ABTG

Research Report

Engineering Analysis of *NFPA 285* Tested Assemblies

ABTG Research Report No. 1505-10

Conducted for
Polyisocyanurate Insulation Manufacturers Association (PIMA)
polyiso.org

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Report Date:

Final Report: June 5, 2015

ABTG is an APPROVED SOURCE

This research report is based on practical scientific research (literature review, testing, analysis, etc.). This research report complies with the following sections of the building code:

- *IBC* Section 104.11.1 and Section 1703.4.2 – "**Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved sources*."
- *IBC* Section 202 – "**APPROVED SOURCE.** An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses."

Table of Contents

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Introduction:

Code requirements for specific testing are often questioned in the industry. For example, is actual testing required, or is engineering analysis permitted? Engineering analysis would fall under the category of alternative materials due to the fact that many tests are conducted as an assembly, and, therefore, any substitutions of products are labeled as alternative materials. The use of alternate materials or methods have been a part of building codes in the United States since the earliest national codes (*UBC* Section 104.2.8, *SBC* Section 103.7, *NBC* Section 104.2.8 and *CABO* Section R108). Provisions for the use of alternate materials or methods are included in the current versions of *IBC* Section 104.11, *IRC* Section R104.11, *IFC* Section 104.9, *NFPA* 5000 Section 105.2, and *NFPA* 1 Section 1.4.

Background:

The earliest edition (2000) of the *International Building Code* (*IBC*) included provisions for alternatives to code requirements.

> **104.11 Alternative materials, design and methods of construction and equipment.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the code official finds that the proposed design 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, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.
>
> **104.11.1 Tests**. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the code official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the code official shall approve the testing procedures. Tests shall be performed by an approved agency. Reports of such tests shall be retained by the code official for the period required for retention of public records.

The language has not changed much over the last 15 years, as indicated by *2015 IBC* Section 104.11.

> **104.11 Alternative materials, design and methods of construction and equipment**. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design 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. Where the alternative material, design or method of construction is not approved, the building official shall respond in writing, stating the reasons why the alternative was not approved.
>
> **104.11.1 Research reports**. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.
>
> **104.11.2 Tests**. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the building official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the building official shall approve the testing procedures. Tests shall be performed by an approved agency. Reports of such tests shall be retained by the building official for the period required for retention of public records.

Evaluation:

This report focuses on code compliance of fire-rated wall assemblies. Here is an example of a specific code requirement for testing, as stated in *IBC* Section 2603.5.5.

> **2603.5.5 Vertical and lateral fire propagation.** The exterior wall assembly shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.
>
> **Exceptions:**
> 1. One-story buildings complying with Section 2603.4.1.4.
> 2. Wall assemblies where the foam plastic insulation is covered on each face by not less than 1-inch (25 mm) thickness of masonry or concrete and meeting one of the following:
>   2.1. There is no airspace between the insulation and the concrete or masonry.
>   2.2. The insulation has a flame spread index of not more than 25 as determined in accordance with ASTM E 84 or UL 723 and the maximum airspace between the insulation and the concrete or masonry is not more than 1 inch (25 mm).

The code requirement appears to be explicit: "shall be tested." Simply put, any exterior wall assembly needs to be tested to, and comply with, *NFPA 285*. However, that raises the question: Is testing required as stated, or may the provisions of Section 104.11 apply? The answer is that analysis may be permitted, if the requirements of Section 104.11 are met.

NFPA 285 Test Summary

NFPA 285 testing of an actual wall assembly is generally required when "noncombustible" walls contain "combustible" materials. In high-rise buildings especially, assembly fire performance is critical for evacuation and life.

NFPA 285 is a two-story test of a wall assembly to resist flame propagation over the face of the wall covering, vertical flame propagation within the combustible core or components, flame propagation over the interior surface from one floor to the next, and lateral flame propagation to adjacent compartments.

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°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 achieve an average first-story room temperature of 1648°F.

For the interior, to pass the test, there can be no flame propagation into the second-floor room, and no thermocouple that is located within 1" of the interior wall surface at the second-story test room can exceed 500°F.

For the exterior, the pass requirement is that flames shall not reach 10' above the top of the window opening and shall not reach 5' laterally from the window's centerline. Also, thermocouples inside the wall assembly shall not exceed 1000°F during the test.

For the internal assembly, the pass requirement is that assemblies with wall coverings greater than ¼" thick, or ¼" thick or less with no air cavity, cannot have combustible components that exceed 750°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°F or in the insulation exceeding 750°F at thermocouples near the assembly perimeter at the second-story test room.

IBC Requirements

2015 IBC combustible components requirements in wall assemblies are:

- Air and water barriers – 1403.5 (*2015 IBC* includes two new exceptions)
- Foam plastic insulation – 2603.5.5
- Combustible claddings (in buildings over 40' tall):
  - EIFS – 1408.2
  - MCM – 1407.10
  - FRP – 2612.5
  - HPL – 1409.10

Section 104.11, as included in the *2015 IBC*, includes instructions on what is required for approval of a submission of an alternate material, design or method to a building code official.

1. Design is satisfactory
2. Complies with the intent of the code
3. Not less than that prescribed in the code in:
    a. quality
    b. strength
    c. effectiveness
    d. fire resistance
    e. durability
    f. safety
4. Research report with supporting data
5. Testing

The International Code Council Evaluation Service publishes *AC12 – Acceptance Criteria for Foam Plastic Insulation*, which establishes guidelines for the evaluation of foam plastic insulation used in accordance with the code. The document notes acceptable test procedures for such insulation.

AC12 Section 6.6 states:

> When recognition includes installation of the foam plastic insulation in exterior walls of Type I through Type IV construction in accordance with Section 2603.5 of the IBC, the evaluation report shall provide details of the assemblies tested in accordance with NFPA 285, and/or NFPA 285 test results extended via a third-party engineering analysis.

Engineering Analysis

Keeping in mind the *NFPA 285* test summary, *IBC* and *AC12* requirements, consider a hypothetical example of Assembly 1 that contains Product X, which has undergone *NFPA 285* testing along with cone calorimeter flammability testing to establish the baseline fuel load of the product. If a similar product, Product Z, undergoes cone calorimeter flammability testing, and the results are the same or better than Product X, then Product Z is essentially an acceptable alternative to Product X.

Now, Product X was tested in *NFPA 285* and, as such, was the only approved material to be used in that assembly. However, since Product Z passed the same cone calorimeter flammability testing that Product X did, that testing proves the two products are equivalent. Therefore, Product Z can be substituted into Assembly 1, while maintaining results that met the testing criteria.

Again, the rationale behind this thought process lies directly in *IBC* Section 104.11.

> ... An alternative material, design or method of construction shall be approved where the building official finds that the proposed design 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 …

In the case of *NFPA 285* testing, only completed assemblies are tested for compliance and, therefore, the specific products used in the assemblies are the only products deemed to pass testing criteria. However, as stated in *IBC* Section 104.11.2, if a material that was not tested in the original assembly is brought into question as being a replacement, the following language dictates the appropriate steps.

> Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the building official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction …

This language is very clear – alternative materials "shall be approved" if they are found to comply with Section 104.11 and are proven to have properties that are equal to or greater than the material tested in the original assembly.

Revisiting the first example of Assembly 1 with Product X, also consider the possibility of replacing more than just Product X with Product Z. If steel studs were used in Assembly 1, then wall types that perform the same or better may be allowed, i.e., cast concrete walls and concrete masonry unit walls. If ½" gypsum exterior based sheathing was used in Assembly 1, then other exterior sheathing with equal or better performance may be allowed, i.e., ½" or thicker exterior gypsum sheathing or no exterior sheathing, if using exterior claddings of brick and cavity insulation is not used.

If material tests prove products are equivalent or better, assembly tests can maintain validity even after alternative material substitution.

Conclusion:

The focus of the requirement in *IBC* Section 2603.5.5 for exterior wall assemblies is flammability rather than fire resistance (2012 *IBC* Commentary). For assemblies using foam plastic insulation, either testing to *NFPA 285* is required or analysis of the substitution of a different product in a tested assembly shall be permitted by the building code official in accordance with Section 104.11 per ICC-ES *AC12*.

The following is the basis for a compliance report for a substituted foam plastic insulation product. The report should:

- Be written by an independent source:
  - approved by the building official
  - with the proper qualifications for the analysis of the engineering principles of materials and methods
- Reference specific *NFPA 285* pass test results
- Include small-scale testing, if appropriate
- Specify all assembly components and constructions
- Substitute only one specific component in a tested assembly in the same location with the same installation requirements (i.e., air gap, attachment method, etc.)
- Include opening and flashing details, where required
- Address all of the applicable concerns listed in *2015 IBC* Section 104.11