

Polyurethane Products

Overview of U.S. Model Building Code Fire Performance Requirements



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Chapter 1: Introduction and Terminology

1.1 General

Model and local building codes used in the United States provide guidance and requirements for the safe use of materials and systems used in buildings. Since the 1970s, foam plastic thermal insulation, including polyurethane and polyisocyanurate, has become an important element in the building envelope and is specifically regulated by the current building codes. This document gives an overview of building code fire performance provisions that control how foam plastic insulation is used and how it must be protected in use. While information is provided on tests mandated by the building codes to measure the fire performance of foam plastic insulation used in buildings, keep in mind that there are other considerations addressed by building codes such as physical properties of products.

Model building codes are “living documents” that are updated and changed on a periodic basis. The information presented here is believed to be current as of the date of publication.

NOTE: The reader is directed to always check with the local authority having jurisdiction with regard to the code edition in effect and requirements for the safe use of foam plastics in a particular project. This document is not meant to be comprehensive and the reader is encouraged to contact raw material suppliers, product manufacturers, registered design professionals and code enforcement officials for information on specific materials and projects.

Additionally, it may be helpful to look at the various types of documents used to oversee fire safety in commercial and residential building:

- **Regulations**: Documents with the force of law which list general objectives and act as a framework for more detailed requirements.
- **Codes**: Documents connected with regulations outlining more specific requirements and are valid for particular environments.
- **Standards**: Documents referenced in regulations and/or codes that put forward special techniques to quantify results.
- **Guides**: Documents explaining the concepts associated with a particular issue, such as test methods or properties.
- **Specifications**: Documents describing requirements for a particular material or product application.

1.2 Polyurethane Foam in Commercial and Residential Buildings

Some of the most efficient thermal insulation materials available are rigid polyurethane (PUR), polyisocyanurate (PIR) and spray polyurethane foam materials (SPF). These foams are used in many different thermal insulation applications for both residential and commercial buildings because they are versatile and high performing.

In homes, foam insulation is found in several forms. Wall insulation can be supplied in panels, or PIR laminates, that are applied to the wall framing at the time of construction or remodeling. Many entry doors and garage doors are insulated with rigid polyurethane foam. SPF is also used for wall insulation and roofing and provides the additional benefit of reducing air infiltration to the building for increased energy efficiency. SPF comes in two types: Open-cell (OC-SPF) and Closed-cell (CC-SPF).

Commercial buildings are also insulated in many ways using PUR and PIR foams. Low slope commercial roofing uses both PIR panels and SPF for insulation. PIR panels and SPF are used in exterior walls such as cavity wall, curtain wall and other exterior applications. Many door applications also use PUR and some buildings exteriors are constructed entirely from metal-faced PUR core panels.

1.3 Polyurethane and Polyisocyanurate Terminology and Product Standards

1.3.1 Terminology: PIR and PUR foams are generally considered synonymous with PUR within the context of the building codes. The two different types of foams are often made using the same or similar raw materials but the “recipes” vary in accordance with the requirements of the production process and the final application and have different physical properties. Rigid-cellular polyurethane thermal insulation is produced by the catalyzed chemical reaction of polyisocyanates with polyhydroxyl compounds, with the addition of other compounds such as stabilizers and blowing agents.

SPF is a foamed plastic material formed by the reaction of an isocyanate and a polyol and employing a blowing agent to develop a cellular structure. SPF may be a two-component reactive system mixed at a spray gun or a single-component system that cures by exposure to moisture. SPF can be formulated to have physical properties (such as density, compressive strength, closed cell content, and R-value) appropriate for the application requirements. Common uses of SPF include insulation, air barrier and roofing membrane.

1.3.2 Product Standards: The ASTM International product standards provide minimum physical property and performance requirements for products or systems and are developed through a consensus process. This process typically involves producers, users and other interested parties who meet at least twice a year for standards development purposes. The standards are formed through a balloting process that allows all interested parties to participate. The process provides for updates on a regular basis to insure the latest technology and test requirements are incorporated. In addition, the ASTM consensus process requires the standards be reviewed and updated at least every five years.

PUR, SPF and PIR foam insulations are addressed in ASTM Committee C 16, Thermal Insulation, and are directly under Subcommittee C 16.22, Organic and Non-Homogeneous Inorganic Thermal Insulations. Building code officials and other authorities readily recognize standards developed through the ASTM consensus process. Generally, a variety of ASTM test standards are contained within product standards. There are three material standards directed to PUR and PIR thermal insulations. Note that these particular standards do not involve fire test requirements.

1.3.2.1 ASTM C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board: This specification covers PIR foam insulation products faced with a variety of facings materials and used mainly as roof and wall insulation in building construction. Various types of products, classified by facer type, are included.

1.3.2.2 ASTM C1029 Standard Specification for Spray Applied Rigid Cellular Polyurethane Thermal Insulation: This specification covers SPF foam insulation materials. SPF is normally applied on site for a variety of applications such as storage tank insulation, roofing and wall insulation in building construction. At the time of this writing, the building codes only require SPF roofing materials to comply with this standard.

- 1.3.2.3 ASTM C591 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation:** This specification covers PIR foam insulation which is formed as bun stock and then cut for a particular application, the main use being pipe insulation. A small quantity is used in roof insulation applications for building construction.

Chapter 2: Introduction to Building Codes

2.1 Building Code Purpose

Building codes help to safeguard life and protect the public welfare by regulating design, construction practices, construction material quality (including fire performance), location, occupancy, and maintenance of buildings and structures. When regulating materials, the model building codes refer to quality consensus standards for products or tests developed by standard-setting organizations such as ASTM and the National Fire Protection Association (NFPA). Some building codes and insurance rating organizations also rely on test information and performance certifications from organizations such as Factory Mutual Global (FM Global or FM) and Underwriters Laboratories Inc. (UL). Appendix 1 contains a glossary and resources that may be helpful in reviewing code related information.

2.2 Building Code Development and Administration

Some people are surprised to learn that there is no federal governance of building codes in the United States. States and in some cases, local or city governments have adopted the building code that is to be enforced in their area of jurisdiction. Rather than develop these building codes on their own, they typically have relied on a model code organization. In the past, several code organizations (Table 1) developed model codes and administered changes to them.

Table 1—Historic U.S. Model Building Codes and Organizations

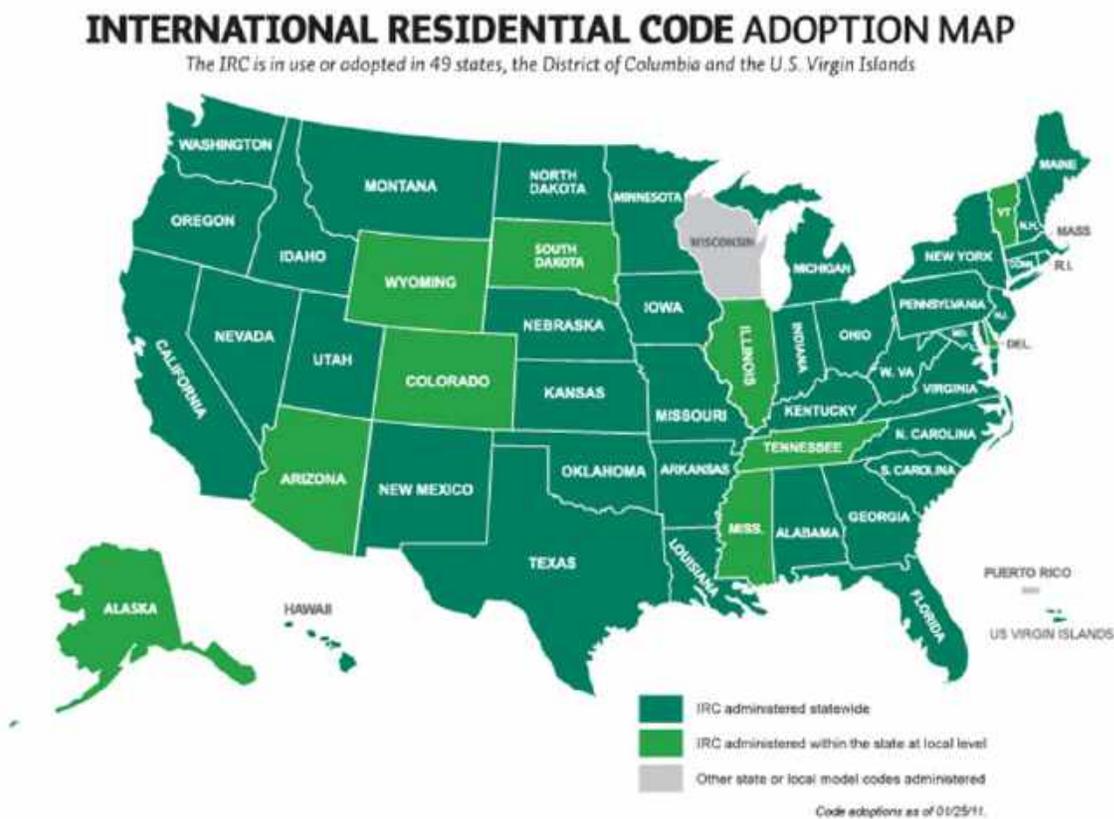
Model Building Code	Organization
National Building Code (NBC)	Building Officials and Code Administrators (BOCA)
Standard Building Code (SBC)	Southern Building Code Congress Intl. (SBCCI)
Uniform Building Code (UBC)	International Conf. of Building Officials (ICBO)
One and Two Family Dwelling Code (CABO)	Council of American Building Officials (CABO)

Through 1997, the Council of American Building Officials (CABO) served as the umbrella organization for BOCA, ICBO, and SBCCI. In order to create uniform code requirements nationally and as a means to improve construction consistency, a plan was organized to merge the activities of these code bodies into a series of codes administered by one organization, the International Code Council (ICC). The current commercial building code and the one adopted by almost all jurisdictions is the International Building Code (IBC). Integration of these separate code bodies under the ICC was approved and implemented in January 2003. Major revisions to the IBC take place every three years, thus new editions of the IBC were released in 2006, 2009, and recently for 2012. While the IBC has been available since 2003, it is important to note that

jurisdictions reserve the right to adopt any version of the model codes and amend it to suit particular needs or circumstances. The IBC is in use or adopted in all 50 states. However, for example, Connecticut is still using the 2003 IBC while Illinois is using the 2009 IBC.

The International Residential Code for One and Two-Family Dwellings (IRC) is widely adopted but not as universally as the IBC (see Figure 1 below).

Figure 1 – Residential Code Coverage (2011)



Source: International Code Council (www.iccsafe.org/gr/Pages/adoptions.aspx) (reprinted with permission from the International Code Council)

A detailed listing of International Code (I-Codes) adoption by state is found in Appendix 5. The International Code State and Jurisdiction Adoption Charts are works in progress and subject to change periodically. Therefore, the reader should be sure he or she has the most up-to-date information and not rely solely on this document. In addition to the model codes, e.g., IBC and IRC, about 28 states have adopted integrated ICC codes that may contain specific requirements or amendments for that specific area or jurisdiction. Up to date information on the state codes can be found at the ICC website: iccsafe.org.

The ICC model codes encompass some 13 separate codes with the IBC and IRC being the most often used for users of polyurethane foams. Other codes include the Mechanical, Plumbing and Energy Conservation Codes. The International Wildland-Urban Interface Code (IWUIC) impacts the use of polyurethane (PU) in residential construction as well. This code was developed to help mitigate damage from wildfires in affected areas, normally in the Southwestern and Western States. There may be provisions that involve PU foam insulation in wall constructions and in roof assemblies. See the reference to the 2012 IWUIC at www.iccsafe.org. At this time, the ASTM E5.14 Committee on External Fire Exposure Tests is developing several standards which are expected to be incorporated into the IWUIC. One ASTM standard has been issued as E2707, “Standard Test Method for Determining Fire Penetration of Exterior Wall Assemblies Using a Direct Flame Impingement Exposure.” This was intended to be similar to the current California WUI area external wall fire test. This has implications for PU containing wall insulation assemblies when used in areas prone to wildland fires, mostly in the southwestern United States.

The National Fire Protection Association (NFPA) developed a model building code (NFPA 5000) which was first published in August 2002, with the latest edition in 2009. Updated information on adoption of this code is expected to be available on the NFPA website (www.nfpa.org) in 2012. This building code has not been adopted as widely as the IBC. For example, it has been adopted in the state of Colorado in its fire safety standards. There are no general state wide adoptions of NFPA 5000 but there are some local adoptions in Maine, Texas and Illinois.

2.3 Product/System Evaluation and Approval

In the United States, products and materials manufactured for use in the built environment must meet the provisions of the model building code that is being enforced in a particular area. Typically, a product or system may demonstrate compliance with a code by testing against a reference standard. However, there are situations where a manufacturer has a new product or an existing product for a new application that is not specifically addressed in the building code or for which there are no reference standards. The ICC has set up an Evaluation Service (ICC-ES) (www.icc-es.org) to handle these alternative application requests from manufacturers. There are several other organizations that also issue product certifications including UL, IAPMO (International Association of Plumbing and Mechanical Officials) and ATI (Architectural Testing, Inc.) but ICC-ES is broadly used for product certification.

The ICC-ES is made up of an Evaluation Committee and staff. The Evaluation Committee is made up of 9 voting members, each of whom is a building code official. The ES staff is composed of people with expertise in various areas of building construction. The ES issues and approves Acceptance Criteria (AC) for different applications, for example, Foam Plastic Insulation (AC 12) and Spray-Applied Foam Plastic Insulation (AC 377). For a listing of current ICC-ES Acceptance Criteria related to plastic foam, foam insulation or foam insulation

applications, see Appendix 2. Acceptance criteria are issued to provide guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. A limited number of standard tests, e.g., ASTM, are referenced in IBC, Chapter 26 on plastics. The Acceptance Criteria typically reference a more substantial number of fire resistance and physical property standards. In AC 12, for example, there are 18 ASTM, 2 Factory Mutual, 5 NFPA and 6 UL standards referenced.

A manufacturer seeking an Evaluation Service Report of a product, material, system or assembly presents its case to the ES. The Evaluation Committee reviews the request and rationale and may give approval to consider the request. A review is made with the ES staff to determine if an existing Acceptance Criteria applies to the new material or application. The objective of the ES is to see that a new application meets the intent of the building code, sometimes through alternate tests not specifically identified in the code. If no existing Acceptance Criteria can be applied, an attempt is made to modify an existing Acceptance Criteria. In that case, the manufacturer may have to present testing data that supports the safe use of its material. In the case where the application does not fit an existing Acceptance Criteria, the manufacturer must present compelling evidence that the new application or product, from a fire perspective, meets the intent of the code, normally through testing data. If a new Acceptance Criteria is required, then a request is presented to the Evaluation Committee in a public forum before a final Acceptance Criteria is issued. Acceptance Criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES Evaluation Reports (ESR). For this type of new product, it can be important to have an ESR issued by ICC-ES to show compliance with the intent of the building codes. More detailed information on ESR's and Acceptance Criteria can be found on the ICC web site (<http://www.icc-es.org>). The ESR's are:

- Issued to a specific company
- For a specific product or group of similar products
- For specific applications
- A guarantee to a customer that the product conforms to and is accepted by the code body
- Important marketing tools

For examples of approved ESR's, see: <http://www.icc-es.org/reports>.

A typical ESR contains the following information on the product(s) evaluated:

- General use areas
- Product description including thermal qualities and fire and physical properties
- Installation guidelines
- Conditions of use
- Test data – evidence submitted to ICC-ES
- Product identification
- Specific application details

Testing data presented to ICC-ES typically must come from an ISO-17025 accredited laboratory or ICC-ES must be contacted prior to the commencement of any testing. An on-site assessment will be done by ICC-ES or its representative immediately before or at the time of testing, and the laboratory will be assessed using the ICC-ES Non-accredited Laboratory Checklist to determine whether the laboratory complies with ISO/IEC 17025 for the work in question.

When evaluation reports require periodic inspections of the manufacturing facility by a third-party agency, ICC-ES Rules of Procedure state that the inspection agency must be accredited by International Accreditation Service (IAS) or by an accreditation body that is a partner of IAS in a Mutual Recognition Arrangement (MRA).

Another code development organization is IAPMO or International Association of Plumbing and Mechanical Officials. The organization has been in existence for about 85 years and has historically serviced the plumbing and mechanical industries. It provides code development and product certifications through the IAPMO Evaluation Service (IAPMO ES). It offers building product certifications in fire tested products through ASTM E84 and other tests. IAPMO ES is accredited by the American National Standards Institute (ANSI).

2.4 Reference Standards in Building Codes

While model building codes encompass a wide variety of issues, they generally do not contain specific details, such as physical properties or performance testing, for each building material and system. Rather, model codes typically direct designers and builders to standards developed by standards setting organizations for the information they need. Compliance with these reference standards can also be a means of code enforcement by building departments. The approved Acceptance Criteria also point to specific tests and testing protocols. For the purposes of this document, a brief description of most of the fire performance reference standards applicable to foam insulation that appear in model building codes or Acceptance Criteria are listed in Appendices 3 and 4. For a more complete narrative on a particular standard, see the link to the standard as it appears on the issuing organization's website.

Chapter 3: General Building Code Fire Performance Requirements for Foam Plastic Insulation

Sections of existing model building codes that regulate foam plastic thermal insulation are:

International Building Code (IBC), 2012	Chapter 26, Plastic, Section 2603
International Residential Code (IRC), 2012	Section R316, Foam Plastic

3.1 Building Code Fire Performance Requirements

Model building codes such as those published by ICC include specific sections pertaining to the safe use of foam plastics in construction. There are three general fire related requirements.

- 3.1.1 Surface burning characteristics, flame spread (IBC and IRC):** With some exceptions, foam plastic insulation and foam plastic cores of manufactured assemblies shall have a flame spread index of 75 or less when tested in accordance with ASTM E84 or UL723. Foams are tested in the maximum thickness and density intended for use. ASTM E84 produces a value that represents a relative burning behavior between a standard material (inorganic reinforced cement board) and the test sample by observing flame spread along a tunnel that is 2 feet wide by 25 feet long.
- 3.1.2 Surface burning characteristics, smoke development (IBC and IRC):** With some exceptions, foam plastic insulation and foam plastic cores of manufactured assemblies shall have a smoke-developed index of not more than 450 when tested in accordance with ASTM E84. Foams are tested in the maximum thickness and density intended for use. Some codes, e.g., IBC, waive the smoke developed rating requirement in certain roof assemblies containing foam plastic insulation. There is not necessarily a relationship between flame spread and smoke developed measurements.
- 3.1.3 Thermal Barrier (IBC and IRC):** With some exceptions, foam plastic shall be separated from the interior of a building by an approved thermal barrier of ½ in (12.7 mm) gypsum wallboard or a material that is tested in accordance with and meets an acceptance criteria (typically from ICC-ES) of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275. The thermal barrier is to limit the average temperature rise of the unexposed surface to not more than 250°F (120°C) after 15 minutes of fire exposure using the ASTM E119 fire test.

3.2 Special Approval

Most model building codes also contain a provision that foam plastic shall not be required to comply with the thermal barrier requirement where specifically approved based on large-scale tests such as those listed below.

- NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth
- FM 4880, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth
- UL 1040, Standard for Fire Test of Insulated Wall Construction
- UL 1715, Standard for Fire Test of Interior Finish Material

The model building codes provide that such testing shall also be related to the actual end-use configuration and be performed on the finished manufactured foam plastic assembly in the maximum thickness intended for use. In this case, an evaluation report from an Evaluation Service is the typical method to demonstrate compliance with the intent of the code to the building regulators.

Chapter 4: Commercial/Industrial—Roofing

4.1 Products Frequently used for Commercial Roofs

- 4.1.1** Polyisocyanurate Laminate Boards (PIR): Typically 4' x 8' or 4' x 4' panels, in thicknesses from 1 to 4 inches with various facing materials. The facing material is frequently glass fiber reinforced cellulosic felt. These products are also available in tapered profiles, intended to provide slope for drainage on flat or low slope roofs.
- 4.1.2** Spray Polyurethane Foam (SPF): Field applied SPF in various thicknesses is typically used as a system with an elastomeric covering or coating to protect the SPF from weathering and ultraviolet (UV) radiation.
- 4.1.3** PIR and PUR Foam Core Panels: Factory produced metal faced foam cored panels in thickness ranging from 2 to 6 inches. These panels may be structural, forming an insulated ceiling roof assembly.

4.2 Building Code Fire Performance Requirements

Building code regulations for foam plastics used in roofing systems include fire tests that evaluate performance of the foam plastic itself as well as complete roof assemblies, from the roof deck through the roof coverings.

- 4.2.1** A flame spread index of 75 or less tested with ASTM E84 or UL 723 for the foam plastic alone. In roofing applications, the Codes do not currently place a limit on the smoke-developed index. (IBC Sec. 2603.3)
- 4.2.2** Flame spread on a roof system when exposed to external fire, assessed using ASTM E108, resulting in these classifications: Class A, Class B, Class C or unclassified. (IBC Sec. 2603.6)
- 4.2.3** Roof/Ceiling resistance to an internal fire exposure measured using ASTM E119 and expressed as an hourly rating.
- 4.2.4** Resistance to interior fire spread tested using UL 1256. Results are *pass* or *fail* based on temperature or flame front criteria. When this test is satisfactorily passed, the ASTM E84 flame spread requirement is waived. (IBC Sec. 2603.3)
- 4.2.5** A roof assembly fuel contribution rate measured using FM 4450. When this test is satisfactorily passed, the ASTM E84 flame spread requirement is waived. (IBC 2603.3)

4.3 Fire Tests and Requirements for Roof Systems

- 4.3.1** Generally, flame spread index ratings of 75 or less determined by ASTM E84 or UL 723 apply to the foam core unless the roof assembly containing the foam plastic insulation has passed either FM 4450 or UL 1256. The PUR insulation/assembly meeting the above requirements is permitted in a Class A, B, or C roofing assembly when tested to ASTM E108 or UL 790. (IBC 2603.3 - 5)
- 4.3.2** Thermal Barrier: The spread of fire on the underside of a roof deck is a concern when buildings have large, open interior space, such as a warehouse or manufacturing facility. The prescriptive thermal barrier (i.e., ½ in. thick gypsum board) between PU foam and the interior of the building is not required where the PU foam is separated from the interior of the building by wood structural panel sheathing not less than 0.47 in. (11.9 mm) in thickness or an equivalent material. Also, the two fire tests used by code bodies to allow elimination of the thermal barrier through evaluation of the spread of fire in this manner are FM 4450, and UL 1256. Other test methods, such as FM 4880, also may be used to qualify the elimination of the thermal barrier in roof assemblies containing foam plastic insulation as a diversified test. These tests are conducted on the complete roof assembly. (IBC 2603.4.1.5)

Chapter 5: Commercial/Industrial—Walls

Foam insulation may be applied to the exterior or interior of the commercial building envelope walls. In addition to the general requirements for foam plastic insulation, building codes typically also have specific provisions based on whether the walls are combustible or noncombustible, the building's occupancy classification and the distance to the nearest adjacent building. Buildings of any height are required to pass a number of fire tests as outlined in the IBC Chapter 26 code. There is an exception to some requirements for buildings of one story.

5.1 Products Frequently used for Commercial Walls

5.1.1 PIR laminate boards for wall sheathing: PIR laminates, usually foil faced, are attached to the exterior of the wood or steel structural frame, then covered with an approved exterior finish.

PIR laminate boards may also be placed on the interior of the wall when covered by a thermal barrier (IBC Sec. 2603.4). Model building codes (e.g., IBC) also contain a provision that foam plastic shall not be required to comply with the thermal barrier requirement where specifically approved based on specific large-scale tests (IBC Sec. 2603.10). Also, as allowed by the IBC and other model codes, the thermal barrier is not required for foam plastics installed in a masonry or concrete wall system where the foam plastic is covered on each face by a minimum of 1 in. (25 mm) thickness of masonry or concrete (IBC 2603.4.1.1).

5.1.2 Spray Polyurethane Foam (SPF): SPF is typically applied either to an interior surface to be covered with a thermal barrier (IBC Sec. 2603.4) or to the exterior surface and covered with approved protection.

5.1.3 PIR and PUR foam core panels: Metal faced panels attached to a structural framework. Approved panels form both the interior and exterior surface (IBC Sec. 2603.4.1.4 and 2603.5.3).

5.2 Building Code Fire Performance Requirements

5.2.1 General requirements of flame spread index of 75 or less and smoke developed index of 450 or less on the foam plastic insulation and foam plastic cores of manufactured assemblies, determined in accordance with ASTM E84, and when tested at the intended thickness and density of use apply except for special circumstances described in 5.2.1.1 and as shown in Table 2. (IBC 2603.3)

5.2.1.1 Non-Combustible Construction: Buildings with non-combustible walls, as defined by the IBC, are regulated by model building codes

based on their height. An overview of these requirements is illustrated in Table 2.

5.2.2 Thermal Barriers are generally required by the IBC unless special conditions apply as illustrated in Table 2. **Note that the provisions for one-story buildings should be treated as an exception to the “buildings of any height” requirements (see IBC section 2603.4.1.4).**

Table 2: Fire Performance Provisions for Exterior Walls

	One-Story Buildings (IBC Sec. 2603.4.1.4)	Buildings of Any Height (IBC Sec. 2603.5)
Flame Spread Index	25 or less	25 or less; exception for metal factory assembled panels which can be tested as an assembly
Smoke Developed Rating	450 or less	450 or less
Thermal Barrier	Must be present or waived if the foam is covered by at least 0.81 mm aluminum or 0.41 mm corrosion resistant steel or if Flame Spread is ≤ 25 or by Special Approval	$\frac{1}{2}$ in gypsum wall board or material that meets the acceptance criteria of NFPA 275 or by Special Approval
Automatic Sprinklers	Yes, if thermal barrier is not used	Normally required
Maximum Foam Thickness	4 in, some exceptions with Special Approval	4 in, some exceptions with Special Approval
Potential Heat	N/A	NFPA 259, e.g., $< 2,000$ BTU/lb or 22.7 MJ/m^2 for siding backer board
2-Story Exterior Spread of Flame Test (Intermediate Multi-Story Test)	N/A	Must meet acceptance criteria of NFPA 285
Ignitability (NFPA 268)	N/A	No sustained flaming

- 5.2.3** Fire Resistance Rated Walls: At times, special requirements may be enforced such as fire resistance rated walls. Fire resistance rated exterior wall assemblies may be required when there are certain building separation conditions, as defined by the IBC. In these situations, the specific wall assembly containing foam plastic insulation will need to have test data in accordance with ASTM E119 substantiating the hourly fire resistance time rating. (IBC Sec. 2603.5.1)
- 5.2.4** Special Approval: Foam plastics, under certain circumstances and designs, are not required to have a thermal barrier where the code allows and it has specifically been approved based on a large-scale test. Refer to the specific building code for a list of acceptable tests and see Section 3.2 of this document. (IBC Sec. 2603.10)

Chapter 6: Residential—Roofing

6.1 Products Frequently used for Residential Roofs

- 6.1.1** Polyiso Laminate Boards: Typically 4' x 8' or 4' x 4' panels, in thickness from 1 to 4 inches, with various facing materials. The facing material is frequently glass fiber reinforced cellulosic felt or foil facings.
- 6.1.2** Spray Polyurethane Foam (SPF): Field applied SPF in various thicknesses and is typically used as a system with an elastomeric covering or coating to protect the SPF from weathering and ultraviolet (UV) radiation.

6.2 Building Code Fire Performance Requirements

The International Residential Code regulates the use of foam plastic in a roof covering assembly.

- 6.2.1** Flame spread index of 75 or less determined by ASTM E84 or UL 723 apply to the foam plastic insulation and foam plastic cores of manufactured assemblies. Smoke developed index is not limited in roofing applications. (IRC Sec. R316.3)
- 6.2.2** Thermal barrier is required unless the foam is separated from the interior of the building by tongue-and-groove wood planks or by wood structural panel sheathing (at least 15/32" or 11.9 mm thick) (in accordance with Sec. R803) that is bonded with exterior glue and identified as Exposure 1, with edges supported by blocking or tongue & groove joints or an equivalent material. (IRC Sec. R316.5.2)

Chapter 7: Residential—Walls

7.1 Products Frequently used for Residential Walls

- 7.1.1 PIR laminate boards for wall sheathing either on the exterior or on the interior of the wall.
- 7.1.2 Spray Polyurethane Foam (SPF) is applied either to an interior surface to be covered with a thermal barrier or to the exterior surface and covered with approved protection.

7.2 Building Code Fire Performance Requirements

The International Residential Code regulates the use of foam plastic in wall construction:

- 7.2.1 Flame spread index of 75 or less on the foam plastic insulation and foam plastic cores of manufactured assemblies, as tested in accordance with ASTM E84 or UL 723 at the maximum thickness and density intended for use. (IRC Sec. R316.3)
- 7.2.2 Smoke developed index of 450 or less on the foam plastic insulation and foam plastic cores of manufactured assemblies, as tested in accordance with ASTM E84 or UL 723 at the maximum thickness and density intended for use. (IRC Sec. R316.3)
- 7.2.3 Thermal Barrier: Required use of a thermal barrier, such as 1/2 in. (12.7 mm) gypsum board, or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and Integrity Fire Test of NFPA 275 separating the foam plastic from the interior of the building, unless there is a Special Approval. (IRC Sec. R316.4 & R316.5.12)
- 7.2.4 Special requirements may be enforced such as Fire Resistance Rated Walls: A fire resistance-rated wall assembly may be required when there are certain building separation conditions or in the case of multifamily residential construction. In this situation, the specific wall assembly containing foam plastic insulation will need to have test data in accordance with ASTM E119 substantiating a fire resistance hourly rating. (IRC Sec. 302.1)

7.3 Other Fire Performance Requirements

In certain areas of the country (IWUIC Sec. 504.5, 505.1), principally in southwestern states where there is a risk of fire exposure from wildland fires, fire test requirements for wall assemblies may be required. In the state of California, the Office of the State Fire Marshal has a requirement for high risk areas (defined for California) as part of their California Wildland-Urban

Interface Code. In this case, new construction must conform to the Cal. Chapter 7A Building Code (see http://www.fire.ca.gov/fire_prevention/downloads/Part_12_CA_SFM_12-7A-1_Test_Standards.pdf). The fire test for wall assemblies involves a 4 ft. x 8 ft. test specimen with an external specified siding and wall insulation when used. A 4 in. x 39 in. propane burner is the ignition source. Absence of flame penetration or glowing combustion on the unexposed assembly side are requirements for passing the test according to ASTM E2707.

ASTM E05.14 Committee on External Fire Exposures has developed a similar fire test to the California test discussed above, E2707, “Standard Test Method for Determining Fire Penetration of Exterior Wall Assemblies Using a Direct Flame Impingement Exposure.” It is intended for adoption in any state with similar wildland-urban interface areas. It is expected in 2012 that this test will become part of the requirements of the International Wildland-Urban Interface Code.

Chapter 8: Ceilings, Attics and Crawl Spaces

8.1 Products Frequently used in Ceilings, Attics and Crawl Spaces

8.1.1 PIR laminate boards for wall sheathing or foundation insulation.

8.1.2 Spray Polyurethane Foam (SPF).

8.2 Building Code Fire Performance Requirements

8.2.1 A flame spread index of 75 or less on the foam plastic insulation and foam plastic cores of manufactured assemblies, as tested in accordance with ASTM E84 or UL 723. (IBC Sec. 2603.3, IRC Sec. R316.3)

8.2.2 A smoke developed index of 450 or less on the foam plastic insulation and foam plastic cores of manufactured assemblies, as tested in accordance with ASTM E 84 or UL 723. (IBC Sec. 2603.3, IRC Sec. R316.3)

8.2.3 Thermal Barrier: Use of a thermal barrier, such as 1/2 inch (12.7 mm) gypsum board on the interior side of the building except in special cases. (IBC 2603.4, IRC Sec. R314.4)

8.2.3.1 A thermal barrier may be omitted in the attic or crawl space where entry is made only for service of utilities. In this case, instead of ½ in. gypsum board, one of the following materials must be used to cover the foam plastic for protection against ignition (frequently referred to as an ignition barrier). (IBC Sec. 2604.1.6, IRC Sec. 314.5.3)

- a. 1 ½ in. (38 mm) thick mineral fiber insulation,
- b. 1/4 in. (6.4 mm) thick wood structural panels, particleboard (9.5 mm), or hardboard (6.4 mm),
- c. 3/8 in. (9.5 mm) thick gypsum board,
- d. 0.016 in. (0.406 mm) corrosion resistant steel, or
- e. 1 ½ in. (38 mm) thick cellulose insulation (only for attics)

8.2.3.2 As discussed in AC12, Acceptance Criteria for Foam Plastic Insulation (Appendices A, B, and C), an ignition barrier is not required for attics when satisfactory testing is conducted in accordance with (Acceptance Criteria are publically available on the ICC-ES web site):

- A room burn test against NFPA 286 or UL 1715 with acceptance criteria in AC12, Section 4.5.2, or

- An alternative test procedure using a modified NFPA test room with gypsum wall board and the exposed foam plastic over the gypsum. If a coating is used, including intumescent coatings, it is applied over the exposed foam before testing, or
- A comparative room burn test (NFPA 286 or UL 1715) in which a plywood covered framing member assembly (both inside and outside walls), the control, is tested against a similar assembly with no inside wall plywood and exposed plastic foam on the inside of the assembly. Flash over can occur in no less time than the control.

8.2.3.3 Similar exemptions are made for exposed plastic foam in crawl spaces, see AC 12, Section A2.2.

8.2.3.4 As discussed in AC 377, Acceptance Criteria for Spray-Applied Foam Plastic Insulation (Appendices X and C), an ignition barrier is not required for attics when satisfactory testing is conducted in accordance with a modified NFPA 286 room burn procedure outlined in Appendix X of AC 377.

8.2.3.5 Special approval may also be obtained for exposed foam plastic in attics and crawl spaces under the Special Approval section of the code (see Section IBC 2603.10 or IRC Sec. R316.6) using large scale tests. Special Approval tests include NFPA 286, FM 4880, UL 1040 or UL 1715, or fire tests related to actual end-use configurations. 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.

Chapter 9: Garage Doors

9.1 Products Frequently used in Garage Doors

For use in garage doors, PUR and/or PIR foam may be supplied in sheets or blocks and attached as a non-structural material, or it may be bonded to facings to form insulated, structural “sandwich” panels. Foam may also be “foamed-in-place” and used as an adhesive between the facings to create an insulated, structural panel. The IRC exempts foam-filled garage doors from surface burning or thermal barrier requirements (IRC Sec. R316.5.6)

9.2 Building Code Fire Performance Requirements—Commercial/Industrial

- 9.2.1** For the core foam insulation, a flame spread index of 75 or less and a smoke developed index of 450 or less are required when tested in accordance with ASTM E 84. (IBC Sec. 2604.3)
- 9.2.2** Thermal Barrier requirements apply UNLESS one of the following conditions is met (Note - exception for garage doors using foam plastic insulation complying with 9.2.1 above in detached and attached garages associated with one- and two-family dwellings): (IBC Sec. 2604.4.1.9)
- 9.2.2.1** Facing materials are among those listed and having a minimum thickness of:
- 0.032 in. (0.8 mm) aluminum
 - 0.010 in. (0.25 mm) steel
 - 0.125 in. (3.2 mm) wood
- 9.2.2.2** If a door has a facing other than those listed above, the complete garage door assembly is tested according to and passes requirements of ANSI/DASMA 107.
- 9.2.3** Fire Resistance Rating, where required: The fire resistance requirements for doors are related to the rating for the wall in which they are located. In general (IBC 2603.5.1), the fire ratings for exterior walls or garage doors range from 3/4 to 1-1/2 hours as determined by ASTM E119, UL 263 or NFPA 252. NFPA 252 states that a hose stream test is part of the test requirement. Sectional garage doors are not intended for installation in a fire rated wall.

9.3 Building Code Fire Performance Requirements—Residential

- 9.3.1** Flame Spread and Smoke Developed Ratings and Thermal Barrier: The 2012 International Residential Code (IRC Section R316.5.6) exempts foam-filled doors from flame spread/smoke developed limits and the use of a thermal barrier.
- 9.3.2** Fire Resistance Rating, where required: As in commercial structures, any need or limit for a fire resistance rating depends on the required rating of the wall in which the door is placed. One and two family dwellings must only meet a 20-minute rating and for this rating only, the hose stream test is optional.

Chapter 10: Entry Doors

10.1 Products Frequently used in Entry Doors

For use in entry doors, polyurethane foam may be supplied in sheets or blocks and attached as a nonstructural material, or it may be bonded to facings to form insulated, structural “sandwich” panels. Foam may also be “foamed-in-place” and used as an adhesive between the facings to create an insulated, structural panel.

10.2 Building Code Fire Performance Requirements—Commercial/Industrial

10.2.1 For the core foam insulation, flame spread index of 75 or less and a smoke developed index of 450 or less are required when tested in accordance with ASTM E84. (IBC 2603.3)

10.2.2 Thermal Barrier requirements apply UNLESS the door is not required to be fire rated and the foam is covered by one of the following facings: 0.032 in. (0.8 mm) aluminum or 0.016 in. (0.4 mm) steel. (IBC Sec. 2603.4.1.7)

10.2.3 Fire Resistance Rating, where required: The fire resistance requirements for doors are related to the rating for the wall in which they are located. In general, the fire rating results are determined by NFPA 252, UL 10B or UL 10C. (IBC Sec. 2603.5.1)

10.3 Building Code Fire Performance Requirements—Residential

10.3.1 Flame Spread, Smoke Developed Ratings and Thermal Barrier: The 2012 International Residential Code (IRC Section R316.5.5) exempts foam-filled doors from flame spread/smoke developed limits and the use of a thermal barrier.

10.3.2 Fire Resistance Rating, where required: As in commercial structures, (IBC Sec. 2603.5.1) any need or limit for a fire resistance rating depends on the required rating of the wall in which the door is placed. For doors that do not require a fire resistance rating, the doors may have wood or any other approved facing.

Chapter 11: Walk-In Coolers and Cooler and Freezer Walls

Building Codes typically address the use of foam plastic insulation for both walk-in coolers and cooler/freezer walls in the thermal barrier section of the foam plastic chapter.

11.1 Products Frequently used in Walk-In Coolers and Cooler and Freezer Walls

11.1.1 PIR laminate boards for wall sheathing: PIR laminates, usually foil faced, are attached to the exterior of the wood or steel structural frame, and then covered with an approved exterior finish.

PIR laminate boards may also be placed on the interior of the wall covered by a thermal barrier. Building codes allow elimination of the thermal barrier if the foam insulation meets certain requirements (see Sections 11.2 and 11.3). Also, a thermal barrier is not required where foamed plastic is covered on each face by a minimum of 1 inch (25 mm) of masonry or concrete. (IBC Sec. 2603.4.1.1)

11.1.2 Spray Polyurethane Foam (SPF): Applied either to an interior surface to be covered with a thermal barrier or to the exterior surface and covered with approved protection as in Section 11.1.1.

11.1.3 PIR and PUR foam core panels: Metal faced panels attached to a structural framework. Approved panels form both the interior and exterior surface.

11.2 Building Code Fire Performance Requirements—Walk-In Coolers and Freezers (maximum 400 square feet)

11.2.1 Flame spread index of 75 or less and a smoke developed index of 450 or less are required when tested in accordance with ASTM E84 or UL 723. (IBC Sec. 2603.3)

11.2.2 The thermal barrier requirement is waived for (IBC Sec. 2603.4.1.3):

11.2.2.1 Foam up to four inches thick: No thermal barrier required IF foam is covered by one of the designated materials:

- a. 0.032 in. (0.81 mm) aluminum
- b. 0.016 in. (0.41 mm) corrosion resistant steel.

- 11.2.2.2** However, when the foam is over four inches thick and up to the maximum allowed of ten inches a thermal barrier is required.

11.3 Building Code Fire Performance Requirements—Cooler and Freezer Walls

Foam plastic up to a maximum thickness of ten inches (254 mm) installed in Cooler and Freezer walls has a number of specific requirements. Thermal barrier provisions are waived if the following are true (IBC 2603.4.1.2):

- 11.3.1** For the core foam insulation, flame spread index of 25 or less and smoke developed index of 450 or less when tested in accordance with ASTM E84, when tested in a minimum thickness of 4 inches.
- 11.3.2** The foam has a flash and self-ignition temperatures of not less than 600°F (316°C) and 800°F (427°C), respectively.
- 11.3.3** The foam is covered by not less than 0.032 in. (0.8 mm) aluminum or 0.016 in. (0.4 mm) corrosion-resistant steel.
- 11.3.4** The cooler/freezer is protected by an automatic sprinkler system and, if the cooler/freezer is within a building, both the cooler/freezer and that part of the building in which the cooler/freezer is located must be sprinklered.

Chapter 12: Exterior Ornamental and Parapet Applications

The EIFS Industry Manufacturers Association (EIMA), in conjunction with ICC-ES, have developed an Acceptance Criteria (AC) for the use of foam plastic in exterior ornamental applications under the process established by ICC-ES. AC161 addresses “Foam Plastic Shapes for Parapet Applications” and covers fire and environmental testing for the shapes including coatings. While the AC describes the use of EPS and XEPS (foamed polystyrenes), ICC-ES states that the AC can also be used for other foamed plastics, such as polyurethane.

Chapter 13: Agricultural and Miscellaneous Buildings or Structures

The IBC does cover agricultural buildings, although insurance companies and underwriters may also regulate usage. Considerable amounts of PIR and PUR foam insulations may be used in agricultural applications, in particular where issues of animal comfort and product storage arise.

In the 2012 IBC Section 312.1, agricultural buildings and several other non-conventional building types are listed under Group U occupancies, which means covered by the code. The provisions of Chapter 26 on Plastic should be considered for agricultural buildings.

Other examples of Group U occupancies included in IBC Sec. 312.1 include:

- Aircraft hangers
- Barns
- Carports
- Grain silos
- Greenhouses
- Livestock shelters
- Private garages
- Sheds
- Stables
- Tanks
- Towers

Appendix 1: Acronyms, Abbreviations and Websites

AC	Acceptance Criteria used by ICC-ES to evaluate products or systems
ACC	American Chemistry Council (americanchemistry.com)
ANSI	American National Standards Institute (www.ansi.org)
ASTM	ASTM International (www.astm.org)
BOCA	Building Officials Council Administrators International (now superseded by ICC)
CABO	Council of American Building Officials (now superseded by ICC)
CPI	Center for the Polyurethanes Industry (www.polyurethane.org)
DASMA	Door & Access Systems Manufacturers Association (www.dasma.com)
EIMA	EIFS Industry Members Association (www.eima.com)
ER	Evaluation Report, typically issued by ES organizations
ES	Evaluation Services associated with building code bodies that assess product/system conformance to a building code
FM	Factory Mutual Global (www.fmglobal.com)
IBC	International Building Code
ICBO	International Conference of Building Officials (now superseded by ICC)
ICC	international Code Council (www.iccsafe.org)
IRC	International Residential Code
ISO	International Organization for Standardization (www.iso.org)
IWUIC	International Wildland-Urban Interface Code
NBC	National Building Code
NER	National Evaluation Report
NES	National Evaluation Service
NFPA	National Fire Protection Association (www.nfpa.org)
NFPA 5000	Building Code issued by NFPA
PIMA	Polyisocyanurate Insulation Manufacturers Association (www.pima.org)
PUR	(Rigid) polyurethane foam products
SBC	Standard Building Code
SBCCI	Southern Building Code Congress International (now superseded by ICC)
SPF	Spray polyurethane foam
SPFA	Spray Polyurethane Foam Alliance (www.sprayfoam.org)
UBC	Uniform Building Code
UL	Underwriters Laboratories (www.ul.com)

Appendix 2: Building Code Acceptance Criteria

As described on the ICC Evaluation Services website (www.icc-es.org/Criteria/index.cfm), “[a]cceptance criteria are documents developed by ICC ES as the basis for evaluating a type of product, and establishing conditions of acceptance, when the product is not clearly regulated by existing codes and code-related documents.” Please go to the ICC-ES website for the most updated information at www.icc-es.org:

- AC 04: Sandwich Panels
- AC 12: Foam Plastic Insulation
- AC 24: Interim Criteria for Exterior Insulation and Finish Systems
- AC 71: Foam Plastic Sheathing Panels used as Water-Resistive Barriers
- AC 84: Testing of Fire Doors and Windows under Positive Pressure
- AC 97: Insulated Garage Doors with Foam Plastic Cores
- AC 142: Foam Plastic Insulation Applied Directly to Steel Decks
- AC 161: Foam Plastic Shapes for Parapet Applications
- AC 181: Rigid Cellular Polyurethane Panels Used as Exterior and Interior Wall Cladding
- AC 214: Sandwich Panels with Metal Skin and a Foamed-in-Place Foam-Plastic Insulated Core
- AC 219: Exterior Insulation and Finish Systems
- AC 309: Foam-in-Place Polyurethane Foam Plastic Core Doors with Fiberglass Facers
- AC 377: Spray-Applied Foam Plastic Insulation
- AC 397: Exterior Continuous Thermal Insulation Systems (ECTIS)

Appendix 3: Alphabetical Listing and Description of Test Methods Referenced in U.S. Building Codes

ANSI/DASMA 107, Room Fire Test Standard for Garage Doors Using Foam Plastic

Insulation: This standard is a test method designed to evaluate the contribution of garage doors using foam plastic insulation to the creation of fire hazard under specified fire exposure conditions. The method is conducted in a standard room configuration. This standard is to be used to evaluate the flammability characteristics of garage door assemblies using foam plastic insulation when the foam plastic is not separated from occupied spaces by a facing of minimum 0.010 in. (0.3 mm) steel or 1/8 in. (3.2 mm) wood.

ASTM D1929, Determining Ignition Temperature of Plastics: This test method determines the flash ignition and spontaneous ignition temperature of plastics using a hot-air furnace.

ASTM D2843, Density of Smoke from the Burning or Decomposition of Plastics: This test method describes a procedure for measuring and observing the relative amounts of smoke obscuration produced by the burning or decomposition of plastics. It is intended to be used for measuring the smoke-producing characteristics of plastics under controlled conditions of combustion or decomposition.

ASTM E84 [UL 723 or NFPA 255], Surface Burning Characteristics of Building Materials:

Often referred to as the “Steiner Tunnel Test,” E84 is a standard method to assess the spread of fire on the surface of a material. A sample about 20 inches wide and 25 feet long is installed on the ceiling of a horizontal test chamber. The material is exposed to a 4-foot long gas flame at one end of the tunnel for a period of 10 minutes. Threat of flame front progression on the material is compared to a standard (inorganic reinforced cement board) and calculations are made to produce a flame spread rating (a unit-less number). Smoke from the fire in the tunnel is measured in the exhaust stack by using a light beam to evaluate smoke developed ratings.

Since E84 is a standard laboratory fire test on a single material, numerical ratings derived from E84 are not intended to reflect hazards presented by the test material under actual fire conditions.

ASTM E108 [NFPA 256, UL790], Fire Tests of Roof Coverings: Combustibility is determined on all components of the roof assembly as a composite. The test includes three parts:

- Spread of flame

- Intermittent flame
- Burning brand

The spread of flame is the only test conducted on roof assemblies with concrete, steel or gypsum decks (non-combustible), while all three tests are performed on assemblies incorporating combustible (wood, plank, plywood, or plastic foam) roof decks. The slope of the roof and maximum insulation thickness are both factors that affect the fire performance of the roof assembly.

ASTM E119 [NFPA 251, UL 263], Fire Tests of Building Construction and Materials: This test is used to determine the fire resistance of a complete assembly. For example, a wall system fire rating is measured by constructing a 10 foot by 10 foot section of a total wall system: framing, cavity insulation, sheathing, siding, gypsum wall board, etc. The wall section is installed vertically on a gas furnace, and the wall is exposed to a standard temperature curve for the time period for which a rating is desired, i.e., one, two, three, or four hours. Failure points during time of fire exposure are:

- Flame penetration through the wall section
- An unacceptable temperature increase on the unexposed side of the assembly
- Structural failure or collapse of the assembly
- Failure of a hose stream test

Therefore, ASTM E119 states: a one hour fire resistance rating means that a structure incorporating the tested wall construction will not collapse, nor transmit flame or a high temperature, while supporting a design load, for at least one hour after a fully developed building fire.

Roof/Ceiling and Floor/Ceiling constructions can also be tested horizontally in accordance with ASTM E119. The building code authorities usually designate the duration of fire resistance needed in a building as specified in various Acceptance Criteria. Factors affecting the duration resistance include type of construction, occupancy designations, location of the building and insurance criteria.

ASTM E662 [NFPA 258], Specific Optical Density of Smoke Generated by Solid Materials:

This fire-test-response standard covers determination of the specific optical density of smoke generated by solid materials and assemblies mounted in the vertical position in thicknesses up to and including 1 in (25.4 mm). Measurement is made of the attenuation of a light beam by smoke (suspended solid or liquid particles) accumulating within a closed chamber due to non-flaming pyrolytic decomposition and flaming combustion. Results are expressed in terms of specific optical density, which is derived from a geometrical factor

and the measured optical density, a measurement characteristic of the concentration of smoke.

ASTM E970, Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source: This standard describes a procedure for measuring the critical radiant flux of exposed attic floor insulation subjected to a flaming ignition source in a graded radiant heat energy environment in a test chamber. The specimen is any attic floor insulation. This test method is not applicable to those insulations that melt or shrink away when exposed to the radiant heat energy environment or the pilot burner.

This standard measures the critical radiant flux at the point at which the flame advances the farthest. It provides a basis for estimating one aspect of fire exposure behavior for exposed attic floor insulation. The imposed radiant flux simulates the thermal radiation levels likely to impinge on the floors of attics whose upper surfaces are heated by the sun through the roof or by flames from an incidental fire in the attic.

ASTM E2074, Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies [This standard was withdrawn in April 2007 in favor of NFPA 252 or UL 10B or C.]

FM 4450/4470, Approval Standard for Class I Insulated Steel Roof Decks: This series of tests evaluates systems or materials for their ability to resist fire, wind, hail, durability and corrosion of metal parts. Roofing assemblies that successfully pass all tests in Standard 4450 are given an FM Class 1 rating. Other assemblies are rated Class 2.

FM classifies roof decks into two categories:

- Noncombustible Rated
- Class 1 Rated

Noncombustible Rated decks are cementitious decks such as structural concrete, fiber reinforced cement, gypsum and certain lightweight insulating concretes. Class 1 Rated Decks may be steel, fire-retardant-treated wood, cementitious wood fiber; fiber reinforced plastic and certain lightweight insulating concretes. FM fire performance tests are the FM Calorimeter (FM Standard 4450/4470), used to assess the fuel contribution rate of a roof assembly and the Exterior combustibility test, conducted in accordance with ASTM E108. Insulation products are evaluated in roof assemblies for fire performance using the FM Calorimeter, which in turn qualifies them to be included in assemblies meeting FM 4450/4470 standards.

FM 4880 [UL 1040], Building Corner Fire Test Procedure 25' High Full Scale Corner Test: Not all roof deck systems are easily configured to be evaluated using FM 4450. About 10

years after use of the FM 4450 Calorimeter Test was started, Factory Mutual developed the FM 4880 25 feet High Full Scale Corner Test. This full scale test is used to evaluate the flame spread potential of insulated roofs, roof panel systems, insulated walls and wall panel systems alone or in combination. This test is accepted by various code bodies and insurance rating organizations and FM 4480 states that it can be used to gain FM approval ratings in lieu of FM 4450 tests.

NFPA 252, Fire Tests of Door Assemblies: This standard measures the amount of heat that can be potentially released by building materials when exposed to a heat source of 750°C in an oxygen bomb calorimeter.

NFPA 259, Standard Test Method for Potential Heat of Building Materials: This test method provides a means of determining, the potential heat of building materials subjected to a defined high-temperature exposure condition. Determinations can be made on individual homogeneous or individual composite, non-homogeneous, or layered materials from which a representative sample can be taken.

NFPA 268, Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source: This standard evaluates the propensity of ignition of an exterior wall assembly and addresses the problem of fire spread from one building to an adjacent building due to radiant ignition.

NFPA 275, Standard Test Method of Fire Tests for the Evaluation of Thermal Barriers Used Over Foamed Plastic Insulation: This method of fire tests for a thermal barrier for foam plastic insulation is applicable to building construction materials, products, or assemblies intended to be used to protect foam plastic insulation from direct fire exposure. The performance of the thermal barrier is evaluated by its ability to limit the temperature rise on its unexposed surface and by the ability of the thermal barrier to remain intact in order to provide protection from ignition of the foam plastic insulation during a standard fire exposure.

NFPA 285, Evaluation of Flammability Characteristics of Exterior Non-Load bearing Wall Assemblies Containing Combustible Components Using the Intermediate Scale, Multi-Story Test Apparatus: This test provides a method of determining the flammability characteristics of exterior, non-load-bearing wall assemblies/panels used as components of curtain wall assemblies. The test method described is intended to evaluate the inclusion of combustible components within wall assembled/panels of buildings that are required to be of non-combustible construction. It is intended to simulate the tested wall assemblies' fire performance. The test apparatus consists of a two story structure with one access opening in the bottom level.

NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth: This standard describes a method for determining the contribution of interior finish materials to room fire growth during specified fire exposure conditions. This method is used to evaluate the flammability characteristics of wall and ceiling interior finish, other than textile wall coverings, where such materials constitute the exposed interior surfaces of buildings. This standard specifies three types of specimen mounting, depending on the application of the interior finish material, as follows: (1) Three walls (for interior finish to be used on walls only) (2) Three walls and the ceiling (for interior finish to be used on walls and ceilings) (3) The ceiling alone (for interior finish to be used on ceilings only).

UL 10B, Fire Tests of Door Assemblies: These methods are intended to evaluate the ability of a door assembly to remain in an opening during a predetermined test exposure. The tests expose a specimen to a standard fire exposure controlled to achieve specified temperatures throughout a specified time period, followed by the application of a standard fire hose stream.

UL 10C, Positive Pressure Fire Tests of Door Assemblies: These methods are intended to evaluate the ability of a door assembly to remain in an opening during a predetermined test exposure. This standard is similar to UL 10B except there is a slight positive pressure inside the test chamber in this case. A hose stream test is also applied at the end of the test.

UL 1256, Fire Test of Roof Deck Constructions: With UL 1256, the entire roof assembly including deck, adhesives, vapor retarder, insulation and roof membranes tested in a 25-foot long tunnel for 30 minutes. The test uses an open flame at one end with prescribed airflow in the tunnel. Ratings derived from the test are reported in the UL Roofing Materials and Systems Directory under the Roof Deck Constructions category (TGKX).

Appendix 4: Test Methods Listed in U.S. Building Codes by Fire Performance Criteria and Application

Ignition behavior

- ASTM D 1929, Determining Ignition Temperature of Plastics
- NFPA 268, Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source
- NFPA 259, Potential Heat of Building Materials

Flame spread and smoke development

- ASTM D 2843, Density of Smoke from the Burning or Decomposition of Plastics
- ASTM E 84, [NFPA 255, UL 723] Surface Burning Characteristics of Building Materials
- ASTM E 662 [NFPA 258] Specific Optical Density of Smoke Generated by Solid Materials

Insulation

- ASTM E 84, [NFPA 255, UL 723] Surface Burning Characteristics of Building Materials
- ASTM E 970, Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source

Walls

- ASTM E 84, [NFPA 255, UL 723] Surface Burning Characteristics of Building Materials
- ASTM E 119, [NFPA 251, UL 263] Fire Tests of Building Construction and Materials
- FM-4880, [UL 1040] Building Corner Fire Test Procedure
- NFPA 268, Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source
- NFPA 275, Standard Method of Fire Tests for the Evaluation of Thermal Barriers Used Over Foam Plastic Insulation
- NFPA 285, Evaluation of Flammability Characteristics of Exterior Non-Load bearing Wall Assemblies Containing Combustible Components Using the Intermediate Scale, Multi-Story Test Apparatus
- NFPA 286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

Roofs

- ASTM E 108, [NFPA 256, UL790] Fire Tests of Roof Coverings
- FM-4450, [UL 1258] Approval Standard for Class I Insulated Steel Roof Decks
- FM-4880, [UL 1040] Building Corner Fire Test Procedure
- UL 1256, Fire Test of Roof Deck Constructions

Doors

- ANSI/DASMA 107, Room Fire Test Standard for Garage Doors Using Foam Plastic Insulation
- NFPA 252, [UL 10B or UL 10C] Fire Tests of Door Assemblies. [ASTM E 2074-00, Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies, was withdrawn as a standard in April 2007.]

Appendix 5: Status of International Codes Adoption by State

International Codes-Adoption by State (Updated 12-01-2011)																	
<p style="text-align: center;">ICC makes every effort to provide current, accurate code adoption information. Not all jurisdictions notify ICC of code adoptions. To obtain more detailed information on amendments and changes to adopted codes, please contact the jurisdiction. To submit code adoption information: www.iccsafe.org/adoptions</p>																	
X=Effective Statewide 12=2012 Edition			A=Adopted, but may not yet be effective 09=2009 Edition			L=Adopted by Local Governments 06=2006 Edition			S=Statewide adoptions with limitations 03=2003 Edition			S=Statewide adoptions with limitations 00=2000 Edition					
*The title of the 2000 and 2003 IUWIC Code was changed to IWUIC in the 2006 version.																	
State	Jurisdiction	IBC	IRC	IFC	IMC	IPC	IPSDC	IFGC	IgCC	IECC	IPMC	IEBC	ICCPC	IUWIC	IZC	ICC700	Chart Comments
AL	Alabama	S09, L	L	S09, L	S09, L	S09, L	L	S09, L		L	L	L	L		L		IBC, IRC, IFC, IMC, IPC, IFGC-AL Building Commission: state-owned, schools, hotels, movie theaters. AL has also adopted the 2008 ICC 500 for storm shelters
AK	Alaska	X06	L06	X06	X06			X06		L06							
AZ	Arizona	S06, L	L	S06, L	S06, L	S06, L	S06, L	S06, L		S06, L	S06, L	L	L	L	L	L	AZ Dept of Health Services, minimum code for licensed health care facilities statewide
AR	Arkansas	X06	X06	X06	X09	X06	L	X06		X03	L	L					AR currently uses the 2007 AR Fire Prevention Code based on the 2006 IFC, IBC and IRC. The 2006 AR Plumbing Code based on the 2006 IPC and the 2006 AR Fuel Gas Code based on the 2006 IFGC.
CA	California	X09	X09	X09								X09					CA has adopted the 2009 IBC, IFC, IRC, and Appendix A of IEBC as appendix.
CO	Colorado	S09, L	S06, L	S06, L	S09, L	S09, L	L	S09, L		S09, L	L	L	L	L	L	L	State Architect-All State Buildings & Facilities: 2009 IBC, IMC, IPC, IFGC, IECC. Division of Fire Safety-All Public Schools & Junior Colleges: 2006 IBC, IRC, IFC, IMC, IEBC, IECC. Colorado Examining Board of Plumbers 2009 IPC, IFGC and plumbing chapters of the 2009 IRC equals Colorado State Minimum Plumbing Code
CT	Connecticut	X03	X03	X03	X03	X03				X06	L	X03					IFC: Portions used in the CT State Fire Code
DE	Delaware	L	L	L	L	X09		L		X09	L	L					
DC	District of Columbia	X06	X06	X06	X06	X06		X06		X06	X06	X06					

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State	Jurisdiction	IBC	IRC	IFC	IMC	IPC	IPSDC	IFGC	IgCC	IECC	IPMC	IEBC	ICCPC	IUWIC	IZC	ICC700	Chart Comments
FL	Florida	X06	X06		X06	X06		X06	X	X06	L06	X06					The 2007 Florida Codes with 2009 supplements are based on the 2006 I-Codes. The 2009 based documents take effect March15, 2012. The IgCC is voluntary for cities and counties and is an option of state owned, leased, operated and financed buildings.
GA	Georgia	X06	X06	X06	X06	X06		X06		X06	L	L					
HI	Hawaii	X06	L03, L06							X06							
ID	Idaho	X09	X09	X09	X09	L06		X09		X09		X09					
IL	Illinois	S09, L	L	S09, L	S09, L	L	L	S09, L		X09	S09, L	S09, L	L	L	L		Supplement for commercial structures statewide. IBC, IFC, IMC, IFGC, IPMC, IECC, IEBC for IL Board of Education Facilities (other than vehicular), but do not apply to Chicago. IBC adopted by Dept. of Health for hospitals where local codes do not apply. The Illinois Energy Conservation Code is based on the 2009 IECC.
IN	Indiana	X06	X03	X06	X06			X06									The 2006 Indiana Building and Fuel Gas Codes and the 2006 Indiana Mechanical and Fire Prevention Codes w/2008 amendments are based on the 2006 IBC, IFGC, IMC and IFC. The 2003 Indiana Residential Code is based on the 2003 IRC.
IA	Iowa	S09, L	S09, L	X09	S09, L	L	L	L		X09	L	S09, L			L		IBC, IRC, IMC, IEBC, IECC: State owned and rented structures. The Iowa Code with amendments is based on the 2009 IBC, IRC, IMC, IECC, and IEBC. The State Fire Code with amendments is based on the 2009 IFC and IBC Chapters 2-7.
KS	Kansas	S03, L	L03	S03, L	L03	L03	L	L03		S06, L	L	L					Applies to state owned facilities
KY	Kentucky	X06	X06	X06	X06			X06		X06	L						Kentucky, with amendments, has adopted the 2006 editions of IBC and IRC statewide. In the KBC (Kentucky Building Code) the state has adopted by reference the 2006 editions of the IMC and IECC. The 2006 IFC is utilized for new construction projects. While the Kentucky codes are applicable statewide, enforcement is only mandatory statewide for commercial buildings. IECC: bldgs. Other than 1&2 family regulated by the KRC.
LA	Louisiana	X09	X09	L	X09			X09		X06,L	L	X09					LA currently uses the 2000 LA State Plumbing Code based on the 1994 Standard Plumbing Code. They also use the LA One-and Two-Family Supplement to the 2006 IMC which is based on the 2006 IRC Mechanical section.
ME	Maine	X09	X09	L	L	L	L	L		X09	L	X09			L		
MD	Maryland	X12	X12		X12	X12, L	L	L	X	X12	X12	X12					IPC: Industrialized housing. Other codes: edition shown may not be in use locally; check with local jurisdiction. The MD Building Performance Standards are based on the 2009 I-Codes. Effective May 2011, Maryland became the first state to legislatively adopt the IGCC.
MA	Massachusetts	X09	X09		X09					X09		X09					MA state code is based on the 2009 IBC, IEBC, IFC and IECC.
MI	Michigan	X09	X09	L	X09	X09	L	X06		X09	L	X09	L				The 2009 Michigan Building / Residential, Rehabilitation and Energy Code Rules were filed with the Secretary of State on November8, 2010, and become effective March9, 2011 Enforcement of the Michigan codes is mandatory statewide for all buildings including 1 and 2 family dwellings.

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State	Jurisdiction	IBC	IRC	IFC	IMC	IPC	IPSDC	IFGC	IgCC	IECC	IPMC	IEBC	ICCPC	IUWIC	IZC	ICC700	Chart Comments
MN	Minnesota	X06	X06	X06	X00			X06			L						MN has a statewide building code. The state building codes division is preparing to adopt the 2012 editions of the I-Codes, and the process should be complete by late 2011.
MS	Mississippi	L06	L06	L06	L06	L06	L	L06		L	L	L	L				The state of Mississippi does not have a statewide building code. Building code adoption and enforcement is primarily the responsibility of local jurisdictions. Mississippi does require that state buildings meet the requirements set forth in the 1997 Standard Building Code, mandatory for all jurisdictions. In 2006, Bill 1 406 created the Mississippi Building Code Council, and requires five coastal counties, Jackson, Harrison, Hancock, Stone and Pearl River to enforce, on an emergency basis, all of the wind and flood mitigation requirements prescribed by the 2003 International Building Code and the 2003 International Residential Code.
MO	Missouri	S00, L	S00, L	L	S00, L	S00, L, S03	L	S00		S06	L	L	L	L	L		State Office Space -03 IPC; Modular Construction-00 IBC, IRC, IMC, IPC, IFGC
MT	Montana	X09	X06	L	X09			X09		X09		X09					
NE	Nebraska	S09, L	S09, L	L	L	L	L	L		S09, L	L	L		L	L		
NV	Nevada	S06, L	S06, L	S03, L	L	L	L	L		S06, L	L	S06, L	L				IBC, IFC: SFM, schools, healthcare, state bldgs commercial bldgs for counties over100k. IBC, IRC, IFC, IECC, IEBC NV Public Works Board, state buildings
NH	New Hampshire	X09	X09	L	X09	X09		L		X09	L						
NJ	New Jersey	X09	X09	X06	X09			X09		X09	L						
NM	New Mexico	S09, L	S09, L	S03, L	S09, L	S09, L		S09, L		X09		S09, L					09 IBC, IRC, IECC & IEBC adopted statewide by NM Const Ind Div.'03 IFC adopted statewide by the State Fire Marshal's Office. NM uses the 2009 NM Codes which are based on the 2009 I-codes and amendments. New Mexico Construction Industries has adopted the 2009 codes effective January1, 2011 (mandatory July1,2011).They can be accessed at http://www.rld.state.nm.us/cid/rules-and-law.htm
NY	New York	X06	X06	X06	X06	X06		X06		X09	X06	X06					The updated 2010 Uniform Fire Prevention and Building Code (Uniform Code) and the Energy Conservation Construction Code of New York State (ECCCNYS) became effective statewide. Originally approved in April 2010 by the State Fire Prevention and Building Code Council, a notice of adoption was published in the September 29 edition of the State Register. The updated Uniform Code is based on the 2006 International family of codes, and the 2010 ECCCNYS will be based on the 2009 IECC and ASHRAE 90.1-2007.
NC	North Carolina	X09	X09	X09	X09	X09		X09	X	X09							All codes contain NC specific amendments. The 2009 NC codes are based on the 2006 I-codes. The NC Building Code Council has adopted a Rain water Appendix to the NC Plumbing Code. The Appendix is based on the IgCC PV1 provisions and is available for immediate use as an owner selected optional requirement

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State	Jurisdiction	IBC	IRC	IFC	IMC	IPC	IPSDC	IFGC	IgCC	IECC	IPMC	IEBC	ICCPC	IUWIC	IZC	ICC700	Chart Comments
ND	North Dakota	S09, L	S09, L	L	S09, L	L		S09, L		S09, L	L	L					The North Dakota Legislative Assembly has mandated that the State Building Code consist of the IBC, IRC, IMC, and IFGC. Energy conservation standards must be included in the State Building Code.
OH	Ohio	X09	X03	X06	X09	X09		X06		X09	L				L		For commercial buildings the state of Ohio has, with amendments, adopted statewide the 2006 editions of the IBC, IMC, IPC, and IFGC and by reference the ICC/ANSI A117.1-2004 and the 2006 edition of the IFGC. The 2006 IECC for commercial buildings has been adopted with a prescriptive package. The 2003 IRC with amendments (including Chapter 11 of the 2006 IRC) has been adopted statewide for 1, 2, and 3 family dwellings. Enforcement of the Ohio Building Codes is mandatory statewide for all buildings except 1, 2 and 3 family dwellings. The Residential Code of Ohio (RCO) is required for jurisdictions that enforce a building code for 1, 2 and/or 3 family dwellings.
OK	Oklahoma	S06, L	S09, L	S06, L	S09, L	S09, L	L	S09, L		S03, L	S09, L	S09, L	S09, L	L	L		IRC-Mechanical, Plumbing and Fuel Gas provisions only
OR	Oregon	X09	X09	X09	X09			X09	L	X09							Oregon adoptions are based on the 2009 I-codes and the state codes can be seen at the Oregon BCD website.
PA	Pennsylvania	X09	X09	X09	X09	X09		X09		X09	L	X09	X09	X09			
RI	Rhode Island	X09	X09		X09	X09		X09	L	X09	X09						
SC	South Carolina	X06	X06	X06	X06	X06		X06		X06	L06	L06	L06				SC currently uses the 2006 I-codes and amendments which can be found on the SC BCC website.
SD	South Dakota	S09, L	L	S09, L	S09, L		L	L		L	L	L	L	L			IBC, IFC: Approved for local adoption; IMC for state school construction
TN	Tennessee	S06, L	X09	S06, L	L	L		L		X06	L	L	L		L		IRC sprinkler requirements not adopted
TX	Texas	X06	X00	L06	L06	L06	L	L06		X06	L	L06	L	L	L		Jurisdictions authorized by state law to adopt later editions of IBC, IRC, IPC, IMC, IFGC, and IECC. See Jurisdiction Chart for specific edition adopted.
UT	Utah	X09	X09	X09	X09	X09		X09		X09				L06			UT code information can be accessed at http://www.dopl.utah.gov/programs/ubc/ . The UT Wildland Urban Interface (UWUIC) was promulgated by the ICC with alternatives and amendments and is adopted by the local jurisdiction.
VT	Vermont	X06	L03			X09				X04							The 2006 Vermont Fire & Building Safety Code is based on the 2006 IBC.
VA	Virginia	X09	X09	X09	X09	X09		X09		X09	X09	X09					The VA Uniform Building Code is based on the 2009 I-codes. The codes will become effective March 1, 2011. There will be 1 year phase in period during which builders and designers can use the 2006 model codes.
WA	Washington	X09	X09	X09	X09			X09			L	L	L	L09			

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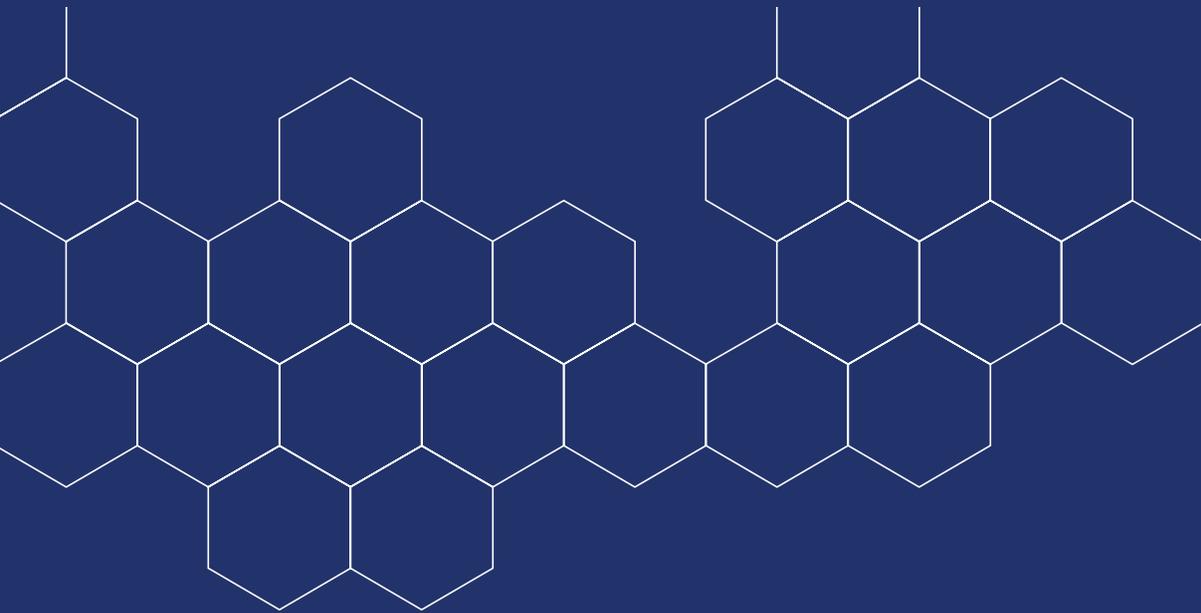
State	Jurisdiction	IBC	IRC	IFC	IMC	IPC	IPSDC	IFGC	IgCC	IECC	IPMC	IEBC	ICCPC	IUWIC	IZC	ICC700	Chart Comments
WV	West Virginia	X09	X09	L	X09	X09		X09		X03	X09	X09					West Virginia, through the WV Fire Commission, has the regulatory authority to adopt the state's building and fire codes. The Commission has adopted state wide the 2009 editions of IBC, IRC, IMC, IFGC, IPC, IPMC and IEBC for any jurisdiction that chooses to enforce building codes as well as the '03 IECC. The State Fire Commission passed a resolution in April of 2008 to encourage all counties and municipalities to utilize the 2006 I-Codes. The IPMC also has been adopted statewide but enforcement is optional. As the Fire Code, the Fire Commission has adopted the entire collection of the NFPA codes and standards excepting NFPA 5000 and NFPA 900 and NFPA 101A. The WV Fire code applies to both new and existing construction and whenever there is a conflict between the State Building Code (Title 87 Series 5b) and the State Fire Code (Title 87 Series 1), the fire code takes precedence.
WI	Wisconsin	X09		L	X09			X09		X09		X09					The WI Commercial Building Code includes the 2006 IBC, IEBC, IFGC, IECC, and IMC.
WY	Wyoming	X06	X06	X06	X06	L	L	X06		L	X06	X06	L				WY uses the 2006 IRC, IPMC and IEBC to the extent that those codes are referenced in the IBC, IFC, IMC and IFGC and contain fire and life-safety provisions.

TY	U.S. Territories	IBC	IRC	IFC	IMC	IPC	IPSDC	IFGC	IgCC	IECC	IPMC	IEBC	ICCPC	IUWIC	IZC	ICC700	Chart Comments
GU	Guam	X09	X09	X09	X09	X09	X09	X09				X09					
NMI	Northern Marianas Islands	X09															
PR	Puerto Rico	X09	X09	X09	X09	X09	X09	X09		X09		X09					
VI	U.S. Virgin Islands	X03	X03		X03					X03							

Source: <http://www.iccsafe.org/gr/Documents/stateadoptions.pdf> (reprinted with permission from the International Code Council)

Various ICC codes that can be adopted by individual states or localities:

- IBC - International Building Code
- IRC - International Residential Code for One- and Two-Family Dwellings
- IFC - International Fire Code
- IMC - International Mechanical Code
- IPC/IPSDC - International Plumbing Code (Includes the 2012 IPSDC)
- IFGC - International Fuel Gas Code
- IGCC – International Green Construction Code
- IECC - International Energy Conservation Code
- IPMC – International Property Maintenance Code
- IEBC - International Existing Building Code
- ICCPC –International Performance Code for Buildings and Facilities
- IWUIC - International Wildland-Urban Interface Code
- IZC - International Zoning Code
- ICC 700 – National Green Building Standard



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