage

- SPF insulation under roof deck separated from attic space with **approved 15-minute thermal barrier**
- **Approved 15-minute thermal barrier not required** (e.g., ceiling tile)
- SPF insulation in walls separated from interior space with **approved 15-minute thermal barrier**
- SPF insulation on walls separated from crawl space with **approved 15-minute thermal barrier**
Application Examples

Vented Attic and Unvented Crawlspace

- Limited-access vented attic space
  - SPF insulation on attic floor separated from attic space with approved ignition barrier prescriptive or per ASTM E970

- Interior space
  - ½" gypsum board walls and ceilings
  - SPF insulation in walls separated from interior space with approved 15-minute thermal barrier

- ¾" subfloor
  - Limited access crawlspace separated from interior space with approved 15-minute thermal barrier

- Limited access unvented crawlspace (no storage)
  - SPF insulation on walls separated from crawl space with approved ignition barrier

ICYNENE®
Application Examples

Finished Room Over Garage

No ignition or thermal barrier needed if space is inaccessible (a.k.a. concealed)

All SPF insulation separated from interior space with approved 15-minute thermal barrier

¼" gypsum board walls and ceilings
Application Examples

Space Under Low-Slope Roof: Tile Ceiling

- **SPF insulation under roof deck separated from air space with approved 15-minute thermal barrier**
- **If air space is used as an air return plenum, SPF must be covered with a 25 FSI / 50 SDI layer in addition to thermal barrier**
- SPF insulation in walls and ceiling separated from interior space with approved 15-minute thermal barrier

*dead* air space

suspended tile ceiling

interior space

½” gypsum board walls

ICYNENE®
Application Examples

Space Under Low-Slope Roof: Gyp Board Ceiling

SPF insulation under roof deck separated from dead air space with **approved ignition barrier**

* If air space is used as an air return plenum, SPF must be covered with a 25 FSI / 50 SDI layer in place of ignition barrier

SPF insulation in walls and ceiling separated from interior space with **approved 15-minute thermal barrier**
Those are the basic requirements as they stand today.

Why is there confusion?
Yet there is confusion with…
– Designers
– Builders
– Contractors
…Even with Codes Officials!
1. Evolution of Requirements

- **Up to 2009**

- **Ignition Barriers:** SWRI 99-02 test used to qualify specific foams and ignition barriers

- **Thermal Barriers:** qualified with NFPA 286 and ASTM E119 (per IRC Sentence R-316.4) giving a “General Approval” for use over all foams.
1. Evolution of Requirements

- **beginning 2010**

- **Ignition Barriers:** AC-377 Appendix A and Appendix X tests used to qualify specific foams/ignition barriers

- **Thermal Barriers** qualified with NFPA 286 only (per IRC Sentence R-316.6) giving a “Specific Approval” over the foams they were tested with.
1. Evolution of Requirements

- beginning 2011

- Ignition Barriers: AC-377 Appendix X tests only used to qualify specific foams/ignition barriers. ASTM E970 used for insulation on attic floors.

- Thermal Barriers qualified with NFPA 286 only (per IRC Sentence R-316.6) giving a “Specific Approval” over the foams they were tested with.
Impact on Contractors and Manufacturers

- **Up to 2009**

- **Ignition Barriers:** Inconsistency in Fire Testing. Most foams could pass some test uncovered.

- **Thermal Barriers:** typically “thick” systems used (e.g. gypsum, cementitious, fibrous spray products.)
Impact on Contractors Manufacturers

• **Beginning 2010**

• **Ignition Barriers:** First foams to pass Appendix X uncovered are MD foams. LD foams require covering on overhead and vertical surfaces vertically in attics.

• **Thermal Barriers:** First intumescent paints gain “specific approval” as Thermal Barriers over foam.
Impact on Contractors and Manufacturers

- **Beginning 2011**
  - **Ignition Barriers**: Most MD foams to pass Appendix X uncovered. LD foams require covering on all roof surfaces not attic floors.
  - **Thermal Barriers**: Many intumescent paints gain “specific approval” as Thermal Barriers over foam.
2. Evolution of Codes and Other Requirements

• **Higher levels of performance:**
  – Insulation
  – Air tightness

• **Greater adoption of Unvented Attic designs:**
  – Less air and duct leakage
  – Less ductwork outside the building envelope

More people are interested in using spray foam who have less experience.
3. More Competition

• Economic Pressure:
  – Less new construction
  – Price cutting on jobs that remain

• Competing Technology:
  – Spray air barrier

Competitors are actually creating some of the confusion.
4. Product Evolution

- New “all-in-one” products that do not require coatings
  - Difficult to duplicate the performance of conventional products
- New coatings that can be applied at minimal thickness to minimize cost
  - Reduce application cost
- Attempts to maximize the thicknesses of spray foam that can be used in assemblies
  - Provide more options for spray foam contractors

It is difficult to differentiate “marketing hype” from legitimate innovations.
Specific Approvals

Approval of Specific Products only:
Specific spray foam
Specific coating

Spray Foam
Approved to a Maximum thickness tested.

IB or TB Coating
Approved to the minimum thickness tested.

STICK TO WHAT IS LISTED IN THE ESR!

ICYNENE®
Final Thoughts

• **Thermal Barriers**
  • All SPF requires thermal barrier between foam and all interior spaces
  • **NEVER** Substitute an Ignition Barrier for a Thermal Barrier—an Ignition Barrier does not provide adequate protection and in the event of a fire **YOU COULD BE LIABLE.**
Final Thoughts

• Thermal Barriers vs. Ignition Barriers
  • Are you missing a selling opportunity?
  • Ignition Barriers cannot be used to protect foam plastics in attics used for storage and other occupancy activities.
  • By selling a Thermal Barrier as an option, you provide the opportunity for your customer to convert an attic into useful, conditioned storage or work space.
  • By selling an option you can identify your client’s price sensitivity and turn a cost item into potential profit!
Thank You!

Questions?

SPFA Website: www.sprayfoam.org