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Foam Plastic Insulation: Fire Safety for Exterior Walls on Commercial Buildings

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Abstract

The tragic June 2017 fire at the Grenfell Tower in London has led British authorities to conduct a comprehensive review of building fire regulations intended to provide answers on how the fire occurred and what should be done to prevent a future tragedy. The Grenfell Tower fire has communities outside of England asking, could this type of fire happen here?

This presentation aims to provide U.S. practitioners with answers, information, and guidance on how to harmonize the goals of building fire safety and energy efficiency. Information presented will be derived from consensus codes and standards, industry research and testing, and best-practice guidance documents.

This paper will:

- Highlight specifically how U.S. codes and standards create a system approach to controlling the use of foam plastic insulation products in commercial buildings of varying heights
- Detail resources that are available to help ensure buildings here in the U.S. are built and renovated to greatly reduce fire incidents and losses when fires do occur
- Present examples of approved assemblies in a variety of exterior walls that utilize foam plastic insulation for different construction configurations
- Provide guidance on how fire safety can be maintained throughout the design process and construction phases

Speakers

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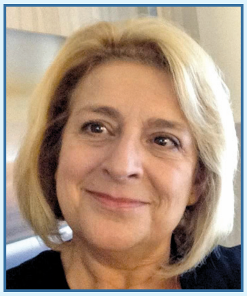

LORRAINE ROSS has been involved in all aspects of the building products industry: manufacturing; technical service; regulatory issues, including building code development and compliance; and testing laboratory experience. As president and CEO of Intech Consulting, Inc. and L Ross Consulting, Inc., she is noted for her skill in the development of successful strategies that provide responsible, reality-based responses to the regulatory pressures placed on the construction industry. She has delivered many presentations on sustainability and building code topics at a variety of industry conferences.

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INTRODUCTION

There is no doubt that the 2017 Grenfell Tower fire in London, England, was a seminal moment, given the tragic loss of life. Causing 72 deaths and 70 injuries, the fire broke out on June 14, 2017, and the initial cause was an electrical fire from a fridge that rapidly spread to the exterior of the building. Several investigations were immediately undertaken to examine all aspects of this most devastating residential event, with an overarching inquiry[1] established by British Prime Minister Theresa May on August 15, 2017:

1. To examine the circumstances surrounding the fire at Grenfell Tower on 14 June 2017, including:
   (a) the immediate cause or causes of the fire and the means by which it spread to the whole of the building;
   (b) the design and construction of the building and the decisions relating to its modification, refurbishment and management;
   (c) the scope and adequacy of building regulations, fire regulations and other legislation, guidance and industry practice relating to the design, construction, equipping and management of high-rise residential buildings;
   (d) whether such regulations, legislation, guidance and industry practice were complied with in the case of Grenfell Tower and the fire safety measures adopted in relation to it;
   (e) the arrangements made by the local authority or other responsible bodies for receiving and acting upon information either obtained from local residents or available from other sources (including information derived from fires in other buildings) relating to the risk of fire at Grenfell Tower, and the action taken in response to such information;
   (f) the fire prevention and fire safety measures in place at Grenfell Tower on 14 June 2017;
   (g) the response of the London Fire Brigade to the fire; and
   (h) the response of central and local government in the days immediately following the fire; and
2. To report its findings to the Prime Minister as soon as possible and to make recommendations.

The investigation by UK authorities continues as potential changes in building construction and regulations are debated.

This event also captured the attention of architects, building product manufacturers, code authorities, and regulators around the world. Questions naturally arose regarding the safety of buildings, the wisdom of current construction practices and their associated building and fire code requirements, and related enforcement processes. It will remain to be seen if these discussions will impact U.S. approaches to exterior wall construction. The U.S. has an active and well-defined code development process, combined with consensus standard development, that accommodates new materials, assemblies, and testing technologies. It is incumbent on the construction industry to keep informed of current requirements, as well as emerging building safety issues.

EARLY CODE REGULATION OF FOAM INSULATION

Before leaping into current building code requirements for the use of combustible materials on exterior walls, it is important to take a step back and look at the genesis of foam plastic fire requirements in the code.

In the United States, the use of foam plastic insulation first occurred in the 1960s and became more prominent during the energy crisis of the 1970s. All types of this energy-efficient insulation—polyisocyanurate, extruded polystyrene, and expanded polystyrene—were available for mainly residential and some limited commercial construction. At that time, foam plastic was understood to be combustible. Most regulators viewed the combustibility as similar to wood, a widely used combustible construction material. Soon, however, a series of fires placed a focus on a deeper understanding of the expected fire performance of foam insulation.

Some fires involving foam insulation occurred in agricultural buildings where code regulations did not apply. However, in 1969, a home fire took the lives of two children (see *Figure 1*). An investigation disclosed that foam insulation was exposed and advertised as "non-burning" or "self-extinguishing," leading to a lawsuit filed by the parents against the foam insulation manufacturer. The U.S. Federal Trade Commission (FTC) then initiated a 14-month investigation into the manner in which foam insulation manufacturers described the fire performance of their products.

The FTC filed a complaint against the Society of the Plastics Industry (SPI), ASTM, and 25 manufacturers of foam plastic insulation for deceptive fire performance marketing. On November 4, 1974, the FTC issued a Consent Cease and Desist Order that included the following items:

- Notification of prior purchasers of their foams
- Sponsor product research – ($5M), leading to the 1980 Final Report of the Product Research Committee
- 1976 Uniform Building Code (UBC) sections specifically addressing foam insulation fire test requirements
- Cease using "non-burning," "self-extinguishing," or "non-combustible" when describing foam plastic products.

FIRE IN KANSAS CITY LED TO CRACKDOWN
The New York Times
May 31, 1973

KANSAS CITY, Mo., May 30 (AP)—The deaths of two children in a house fire nearly four years ago led to today's crackdown on plastics manufacturers by the Federal Trade Commission, a spokesman for the commission said.

The regional F.T.C. office said the crackdown was sparked by Jerry Childress, father of the dead children. The interior walls of the Childress home in Kahoka. Mo., had been insulated with a coating of plastic foam.

A three-year effort by Mr. Childress led to 14 months of investigation by the commission here and in Washington.

Preliminary investigations by the F.T.C. office here were the impetus for the national inquiry, according to Tom Hankins, assistant regional director for the commission.

"We had reports of fires associated with plastics," Mr. Hankins said. "We gathered evidence from various sources, including court records and witnesses. Then we gathered evidence of alleged misrepresentations made in various companies advertising."

"Based on what we knew," he added, "we recommended, the investigation be extended nationwide to all major manufacturers.'

Figure 1 –* New York Times *article covering the Federal Trade Commission's response to the Childress home fire of 1969 (published May 31, 1973).

- Delete any reference to numerical flame spread ratings based on small-scale tests, such as ASTM E84. Products would contain a disclaimer: "This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions."

A significant result of the FTC action was the establishment of a cooperative research program, with participation by the foam plastics industry, Underwriters Laboratory (UL), and the National Bureau of Standards (now NIST), to develop new fire tests for foam plastics. The program addressed material tests (single material) and assembly tests (multiple materials configured in a specific way as they would be found within a structure).

The outcome of these studies was the development and adoption of a separate chapter in the 1976 UBC establishing basic fire test provisions for foam plastics.

- ASTM E84[2] testing with limits of 75 flame spread and 450 smoke developed index
- The use of a thermal barrier (typically ½" gypsum board separating the foam from the interior of the building)

These material requirements are similar to those in use today, with additional provisions to address the fire safety of emerging new formulations and applications of foam plastic insulation.

DEVELOPMENT OF NFPA 285

As the uses for foam insulation expanded from residential wall and below grade to new applications such as roofs and commercial construction, new fire tests were needed with corresponding code provisions.

Driven by more stringent energy codes in the late 1970s, foam insulation was proposed for use as exterior insulation on noncombustible construction, described in the codes as Types I, II, III, and IV. However, the existing codes then did not allow foam plastic insulation due to its combustibility. Potential flame spread on the exterior wall was a major concern.

The SPI convened an Exterior Wall Task Group, with a stated goal of developing a large-scale fire test that would qualify the use of foam plastic insulation on buildings of Types I, II, III, and IV.[3] Based on the input of building code and fire code officials, along with fire science and fire test experts, the program was designed to address a typical fire scenario where a fire occurs inside a room, breaks through a window, and causes fire that travels vertically and/or laterally on the exterior wall surface, leading to potential fire propagation from room to room.

The fire test was therefore designed to evaluate:

- Vertical and lateral flame spread over the exterior face of the wall assembly
- Vertical flame spread within the combustible core, cavities, or within the combustible components from one story to the next
- Vertical flame spread over the interior surface of the wall assembly from one story to the next
- Lateral flame spread from the compartment of fire origin to adjacent compartments or spaces

Test development was conducted at Southwest Research Institute in San Antonio, Texas (see *Figure 2*). Primary investigator Jess J. Beitel[4] described the test as follows:

> The test fixture consisted of an outside two-story building that was 24 ft. high, with floor heights of 12 ft. The full-scale fire test was designed to provide the recommended fire exposure to the exterior walls and to demonstrate, in a realistic fire scenario, if the appropriate fire performance characteristic could be demonstrated by the exterior walls.

The large-scale fire tests of a number of exterior wall assemblies containing foam plastic insulation led to two important actions:

1. A code change was incorporated into the 1988 UBC.
2. The fire test was designated as UBC

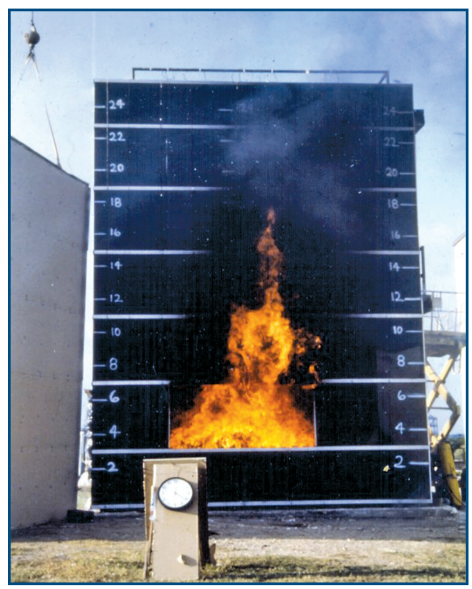


Figure 2 – View (front) of the two story, exterior wall apparatus during a fire test. Earlier versions of the NFPA 285 test were conducted outside. Courtesy of Jensen Hughes.

17-6, *Method of Test for the Evaluation of Flammability Characteristics of Exterior Nonload-Bearing Wall Panel Assemblies Using Foam Plastic Insulation* (renamed as UBC 26-4, *Method of Test for the Evaluation of Flammability Characteristics of Exterior, Nonload-bearing Wall Panel Assemblies Using Foam Plastic Insulation* in 1994).

The Standard Building Code and (SBC) the National Building Code (NBC) followed suit.

History of NFPA 285

1970s	1980s	1990s	2000s	2010s
Energy Crisis: Leads to increased exterior insulation applications	**1988:** Uniform Building Code adopts UBC 17-6	**1997:** Uniform Building Code adopts UBC 26-9	**2000:** IBC begins requiring NFPA 285 testing	
Late 70s: SPI develops full-scale test		**1998:** NFPA adopts UBC 26-9 as NFPA 285		**2012:** IBC expands NFPA 285 testing to WRB

From its official adoption to the Uniform Building Code in 1988 to the 2012 International Building Code, fire testing is required for combustible components in wall assemblies.

Source: DuPont Building Innovations

Figure 3 – Timeline illustrates the evolution of the NFPA 285 test standard from the 1970s to present.

Due to the sheer size of this test, it had to be performed outdoors, leading to weather issues, additional costs, and related construction difficulties. The SPI then undertook another research program[5] that determined a smaller intermediate-scale test apparatus could be developed that would correlate to the larger-scale outdoor test. The intermediate-scale test was adopted and named UBC 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.*

In 1998, NFPA took UBC 26-9 through its consensus process, and after some editorial and formatting changes, issued NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-load-bearing Wall Assemblies Containing Combustible Components* (see *Figure 3*).

The International Building Code (IBC) references this test as a means to evaluate the fire performance of exterior walls containing combustible components on Types I, II, III, and IV buildings.

NFPA 285 TEST DETAILS

NFPA 285 is an assembly test conducted on an apparatus that is 18 ft. high and 13-⅓ ft. wide, with a 78-in.-wide window opening. The fire sources are two gas burners (one room burner located inside the first floor, and another window burner on the exterior side). This setup simulates flashover, where the fire suppression system has failed, and all interior materials are burning (see *Figure 4*).

The test assembly is mounted on the face of the apparatus. Thermocouples are fitted on the exterior wall surface, in the wall cavity air space, the stud cavity, and in the insulation. After a testing period of 30 minutes, a successful test will show no flame propagation to the second-story room, and no thermocouple may exceed 1000°F. Flame spread cannot exceed 10 ft. above the top of the window, nor more than 5 ft. laterally from the centerline of the window.

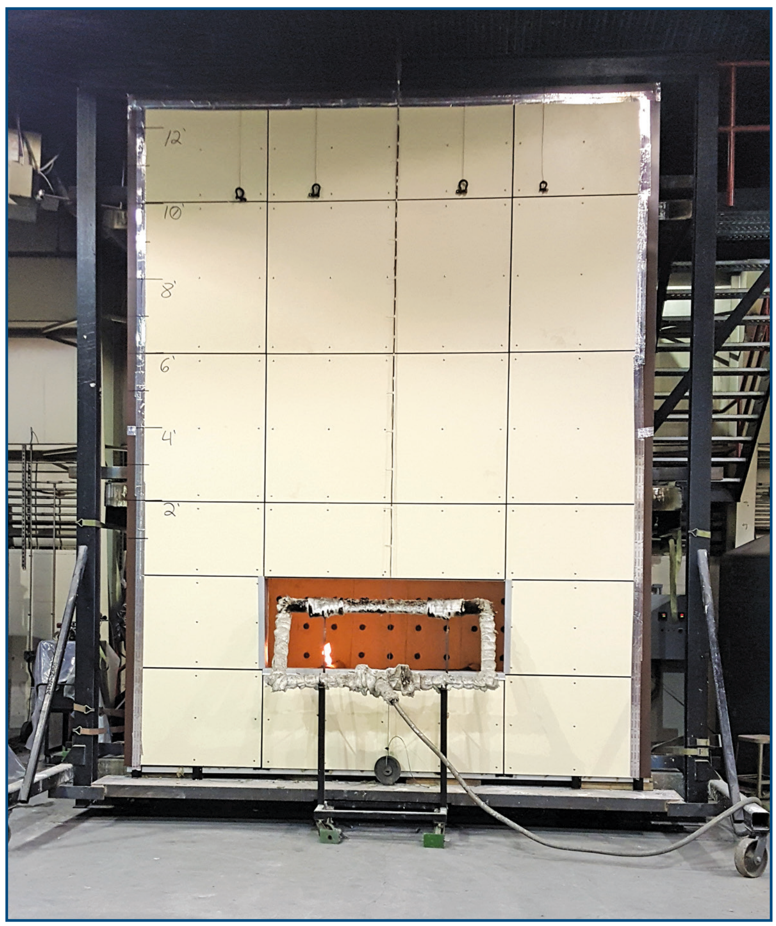


Figure 4 – Image illustrates the window burner placement for the NFPA 285 test apparatus. Note that the room burner is located inside the first floor of the test apparatus. Courtesy of Jensen Hughes.

NFPA 285 IN THE INTERNATIONAL BUILDING CODE

When the three "legacy" codes (UBC, SBC, and NBC[6]) were consolidated into the 2000 IBC, the reference to NFPA 285 as a consensus standard for testing exterior walls containing combustible components on buildings of Types I, II, III, and IV construction continued.

Chapter 6 of the IBC governs the fire resistance requirements for the various building elements for the five types of construction, which are described as follows:

- Types I and II – the various building elements are made up of noncombustible materials.
- Type III – exterior walls are made of non-combustible materials and the interior building materials are of any material permitted by the IBC.
- Type IV heavy timber (HT) – exterior walls are made of non-combustible materials, and the interior elements are made of solid or laminated wood without concealed spaces.
- Type V – structural elements for both exterior and interior walls are of any materials permitted by the IBC—usually combustible construction.

The current 2018 IBC contains the fire safety requirements for exterior walls containing foam plastic insulation in Chapter 14, Exterior Walls, and Chapter 26, Plastic.

In general, NFPA 285 testing is required for the following systems:

- Foam plastic insulation (Ch. 26)
  - — Applies to Types I, II, III, and IV buildings (added in 1988 legacy codes)
  - — Applies to buildings of any height
  - — Plus material tests and labeling
- Combustible exterior cladding (Ch. 14) on Types I, II, III, and IV buildings over 40 ft. in height
  - — Exterior insulation and finish systems (EIFS) (added to 2000 IBC)
  - — Metal composite materials (MCMs) (added to 2003 IBC)
  - — Fiber-reinforced polymers (FRPs) (added to 2009 IBC)
  - — High-pressure laminates (HPLs) (added to 2012 IBC)
- Water-resistive barriers (WRBs) (Ch. 14)
  - — Where combustible WRBs are the only combustible in the wall assembly
  - — Applies to Types I, II, III, and IV buildings over 40 ft.
  - — Applies to combustible WRBs (added to 2012 IBC)

2018 IBC Chapter 26, Plastic

- 2603 Foam Plastic Insulation
  - — 2603.5 – Exterior walls of buildings of any height
  - — 2603.5.3 – Potential heat
  - — 2603.5.4 – Flame spread and smoke-developed indices
  - — 2603.5.5 – Vertical and lateral fire propagation
  - — 2603.5.6 – Label required
  - — 2603.5.7 – Ignition
- 2613 – FRP
  - — 2613.5 – Exterior use complies with Section 2603.5

2018 IBC Chapter 14, Combustible Exterior Claddings

- 1406 – Metal composite panels
  - — 1406.9 – Surface-burning characteristics
  - — 1406.10 – Types I, II, III, and IV buildings
  - — 1406.10.4 – Full-scale tests (NFPA 285) over 40 ft. in height
- 1407 – EIFS
  - — 1407.2 – Performance characteristics
    - ASTM E2568 included requirements for NFPA 285 when installed Types I, II, III, and IV buildings over 40 ft. in height
- 1408 – High-pressure decorative exterior-grade compact laminates (HPLs)
  - — 1408.9 – Surface-burning characteristics
  - — 1408.10.4 – Full-scale tests (NFPA 285) over 40 ft. in height
- 1402.5 Combustible water-resistive barriers
  - — NFPA 285 when installed on Types I, II, III, and IV buildings over 40 ft. in height
  - — Exceptions for special conditions
    - If the WRB is the only combustible wall component and the wall has a noncombustible covering
    - If the WRB is the only combustible wall component and meets specific fire test parameters
    - Flashings around windows and doors are excluded.

As a summary, *Figure 5* illustrates a flow chart in determining the requirements for NFPA 285 testing.

COMPLIANCE PATHWAYS FOR EXTERIOR WALLS REQUIRING NFPA 285

The most straightforward method to demonstrate compliance with required NFPA 285 testing is through a full test report. In this case, the exact wall assembly, with all components specified, is tested at a code-accredited laboratory. In other words, every configuration requires a separate test. However, considering the variables in types of foam plastic insulation, claddings, attachment methods, framing, etc., the number of tests will quickly become unmanageable. The situation is more complicated given that there are a limited number of accredited testing laboratories performing NFPA 285 tests.

Another compliance route is through the use of an engineering judgement (EJ) analysis letter issued by a competent code and fire test expert. In this case, tested assemblies are used as the basis to allow changes in materials or installation details. At the end of the process, though, the authority having jurisdiction (AHJ) has the final decision on whether such EJs are acceptable for use on a specific project.

INDUSTRY DISCUSSIONS

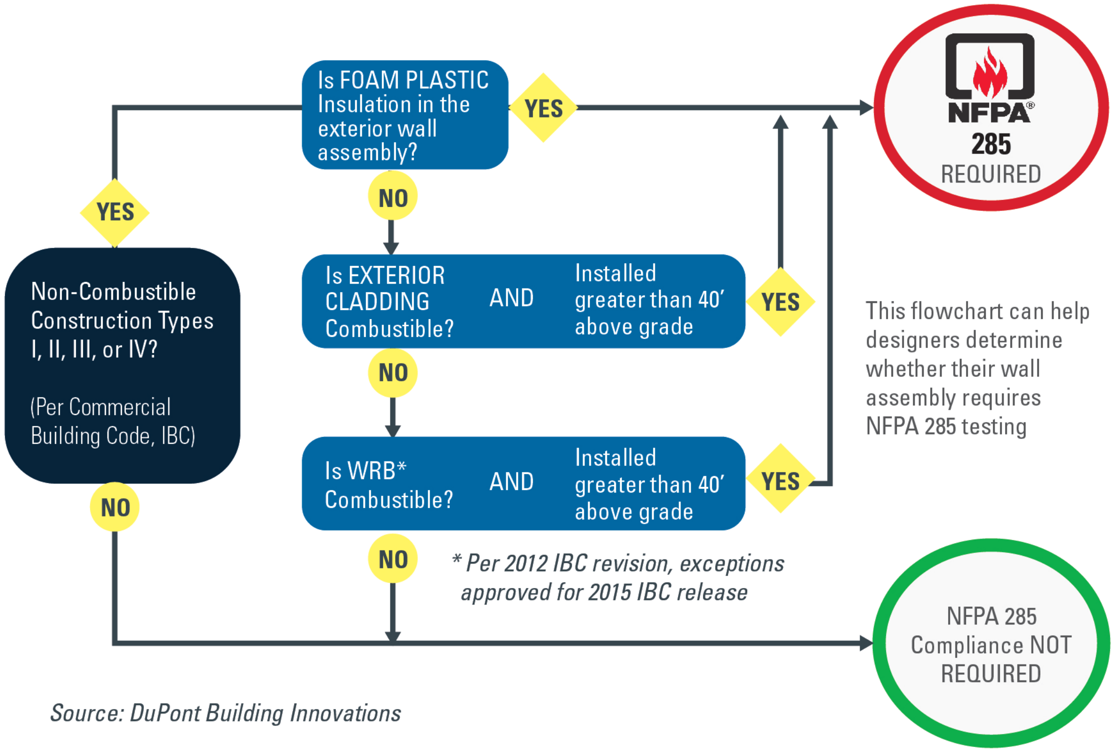
The NFPA 285 test development that allowed the safe use of combustible components on the exterior wall of noncombustible construction is an example of cooperation of manufacturers, fire science and fire test experts, and building code and fire code officials. The foam insulation and combustible cladding industries are exploring the following projects:

Consolidated Database

At present, there is no single database that contains all of the tested NFPA 285 assemblies. Responding to requests from architects, specifiers, and code enforcement community, the foam insulation industry is exploring the development of this type of information platform.

EJ Guidelines

With the increasing number of tested NFPA 285 assemblies, the NFPA 285 Committee has formed a new work group to discuss guidelines for code and fire experts to use when issuing EJs. This action will inform these consultants on acceptable substitutes, while cautioning against others.



Source: DuPont Building Innovations

Figure 5 – This flowchart can help building designers determine if a wall assembly requires NFPA 285 testing per the IBC.

NFPA 285 Education and Outreach

Although NFPA 285 testing has been required in the codes since 1988, it had not been often utilized until improved energy codes prompted the increased use of foam insulation on exterior walls. New combustible claddings were also developed and found widespread acceptance in the commercial construction market. These industries are ramping up educational presentations to ensure that the design community, as well as code enforcement personnel, are up to date on the latest systems and corresponding requirements.

CONCLUSION

The IBC utilizes NFPA 285, which is the primary test method to regulate the use of combustible assemblies on exterior walls of noncombustible construction. These are the important points to remember:

- NFPA 285 is an assembly test. There is no such thing as an NFPA 285 product.
- NFPA 285 test reports detail specific components. Either a new test or a credible engineering report, accepted by the code official, must be provided for material substitutions. The same requirement applies if attachment methods or test geometry are changed, such as increased air spaces.
- Keep up to date with changing code requirements.

REFERENCES

1. Grenfell Tower Inquiry, https://www.grenfelltowerinquiry.org.uk/news/prime-minister-announces-inquiry-terms-reference.
2. ASTM E84, Standard Method of Test for Surface Burning Characteristics of Building Materials.
3. Types I and II – the various building elements are made up of non-combustible materials; Type III – exterior walls are made of non-combustible materials, and the interior building materials are of any material permitted by the IBC; Type IV (heavy timber) – exterior walls are made of non-combustible materials and the interior elements are made of solid or laminated wood without concealed spaces; Type V – structural elements for both exterior and interior walls are of any materials permitted by the IBC, usually combustible construction.
4. J.J. Beitel and W.R. Evans. "Multistory Fire Evaluation Program, Final Report." SWRI Project 01-6112, prepared for the Society of the Plastics Industry, Southwest Research Institute, San Antonio, TX. November 1980.
5. J.J. Beitel and J.R. Griffith Jr. "Development of an Intermediate-Scale Fire Test for the Evaluation of Flammability Characteristics of Exterior, Non-Loadbearing Wall Panel Assemblies Using Foam Plastic Insulation, Phase." Phase II, Revised Final Report, 1 Society of the Plastics Industry, New York, NY. May 1994.
6. National Building Code (NBC) by the Building Officials Code Administration International; Uniform Building Code (UBC) by the International Conference of Building Officials; Standard Building Code (SBC) by the Southern Building Code Congress International.