

NFPA 285: Flame Propagation in Exterior Walls

2012 International Building Code

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Late morning on a winter day, a contracting crew was up on the roof of a building performing welding and cutting on a steel fabrication that was to become a catwalk for a window washing system. The hot work, unfortunately, ignited adjacent polyurethane-coated foam plastic trim and the fire spread laterally and vertically down the exterior face of the building. The outcome of the January 25, 2008, fire at the Monte Carlo Resort and Casino in Las Vegas, Nevada, was a \$100 million price tag for damage and lost business. Fortunately there were no deaths, but 17 people were sent to hospitals for injuries.

The Monte Carlo fire illustrates the growing problem with incorporating combustible foam plastics within exterior wall assemblies. Large continuous planes of combustible material allow a fire to spread quickly horizontally and vertically to other areas of a building. Due to this fire propagation potential, the *International Building Code (IBC)* requires wall assemblies that integrate combustible plastics and most recently combustible water-resistive barriers be tested in accordance with the National Fire Protection Association's (NFPA) standard 285, *Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components*.

NFPA 285 and the IBC

Even though the standard's scope applies to nonload-bearing walls as its title implies, the IBC's requirements for testing does not differentiate between load-bearing and nonload-bearing walls—all wall assemblies with combustible materials (with some exceptions) are required to be tested. The 2012 IBC includes six provisions where NFPA 285¹ testing is specifically required:

- *Section 1403.5:* For combustible water-resistive barriers in buildings over 40 feet in height of Type I, II, III, or IV construction. This is a new requirement in the 2012 IBC.
- *Section 1407.10.4:* For metal composite materials (MCM) used on buildings of Type I, II, III, and IV construction. Section 1407.11 of the IBC provides alternate conditions that do not require compliance with NFPA 285, such as using MCM not higher than 40 feet and having a fire separation distance² of more than 5 feet. If the fire separation distance is 5 feet or less, then only 10% of the wall area can include MCM.
- *Section 1409.10.4:* For high-pressure decorative exterior-grade compact laminates (HPL) exterior wall coverings used on buildings of Type I, II, III, and IV construction. Section 1409.11 of the IBC provides alternate conditions that do not require compliance with NFPA 285, such as using HPL not higher than 40 feet and having a fire separation distance of more than 5 feet. If the fire separation distance is 5 feet or less, then only 10% of the wall area can include HPL. These are new requirements in the 2012 IBC.
- *Section 1509.6.2:* Combustible mechanical equipment screens used on buildings of Type I, II, III, and IV buildings.

¹ Although the latest edition of NFPA 285 is the 2012, the 2006 edition is the one referenced in the 2012 IBC. However, the first and second printings of the 2012 IBC indicate a "NFPA 285-11" edition, but an errata dated 02-27-13 was issued correcting the edition to the 2006.

² Fire separation distance is the distance measured between the face of the building and the closest interior lot line, the centerline of a street, alley, or public way, or to an imaginary line between two buildings on the same property. The distance is measure at right angles to the face of the wall.

- *Section 2603.5.5:* Exterior walls of buildings of Type I, II, III, and IV construction of any height incorporating foam plastic insulation, except for one-story sprinklered buildings.
- *Section 2612.5:* For fiberglass-reinforced polymer (FRP) exterior wall coverings. This section references Section 2603.5, which means NFPA 285 is required for Type I, II, III, and IV buildings that are more than two stories and higher. However, this section does offer two exceptions that would not require NFPA 285 testing.

Noticeably missing in the list of requirements above are exterior insulation and finish systems (EIFS). That is because EIFS were not directly addressed in the IBC until the 2009 edition. Prior to the 2009 IBC, EIFS were regulated by the foam plastic insulation requirements of Chapter 26. In the 2009 IBC, EIFS were directly incorporated into the code in Section 1408, which requires compliance with ASTM E 2586, *Standard Specification for PB Exterior Insulation and Finish Systems*. Since ASTM E 2586 requires EIFS to pass NFPA 285, Section 1408 essentially supplants the foam insulation requirements of Chapter 26 for EIFS.

The IBC has always referenced NFPA 285 for foam plastic insulation; however, *Uniform Building Code* (UBC) Standard 26-4, *Method of Test for the Evaluation of Flammability Characteristics of Exterior, Nonload-Bearing Wall Panel Assemblies Using Foam Plastic Insulation*, was permitted by the 2000 IBC and, prior to the IBC, the UBC.³ The 1997 UBC introduced UBC Standard 26-9, *Method of Test for the Evaluation of Flammability Characteristics of Exterior, Nonload-bearing Wall Assemblies Containing Combustible Components Using the Intermediate-scale, Multistory Test Apparatus*, which eventually became NFPA 285. The significant difference between UBC Standards 26-4 and 26-9 was that 26-4 was based on a full-scale mockup of the wall assembly, whereas 26-9 (and subsequently NFPA 285) is based on a smaller, intermediate-scale mockup.

Impact of NFPA 285 on Building Design

Since some form of fire propagation requirements for combustible materials in exterior walls have been in the code for over thirty years, why is it that design professionals are just now learning about NFPA 285? The answer is rather simple: energy codes are requiring higher performance from building envelopes, and the best method to improve thermal performance is providing continuous insulation. Continuous insulation interrupts the thermal bridging created by common exterior wall construction. When EIFS were introduced in the 1970s, they were the only foam plastic insulations used in this manner. When the codes caught up with the new technology in the 1980s and developed testing standards, EIFS manufacturers immediately sought testing for their systems. However, with few manufacturers and a limited number of common substrates, it was easier to test most, if not all, of the typical EIFS assemblies at the time.

It is important to stress that the NFPA 285 test is an assembly test and not a material component test. With the constant introduction of new exterior wall coverings, the implementation of the ‘rain screen principle,’ and the increasing requirements for improved thermal performance, the building exterior envelope suddenly became a very complex assembly with thousands of possible combinations, thereby making it cost-prohibitive for a manufacturer to test every probable wall assembly. If an assembly can be found that has passed the NFPA 285 test, then the assembly must be designed and built exactly as it was

³ In UBC editions prior to the 1994 edition, the standard referenced was UBC Standard 17-6. The number change was the result of chapter restructuring in response to the efforts of the Council of American Building Officials’ (CABO) Board for Coordination of Model Codes (BCMC) to standardize the organization of the three model building codes.

tested. Therefore, the designer must use all of the proprietary products that are indicated in the tested assembly—any change in the assembly, regardless of how minor, will require a new test.

With this wide variety of potential exterior wall assemblies to choose from, the design professional must now consider one of the following options to remain compliant with the building code:

1. Design a building using Type V construction;
2. Design a sprinklered building with only one story above grade plane;
3. Design an exterior wall assembly that has no combustible materials;
4. Design a building using MCM and HPL that is more than 5 feet from the lot line and is less than 40 feet in height and includes no foam insulation or combustible water-resistive barrier;
5. Select a tested wall assembly from the few assemblies that are available; or,
6. Design a wall assembly and have it tested.

Some of the options mentioned above may not be immediately available to the design professional due to a building's design program (*i.e.* size and types of spaces required), available site area, or project budget. For example, designing a 100,000 sq. ft. office building on a tight urban site will likely eliminate the first two options. The third option, although achievable, will require some additional research time on part of the design team; however, to obtain equal energy performance using noncombustible materials (*e.g.* mineral wool insulation) will require thicker wall assemblies that may pose some design challenges. The fourth option is probable, but the use of foam plastic insulation or combustible water-resistive barriers (both are common with these exterior wall coverings) may require testing anyway. Resorting to the fifth option will limit the number of material and assembly options on a designer's palette. Lastly, the project budget may eliminate the sixth option, since project-specific testing can be very expensive.

The NFPA 285 Test

As mentioned earlier, the NFPA 285 test is conducted on an intermediate-scale mockup. A mockup is an exact fabrication of a proposed assembly. For the NFPA 285 test, the mockup is attached to a test apparatus that consists of a three-walled, two-story structure with an overall height of 15'-8". Each story contains a test room—each having dimensions of 10 feet wide by 10 feet deep by 7 feet high. The apparatus is constructed of steel, concrete, and concrete masonry units. The interior wall and ceiling surfaces of the first story are covered with a layer of Type X gypsum board over ceramic fiber insulation. The floor of the first story is covered by two layers of gypsum board.

The mockup test specimen is constructed on the open face of the test apparatus or on a portable frame that is moved into place and attached to the test apparatus. The size of the mockup is 17'-6" high by 13'-4" wide and must include a window opening approximately 30 inches high by 78 inches wide that is centered horizontally in relation to the first story test room's side walls. The sill height of the window opening must be 30 inches. Thermocouples, which are used to measure temperature, are attached to the exterior face of the mockup, the interior of the mockup assembly, and the interior face of the mockup at the locations indicated in the test standard. Thermocouples are also attached to the ceiling of the first-story test room.

The test procedure includes two burners: a fixed gas burner in the center of the first-story test room and a portable gas burner that is placed in the window opening. The room burner is ignited and must achieve a first-story room temperature of 1151 deg. F within the first 5 minutes. At that time, the window burner is ignited and both continue to burn for another 25 minutes for a total 30-minute test period and achieving an average first-story room temperature of 1648 deg. F.

After the test, the mockup is dismantled and visually observed. The assembly fails if flame propagation exceeds the limits indicated in the standard. Flame propagation is determined in three locations of the mockup: the exterior face of the assembly, core components of the assembly, and the areas beyond the first-story test room.

- *Exterior face of assembly:* Flame propagation is determined 1) if the flames reach a height of 10 feet or greater above the window opening, 2) if the flames extend laterally a distance of 5 feet or greater from the centerline of the window opening, or 3) if any of the thermocouples at the roof line record a temperature of 1000 deg. F or higher.
- *Core components of assembly:* Assemblies with wall coverings greater than ¼” thick, or ¼” thick or less with no air cavity, cannot have combustible components that exceed 750 deg. F at thermocouples near the assembly perimeter at the second-story test room. Assemblies with wall coverings ¼” thick or less and having an air space cannot have temperatures in the air cavity exceeding 1000 deg. F or in the insulation exceeding 750 deg. F at thermocouples near the assembly perimeter at the second-story test room.
- *Areas beyond the first-story test room:* Flame propagation is determined if flames on the exterior surface extend beyond the side walls of the apparatus or flames occur beyond the intersection of the wall assembly and the side walls of the apparatus. Assemblies with wall coverings greater than ¼” thick, or ¼” thick or less with no air cavity, cannot have combustible components that exceed 750 deg. F at thermocouples located in line with side walls. Assemblies with wall coverings ¼” thick or less and having an air space cannot have temperatures in the air cavity exceeding 1000 deg. F or in the insulation exceeding 750 deg. F at thermocouples located in line with side walls.

There are two other conditions that will also warrant a failing report for a NFPA 285 test. The first condition is when any thermocouple that is located within 1 inch of the interior wall surface at the second-story test room exceeds 500 deg. F. The second condition is when flames occur in the second-story test room.

The Future of NFPA 285 in the IBC

The 2015 IBC will likely include a reference to the 2012 edition of NFPA 285. There are some changes in the 2012 edition, which include expanded conditions of acceptance that may impact some assemblies previously tested under the 2006 edition.

For water-resistive barriers, the 2015 IBC will include some changes that will help relax the requirement for NFPA 285 testing for combustible barriers. Based on a public comment during the IBC final action hearings in 2012, Section 1403.5 will add the following three exceptions:

- *Exception 1:* “Walls in which the water-resistive barrier is the only combustible component and the exterior wall has a wall covering of brick, concrete, stone, terra cotta, stucco, or steel with thicknesses in accordance with Table 1405.2.”
- *Exception 2:* “Walls in which the water-resistive barrier is the only combustible component and the water-resistive barrier has a Peak Heat Release Rate of less than 150 kW/m², a Total Heat Release of less than 20 MJ/m² and an Effective Heat of Combustion of less than 18 MJ/kg as determined in accordance with ASTM E 1354 and has a flame spread index of 25 or less and a smoke-developed index of 450 or less as determined in accordance with ASTM E 84 or UL 723. The ASTM E 1354 test shall be conducted on specimens at the thickness intended for use, in the horizontal orientation and at an incident radiant heat flux of 50 kW/m².”
- *Exception 3:* “Windows and doors and flashing for windows and doors shall not be considered to be part of a water resistive barrier for purposes of this section.”

Unfortunately, the publication of the 2015 IBC is still a couple of years away with many jurisdictions likely not adopting it until a few years after that. However, using Section 104.11 for alternative materials, designs, and methods, a design professional could request a code modification allowing the use of the approved exceptions prior to the publication and adoption of the 2015 IBC.

Unlike assemblies tested by Underwriters Laboratories, which are included in its online certifications directory, the reports for successful NFPA 285-tested assemblies are retained solely by the manufacturer. Therefore, the design professional must seek out tested assemblies through manufacturers without the convenience of a directory of approved assemblies. Hopefully, some form of directory for NFPA 285-tested assemblies will be compiled by a professional, manufacturer, or trade association. With a consolidated directory of NFPA 285-tested assemblies, design professionals could easily select code-compliant exterior wall assemblies, thereby avoiding incidents such as the Monte Carlo fire, which, as it turns out, was not constructed of foam plastic materials tested per UBC Standard 26-4, the applicable standard at the time of its construction.

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