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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
FIRE TECHNOLOGY DEPARTMENT
WWW.FIRE.SWRI.ORG
FAX (210) 522-3377



**FIRE PERFORMANCE EVALUATION OF
BPL 1445-1.8/FX245 1.8-PCF SPRAY-APPLIED
POLYURETHANE FOAM INSULATION WITH
PYRODYNE™ FIRE RETARDANT ACRYLIC
COATING (ACRY-TEK 5026), IN ACCORDANCE
WITH AC377, APPENDIX X, ALTERNATE
TESTING FOR USE IN ATTICS AND CRAWL
SPACES WITHOUT A CODE-PRESCRIBED
IGNITION BARRIER**

MODULE: D

**REVISED FINAL REPORT
Consisting of 18 Pages**

**SwRI Project No. 01.15216.01.201d[1]
Test Date: January 14, 2010
Report Date: February 22, 2010**

Prepared for:

**Burtin Polymer Laboratories
100 Enterprise Drive
Cartersville, GA 30120**

Prepared by:

**Chad Brewer
Assistant Technical Specialist
Fire Testing Services Section**

Approved by:

**Anthony L. Saucedo
Group Leader
Fire Testing Services Section**

2/25/10

Reviewed By:

**Barry L. Badders, Jr. P.E.
No. 61907, Florida**

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INTRODUCTION

This report presents the results of a fire performance evaluation performed in accordance with AC377, Appendix X, *Alternate Testing for Use in Attics and Crawl Spaces without a Code-Prescribed Ignition Barrier*, which may be found in Appendix B of this report. This criteria requires testing per the 2006 edition of National Fire Protection Association (NFPA) Standard 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, as modified in Section X2.1 of AC377. Testing was conducted on January 14, 2010, by Southwest Research Institute's (SwRI) Fire Technology Department, in San Antonio, TX.

At the Client's request, this report has been revised to reflect the trademarked name and manufacturer of the fire retardant coating as *Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)*, manufactured by Coating and Foam Solutions, LLC. A revision has also been made to the headers of Appendix A of this report, to reflect that testing was performed in accordance with NFPA 286, using AC377, Appendix X Criteria.

The objective of this test was to evaluate the fire performance of spray-applied polyurethane foam (SPF) insulation materials when tested in a room/corner test configuration to determine if the insulation and/or the insulation system is acceptable for use in attics and crawl spaces without a code-prescribed barrier per the International Residential Code® (IRC) or International Building Code® (IBC).

For this test, the specimen was mounted per Section X2.1.2b of AC377, except that, ½-in. thick gypsum wallboard was used instead of 5/8 in. Also, according to Figure X3, from the same appendix, the foam shall be measured at 12 in., 24 in., 36 in., and 48 in. above the floor from the outside of the burner. These tolerances, according to the figure shall be met. After calculating the distances from the burner to irregular foam surface, it has been determined that it meets the AC377 requirement of Figure X3.

According to Section X2.1.6 of AC377, *Conditions of Acceptance*, a test shall be determined to be successful when the average time for attainment of the four measured test parameters is 4 min 18 s or greater. These parameters are as follows:

- Heat release rate exceeds 1 MW,
- Heat flux at the floor exceeds 20 kW/m²,
- Average upper layer temperature exceeds 600 °C (1,112 °F), and
- Flames exit doorway.

This acceptance criteria is based on comparison of results for the tested assembly versus results for a code-prescribed ignition barrier applied over foam plastic insulation. The test parameters mentioned above, plus autoignition of paper targets on the floor, are used to determine if flashover has occurred, as outlined in Section 1.3.11 of NFPA 286.

NFPA 286 (2006) with AC377

Client: Burtin Polymer Laboratories

Project No.: 01.15216.01.201d[1]

Test Date: January 14, 2010

Florida P.E. Witness: Mr. Barry L. Badders (Professional Engineer, License No. 61907, registered in the state of Florida) of SwRI.

Comments: Test Notification Number from Miami-Dade County Florida for this test program is SwRI 10005.

Material ID: *BPL 1445-1.8/FX245*

- Batch (0912B1257)
- Manufactured by: Burtin Polymer Laboratories

Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)

- Lot# (LAB 12.11.09)
- Manufactured by: Coating and Foam Solutions, LLC

Material Description: 1.8-pcf spray-applied polyurethane foam (SPF), *BPL 1445-1.8/FX245*. The SPF was selected and inspected by a representative of PRI/TAG, on December 10, 2009. *Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)*, was selected and inspected by a representative of PRI/TAG, on December 15, 2009.

Construction Details: The stud walls were constructed using nominal 2 × 8 in. studs for the walls, creating a nominal 7 3/8-in. wall cavity, and the ceiling joists were constructed using nominal 2 × 12 in. lumber, creating a nominal 11 3/8-in. high ceiling cavity. The exterior of the test module was covered with one layer of ½-in. thick type X gypsum wallboard and attached using 1 5/8-in. long drywall screws every 8 in. on center, around the perimeter, and in the field.

The SPF insulation was applied into the stud and ceiling cavities to their respected depth (see Table 1.) The excess SPF was removed and cleaned from the exposed face of the studs and joists. An acrylic FR coating was applied to the test room interior at a nominal coverage rate of 88 ft² per gal. The finished interior dimensions of the test room measured 8 × 12 × 8 ft high.

Table 1. Material Preparation.

Dimensions (nominal in.)			SPF Thickness* (nominal in.)		Dates (mm/dd/yy)				Nominal Coating Coverage Rate (ft ² /gal)
Wall Studs	Ceiling Joists	Stud/ Joist Spacing	Walls	Joists	SPF Received	SPF Applied	Coating Received	Coating Applied	
2 × 8	2 × 12	24	7	11	12/15/09	12/22/09	12/17/09	12/29/09	88

*As measured.

Test Results: Mr. Barry L. Badders (Professional Engineer, License No. 61907, registered in the State of Florida) of SwRI witnessed this test. The Test Notification Number from Miami-Dade County, Florida for this test program is 10005. The test room and building were at approximately 67 °F and 69% relative humidity prior to the test. Material preparation is provided in Table 1, and a summary of the test results is shown in Table 2. Visual observations can be found in Table 3. Selected photographic documentation is provided in Figures 1 through 4. The test data is presented in Appendix A, and a copy of the AC377 criteria can be found in Appendix B.

Table 2. Summary of Test Results and Flashover Limits.

	Maximum Heat Release Rate (Total)	Total Heat Flux to the Floor	Maximum Average Upper Layer Temperature	Flames Exiting Doorway?	Auto-Ignition of Paper Targets?
<i>BPL 1445-1.8/FX245 with Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)</i>	1,083 kW	41.6 kW/m ²	846 °C	Yes	Yes
Flashover Limits per Section 1.3.11 of NFPA 286	1,000 kW	20 kW/m ²	600 °C	Not Allowed	Not Allowed
Time Flashover Limits were Exceeded (min:s)	6:40	6:26	6:15	6:32	N/A

Table 3. Visual Observations.

Time (min:s)	Observation
00:00	Ignition of burner. Burner set at 40 kW.
00:03	Flames from the burner are up to 3 ft above the floor.
00:09	Flames from the burner are up to 4 ft above the floor.
00:16	Mild discoloration radius of 10 in. between 1 and 2 ft above the floor in the burner corner.
00:22	Charring and discoloration radius of 11 in. at 1 ft, tapering to 3 in. at 4 ft above the floor in the burner corner.
00:30	Light white smoke down to 6 ft above the floor.
00:47	FR coating falling to the floor from the back wall, 4 ft above the floor, 6 in. to the left of the burn corner.
00:51	Medium density gray smoke down to 5¼ ft above the floor.
01:00	Burn corner ceiling not visible. Lights turned off.
01:16	Charring and discoloration radius of 12 in. at 1 ft, tapering to 3 in. at 5 ft above the floor in the burner corner.
01:55	Spotty ignition on the left wall between 1 and 2 ft above the floor in the burner corner.
02:30	Flames intermittent to 5½ ft above the floor in the burner corner.
02:40	Dense gray smoke down to 5¼ ft above the floor.

03:00	Charring and discoloration radius of 14 in. at 1 ft, tapering to 3 in. at 6 ft above the floor in the burner corner.
03:55	Charring and discoloration radius of 17 in. at 1 ft, tapering to 3 in. at 6½ ft above the floor in the burner corner.
04:18	Spotty ignition on the left wall between 2 and 3 ft above the floor in the burner corner.
05:00	Burner increased to 160 kW.
05:07	Flames flashing along the back wall/ceiling junction out to 4 ft and along the left wall/ceiling junction out to 3 ft.
05:15	Flames flashing along the back wall/ceiling junction out to 5 ft and along the left wall/ceiling junction out to 4 ft.
05:49	Flames on the back wall down to 5 ft above the floor.
06:05	Flames on the left wall down to 5 ft above the floor.
06:10	Dense black smoke, heavy volume at 4½ ft above the floor.
06:22	Flames on the left wall down to 4½ ft above the floor.
06:28	Autoignition of back paper target.
06:32	Flames out the open doorway.
06:34	Autoignition of front paper target.
06:38	Termination of Test. Flames out the front. Burner extinguished. Fire extinguished.

Conclusions: The system material identified as *BPL 1445-1.8/FX245*, applied at a nominal thickness of 7 in. in the walls and 11 in. (as measured) in the ceiling with *Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)*, applied at an approximate coverage rate of 88 ft² per gal, meets the AC377, *Acceptance Criteria for Spray-Applied Foam Plastic Insulation* (effective July 1, 2009). According to Section X2.1.6, *Conditions of Acceptance*, a test shall be determined to be successful when the average time for attainment of the four measured test parameters is 4 min 18 s or greater. The parameters for the material tested, achieved an attainment time of 6 min 28 s. This acceptance criteria is based on a comparison of results for the tested assembly versus results for a code-prescribed ignition barrier (plywood) over foam.

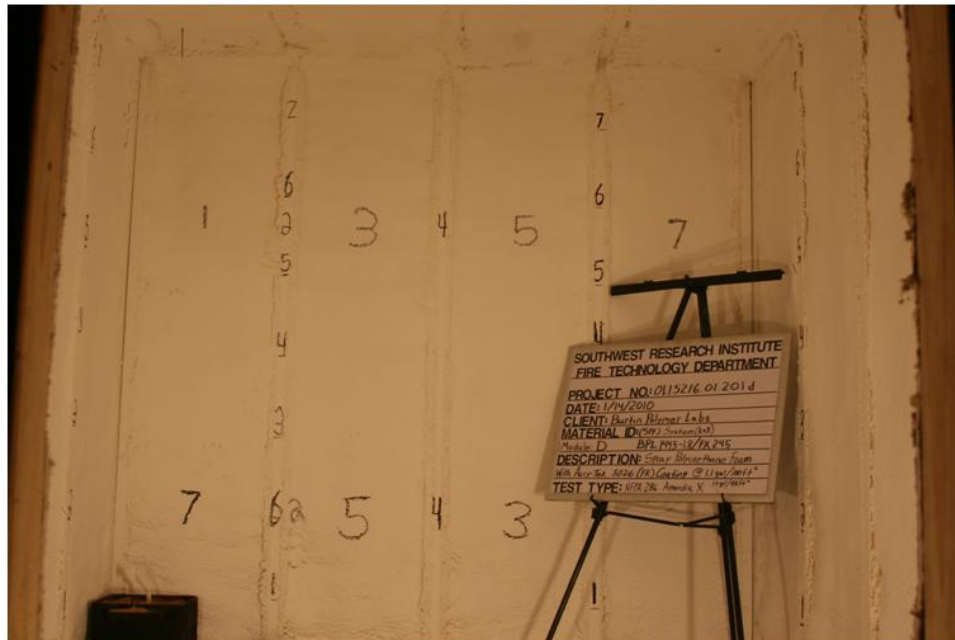


Figure 1. Pretest Setup.



Figure 2. Burner at 40 kW: 4 min 8 s into Test.



Figure 3. Burner at 160 kW: 6 min 28 s into Test.



Figure 4. Post Inspection (back wall).

APPENDIX A
TEST DATA
(Consisting of 5 Pages)

Material ID: *BPL 1445-1.8/FX245 with Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)*
 NFPA 286, using AC377, Appendix X Acceptance Criteria

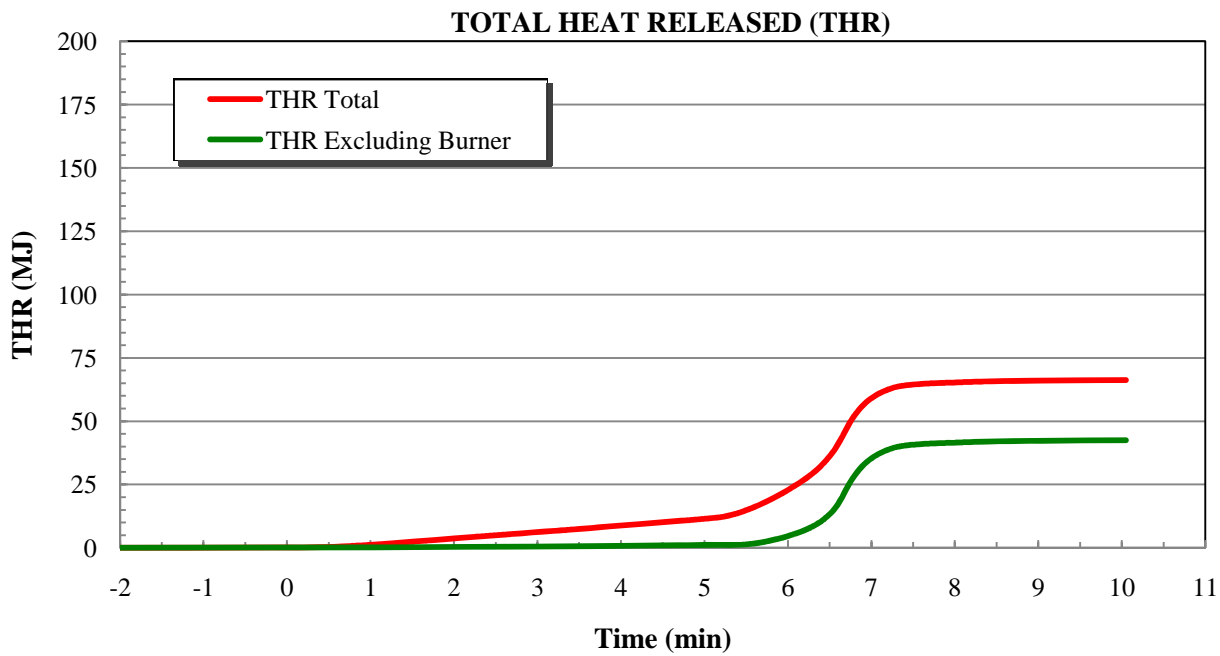
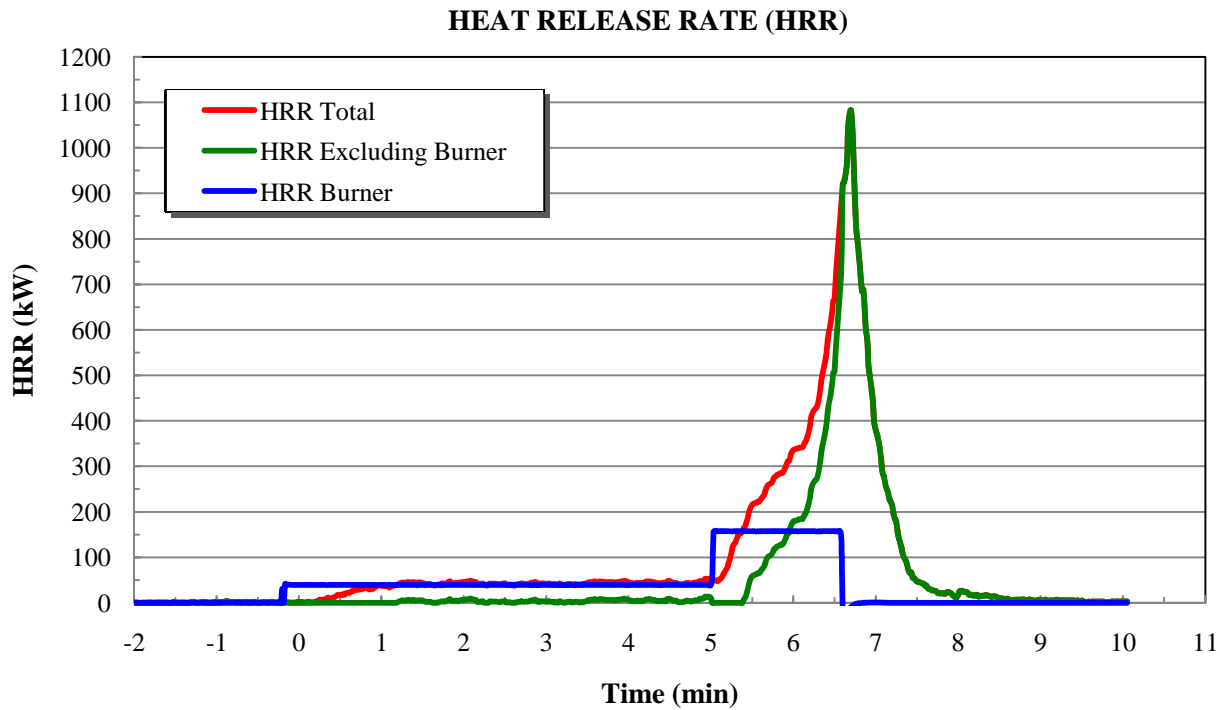
SUMMARY OF TEST RESULTS

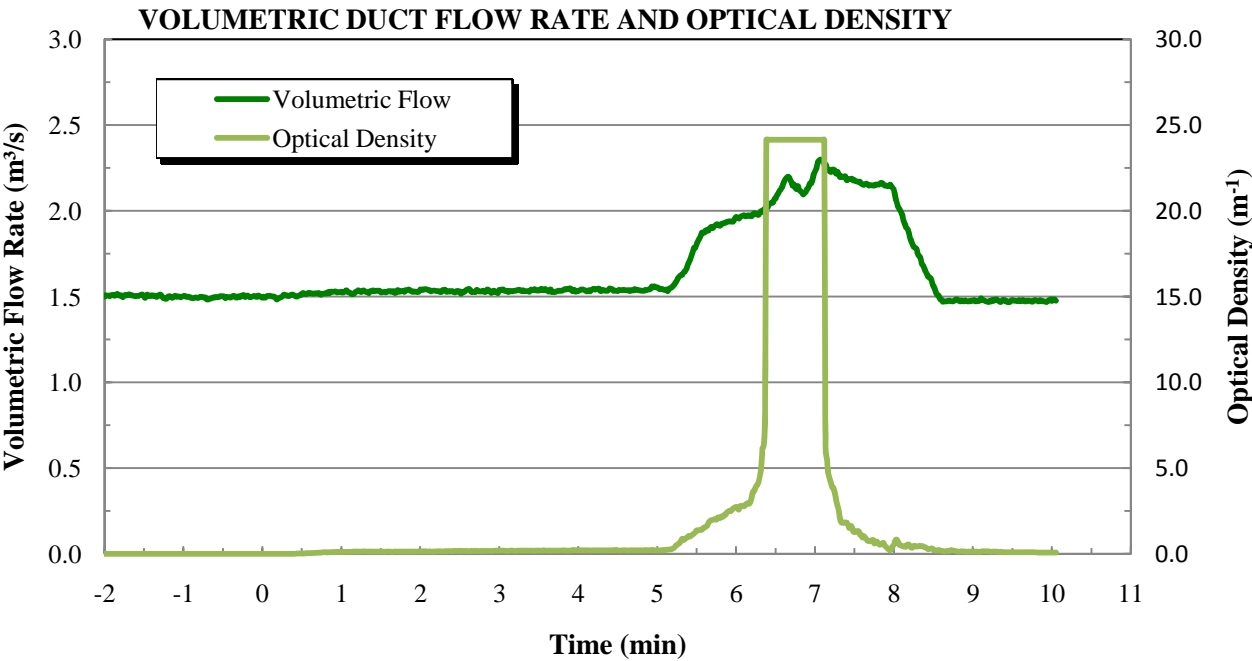
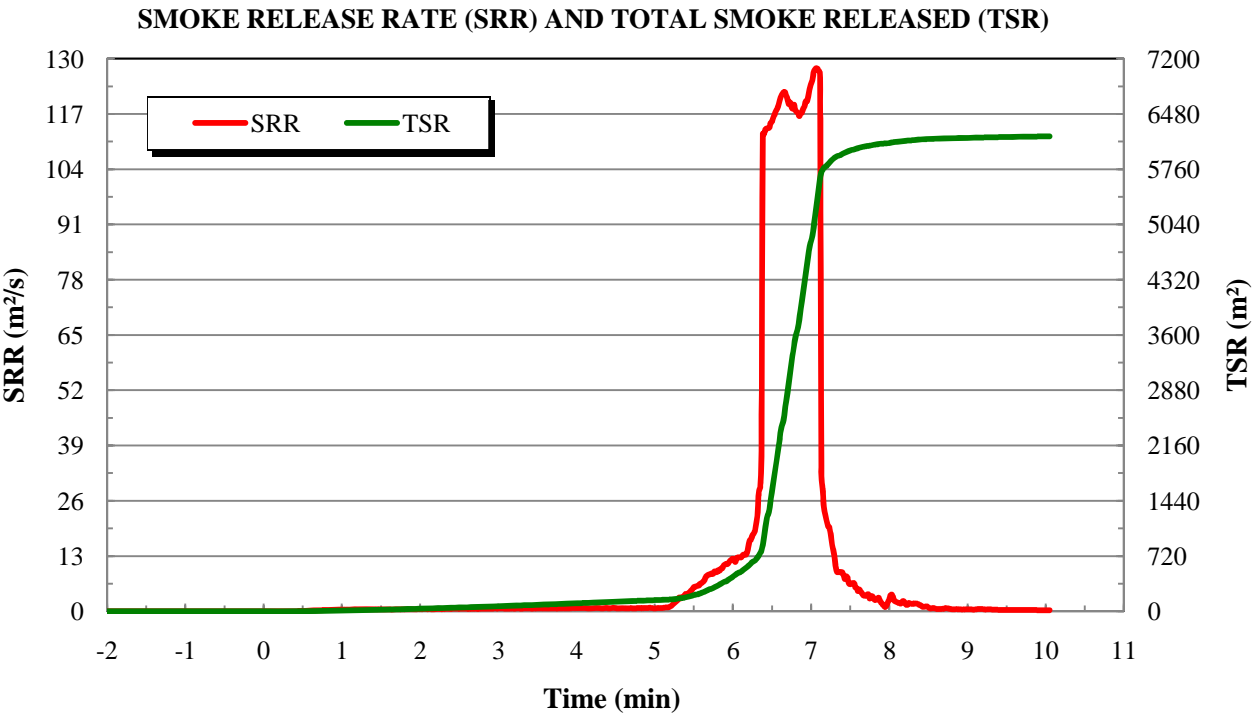
		Time to Maximum	Time to Flashover*
Maximum HRR_{total}	1083 kW	6:42	6:40
Average HRR_{total}	110 kW		
Total Heat Released	66.3 MJ		
Maximum $HRR_{excl. \text{ Burner}}$	1083 kW	6:42	
Average $HRR_{excl. \text{ Burner}}$	71 kW		
Total Heat Released (Excluding Burner)	42.5 MJ		
Maximum Smoke Release Rate	127.74 m ² /s	7:04	
Average Smoke Release Rate	11.01 m ² /s		
Total Smoke Released	6188 m ²		
Maximum Optical Density	24.13 l/m	6:23	
Average Optical Density	2.27 l/m		
Maximum Duct Flow Rate	2.30 m ³ /s	7:04	
Average Volumetric Duct Flow Rate	1.67 m ³ /s		
Total Heat Flux to the Floor	41.6 kW/m ²	6:37	6:26
Max. Average Upper Layer Temperature	846 °C 1555 °F	6:40	6:15
Maximum Doorway Temperature	664 °C 1228 °F	6:39	

*Times at which flashover limits, per NFPA 286, were exceeded. See limits in Table 1.

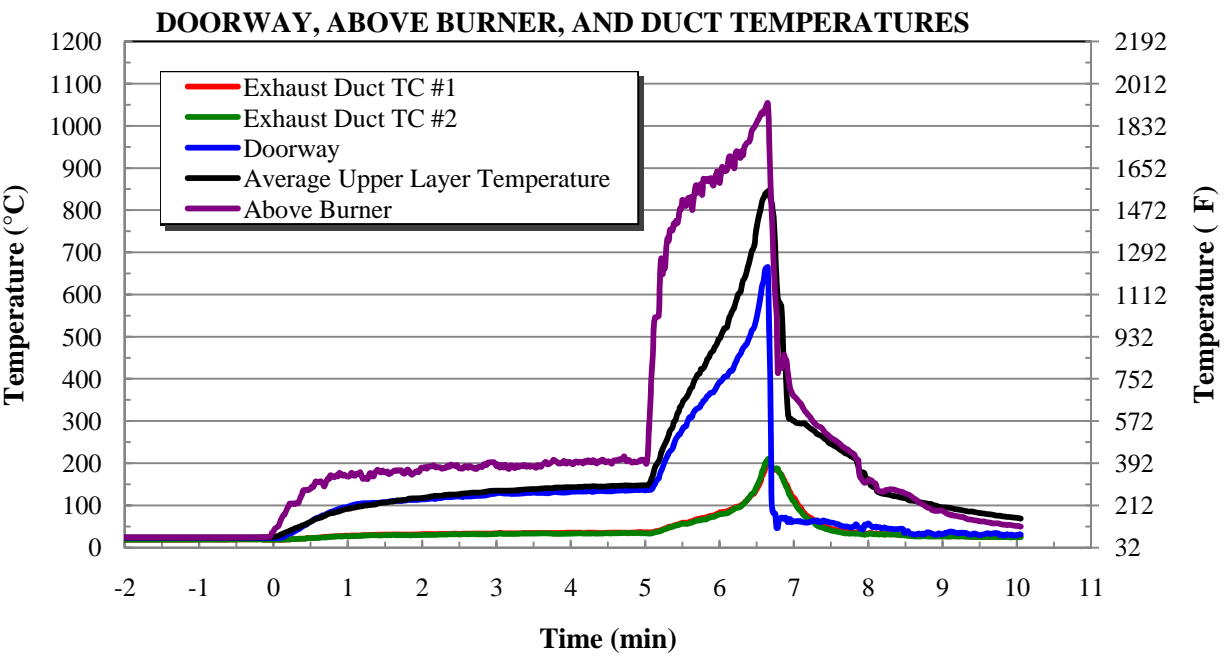
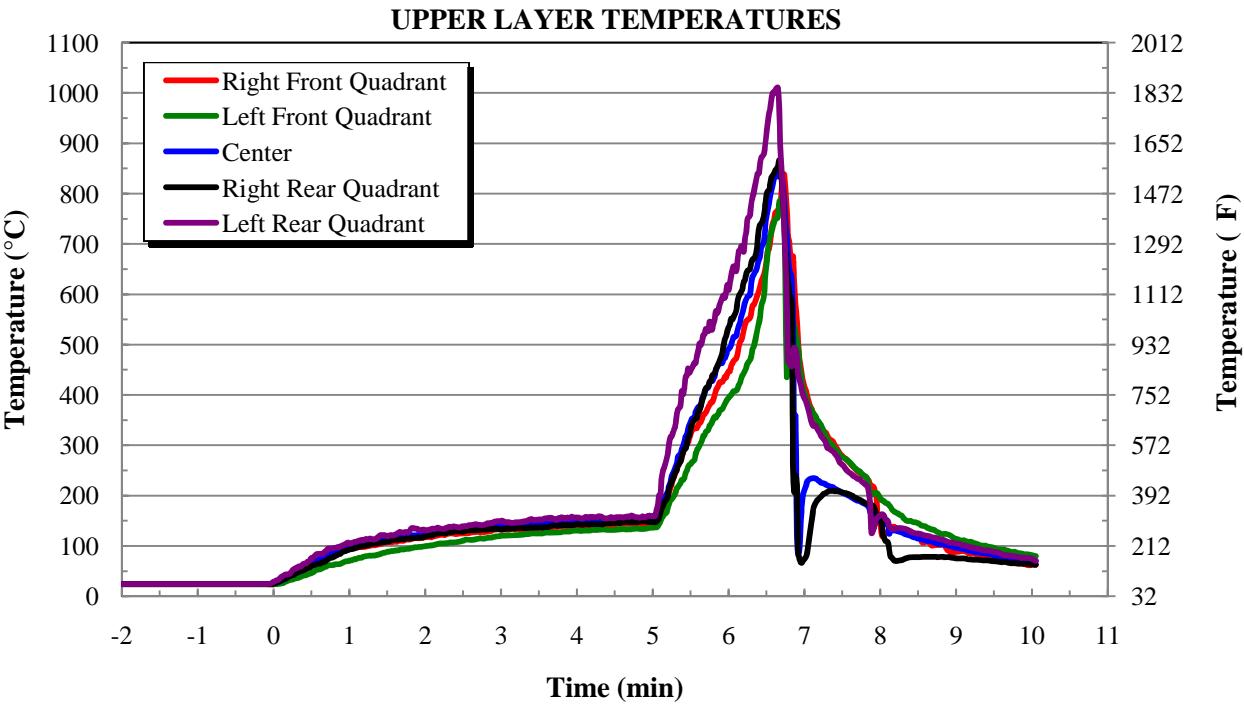
NA = Not applicable

Material ID: *BPL 1445-1.8/FX245 with Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)*
NFPA 286, using AC377, Appendix X Acceptance Criteria

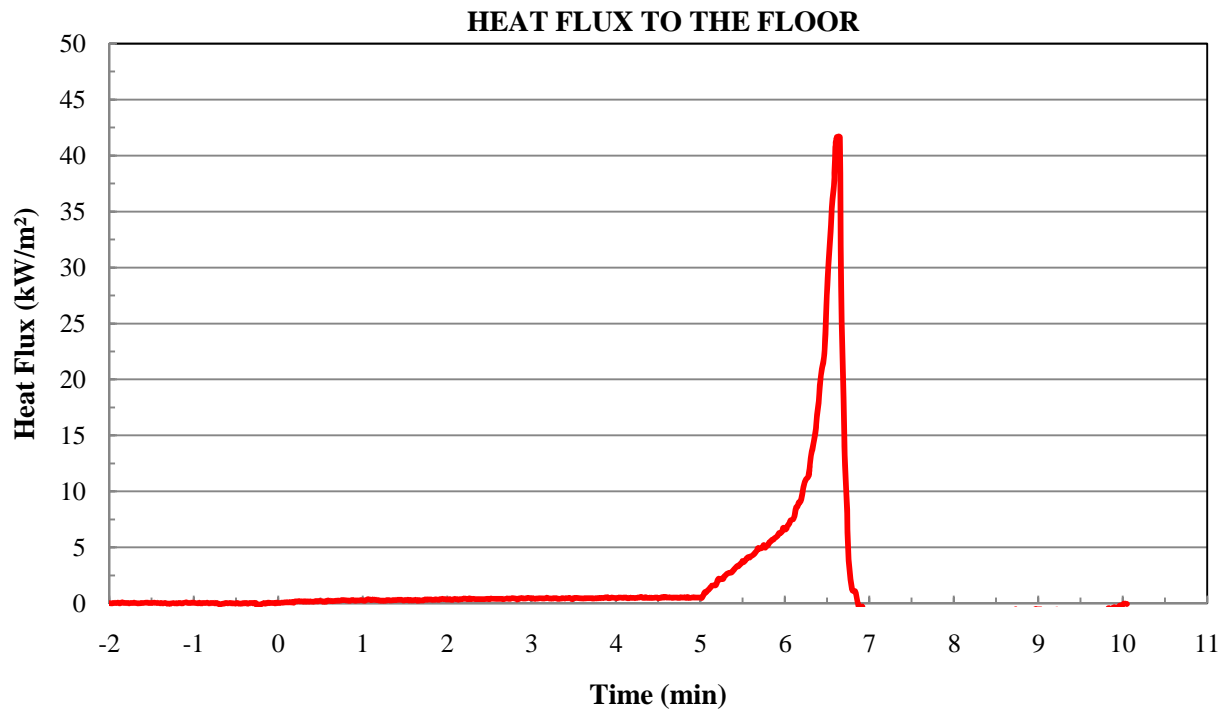




Material ID: BPL 1445-1.8/FX245 with Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)
NFPA 286, using AC377, Appendix X Acceptance Criteria



Material ID: *BPL 1445-1.8/FX245 with Pyrodyne™ Fire Retardant Acrylic Coating (Acry-Tek 5026)*
NFPA 286, using AC377, Appendix X Acceptance Criteria



APPENDIX B
AC377, APPENDIX X
(Consisting of 4 Pages)

ACCEPTANCE CRITERIA FOR SPRAY-APPLIED OAM PLASTIC INSULATION (AC377)

Appendix X

Alternate Testing for Use in Attics and Crawl Spaces without a Code-prescribed Ignition Barrier

X1.0 Scope:

X1.1 General: The objective of this testing is to evaluate the fire performance of spray-applied, polyurethane foam plastic insulation materials (SPF) when tested in a room/corner test configuration to determine if the insulation and/or the insulation system is acceptable for use in attics and crawl spaces without prescriptive ignition barriers per the IRC or IBC.

X1.2 Use in Attics: Spray-applied polyurethane foam plastic insulation installed in attics where entry is made only for service of utilities shall be protected by an ignition barrier as set forth in IBC Section 2603.4.1.6, IRC Section R314.5.3 or Exception 4 of UBC Section 2602.4, except as noted in Section X2.0. Utilities include, but are not limited to, mechanical equipment, electrical wiring, fans, plumbing, gas or electric hot water heaters, and gas or electric furnaces.

X1.3 Use in Crawl Spaces: Spray-applied polyurethane foam plastic insulation installed in a crawl space where entry is made only for service of utilities shall be protected by an ignition barrier as set forth in IBC Section 2603.4.1.6, IRC Section R314.5.4 or Exception 4 of UBC Section 2602.4, except as noted in Section X2.0. Utilities include, but are not limited to, mechanical equipment, electrical wiring, fans, plumbing, gas or electric hot water heaters, and gas or electric furnaces.

X2.0 The ignition barrier shall not be required when satisfactory testing is conducted with exposed foam plastic insulation or with a foam plastic insulation system covered by a coating in accordance with the following:

X2.1 Test Method: The test method to be used is NFPA 286, "Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth," with the modifications described below.

X2.1.1 Ignition Source: The standard gas burner shall be used. The burner shall be positioned such that it is in contact with both sidewalls in the test corner of the fire test room as indicated in Figure X3.

X2.1.2 Specimen Mounting: The test specimens can be mounted in either of two configurations. Whichever configuration is used, the interior room dimensions as required by NFPA 286 shall be maintained. The two configurations are:

a. The fire test room shall be completely lined with one layer of $\frac{5}{8}$ -inch-thick, Type X gypsum wallboard. The SPF shall be applied directly to the gypsum wallboard at the maximum thickness and density intended for use. The SPF shall be applied to both the three test walls and the test ceiling. If a covering is used over the foam, it shall be applied to both the walls and the ceiling at the same minimum thickness or coverage rate intended for use.

b. The three walls of the test room without the doorway will be constructed with wood studs sized to the same depth as the test specimen, 93 inches high, 24 inches on center with a single top and bottom plate, as shown in Figure X1. The exterior side of the walls will be covered with one layer of $\frac{5}{8}$ -inch-thick, Type X gypsum wallboard. The SPF will be sprayed to fill each stud cavity and be continuous from the bottom plate to the top plate and from stud to stud. The ceiling of the test room will be constructed as shown in Figure X2. The ceiling will consist of wood joists sized to the same depth as the test specimen at 24 inches on center. A total of five joists will be used and they will run parallel with the 12-foot length of the test room (front to back). The two outboard joists will rest on the top plates of the walls. The exterior side of the ceiling will be covered with one layer of $\frac{5}{8}$ -inch-thick, Type X gypsum wallboard. The SPF will be sprayed to fill each joist cavity and will be continuous from the front to the back and from joist to joist. If a coating (e.g., intumescent coating) is used over the foam, it shall be applied to both the walls and the ceiling at the same minimum thickness or coverage rate intended for use.

X2.1.3 Test Corner Configuration: During the installation of the SPF, care shall be taken to provide as smooth a surface as possible, especially in the wall areas that will be adjacent to and above the burner. The maximum allowable deviations are described in Figure X3.

X2.1.4 Test Data: During the test, all of the following test parameters shall be determined:

- Time at which the Heat Release Rate exceeds 1 MW.
- Time at which the heat flux to the floor exceeds 20 kW/m^2 .
- Time at which the average upper layer temperature exceeds 600°C .
- Time at which flames exit the doorway.

X2.1.5 Report: The following additional items shall be reported:

- Type, description, average thickness and nominal density of the SPF wall and ceiling specimens.

ACCEPTANCE CRITERIA FOR SPRAY-APPLIED OAM PLASTIC INSULATION (AC377)

- b. If used as part of the insulation system, the type, description, and nominal thickness (in mils) or application rate (in gallons per 100 square feet) of coating.
- c. Time recorded for each test parameter from Section X2.1.4 above.
- d. Average of the four time values indicated in Item X2.1.5c.

X2.1.6 Conditions of Acceptance: A test shall be determined to be successful when the average time for attainment of the four measured test parameters (Item X2.1.5c, above) is 4 minutes 18 seconds or greater. This acceptance criteria is based on comparison of results for the tested assembly versus results for a code-prescribed ignition barrier applied over foam plastic insulation.

X2.2 Limitations:

X2.2.1 Attic Installation:

When testing is in accordance with Appendix X, the evaluation report shall include the following limitations:

- a. Entry to the attic is only to service utilities, and no storage is permitted.
- b. There are no interconnected attic areas.
- c. Air in the attic is not circulated to other parts of the building.
- d. Attic ventilation is provided when required by IBC Section 1203.2 or IRC Section R806, or as required.
- e. The foam plastic insulation is limited to the maximum thickness and density tested.
- f. Combustion air is provided in accordance with IMC Sections 701 and 703.
- g. The installed coverage rate or thickness of coatings, if part of the insulation system, shall be equal to or greater than that which was tested.

X2.2.2 Crawl Space Installation:

When testing is in accordance with Appendix X, the evaluation report shall include the following limitations:

- a. Entry to the crawl space is only to service utilities and no storage is permitted.
- b. There are no interconnected crawl space areas.
- c. Air in the crawl space is not circulated to other parts of the building.
- d. Under-floor (crawl space) ventilation is provided when required by IBC Section 1203.3 or IRC Section R408.1, as applicable.
- e. The foam plastic insulation is limited to the maximum thickness and density tested.
- f. Combustion air is provided in accordance with IMC Sections 701 and 703.
- g. The installed coverage rate or thickness of coatings, if part of the insulation system, shall be equal to or greater than that which was tested.

X2.3 Attic Floors:

The maximum thickness of foam plastic applied on the walls for the test method outlined in Appendix X can be used to establish the maximum thickness of foam plastic without a covering in attic floors. If a proprietary ignition barrier is used on the tested walls, it will be required for the attic floor application, also.

ACCEPTANCE CRITERIA FOR SPRAY-APPLIED OAM PLASTIC INSULATION (AC377)

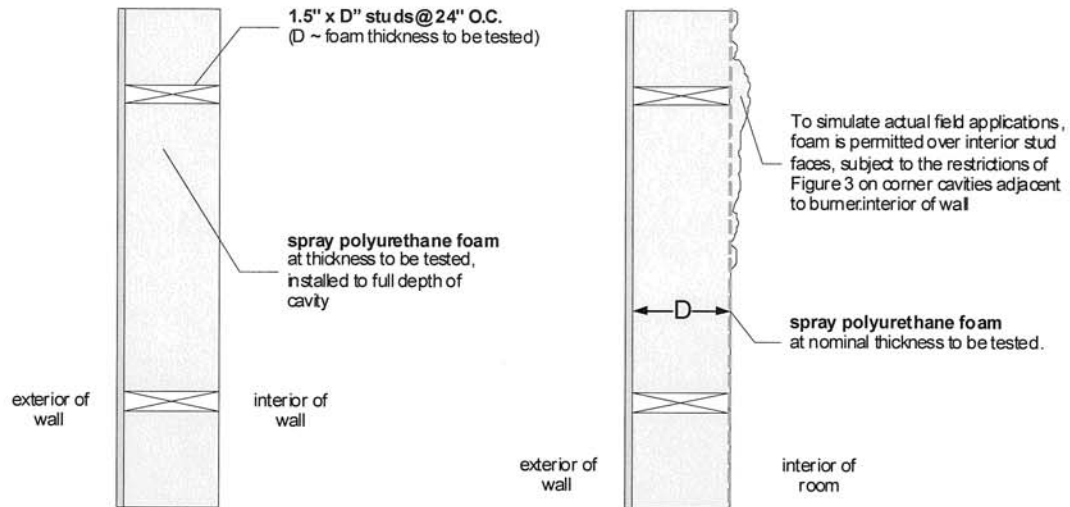


FIGURE X1—TOP VIEW OF WALL CONSTRUCTION

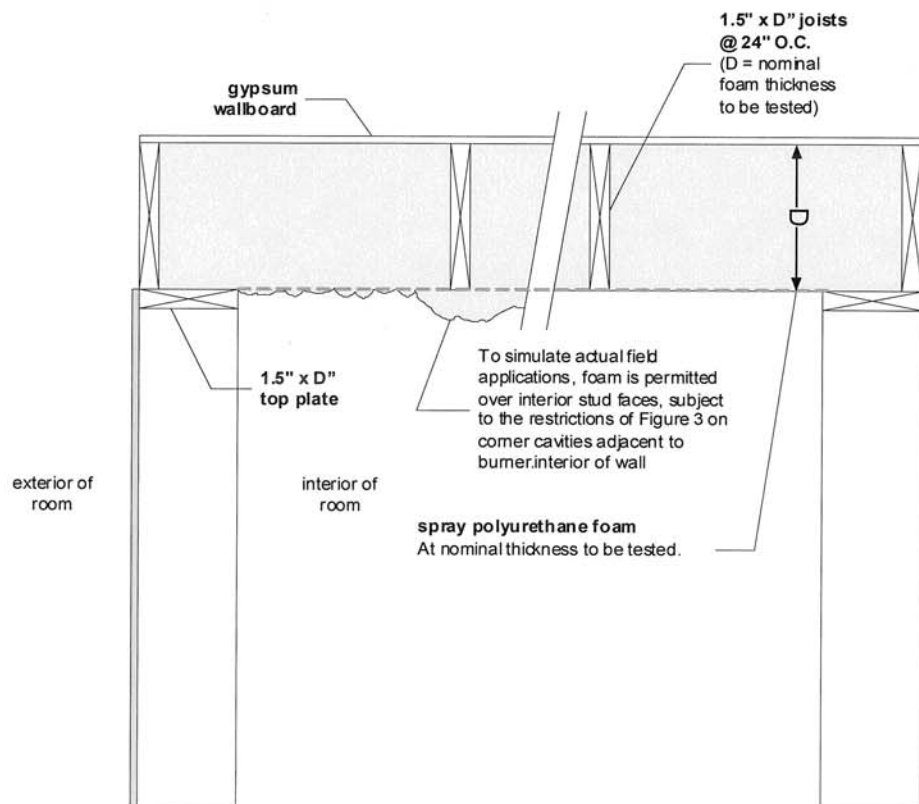
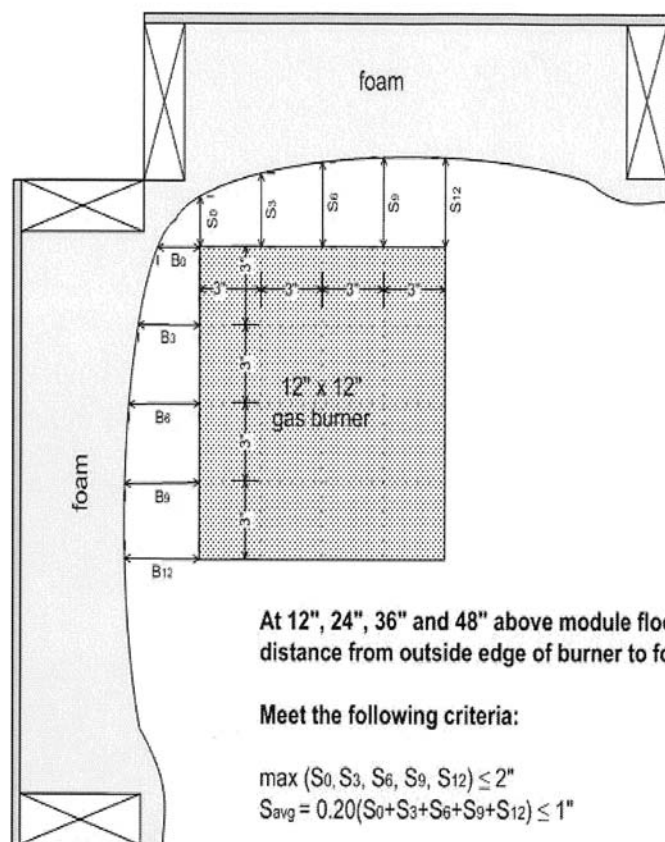


FIGURE X2—SIDE VIEW OF CEILING CONSTRUCTION

ACCEPTANCE CRITERIA FOR SPRAY-APPLIED OAM PLASTIC INSULATION (AC377)



At 12", 24", 36" and 48" above module floor, measure distance from outside edge of burner to foam surface.

Meet the following criteria:

$$\max (S_0, S_3, S_6, S_9, S_{12}) \leq 2"$$

$$S_{avg} = 0.20(S_0 + S_3 + S_6 + S_9 + S_{12}) \leq 1"$$

$$\max (B_0, B_3, B_6, B_9, B_{12}) \leq 2"$$

$$B_{avg} = 0.20(B_0 + B_3 + B_6 + B_9 + B_{12}) \leq 1"$$

FIGURE X3—MEASUREMENT POINTS FOR BURNER SPACING FROM FOAM