



Code Compliance Research Report

Subject: NCFI 11-033 Spray Polyurethane Foam System
Closed-cell, Medium-density Spray Polyurethane Insulation

Date: August 23, 2018

Materials: NCFI 11-033 SPF
DC315 Fireproof Paint (International Fireproof Technologies, Inc.)

Test Standards:

<u>Property</u>	<u>Standard</u>
Core Density	ASTM D1622
Compressive Strength	ASTM D1621
Tensile Strength	ASTM D1623
Dimensional Stability	ASTM D2126
Water Vapor Transmission	ASTM E96
Thermal Transmission Properties	ASTM C518
Flame Spread and Smoke Developed	ASTM E84
Alternative Ignition Barrier Assembly	NFPA 286, as modified in AC377, Appx. X
Air Permeability	ASTM E2178
Alternative Thermal Barrier Assembly	NFPA 286
Exterior Walls Types I - IV Construction	NFPA 285

Building Codes and Code References:

1. 2009, 2012, 2015, 2018 International Building Code (IBC)
2. 2009, 2012, 2015, 2018 International Residential Code (IRC)
3. AC377 Acceptance Criteria for Spray-Applied Foam Plastic Insulation, 4/2016.

Special Note:

NCFI 11-033 SPF insulation passes all of the requirements for a medium density SPF system under AC377 except compressive strength. Per AC377, Table 1, the requirement for a medium density SPF is 15 psi; per QAI Report No. TJ5288-1PT (June 29, 2018), NCFI 11-033 compressive strength is 12.68 psi. While this does not meet the AC377 criteria for a medium density SPF, the lower compressive strength in no way affects the building code compliance of the insulation. NCFI 11-033 is a suitable spray polyurethane foam system for use in interior insulation applications. Uses for which compressive strength may be an issue, such as sub-slab insulation, should be specifically evaluated.

Summary:

1. **Surface Burning Characteristics, Thermal Barrier and Maximum Thickness:** Based on the test data submitted and the reference documents, NCFI 11-033 SPF insulation covered with a prescriptive thermal barrier of 1/2-inch minimum thick gypsum wallboard (or other material specifically prescribed by the appropriate building code) meets the requirements for use under 2009 IBC, 2009 IRC, 2012 IBC, 2012 IRC, 2015 IBC, 2015 IRC, 2018 IBC and 2018 IRC. When covered in this manner, the maximum thickness of NCFI 11-033 SPF insulation is not limited.
2. **Attics and Crawl Spaces:** Based on the test data submitted and the reference documents, NCFI 11-033 SPF insulation may be applied up to a maximum thickness of 8 inches for vertical surfaces and applied up to a maximum thickness of 10 inches for horizontal and overhead surfaces and left exposed. This qualifies as an alternative ignition barrier without the prescribed protection from ignition as required in 2009, 2012, 2015 and 2018 IBC Section 2603.4.1.6 or 2009, 2012, 2015 and 2018 IRC Sections R316.5.3 and R316.5.4 provided the following limitations are followed:
 - 1) Entry to the attic or crawl spaces is only to service utilities and no storage is permitted.
 - 2) There are no interconnected attic or crawl space areas.
 - 3) Air in the attic or crawl space is not circulated to other parts of the building.
 - 4) Attic ventilation is provided when required by IBC Section 1202.2 (2015, 2012, 2009 IBC Section 1203.2) or IRC Section R806, except when air-impermeable insulation is permitted in unvented attics in accordance with 2018 IBC Section 1202.3, 2015 IBC Section 1203.3 or Section R806.5 of IRC (2009 IRC Section R806.4), Under-floor (crawl space) ventilation is provided when required by 2018 IBC Section 1202.4 (2015 IBC Section 1203.4, 2012 IBC Section 1203.3, or 2009 IBC Section 1203.3) or IRC Section R408.1, as applicable.
 - 5) Combustion air is provided in accordance with IMC Section 701.

Option: NCFI 11-033 SPF insulation may be coated with 4 mils wet film thickness (2.7 mils dry film thickness; 0.25 gal/100 ft² theoretical application rate) of DC315 Fireproof Paint as an alternative ignition barrier assembly to leaving the spray foam exposed. The coating, when used in this manner as an alternative ignition barrier, need not form a continuous film; that is, “holidays,” “blow holes,” “pin holes” and other small areas where the spray foam remains exposed is acceptable. The limitations above (1 - 5) apply under this option.
3. **Sill Plates, Rim Joists and Headers:** Based on the test data submitted and the reference documents, NCFI 11-033 SPF insulation at a maximum thickness of 3.25 inches would not need to be covered with a thermal barrier when applied to sill plates, rim joists and headers in accordance with IBC Section 2603.4.1.13 (Type V construction) or IRC Section R316.5.11.
4. **Thermal Resistance:** Thermal resistance values (R-values) are provided in Table 1 of this document.
5. **Vapor Retarder:** NCFI 11-033 SPF insulation qualifies as a Class II vapor retarder at thicknesses of 1 inches or greater.
6. **Air Impermeable Insulation:** NCFI 11-033 SPF insulation qualifies as an air impermeable insulation at a thickness of 1/2 inch or greater.
7. **Alternative Thermal Barrier Assembly:** Based on the test data submitted and the reference documents, the thermal barrier required by IBC Section 2603 and/or IRC Section R316 may be omitted when:
 - The thickness of NCFI 11-033 SPF insulation does not exceed 5.5 inches on walls (vertical surfaces) and 9.5 inches on ceilings (horizontal and overhead surfaces); and
 - The NCFI 11-033 SPF insulation is coated with DC315 Fireproof Paint manufactured by International Fireproof Technologies, Inc. at 14 mils wet film thickness (9 mils dry film thickness; 0.87 gal/100 ft² theoretical application rate).

8. **Construction Types I - IV:** NCFI 11-033 SPF insulation may be installed on the exterior walls of Types I, II, III and IV construction when installed in accordance with Table 2 or Table 3 of this report.
9. **Installation:** All materials referenced in this report must be installed in accordance with the manufacturer's installation instructions by installers qualified and authorized by the appropriate manufacturer.

Labeling Requirements:

A- and B-components for NCFI 11-033 SPF insulation must be identified with the manufacturer's name (NCFI Polyurethanes), address and telephone number; the name of the insulation product (NCFI 11-033 SPF insulation); the flame spread and smoke developed indices; and the name of the third-party inspection agency.

Discussion:

1. **Surface burning characteristics:** The 2018 IBC and IRC (and earlier editions) require that unless otherwise allowed, foam plastic must be tested in accordance with ASTM E 84 as having a flame spread index of not more than 75 and a smoke-developed index of not more than 450.

QAI Test Reports RJ6419F-3, RJ6419F-4 and RJ6419F-6 (August 15, 2018) report the following at a thickness of four (4) inches in accordance with ASTM E 84:

Flame Spread Index	<25
Smoke Developed Index	<450

Therefore, NCFI 11-033 SPF insulation meets the surface burning characteristics as stipulated in the IBC and IRC.

2. **Maximum thickness:** The maximum thickness that can be tested in accordance with ASTM E 84 is four (4) inches. For thicknesses greater than four inches, the IBC (Section 2603.3, Exception 4) and the IRC (R316.3, Exception) provide for testing greater thicknesses in accordance with the Special Approval and Specific Approval sections, respectively.

Traditionally, small room corner tests (such as NFPA 286) were employed to test thicknesses greater than 4 inches, with the spray foam covered with a prescriptive thermal barrier (i.e., 1/2-inch gypsum wallboard). However, after reviewing voluminous small room corner test results, ICC-ES staff recommended and the ICC-ES board approved a modification to AC 377 wherein this test protocol may be omitted. Under this provision, the maximum thickness of the spray foam is not limited. The limitations placed on this provision reflect the data that ICC-ES reviewed, namely:

- The spray foam product must have passed ASTM E84 testing at a thickness of four (4) inches with maximum flame spread and smoke developed results of 25 and 450 respectively.
- The spray foam product must be separated from the building interior by a prescriptive thermal barrier (1/2-inch [min.] gypsum wallboard).

The provisions described above are within AC 377, Section 3.2.2.3.

NCFI 11-033 SPF insulation has been tested in accordance with ASTM E84 with flame spread of less than 25 and smoke developed of less than 450. Therefore, NCFI 11-033 SPF insulation falls within

the provisions of AC 377, Section 3.2.2.3 and may be installed at any thickness provided it is covered with a prescriptive thermal barrier.

3. **Use in attics and crawl spaces:** Both the IBC and IRC provide exceptions to the thermal barrier requirement for the use of foam plastic insulation in certain attics and crawl spaces. Specifically, both model building codes provide for protecting the foam plastic from ignition through the use of coverings described as prescriptive ignition barriers (2009, 2012, 2015 and 2018 IBC Section 2603.4.1.6 or 2009, 2012, 2015 and 2018 IRC Sections R316.5.3 and R316.5.4).

Omitting the prescriptive ignition barriers is permitted under both model building codes under the IBC Section 2603.9 Special Approval and the IRC Section R316.6 Specific Approval. However, neither the IBC or the IRC provides a specific test method for the approval of alternate materials or assemblies to prescriptive ignition barriers.

ICC Evaluation Service, in AC 377 Acceptance Criteria for Spray-Applied Foam Plastic Insulation, provides a protocol in Appendix X based on NFPA 286 to qualify alternate assemblies to those using prescriptive ignition barriers. ICC-ES accepts Appendix X test results for the purposes of issuing Evaluation Reports. Furthermore, this protocol is widely accepted within the building construction community as providing acceptable evidence under IBC Special Approval and IRC Specific Approval sections.

QAI Test Report No. TJ5037-2 (January 29, 2018) reports that NCFI 11-033 SPF insulation passes the AC 377, Appendix X protocol at maximum thicknesses of 8 inches in the walls (vertical surfaces) and 10 inches in the ceiling (horizontal and overhead surfaces). No prescriptive ignition barriers covered the foam plastic in this test; neither were there any coatings or other coverings applied (i.e., the foam plastic was left exposed for this test).

Therefore, NCFI 11-033 SPF insulation without a prescriptive ignition barrier or a fire protective coating meets the Special Approval and Specific Approval sections of the IBC and IRC respectively for use in attics and crawl spaces. The limitations as stipulated in AC 377, Appendix X apply.

4. **Sill plates, rim joists and headers:** Based on the surface burning characteristics referenced above, NCFI 11-033 SPF insulation meets the requirements of IBC Section 2603.4.1.13 (Type V construction) or IRC Section R316.5.11 for use on sill plates, rim joists and headers without being covered with a thermal barrier at a maximum thickness of 3.25 inches.
5. **R-Values:** Table 1 below lists R-values based on QAI Report No. TJ5288-5PT (July 13, 2018), QAI Report No. TJ5342R3 (July 13, 2018) and the reporting procedures outlined in AC 377.

Table 1
THERMAL RESISTANCE (R-VALUES^{1,2})

THICKNESS (inches)	R-VALUES (°F•ft ² •hr/Btu)
1	7.0
2	13
3	20
3.5	23

THICKNESS (inches)	R-VALUES ($^{\circ}\text{F}\cdot\text{ft}^2\cdot\text{hr}/\text{Btu}$)
4	27
5	33
6	40
7	47
8	53
9	60
10	67
11	73
12	80

For SI: 1 inch = 25.4 mm; $1^{\circ}\text{F}\cdot\text{ft}^2\cdot\text{h}/\text{Btu} = 0.176^{\circ}\text{K}\cdot\text{m}^2/\text{W}$.

¹R-values are calculated based on tested k -values at 1 and 3.5-inch thicknesses for 180-day aged sampled.

²R-values greater than 10 are rounded to the nearest whole number.

6. **Vapor Retarder:** NCFI 11-033 SPF insulation qualifies as a Class II vapor retarder (between 0.1 and 1.0 perms) at a minimum thickness of 1 inch.
7. **Air Impermeable Insulation:** Air-impermeable insulation is defined in 2018 IBC Section 202 as “An insulation having an air permeance equal to or less than $0.02 \text{ l/s}\cdot\text{m}^2$ [$0.004 \text{ ft}^3/\text{min}\cdot\text{ft}^2$] at 75 pa pressure differential tested in accordance with ASTM E2178 or ASTM E283.” Based on QAI Report No. RJ5929P-1R1 (June 13, 2018), NCFI 11-033 SPF insulation meets this criteria at a thickness of $\frac{1}{2}$ inch or greater.
8. **Alternative Thermal Barrier Assembly:** In IBC Section 2603.9 (Special approval) and IRC Section R316.6 (Specific approval), the building code permits alternate assemblies to the use of the required thermal barrier when tested in accordance with specific tests. One such test is NFPA 286 (Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth) when used in combination with the acceptance criteria of 2018 IBC Section 803.1.1.1 (2015, 2012, 2009 IBC Section 803.1.2.1) or IRC Section R302.9.4. (NFPA 286 does not provide its own acceptance criteria, hence this is specifically defined within the building codes.)

NCFI 11-033 SPF insulation was tested in accordance with NFPA 286 with results reported in QAI Test Report No. TJ5197-19-R3 (July 17, 2018) wherein the spray foam was coated with the intumescent coating DC315 Fireproof Paint. The test result successfully passed the acceptance criteria as defined in the IBC and IRC.

Therefore, the thermal barrier as required in IBC Section 2603 and/or IRC Section 316 may be omitted provided the following limitations are observed:

- The maximum thickness NCFI 11-033 SPF insulation in wall and ceiling assemblies is limited to 5.5 inches on vertical surfaces and 9.5 on horizontal and overhead surfaces; and
- The NCFI 11-033 SPF insulation is coated with DC315 Fireproof Paint manufactured by International Fireproof Technologies, Inc. at 14 mils wet

film thickness (9 mils dry film thickness; 0.87 gal/100 ft² theoretical application rate).

9. **Exterior Walls of Types I, II, III and IV Construction:** Based on engineering evaluations by Jensen-Hughes (July 27, 2018), the following assemblies are permitted to be installed on exterior walls of Types I, II, III and IV construction (Table 2 and Table 3):

Table 2
NFPA 285 COMPLYING WALLS – NCFI Closed-Cell SPF on Exterior
 (Based on Table I of Jensen-Hughes Letter, Various NFPA 285 Complying Exterior Wall Constructions,
 No. 1JJB00035.000, July 27, 2018.)

Wall Component	Materials
Base wall system – Use either 1, 2 or 3	<ol style="list-style-type: none"> 1. Concrete wall – minimum 2-inch thick 2. Concrete Masonry wall 3. One layer – 5/8-inch thick Type X Gypsum wallboard on interior, installed over steel studs: minimum 35/8-inch depth, minimum 20-gauge at a maximum of 24-inch OC with lateral bracing every 4 ft. vertically.
Floorline Firestopping	4 lb/cu ft. mineral wool (e.g., Thermafiber) in each stud cavity and at each floorline – attached with Z-clips or equivalent. Mineral wool not required in stud cavities at floorlines when infill studwall ¹ construction is employed for exterior wall construction.
Cavity Insulation – Use either 1, 2, 3 or 4	<ol style="list-style-type: none"> 1. None 2. Full cavity depth or less of InsulBloc[®], InsulStar[®], InsulStar[®] Plus, ThermalStop[™] closed cell (2.0 lb/ft³), or NCFI 11-033 SPF insulation applied using sheathing as substrate and covering the width of the cavity and inside the stud flange. 3. Full cavity depth or less of Sealite[™] (NCFI 12-002) or Sealite[™] OCX (NCFI 12-005) open cell (0.5 lb/ft³) SPF applied using sheathing as substrate and covering the width of the cavity and inside the stud flange. 4. Any noncombustible insulation (if batts, can be either faced or unfaced)
Exterior sheathing – Use either 1 or 2	<ol style="list-style-type: none"> 1. 1/2-inch thick, exterior type gypsum sheathing 2. 5/8-inch thick, exterior type gypsum sheathing
Exterior insulation – Use either 1 or 2	<ol style="list-style-type: none"> 1. None 2. InsulBloc[®], InsulStar[®], InsulStar[®] Plus, ThermalStop[™] – Total thickness to be a maximum of nominal 5 inches or NCFI 11-033 SPF insulation – Total thickness to be a maximum of nominal 4 inches.
Exterior Veneer – Use either 1, 2, 3, 4 or 5	<ol style="list-style-type: none"> 1. Brick – Standard nominal 4-inch thick, clay brick. Installed with brick veneer anchors – standard types – installed maximum 24 inches OC vertically on each stud. Maximum 2-inch air gap between exterior insulation and brick. 2. Stucco – Minimum 3/4-inch thick, exterior cement plaster and lath. A secondary water-resistive barrier can be installed between the exterior insulation and the lath. The secondary water-resistive barrier shall not be full-coverage asphalt or butyl-based self-adhered membranes. 3. Minimum 2-inch thick Limestone, natural stone or minimum 1 1/2-inch thick cast artificial stone. Any standard non-open-jointed installation technique such as ship-lap, etc. can be used. 4. Terracotta cladding – Use any terracotta cladding system in which the terracotta is minimum 1 1/4-inch. Any standard non-open-jointed installation technique such as ship-lap, etc. can be used. 5. 1-inch thick, Clark Pacific glass-fiber-reinforced-concrete (GFRC) panels. Standard installation technique can be used.

¹Infill studwall construction refers to the condition where the stud framing of an exterior wall is interior to the floorline slab edges, effectively terminating the stud cavity at each floorline and creating sectioned stud bays in between sequential floors.

Table 3

NFPA 285 COMPLYING WALLS – NCFI Closed-Cell or Open-Cell SPF in Wall Cavity Only
 (Based on Table II of Jensen-Hughes Letter, Various NFPA 285 Complying Exterior Wall Constructions,
 No. 1JJB00035.000, July 27, 2018.)

Wall Component	Materials
Base wall system – Use either 1 (with interior, steel studs, minimum 3 ⁵ / ₈ -inch depth, minimum 20-gauge at a maximum of 24-inch OC with lateral bracing every 4 ft. vertically), 2 or 3	<ol style="list-style-type: none"> 1. One layer of 5/8-inch thick Type X exterior gypsum sheathing installed on the exterior side of the steel studs. 2. Concrete wall – minimum 2-inch thick 3. Concrete Masonry wall
Floorline Firestopping	4 lb/cu ft. mineral wool (e.g., Thermafiber) in each stud cavity and at each floorline – attached with Z-clips or equivalent. Mineral wool not required in stud cavities at floorlines when infill studwall ¹ construction is employed for exterior wall construction.
Cavity Insulation – Use either 1, 2, or 3; or any combination of 2 and 4; or any combination of 3 and 4.	<ol style="list-style-type: none"> 1. None 2. Full cavity depth or less of InsulBloc[®], InsulStar[®], InsulStar[®] Plus, ThermalStop[™] closed cell (2.0 lb/ft³), or NCFI 11-033 SPF insulation applied using sheathing as substrate and covering the width of the cavity and inside the stud flange. 3. Full cavity depth or less of Sealite[™] (NCFI 12-002) or Sealite[™] OCX (NCFI 12-005) open cell (0.5 lb/ft³) SPF applied using sheathing as substrate and covering the width of the cavity and inside the stud flange. 4. Any noncombustible insulation (if batts, can be either faced or unfaced)
Interior gypsum wallboard	Minimum 5/8-inch Type X gypsum wallboard
Exterior Wall Covering – Use either 1, 2, or 3	<ol style="list-style-type: none"> 1. Any non-combustible exterior wall covering material 2. Any combustible exterior wall covering system that has successfully been tested in accordance with NFPA 285 3. Any combustible exterior wall covering system up to a maximum wall height of 40 ft above grade plane. If the combustible material is fire retardant treated wood, the maximum wall height can be 60 ft above grade plane. 4. For base wall 2 or 3, a covering is optional but not required. Use an exterior wall covering as described in 1, 2 or 3 above.

¹Infill studwall construction refers to the condition where the stud framing of an exterior wall is interior to the floorline slab edges, effectively terminating the stud cavity at each floorline and creating sectioned stud bays in between sequential floors.

Conclusions:

NCFI 11-033 SPF insulation meets the requirements and intent of the IBC and IRC as specified and as limited in the Summary section above.

Respectfully submitted,
Deer Ridge Consulting, Inc.



Roger V. Morrison, PE, RRC
President

Reference Documents:

1. 2009, 2012 and 2015 International Building Code: Sections 803.1.2.1; 2603.
2. 2018 International Building Code: Section 803.1.1.1; 2603.
3. 2009, 2012, 2015 and 2018 International Residential Code: Sections R302.9.4; R316.
4. QAI Laboratories, Test Report No. TJ5288-1PT, June 29, 2018 (AC377 physical properties).
5. QAI Laboratories, Test Report No. TJ5288-5PT, July 13, 2018 (Thermal resistance at 1 inch).
6. QAI Laboratories, Test Report No. TJ5342R3, July 13, 2018 (Thermal resistance at 3.5 inches).
7. QAI Laboratories, Test Report No. RJ6419F-3, August 15, 2018 (ASTM E84).
8. QAI Laboratories, Test Report No. RJ6419F-4, August 15, 2018 (ASTM E84).
9. QAI Laboratories, Test Report No. RJ6419F-6, August 15, 2018 (ASTM E84).
10. QAI Laboratories, Test Report No. RJ5929P-1R1, June 13, 2018 (Air permeability).
11. QAI Laboratories, Test Report No. TJ5037-2, January 29, 2018 (AC377, Appendix X).
12. QAI Laboratories, Test Report No. TJ5197-19-R3, July 17, 2018 (NFPA 286, alternative thermal barrier assembly).
13. QAI Laboratories, Test Report No. TJ5288-2PT, June 29, 2018 (ASTM E96, water vapor transmission).
14. Jensen-Hughes Letter, Various NFPA 285 Complying Exterior Wall Constructions, No. 1JJB00035.000, August 22, 2018.
15. Jensen-Hughes Letter, Analysis of System ID No. 11-033 spray polyurethane foam insulation for use in NFPA 285 Complying Exterior Wall Assemblies, Project No. 1JJB00035.000, July 27, 2018.
16. NCFI 11-033 SPF insulation Technical Data Sheet
17. NCFI 11-033 SPF insulation Installation Instructions
18. Acceptance Criteria 377, April 2016.