
# Building Codes, Testing Standards and Test Methods

# Topics

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   - ICC Acceptance Criteria
   - Physical Properties
   - Thermal Properties
   - Fire Resistance
   - Moisture

# Introduction

**OBJECTIVES for Chapter 4**

- **Agencies that set building code model standards**
- **Building code model standards**
- **Agencies that develop and perform standardized test methods**
- **Building code compliance with spray polyurethane foam**

# Building Codes

## Prescriptive vs Performance Codes

**Building codes regulate the design, construction and maintenance of buildings. They are the legally enforceable minimum requirement.**

- **Prescriptive codes provide detailed descriptions of the materials and methods of construction**
  - **compliance monitored by observation**
  - **generally focuses on R-value, often ignoring other beneficial SPF features, such as air sealing and void elimination**

**Does not ensure the most economical or best performance**

# Building Codes

## Prescriptive vs Performance Codes

**Building codes regulate the design, construction and maintenance of buildings. They are the legally enforceable minimum requirement.**

- **Performance codes require the completed building to satisfy a specified level of performance.**
  - **building analysis typically required – e.g. HERS**
  - **performance software is available - COMcheck-EZ™ for commercial buildings, REScheck™ for homes, etc.**
  - **energy savings exceeding code minimums can be used to qualify for sustainability programs – LEED, etc.**

**One energy saving feature may be swapped for another, overall building performance must be maintained**

# Building Codes

## Model Building Code History

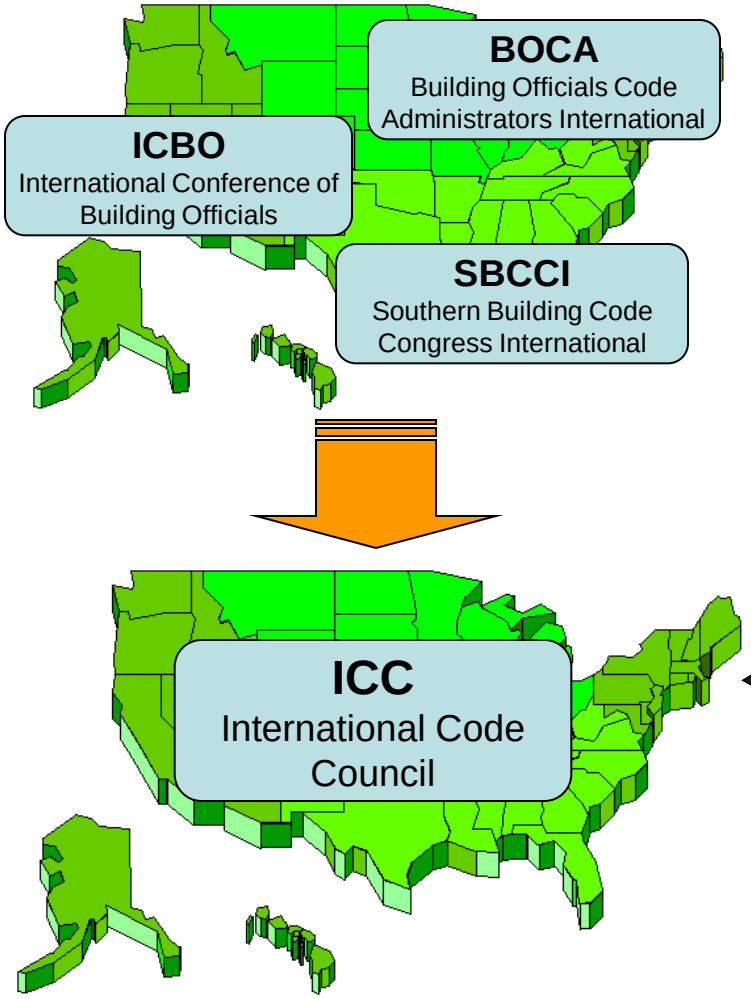
**ICC is a non-profit organization, member owned and governed**

**Members consist of units from state and local governments**

**Members vote on changes to code, anyone can submit a change proposal**

**New codes are published every 3 yrs, 2009 is the most recent**

**State and local officials may adopt all or part of the code, but may not be up to date with all revisions**

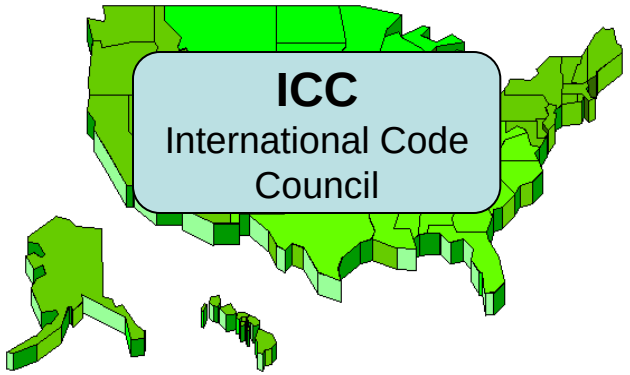



**Since the early 1900s building regulations in the U.S. were based on model codes from three regional groups**

**In 1994 the regional groups combined to form an international model code agency**

# Building Codes

## ICC Code Bodies




**IRC: International Residential Code**

model building code for one and two family dwellings

**IBC: International Building Code**

model building code for commercial, public, institutional, and industrial buildings

**IECC: International Energy Conservation Code**

model building code that specifies requirements for energy conservation

# Building Codes

## ICC Code Bodies

## ICC-ES: ICC Evaluation Service

**Reviews data submitted by manufacturers to determine if their product complies with code, issues an evaluation report.**

**ESRs are not required for a material to be code compliant; rather they are for the convenience of the code official to evaluate the properties and use of a building material or method.**

**Evaluation reports issued under one of the agencies that predates ICC are grandfathered via an ICC-Legacy Report**

**ICC-ES and ICC-Legacy reports are used by building officials to aid in determining if a product is code compliant**

**Other Evaluation Services such as IAPMO have been writing ESR's for decades and are equally valid to ICC-ESRs**

# Building Codes

## Other Agencies that Set Standards

## ASHRAE: American Society of Heating, Refrigeration and Air-Conditioning Engineers

International organization, publishes methods for testing and rating equipment in the HVAC&R industry

ASHRAE publishes performance-based standards for HVAC&R equipment that are used in building codes, including:

- ASHRAE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE Standard 62.2 – Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings

# Building Codes

## Other Agencies that Set Standards

National Fire Protection Association

The authority on fire, electrical, and building safety

### NFPA: National Fire Protection Association

**Publishes methods and standards for fire, electrical, and building safety used in building codes**

# Building Codes

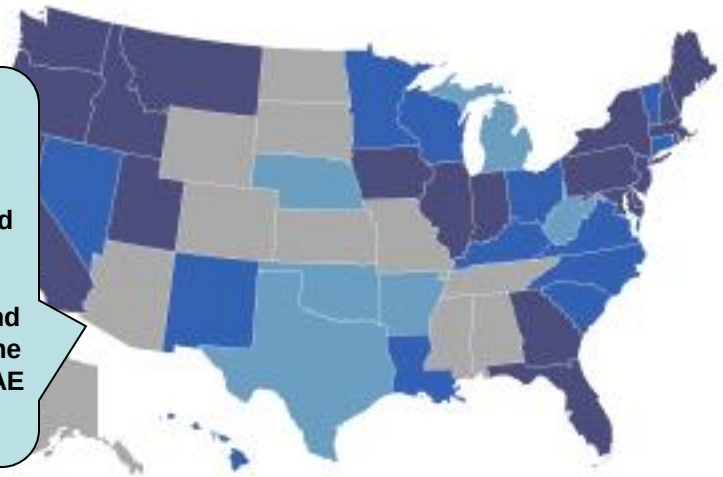
## The National Picture

**Energy codes dictate requirements for the building envelope, mechanical systems, and lighting**

**Building envelope requirements typically include minimum insulation levels by climate region**

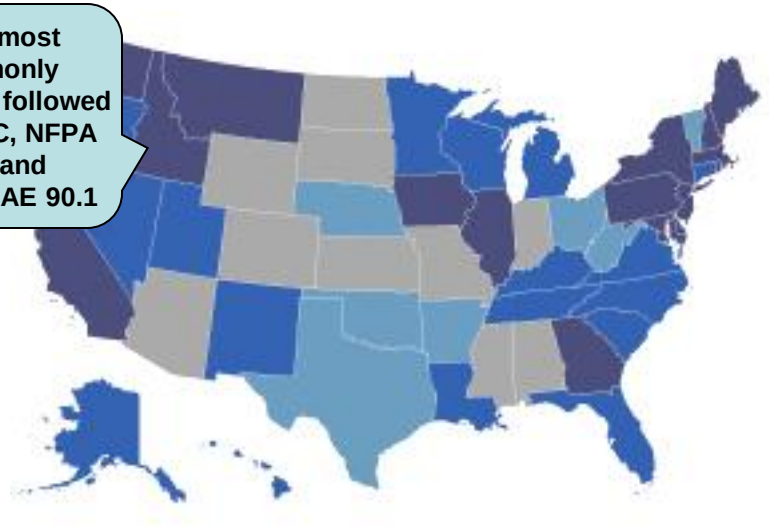
**The US Energy Conservation and Production Act (ECPA) requires each state to certify that it has a commercial building code that meets or exceeds ASHRAE 90.1-1999. Some states are not yet compliant with the federal mandate**

**ASHRAE 90.1 most commonly used, followed by IECC, then NFPA 5000 (both IECC and NFPA allow the use of ASHRAE 90.1)**



Source: Building Codes Assistance Project www.bcap-energy.org

**IECC most commonly used, followed by IRC, NFPA 5000, and ASHRAE 90.1**



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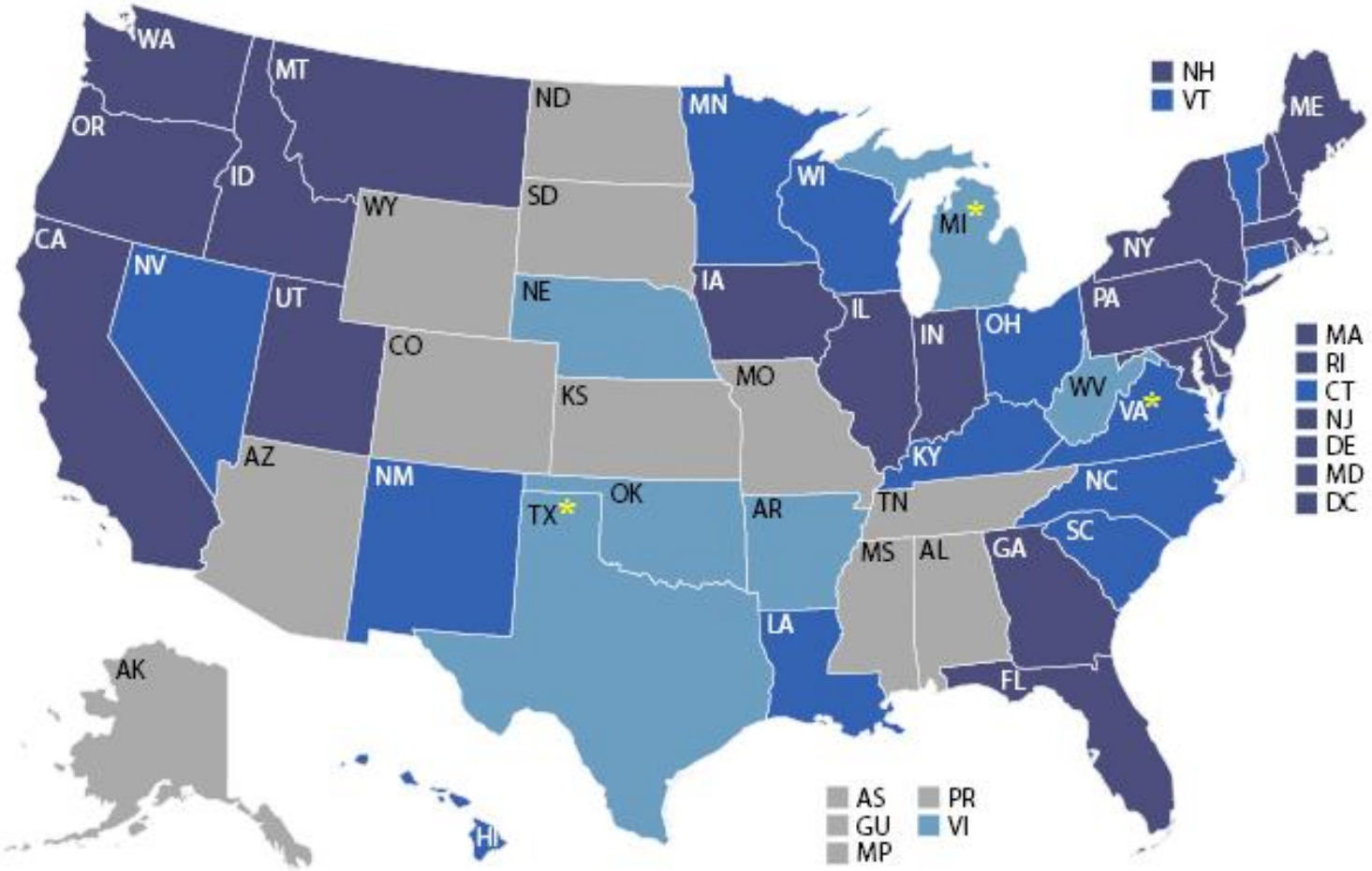



more efficient

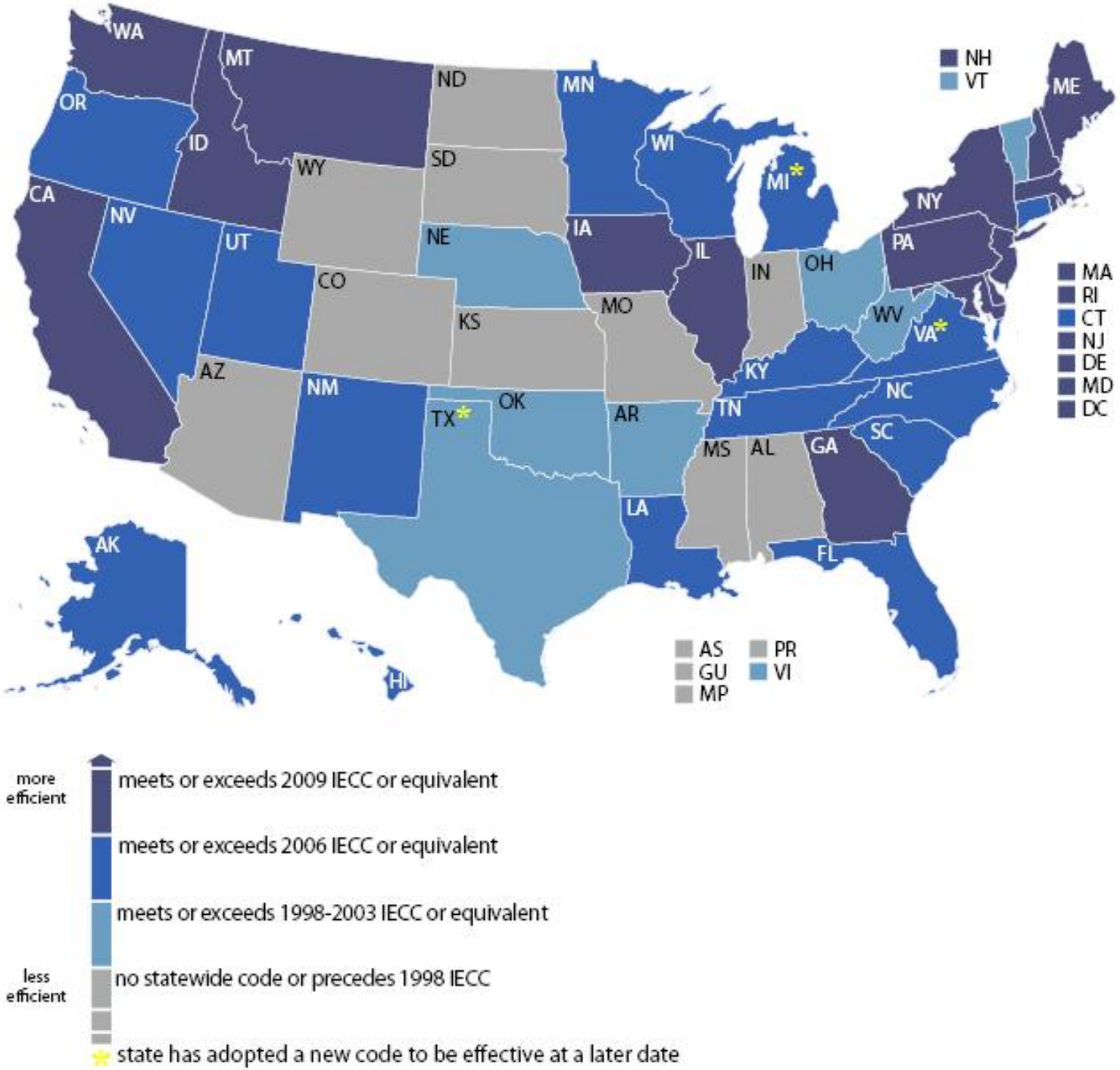
- meets or exceeds ASHRAE Standard 90.1-2007 or equivalent
- meets or exceeds ASHRAE Standard 90.1-2004 or equivalent
- meets or exceeds ASHRAE Standard 90.1-1999-2001 or equivalent

less efficient

- no statewide code or precedes ASHRAE Standard 90.1-1999

* state has adopted a new code to be effective at a later date

Source: Building Codes Assistance Project
www.bcap-energy.org




uilding Codes
e Project
-energy.org

# Testing Agencies

## ASTM, FM, UL

### ASTM International: originally known as the American Society of Testing and Materials

Sets standards across a broad spectrum of materials, products, systems, and services, largest voluntary standard setting organization in the world

technical committees develop the standards, each committee is made up of volunteers with experience in the industry area they represent

ASTM test methods are used to measure SPF density, R-value, air transmission, water vapor permeance, etc

### FM: FM Global

Mutual insurance company that maintains an engineering and research complex

Tests roof systems for wind, hail, and fire resistance

### UL: Underwriters Laboratories

Maintains a product directory listing companies whose products were tested and comply with the UL standards for safety

only products bearing the UL mark should be considered UL listed

# Building Code Compliance

## SPF Requirements

- **Insulation materials (including fiberglass and cellulose) must meet two requirements to comply with ICC or IECC model code:**

  1. **a valid 3rd party thermal test of R-value**

  2. **a valid 3rd party ASTM E-84 fire test showing flame spread and smoke developed numbers meeting the minimum of the code requirements**

- **Specifically approved alternative fire tests cited by the ICC, such as NFPA 286, may also be used to show product acceptance in the end use application, including thickness and density**

- **When used more than 4” thick, foam plastic insulation must have the minimum flame spread & smoked developed numbers at the 4” tested thickness, and also have an end use approval test in accordance with the “Specific approval” section of the ICC**

- **Additional data may be required if the SPF is to be considered a vapor retarder or air barrier.**

# Building Code Compliance

## ICC Acceptance Criteria

- **ICC-ES has developed Acceptance Criteria for many classes of building products that describe the required material properties.**

- **Some manufacturers submit test data to ICC-Evaluation Services to receive an ICC-ES report that specifies code compliance.**

  **The ICC-ES report is not mandatory, but can simplify the approval process with code officials.**

- **SPF is listed in AC-377 "Acceptance Criteria for Spray-Applied Foam Plastic Insulation"**

- **AC-377 was made effective in March 2008 as the new acceptance criteria for SPF only, replacing AC-12 (for SPF acceptance). AC-12 is now applicable only to EPS, XPS and PIR.**

  **Material requirements are the same as AC-12 except for a difference in the thickness required for R-value testing**

# Building Code Compliance

## AC-377 Requirements for SPF

**AC-377: Physical Properties of Spray-Applied Polyurethane Foam Plastic (SPF) Insulation by Application/Product Type**

**Nonstructural:**
**0.5-1.0 pcf with tensile strength ≥ 5 lb/in²**

**Structural**
**1.5-3.0 pcf with tensile and compressive strength ≥ 15 lb/in²**

| APPLICATION | TESTS REQUIRED | | VALUE |
|---|---|---|---|
| Low density insulation (nominal core density 0.5 - 1.0 pcf) | Thermal Resistance at 75°F(24°C) mean temperature. One of the four test methods listed below shall be used:<br>ASTM C 177<br>ASTM C 236<br>ASTM C 518<br>ASTM C 1363 | | As reported |
| | Core Density:<br>ASTM D 1622 | | As reported |
| | Tensile Strength:<br>ASTM D 1623 | Minimum closed cell content of 90% | 5 lbf/in², minimum |
| | Note: Closed cell content shall be determined in accordance with ASTM D 2856 | Closed cell content less than 90% | 3 lbf/in², minimum |
| | Dimensional Stability:<br>ASTM D 2126 | | 15% maximum total change |
| | Surface Burning Characteristics:<br>IBC—ASTM E 84 or UL 723<br>UBC Standard 8-1 | | 75 flame-spread index or less,<br>450 smoke-developed index or less |
| Medium density insulation (nominal core density 1.5 - 3.0 pcf) | Thermal Resistance at 75°F (24°C) mean temperature. One of the four test methods listed below shall be used:<br>ASTM C 177<br>ASTM C 236<br>ASTM C 518<br>ASTM C 1363 | | As reported |
| | Core Density:<br>ASTM D 1622 | | As reported |
| | Tensile Strength:<br>ASTM D 1623 | | 15 lbf/in², minimum |
| | Dimensional Stability:<br>ASTM D 2126 | | 15% maximum total change |
| | Surface Burning Characteristics:<br>IBC—ASTM E 84 or UL 723<br>UBC Standard 8-1 | | 75 flame-spread index or less,<br>450 smoke-developed index or less |
| | Compressive Strength:<br>ASTM D 1621 | | 15 lbf/in², minimum |
| Roofing (nominal core density 2.5 - 3.0 pcf) | Core Density:<br>ASTM D 1622 | | As reported |
| | Tensile Strength:<br>ASTM D 1623 | | 40 lbf/in², minimum |
| | Dimensional Stability:<br>ASTM D 2126 | | 15% maximum total change |
| | Surface Burning Characteristics:<br>ASTM E 84 or UL 723<br>UBC Standard 8-1 | | 75 flame-spread index or less |
| | Compressive Strength:<br>ASTM D 1621 | | 40 lbf/in², minimum |
| | Thermal Resistance at 75°F(24°C) mean temperature. One of the four test methods listed below shall be used:<br>ASTM C 177<br>ASTM C 236<br>ASTM C 518<br>ASTM C 1363 | | As reported |
| Sealant (nominal core density 0.5 - 1.0 pcf) | Core Density:<br>ASTM D 1622 | | As reported |
| | Surface Burning Characteristics: | | 75 flame-spread index or less, |

Roofing and Sealants

**Surface burning requirements same for both SPF types:**

**Flame spread ≤ 75**
**Smoke-developed ≤ 450**

# Building Code Compliance

## Thermal Resistance

- **Thermal resistance is characterized by R-value**

  **ASTM C518 or C177 test R-value for materials**

  **ASTM C1363 "guarded hot box" is used to measure R-value of wall assemblies**

- **R-value is not linear with thickness**

  **AC-377 R-value must be tested at 1 inch and 3.5 inches (or greater, no less), with extrapolation to be allowed for thicker applications based on the maximum tested thickness**

- **K-Factor and R-Value define thermal properties**

# Building Code Compliance

## Thermal Resistance

### Text

TITLE 16 – COMMERCIAL PRACTICES

CHAPTER I – FEDERAL TRADE COMMISSION

SUBCHAPTER D – TRADE REGULATION RULES

PART 460 – LABELING AND ADVERTISING OF HOME INSULATION

460.20 – R – value per inch claims.

In labels, fact sheets, ads, or other promotional materials, do not give the R-value for one inch or the R-value per inch of your product. There are two exceptions: (a) If an outstanding FTC Cease and Desist Order applies to you but differs from the rules given here, you can petition to amend the order.

(b) You can do this if actual test results prove that the R-values per inch of your product does not drop as it gets thicker.

You can list a range of R-value per inch. If you do, you must say exactly how much the R-value drops with greater thickness. You must also add this statement: The R-value per inch of this insulation varies with thickness. The thicker the insulation, the lower the R-value per inch.

[44 FR 50242, Aug. 27, 1979, as amended at 70 FR 31276, May 31, 2005]

# Building Code Compliance

## Surface Burning Resistance

- **Surface burning resistance is characterized by ASTM E84, also known as NFPA 255, UL 723, and the Steiner Tunnel**

  **Foam is mounted on the ceiling of a 25 ft tunnel, ignited at one end, and a controlled draft runs through the tunnel**

  **Flame progress is observed through side windows to develop a Flame Spread Index (FSI). A higher number means the flame spread is faster**

  **Smoke density (SD) is measured in the air that exits the tunnel via the controlled draft.**

  **Building materials are classified according to FSI**

| | |
|---|---|
| Class I A | FSI 0-25 |
| Class II B | FSI 26-75 |
| Class III C | FSI 76-200 |
| Class IV | 200 < FSI |

- **IRC, IBC, and AC-377 require that foam plastics have FSI ≤ 75 and SD ≤ 450***

- **Specific alternative fire tests may allow other end use configurations, or applications thicker than 4”**

***Numerical flame spread ratings are not intended to reflect actual hazards under fire conditions.**

# Building Code Compliance

## The Steiner Tunnel

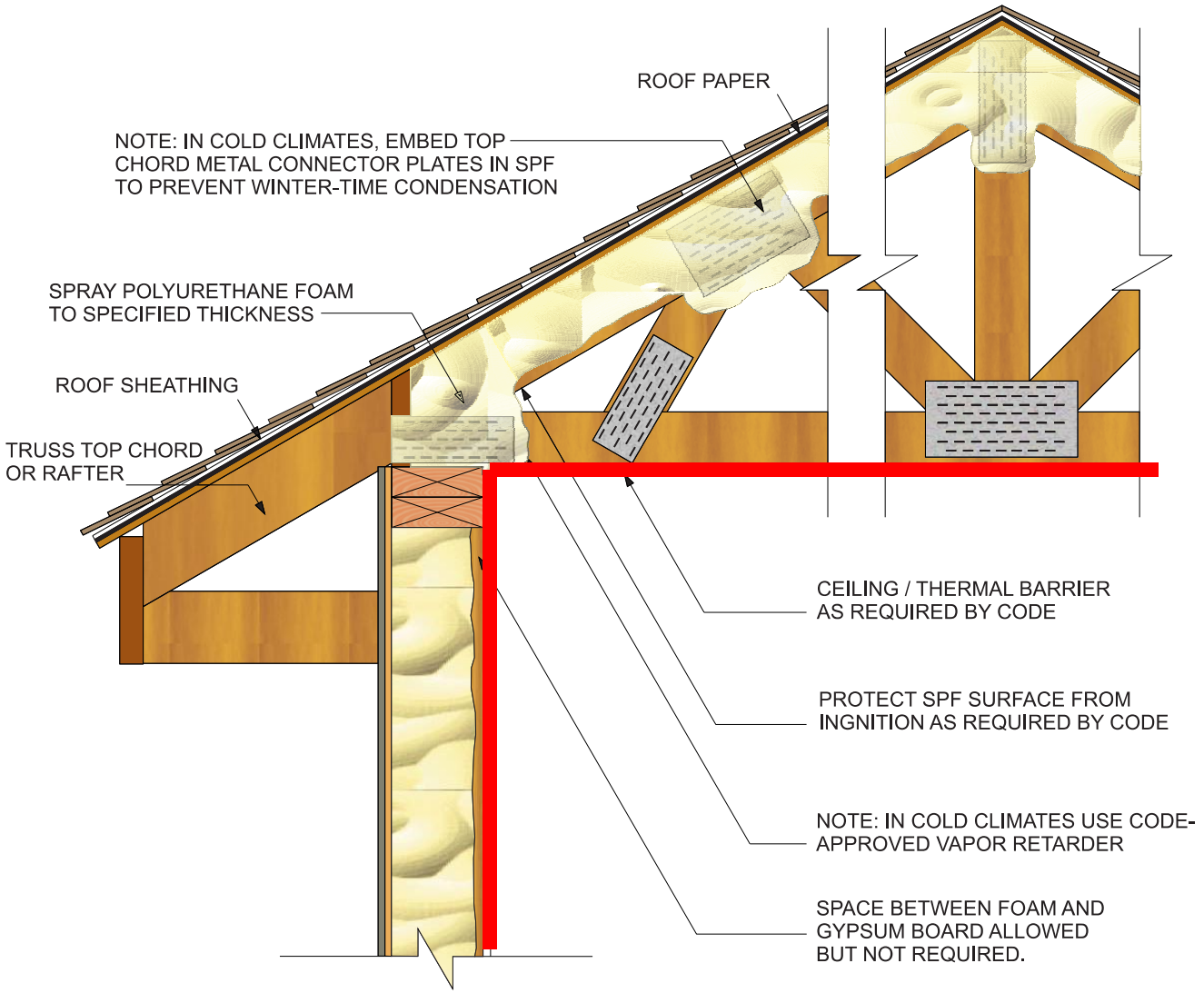
# Building Code Compliance

## Thermal Barriers

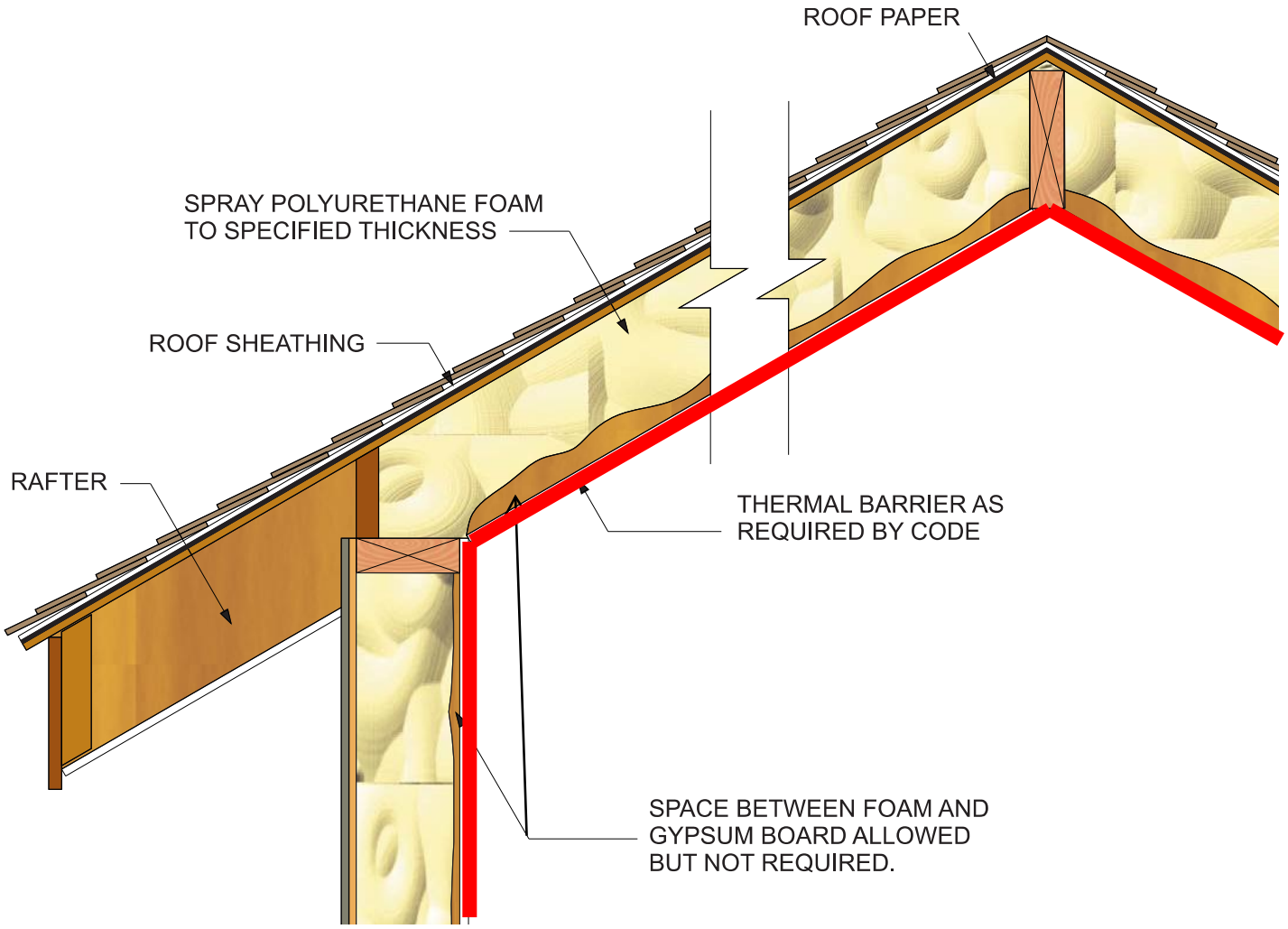
**Thermal barriers slow the temperature rise of the material behind the barrier during a fire situation.**

- **All model building codes require a 15 minute thermal barrier between SPF and the interior occupied space in a building unless approved based on diversified full-scale fire tests.**
- **½” gypsum board passes the test as a 15 minute thermal barrier**

# Where a Thermal Barrier Should Be Applied?



# Where a Thermal Barrier Should Be Applied?



# Building Code Compliance

## Thermal Barriers

**Thermal barriers slow the temperature rise of the material behind the barrier during a fire situation.**

- **All model building codes require a 15 minute thermal barrier between SPF and the interior occupied space in a building unless approved based on diversified full-scale fire tests.**

  **Using the ASTM E119 procedure the temperature of the underlying SPF cannot be more than 325ºF (166ºC) after 15 minutes of fire exposure (250ºF average)**

  **Alternative materials must be tested in accordance with the above procedure or other full-scale fire tests in order to comply with the thermal barrier performance requirements of the ICC**

# ASTM E-119 One-Hour Assembly Test

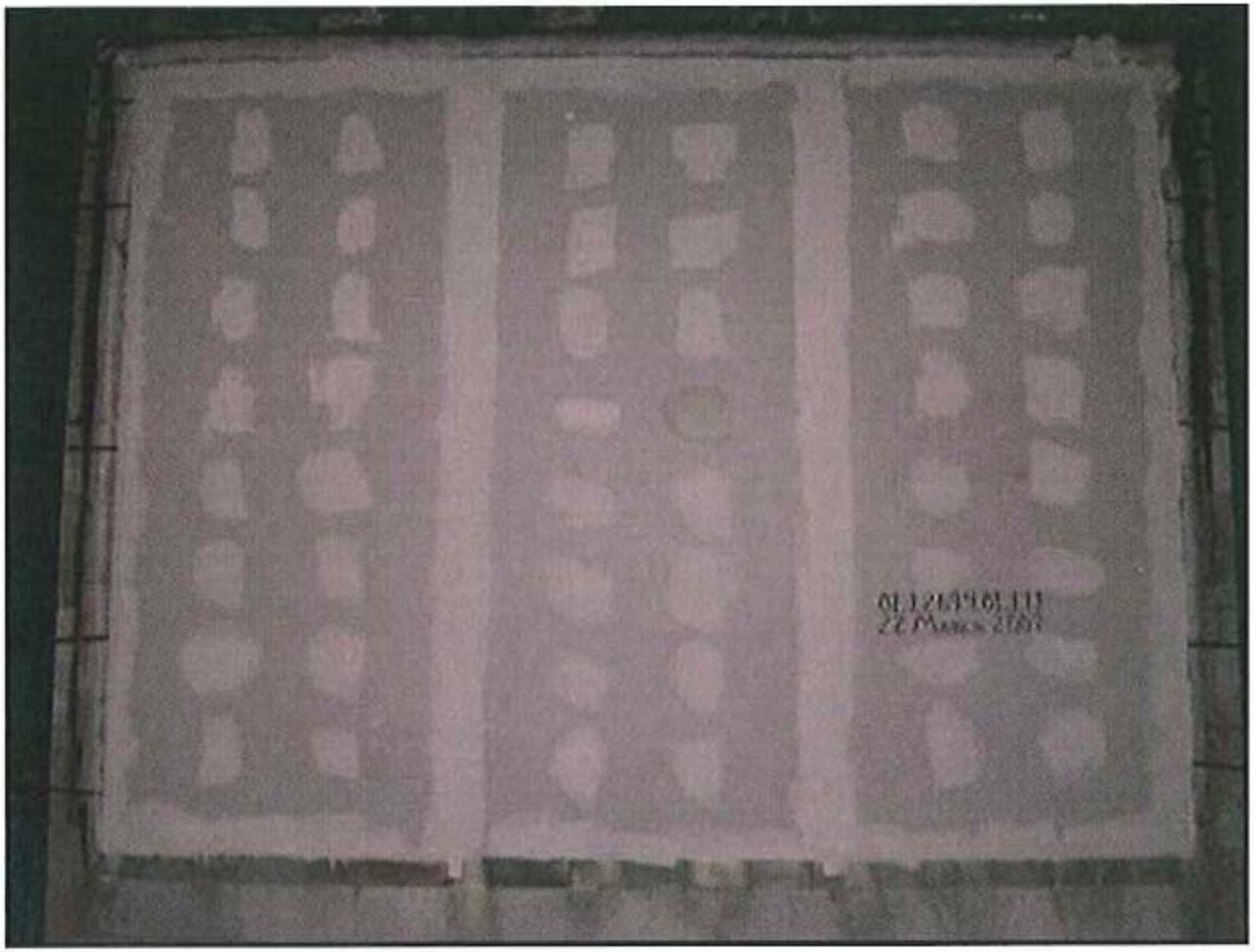


**Figure B-1. Exposed Side of the Wall Assembly Prior to the Fire Test.**

# ASTM E-119 One-Hour Assembly Test

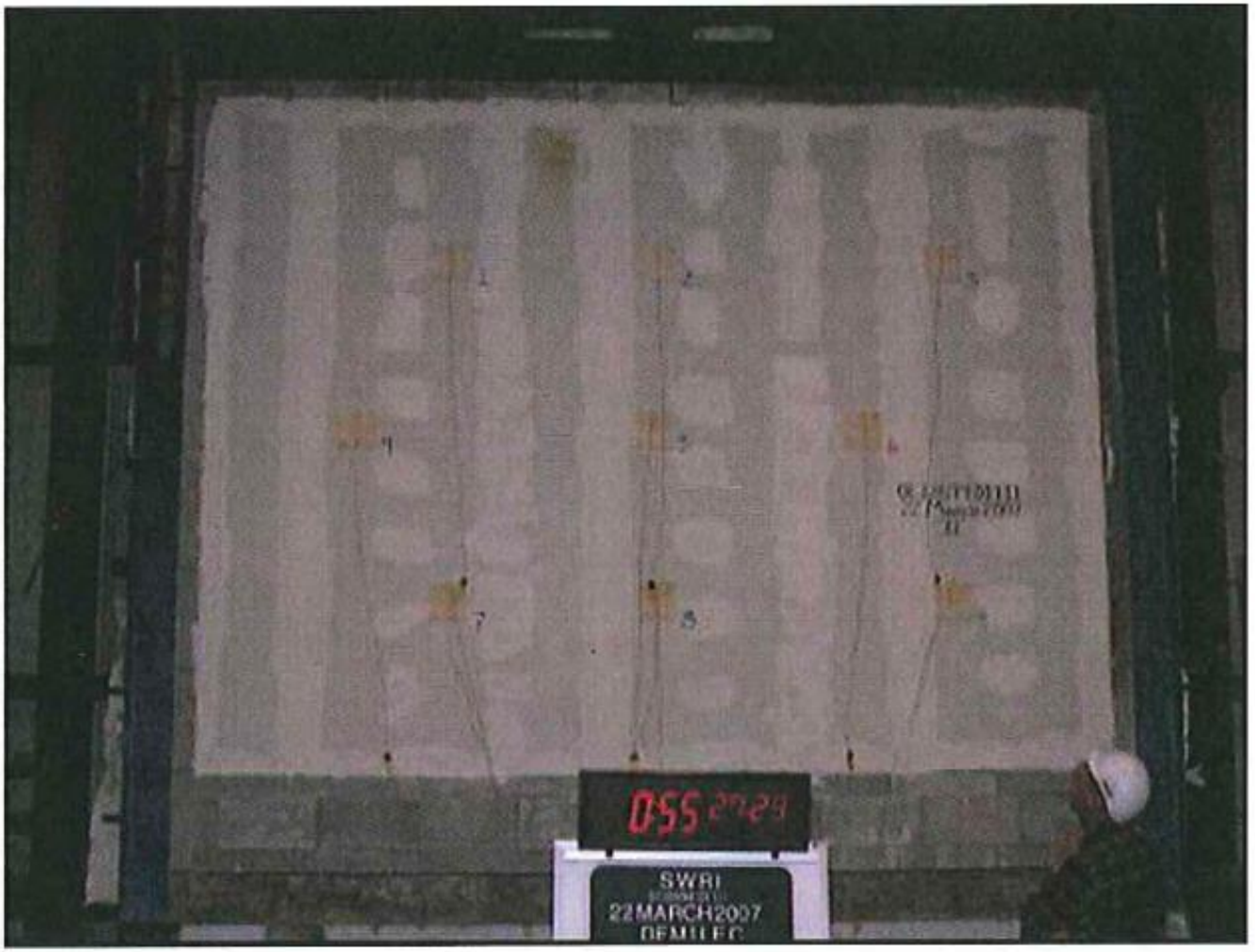



**Figure B-2. Unexposed Side of the Wall Assembly During the Fire Test.**

# ASTM E-119 One-Hour Assembly Test

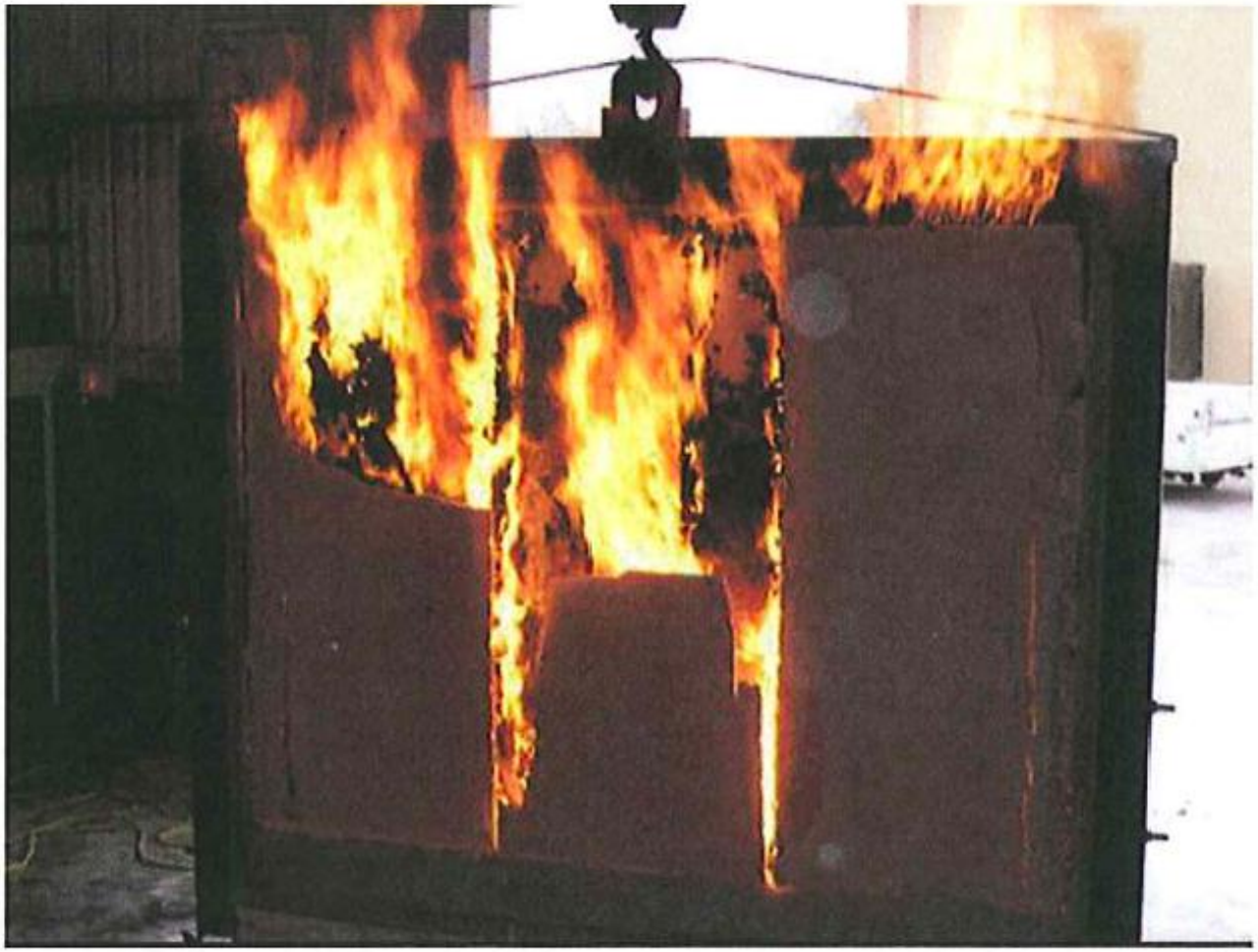


**Figure B-3. Exposed Side of the Wall Assembly Immediately After the Fire Test.**

# ASTM E-119 One-Hour Assembly Test

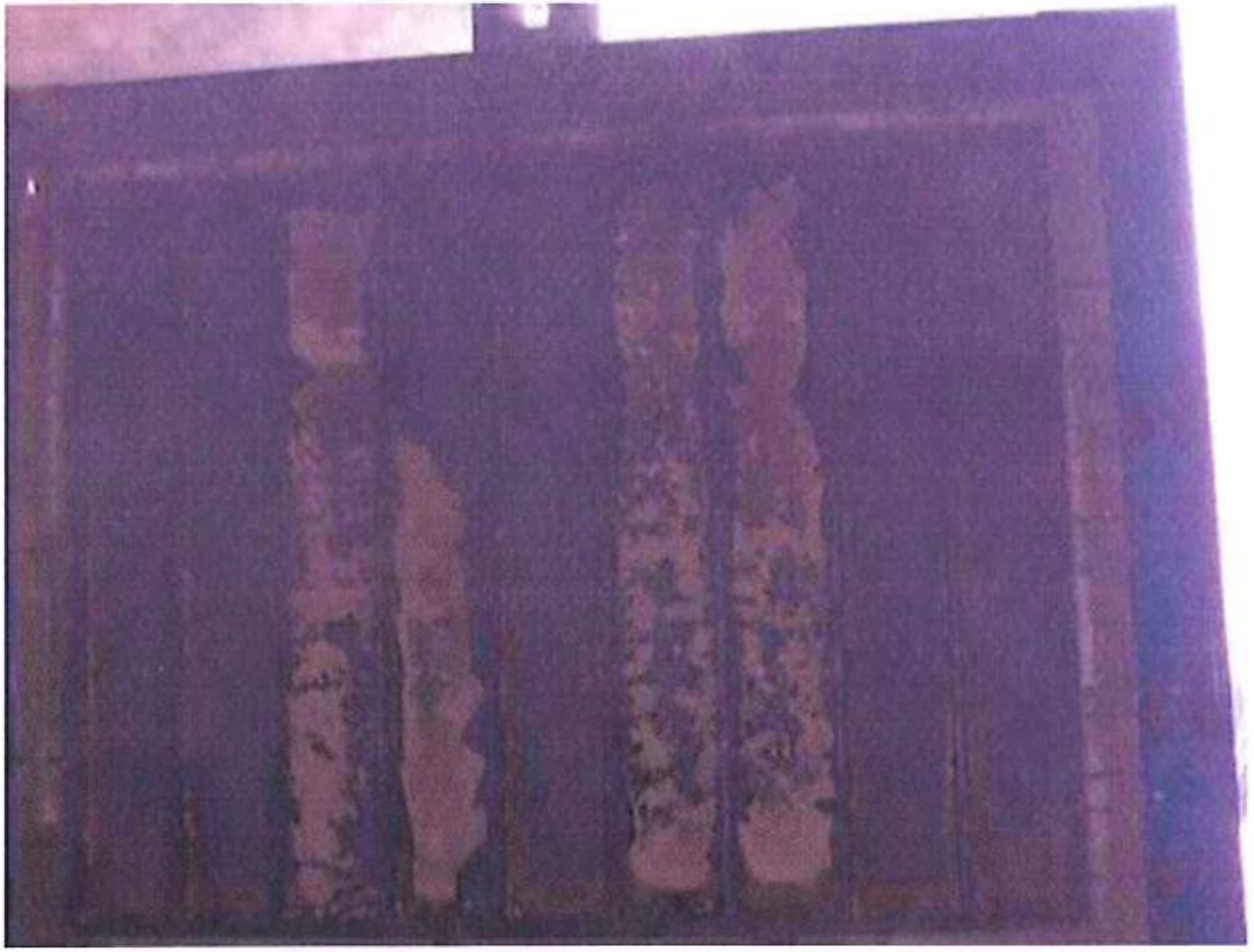


Figure B-7. Exposed Side of Assembly Following Hose Stream Retest.

# Building Code Compliance

## Thermal Barriers

- **Thermal barriers are not required in the following types of construction:**

### Masonry or concrete construction

**Thermal barrier is not required if the SPF is separated from the interior of the building by ≥ 1 inch of masonry or concrete**

### Attics and crawlspaces

**Thermal barrier is not needed if access is only required for the service of utilities; however, the SPF must be protected by an ignition barrier.**

**No Storage is permitted!**

### Sill plates and headers

**Thermal barrier not required in the IRC if the SPF has: thickness is ≤ 3.25 inches, density is 0.5-2.0 pcf, and ASTM E84 Class I or A rating.**

**Thermal barrier not required in the IBC if the SPF has: thickness is ≤ 3.25 inches, density is 1.5-2.0 pcf, and ASTM E84 Class I or A rating.**

# Building Code Compliance

## Ignition Barriers

**Ignition barriers do not provide as much protection from fire as thermal barriers.**

- **Model building codes allow an exception to the thermal barrier requirement in attics and crawlspaces where entry is made only for the service of utilities. These reduced requirements are restricted to areas that have no other uses, such as storage.**

- **SPF in these spaces must be protected against ignition by one of the following materials:**

  **1-1/2" Mineral fiber**
  **1/4" Wood structural panels (paneling or sheathing)**
  **3/8" particleboard**
  **¼"hardboard**
  **(0.375 inch)(3/8") gypsum board (wallboard)**
  **Corrosion resistant steel have a base metal thickness of 0.016 inch**

- **Building code officials may accept alternative end-use tests. Consult with the manufacturer for testing – ICC-ES reports are often required to show acceptance.**

# Building Code Compliance

## Combustibility of SPF

- **SPF is combustible! Codes require thermal and ignition barriers to reduce the risk of ignition and flash fire**
- **Other types of thermal barriers are available in addition to gypsum board:**
  - **spray-applied cementitious and cellulose materials**
  - **portland cement plaster and other proprietary materials**
- **Thermal barrier materials should have a building code evaluation report with report number and validity dates**
- **Code officials may accept thermal barriers that have not been evaluated by ICC-ES on the basis of performance in these generally accepted end-use tests:**
  - **UL 1715 - Fire Test of Interior Finish Material**
  - **UL 1040 - Insulated Wall Construction**
  - **FM 4880 - Building Corner Fire Test**
  - **UBC 26-3 - Room Fire Test Standard for Interior of Foam Plastic Systems**

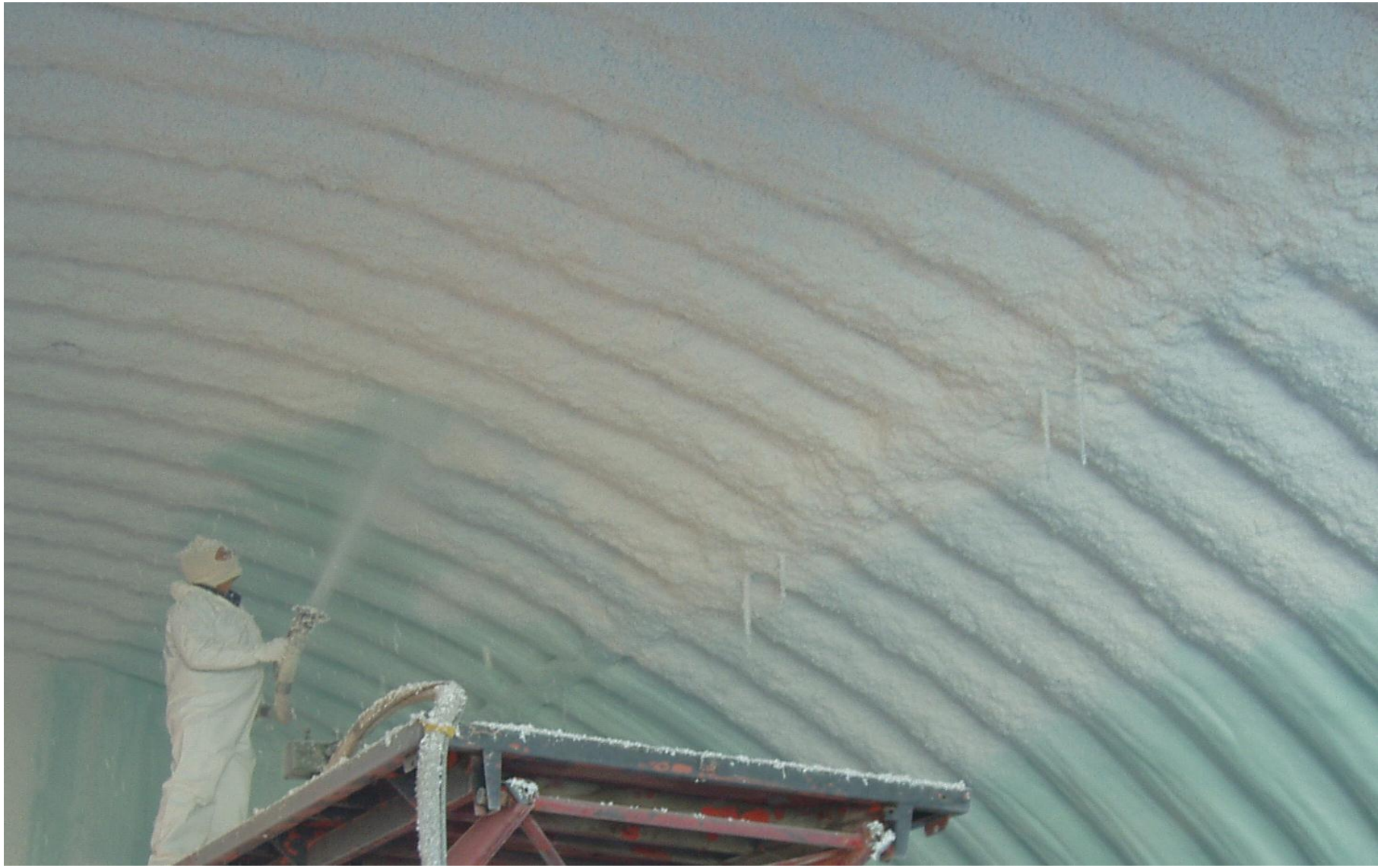
# Cellulose Thermal Barriers

- Composition – Dry wood pulp based fiber latex adhesive and fire retardants.
- Code Approval – Current code certification listing report number and date.

# Cellulose-Based Thermal Barrier Over Foam

# Cellulose-Based Thermal Barriers

# Cellulose-Based Thermal Barriers



# Building Code Compliance

## Water Vapor Permeance

- **ASTM E96 is the method used for measuring water vapor permeance, the performance unit is the "perm"**

  **Perm units indicate the rate of water vapor transmission through a material at a specified thickness**

  **Higher perm ratings indicate more water vapor transmission**

- **IECC requires a vapor retarder on the 'warm in winter' side of the building envelope in climate zones ≥ 5, and Marine Zone 4**

- **To qualify as a vapor retarder the material must have ≤ 1 perm**

  **Most closed-celled foams have permeance ≤ 1 at thickness ≥ 2 inches**

  **Open-celled foams are about 4-16 perms at an installed thickness of 4 inches, and require the addition of a vapor retarder to comply with code in climate zones where one is required**

# Building Code Compliance

## Physics of Moisture Transfer

- **Water vapor is transmitted by two mechanisms**

Vapor barriers and retarders limit the diffusion of water vapor

1. **Diffusion – water vapor always moves from the region of high absolute humidity to low**

Air barriers limit vapor transport by air movement

2. **Air Movement – air leakage through the building envelope transports water as humidity in the air**

- **The primary mechanism for water transport in buildings is air leakage**

Both open cell and closed cell SPF provide an effective air seal, protecting the building envelope against vapor transport via air movement.

- **If air drops below its dew point condensation can occur, depositing liquid water within the building envelope**
- **Water can damage the building components and create a site for mold**
- **Vapor barriers should never be installed on both sides of the building envelope – water can be trapped within**

# Review

1. What types of building codes are used to enforce spray foam insulation?
   a) Prescriptive-based codes
   b) Uniform codes
   c) Performance-based codes
   d) Both A and C

2. What is the new uniform building code that most jurisdictions are using called?
   a) International Code, by the International Code Council
   b) National Building Code
   c) National Energy Code
   d) Model Energy Code

# Review

3. Energy Codes are universal and uniform across the United States, for all types of construction.

   True

   **False**

4. Which of the following testing organizations is actually an insurance agency?

   a) ASTM (American Society for Testing and Materials)

   b) UL (Underwriters Laboratories)

   **c) FM (Factory Mutual)**

   d) ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers)

# Review

5. Which of the following is the acceptance criterion for spray foam insulation that shows compliance with the I-codes?
   a) AC12
   b) AC201
   c) AC377
   d) Both A & C

6. What are the terms used for defining thermal properties?
   a) k-factor
   b) R-value
   c) Perms
   d) Thickness
   e) Both A & B

# Review

7. For foam plastic insulation, what is the minimum requirement for surface burning characteristics, to meet the International codes?
   a) 25 or less flame spread
   b) 75 or less flame spread
   c) 450 or greater smoke developed
   d) Doesn't matter, as long as there is sheetrock, in accordance with ASTM E119

8. A kraft-faced fiberglass batt is a suitable thermal barrier for unfinished basements.
   True
   False

# Review

9. A open-cell foam should use a vapor retarder in some northern climates, because it still has some vapor permeance.

   **True**

   False

10. What is the type and minimum thickness of spray foams that *may* qualify as a vapor retarder?

    a) Open-cell, 10” minimum

    b) Open-cell, 6” minimum

    c) Closed-cell, 4” minimum

    **d) Closed-cell, 2” minimum**

# Suggested Addition

- The following slides answer a question about R-Value and U-Factor that came up in the previous presentation. I suggest we include them in this presentation for the future.

# R-Value vs U-Factor

- The IRC has a table of R-Values to be used if you have stud wall cavities or a cathedral ceiling (roof/ceiling combination)

**TABLE N1102.1**
**INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]**

| CLIMATE ZONE | FENESTRATION *U*-FACTOR | SKYLIGHT[b] *U*-FACTOR | GLAZED FENESTRATION SHGC | CEILING *R*-VALUE | WOOD FRAME WALL *R*-VALUE | MASS WALL *R*-VALUE[k] | FLOOR *R*-VALUE | BASEMENT[c] WALL *R*-VALUE | SLAB[d] *R*-VALUE AND DEPTH | CRAWL SPACE[c] WALL *R*-VALUE |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.2 | 0.75 | 0.35[j] | 30 | 13 | 3/4 | 13 | 0 | 0 | 0 |
| 2 | 0.65[j] | 0.75 | 0.35[j] | 30 | 13 | 4/6 | 13 | 0 | 0 | 0 |
| 3 | 0.50[j] | 0.65 | 0.35[e,j] | 30 | 13 | 5/8 | 19 | 5/13[f] | 0 | 5/13 |
| 4 except Marine | 0.35 | 0.60 | NR | 38 | 13 | 5/10 | 19 | 10/13 | 10, 2 ft | 10/13 |
| 5 and Marine 4 | 0.35 | 0.60 | NR | 38 | 20 or 13 + 5[h] | 13/17 | 30[f] | 10/13 | 10, 2 ft | 10/13 |
| 6 | 0.35 | 0.60 | NR | 49 | 20 or 13 + 5[h] | 15/19 | 30[g] | 10/13 | 10, 4 ft | 10/13 |
| 7 and 8 | 0.35 | 0.60 | NR | 49 | 21 | 19/21 | 30[g] | 10/13 | 10, 4 ft | 10/13 |

# The IRC

- If the roof deck is sprayed so no studs are showing, the U-Factor table can be used instead of the prescriptive R-Value.

**TABLE N1102.1.2**
**EQUIVALENT *U*-FACTORS[a]**

| CLIMATE ZONE | FENESTRATION *U*-FACTOR | SKYLIGHT *U*-FACTOR | CEILING *U*-FACTOR | FRAME WALL *U*-FACTOR | MASS WALL *U*-FACTOR[b] | FLOOR *U*-FACTOR | BASEMENT WALL U-FACTOR | CRAWL SPACE WALL *U*-FACTOR |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.20 | 0.75 | 0.035 | 0.082 | 0.197 | 0.064 | 0.360 | 0.477 |
| 2 | 0.65 | 0.75 | 0.035 | 0.082 | 0.165 | 0.064 | 0.360 | 0.477 |
| 3 | 0.50 | 0.65 | 0.035 | 0.082 | 0.141 | 0.047 | 0.091[c] | 0.136 |
| 4 except Marine | 0.35 | 0.60 | | 0.082 | 0.141 | 0.047 | 0.059 | 0.065 |
| 5 and Marine 4 | 0.35 | 0.60 | 0.030 | 0.060 | 0.082 | 0.033 | 0.059 | 0.065 |
| 6 | 0.35 | 0.60 | | 0.060 | 0.060 | 0.033 | 0.059 | 0.065 |
| 7 and 8 | 0.35 | 0.60 | 0.026 | 0.057 | 0.057 | 0.033 | 0.059 | 0.065 |

# Rule of Thumb

- R-Value is used in a cavity
- U-Factor may be used in an “Opaque Assembly” or has “Continuous Insulation” (No framing connecting the inner and outer skins of the building)

# The IRC

- In Zones 4 and higher it makes a big difference

| Climate Zone | U-Factor | Inches of Low Density Foam | R-Value | Inches of LD SPF |
|---|---|---|---|---|
| 1 | 0.035 | 7.5 | 30 | 7.9 |
| 2 | 0.035 | 7.5 | 30 | 7.9 |
| 3 | 0.035 | 7.5 | 30 | 7.9 |
| 4 Except Marine | 0.03 | 8.7 | 38 | 10.0 |
| 5 & 4 Marine | 0.03 | 8.7 | 38 | 10.0 |
| 6 | 0.026 | 10.1 | 49 | 12.9 |
| 7 & 8 | 0.026 | 10.1 | 49 | 12.9 |

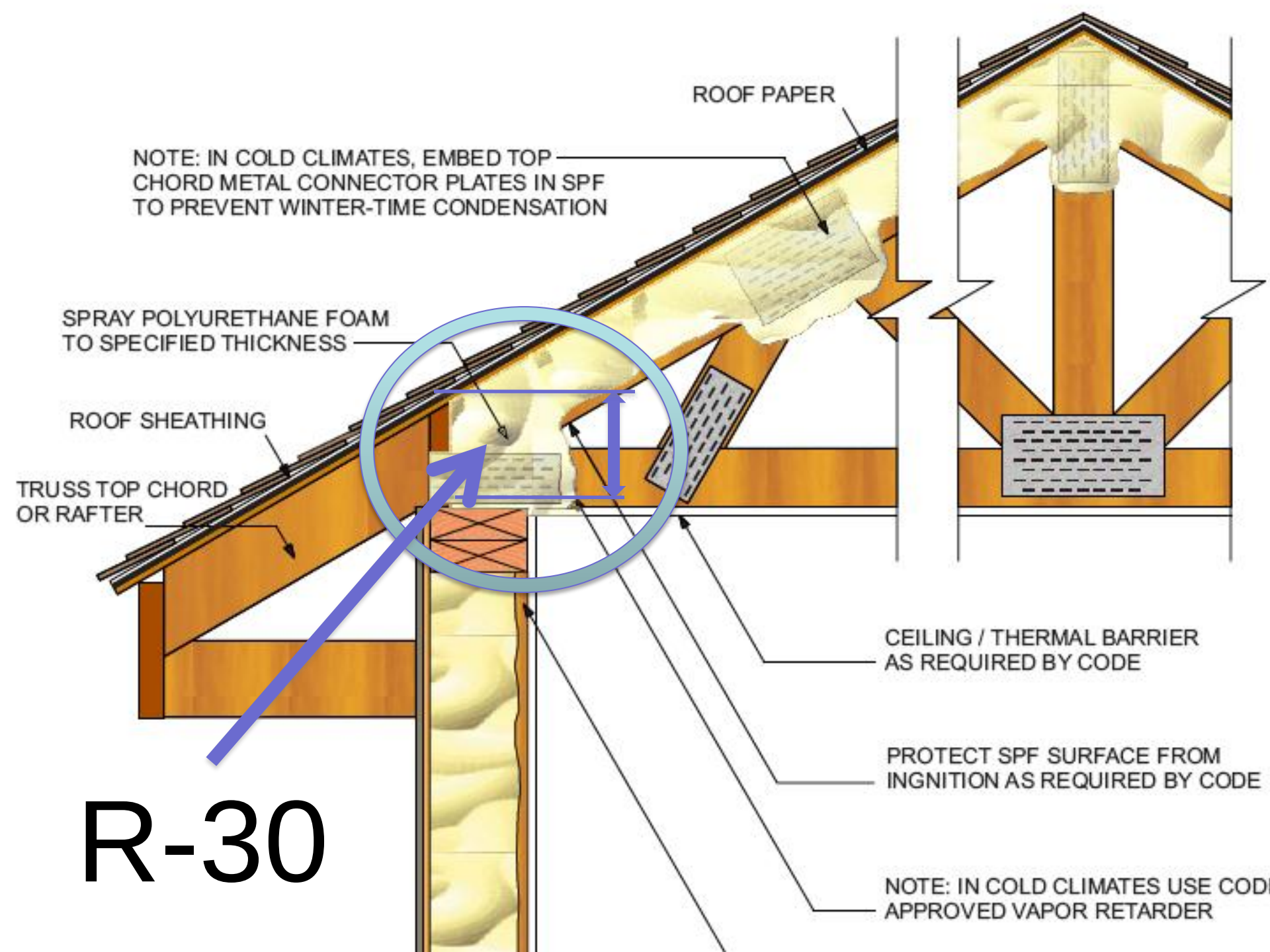
# The IRC

- With Floors it Works Against Us….Slightly

| Climate Zone | U-Factor | Inches of Low Density Foam | R-Value | Inches of LD SPF |
|---|---|---|---|---|
| 1 | 0.064 | 4.1 | 13 | 3.4 |
| 2 | 0.064 | 4.1 | 13 | 3.4 |
| 3 | 0.047 | 5.6 | 19 | 5.0 |
| 4 Except Marine | 0.047 | 5.6 | 19 | 5.0 |
| 5 & 4 Marine | 0.033 | 8.0 | 30 | 7.9 |
| 6 | 0.033 | 8.0 | 30 | 7.9 |
| 7 & 8 | 0.033 | 8.0 | 30 | 7.9 |

# Another Approach

**N1102.2.1 Ceilings with attic spaces.** When Section N1102.1 would require R-38 in the ceiling, R-30 shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Similarly R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the *U*-factor alternative approach in Section N1102.1.2 and the Total UA alternative in Section N1102.1.3.


ROOF PAPER
NOTE: IN COLD CLIMATES, EMBED TOP CHORD METAL CONNECTOR PLATES IN SPF TO PREVENT WINTER-TIME CONDENSATION
SPRAY POLYURETHANE FOAM TO SPECIFIED THICKNESS
ROOF SHEATHING
TRUSS TOP CHORD OR RAFTER
CEILING / THERMAL BARRIER AS REQUIRED BY CODE
PROTECT SPF SURFACE FROM INGNITION AS REQUIRED BY CODE
NOTE: IN COLD CLIMATES USE COD
APPROVED VAPOR RETARDER
R-30