NFPA 285 – Extending Data with Comparative Engineering Analysis

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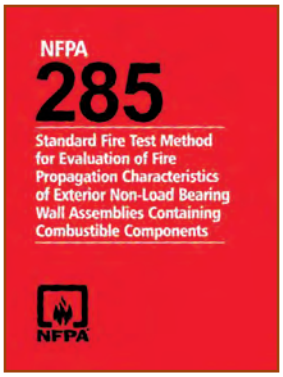
Exterior wall assemblies have become increasingly complex and are critical elements of the building enclosure. Advancements in our understanding of building science, coupled with the need to improve the energy efficiency and resilience of buildings, have led to innovative solutions in both building products and construction methods. Many of the innovative products available to the market today are subject to compliance with prescriptive fire testing and performance requirements as regulated under the *International Building Code* (IBC). One of the critical prescribed fire tests within the IBC for exterior wall assemblies is the National Fire Protection Association's *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components* (NFPA 285).[1] This article discusses *engineering judgments* and their use as a practical tool to assist designers and building officials with assessing the compliance of exterior wall assemblies with the acceptance criteria of NFPA 285.

In recent years, the code-enforcement community has expressed concerns about engineering judgments regarding NFPA 285. This article discusses the code basis for engineering judgments, the actual data, and how the data can be used to determine compliance. Following the discussion, the article closes with an update regarding efforts to improve transparency and consistency of these engineering judgments via an annex to NFPA 285, bringing together current industry best practices.

ENGINEERING JUDGMENTS AND THE INTERNATIONAL BUILDING CODE

Section 104.11 of the IBC provides the building official with authority to approve alternative materials, design and methods of construction, and equipment. Approval is granted on the basis of the building official's finding that the alternative "is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety." Data, analysis, and engineering judgments are often provided to the building official to support a finding that the proposed alternate complies with the applicable provisions of the code. Engineering judgments that extend NFPA 285 results to modifications of tested assemblies fall within the scope and intent of IBC 104.11.

Editor's note: In this article, the term "engineering judgments" is used to refer to analyses performed by qualified engineers or consultants and used to support code compliance under the IBC alternate materials and methods provisions. These engineering judgments could be among the data supporting a design listing or code evaluation report published by an accredited certification agency or an unpublished report held by a material supplier that is submitted to the engineer of record or building official. "Engineering judgments" is the term used within the fire safety and building products communities.



For exterior walls complying with NFPA 285, an engineering judgment is a report that provides a comparative analysis of the effects that one or more variations to a tested assembly will have on compliance with the acceptance criteria of NFPA 285. These reports are prepared by qualified individuals and organizations and must be based on actual NFPA 285 fire test data and, if appropriate, supplemental test data. Engineering judgments may be general or specific to one construction project or project condition.

The complexity of today's wall assemblies that results from compliance with all code requirements (such as energy efficiency, fire safety, water/weather resistance, air leakage, vapor transmission, structural loading, and the like), combined with the multitude of products and design options, renders full-scale testing of every possible assembly combination or slight variation impractical.

Other realities of today's construction industry necessitate the use of engineering judgments to validate compliance. For example, unforeseen issues, such as errors or in-field conditions that arise during construction, can result in in-place assemblies that deviate from tested assemblies, third-party-listed design(s), or the design described in the approved construction documents. Such deviations from approved assemblies can "red tag" a project, either halting construction or preventing issuance of a certificate of occupancy until a determination of compliance is made or the condition is rectified in a satisfactory manner.

For these reasons, engineering judgments evaluating variations of full-scale fire-tested assemblies offer building officials a practical tool for establishing compliance of alternate assemblies with the acceptance criteria of NFPA 285 in support of granting approval.

The model codes recognize that principles of fire science and fire protection engineering allow for the reasonable extension of test results to modifications of tested assemblies using comparative analysis of pertinent fire test data. For example, IBC Chapter 7 on *Fire and Smoke Protection Features* contains provisions in IBC Section 703.2 and 716.1.1 that permit the use of engineering analysis to determine fire resistance. For those situations where the code does not provide prescriptive provisions, IBC Section 104.11 provides building officials with duties and powers to consider supporting information, such as test data and engineering analysis, in their review and approval of alternative materials, designs, and methods of construction as meeting the intent of the code. Both IBC Sections 703.2 and 716.1.1 include reference to Section 104.11 as a compliance method.

Several certification agencies, within the scope of their ISO/IEC 17065[2] accreditation, provide listing and certification services for wall assemblies complying with NFPA 285. These agencies routinely perform analyses and engineering judgments regarding modifications to recognized products and the recognized assemblies containing them. These analyses are performed as part of the ongoing maintenance of certifications for recognized products and designs. Additionally, test programs developed for purposes of third-party certification will often include "worst-case" assembly design(s) to allow for subsequent analysis and engineering judgments to provide a scope of recognition beyond only the tested assembly.

Product manufacturers also engage with independent fire-protection engineers (FPEs) and other qualified consultants to prepare engineering judgments. Judgments by FPEs and consultants are most often prepared for submission to building officials in support of approval; and to certification agencies in support of test programs, recognition expansion, and ongoing certification.

Whether issued by a certification agency, an independent FPE or consultant, or an independent fire-protection consulting firm, the final duty and power to accept engineering judgments in support of approval rests with the building official as stated in Section 104.11 of the IBC.

THE TEST AND THE DATA

The NFPA 285 test method evaluates vertical and lateral flame propagation characteristics of full-scale exterior wall assembly designs. The fire exposure simulates a fire scenario where a post-flashover fire has breached the window of the room of origin, exposing the wall assembly to a flame assault and heat plume. Test specimens are full-scale (minimum 17-ft.-6-in. high × minimum 13-ft.-4-in. wide) and fully configured wall assemblies, containing all assembly layers (such as the exterior wall covering, water-resistive barrier, air barrier, vapor barrier/retarder, and insulation), accessories (for example, sealants, brackets, or shims), and a base wall (most typically a light-gage metal frame curtainwall). Each test wall assembly is

About the North American Modern Building Alliance

The North American Modern Building Alliance (NAMBA) is focused on addressing fire safety through the development and enforcement of building codes. Members of NAMBA are: ACC Center for the Polyurethanes Industry, ACC North American Flame Retardant Alliance, Atlas Roofing Corp., BASF Corporation, Carlisle Construction Materials, Covestro, DuPont, EIFS Industry Members Association, GAF, Huntsman, Kingspan Insulation LLC, Metal Construction Association, Owens Corning, Polyisocyanurate Insulation Manufacturers Association, and Rmax - A Business Unit of the Sika Corporation.

highly instrumented with each assembly layer (including air gaps) containing multiple thermocouples (TCs). The specific number of TCs, TC locations, and any applicable acceptance criteria are specified by the NFPA 285 test method and determined by the materials of construction and the configuration of the wall assembly. The criteria determining the pass/fail result are a combination of temperature limitations, temperature-rise limitations, and visual observations of flaming at certain locations in the specimen and the second-story room of the test apparatus. Information required for test reports includes: time versus temperature data for all TCs, visual observations, photographs of the assembly (pre-test exterior, pre-test interior, post-test exterior, post-test interior, and wall cavity insulation post-test), damage sketch(es), other burn-related and calibration-related information, and detailed drawings for the assembly and window opening area.

The data collected during an NFPA 285 test record the "real-time" dynamic behavior of each individual assembly layer. When combined, the data from all assembly layers describe how heat and fire moved throughout the assembly in all three dimensions during the entire test duration. It is this quality of NFPA 285 test data that makes it possible for qualified individuals, using experience and sound principles of fire science and fire engineering, to evaluate and predict performance effects presented by certain modifications to tested assemblies. If the comparative evaluation supports a finding of equivalent performance, then the engineering judgments will confirm that the alternative assembly will continue to comply with the acceptance criteria of NFPA 285. It is important to keep in mind, however, that there are limitations to the appropriate use of evaluation and engineering judgments to extend full-scale fire test results to modified assemblies. In some cases, extension via evaluation may not be recommended for a proposed modification; examples could include doubling or tripling of an air-gap depth behind an exterior cladding, doubling the thickness of a combustible continuous insulation at a given insulation density, and extensions without consideration of supporting fire test data.

EQUIVALENCE AND DEVELOPING GUIDELINES FOR ENGINEERING JUDGMENTS

Engineering judgments extending full-scale NFPA 285 test results are a determination of equivalence; that is, whether a modified assembly will perform at least equivalently to the tested assembly in terms of meeting the acceptance criteria of NFPA 285. As discussed previously, NFPA 285 data tell a detailed story of how an assembly performed during the test. These detailed data, when reviewed by qualified and knowledgeable individuals, provide valuable insight into each assembly layer's behavior as well as its influence on, and reaction to, the behavior of adjacent assembly layers. Ongoing testing within the fire testing and certification community, and the community of building product manufacturers, continues to increase experience and understanding of comparative performance and performance trends for products and assemblies subjected to the NFPA 285 test.

In March 2018, efforts to improve the transparency and consistency of engineering judgments led to the NFPA Committee on Fire Tests approving the formation of a task group for the purpose of developing guidance for extending NFPA 285 test results. Under the task group, experts from fire test laboratories, certification bodies, and independent consultants came together to collect experience and industry best practices into the NFPA 285 test standard regarding the extension of test results for assemblies meeting NFPA 285. At the time of this article, two public comments containing guidance for the extension of NFPA 285 test results will have been submitted under the current NFPA revision cycle (Fall 2021 cycle) for inclusion in the 2022 edition of NFPA 285. The guidance provided in both comments is similar: one adds the guidance as a new section to the standard, whereas the other adds the guidance as a new annex.

Both approaches provide guidance regarding items for which evaluation and engineering judgments are more commonly requested or required today. These items include analyses regarding base walls, exterior sheathing, water-resistive barriers, air gaps, exterior insulations, drainage media, exterior claddings and attachment systems, and the window perimeter. Key elements of the guidance include, but are not limited to, the following:

- These wall assemblies are treated as systems.
- Analyses are based on assemblies tested in accordance with, and meeting the acceptance criteria of NFPA 285.
- Changes to the assembly under evaluation are normal and reasonable within the limits of standard construction.

It is not possible to analyze every configuration, every potential change, or every combination of changes to a tested configuration.

SUMMARY AND CLOSING

Engineering judgments to extend NFPA 285 test results are a necessary and practical tool to assess exterior wall assemblies with specific alterations from an assembly tested and shown to comply with the acceptance criteria. Efforts among fire testing, certification, and independent-consulting communities to collaborate under NFPA to develop an annex to the NFPA 285 standard providing consensus guidance regarding extensions of test results are underway to improve transparency and address concerns expressed by the code-enforcement community. When completed, the annex will provide increased transparency regarding the process, scope, and limitations for engineering judgments regarding NFPA 285 and to improve their consistency among providers.

The guidance submitted for possible inclusion into the 2022 edition of NFPA 285 comes directly from the work and experience of those individuals and organizations regularly engaged in performing the testing, analyzing the data, and preparing the engineering judgments. These assessments are based on sound principles and used for the purpose of providing building officials with the

supporting information they need when considering approval of wall assemblies with reasonable deviations from one or more tested assemblies based on comparative analysis with additional supplemental data when needed.

REFERENCES

1. NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components.* National Fire Protection Association. https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=285.
2. ISO/IEC 17065, *Conformity assessment – Requirements for bodies certifying products, processes, and services.* ISO. 2012. Reviewed 2018. https://www.iso.org/standard/46568.html.

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Trouble in the Sky

The supertall tower at 432 Park Avenue, New York City, was the tallest residential building in the world when it was built in 2015. Extremely tall, narrow "pencil" towers have been popping up in Manhattan's skyline. According to *The New York Times*, more than 20 buildings that are more than 1,000 ft. tall have been built or planned since 2007, and many are experiencing trouble. At nearly 1,400 ft. tall, 432 Park Avenue has only one apartment on each floor. Two-story electrical breaks allow the wind to go through at intervals every 12 stories. Six years after it was built, residents have expressed a spate of complaints, ranging from flooding, to nonfunctional elevators, to excessive noise. Multiple incidences of flooding from purportedly varied causes have occurred, causing an estimated $500,000 in damage to one apartment alone. The walls reportedly "creak like the galley of a ship." This sound is common in tall buildings as they sway in the wind, a problem that is even more acute in very tall, very thin buildings.

A 1,200-ton tuned mass damper was installed near the top of 432 Park Avenue to counteract its sway. You can see the damper in action in this video: https://tinyurl.com/jf2jmb34, taken by Terri Boake of the University of Waterloo.

A group commissioned by engineering firm SBI Consultants to study mechanical and structural issues reported initial findings of failure to "conform with the developers' drawings" in 73% of mechanical, electrical, and plumbing components.

— The New York Times, Treehugger

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