EXPANDED PLASTICS IN BUILDING CONSTRUCTION

INTRODUCTION

Because of their excellent thermal insulation properties, foamed plastics have gained wide acceptance in building constructions. However, being derived from organic chemical compounds, they will burn to varying degrees and in some applications can present an unacceptable hazard, which can threaten the fire security of a building. A thorough understanding of the burning characteristics of the various types of materials used and the tests used to evaluate these “burning characteristics” is necessary to adequately evaluate the acceptability of constructions involving foamed plastics.

Foamed expanded plastics have been in use in the roofing industry for years as the insulation in roof assemblies. They are also found in walls and ceilings of coolers and freezers used in the food and pharmaceutical industries.

In recent years the concept of providing insulating material on the exterior of buildings has flourished. Exterior Insulation Finishing Systems (EIFS) allows retrofitting of insulation to a building at minimal cost and does not reduce the workspace or disrupt people working inside. The installation is also used by architects to allow designs to be incorporated in the exterior of buildings. EIFS is a system which uses sheets of expanded polystyrene or polyisocyanurate attached to the exterior of the buildings. The expanded plastic is covered by a material that looks and feels like concrete. EIFS can be installed over concrete blocks or panels, or on wood, gypsum board or metal panels. The insulation can be mechanically fastened, clipped, or adhered with adhesive to the wall system. A reinforcing mesh (mostly polypropylene) is troweled into a base coat applied to the insulation board to add additional strength and to minimize damage to the assembly. A finish coat of either a thin Portland cement or acrylic is applied over the base coat. The finish coat can be textured to look like concrete or stucco.

Other construction materials for exterior curtain walls are: metal composite material (MCM) or aluminum composite material (ACM), and structural insulated panels (SIP) or insulated sandwich panels (ISP).

MCM and ACM are constructed of 25 gauge (0.019 in. 0.5 mm) thick aluminum sheets adhered to both sides of 0.08 to 0.2 in. (2 to 5 mm) thick insulation core of either a polyethylene or polyethylene/mineral fiber mixture. They are manufactured in various colors and are secured to the exterior by either a metal frame or adhered to the substructure. Since these panels do not give much thermal insulation, additional insulation, usually foam plastic, is installed between the panel and the interior wall.

ISP are broken down into two groups, those with metal skin and those with composite skin. Both can be used for walls, ceilings, floors, and roofs. The metal skinned panels are constructed of 24 to 27 gauge (0.16 to 0.22 in. 0.4 to 0.6 mm) thick steel sheets adhered to both sides of 2 to 8 in. (50 to 200

mm) thick insulation core of either expanded polystyrene (EPS), polyisocyanurate (PIR), phenolic, or mineral fiber. The composite skin panels are constructed of either: plywood, oriented strand board (OSB), paper or cardboard based products, gypsum or cement board. The insulation would be the same as the metal skinned panels.

POSITION

Wall Construction Acceptance Considerations

Any EIFS, MCM, ACM, SIP or ISP wall construction with foam plastic is considered combustible. To lessen the extent of fire spread and damage, use only listed panels that have been tested to one of the following full scale or room corner fire tests. Do not use any listed panels tested using a small scale or cone calorimeter test. The use of a small scale or cone tests does not adequately characterize the fire growth and spread of a installed panel.

Large Scale Fire Tests

- BS 8414-1
- BS 8414 Part 2
- CAN/ULC S134
- FM 4880
- ISO 9705
- ISO 13784 Part 1
- ISO 13784 Part 2
- ISO 13785 Part 2
- LPS 1181 Part 1
- LPS 1181 Part 2
- NFPA 285
- SP Fire 105
- UBC 26-3
- UL 1040

Small Scale Fire Tests

- AS 1530
- ASTM E84
- ASTM E136
- ASTM E2652
- BS 476-6
- BS 476-7
- BS 476-11
- EN 13823
- ISO 1182
- ISO 1716
- ISO 11925-2
- NFPA 255
- UL 723

Prefabricated Wall Panels

Use interior and exterior wall systems such as metal composite material, aluminum composite material, structural insulated panels, and insulated sandwich panels, constructed of non-combustible materials such as fiberglass or mineral wool insulation.

Panels listed in any of the following categories are acceptable in wall constructions:

- Underwriters Laboratories *Products iQ*® online certifications program, UL Category Code OEQX
- FM Approvals *Online Approval Guide* - "Building Insulations – Walls and Ceilings"
- Loss Prevention Certification Board *RedBookLive* online certifications program - "Cladding Products Used For The External Envelope Of Buildings" Part 1, Section 2.1.2

When prefabricated panels are used, evaluate the exposures using NFPA 80A and PRC.2.0.5. Listed prefabricated panels can be considered as "noncombustible exposed exterior walls" when evaluating to PRC.2.0.5. Nonlisted panels should be considered as "combustible exterior walls." If the exposure is within the separation distance derived from PRC.2.0.5, provide protection to the wall.

Exterior Insulation Finishing Systems

When EIFS are used, evaluate the exposures using NFPA 80A and PRC.2.0.5. Listed EIFS (the entire assembly, not just the insulation) can be considered as "noncombustible exposed exterior walls" when evaluating to NFPA 80A and PRC.2.0.5. Nonlisted EIFS should be considered as "combustible exterior walls." If the exposure is within the separation distance derived from NFPA 80A and PRC.2.0.5, provide protection to the wall.

Other Insulated Wall Constructions

Figures 1 through 3 (See also Table 1 for construction notes) show acceptable arrangements of thermal barriers over various types of cellular plastics for constructions other than the acceptable wall panels previously described. A wall panel not in accordance with the previously described criteria requires a thermal barrier. (**Note**: See Table 2 for a summary of acceptable thermal barrier constructions.)

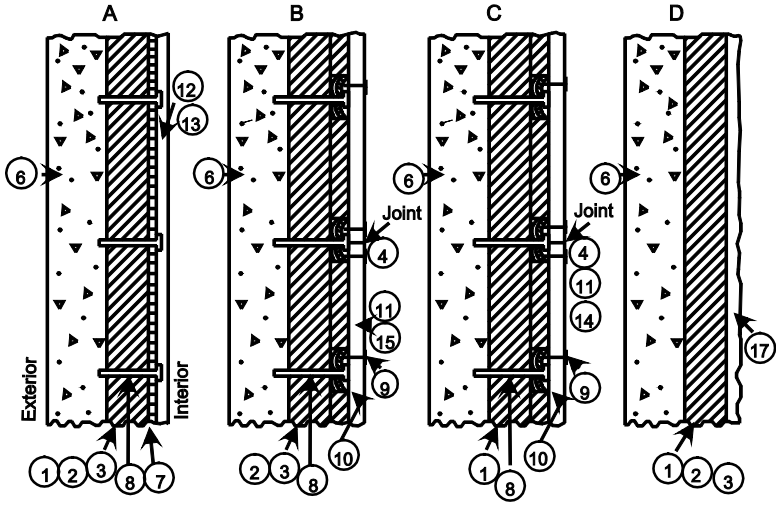

Figure 1. Foam Applied To Interior Of Masonry Wall.

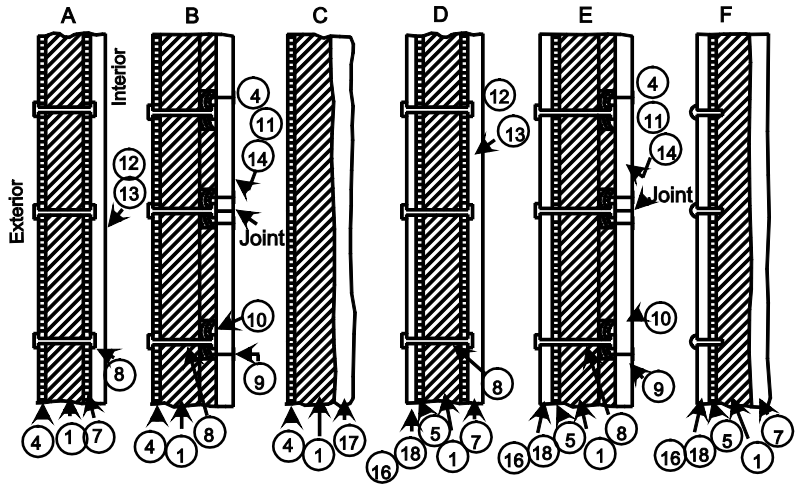

Figure 2. Low Flamespread Polyurethane Or Polyisocyanurate Foam Applied To Interior Of Metal Wall.

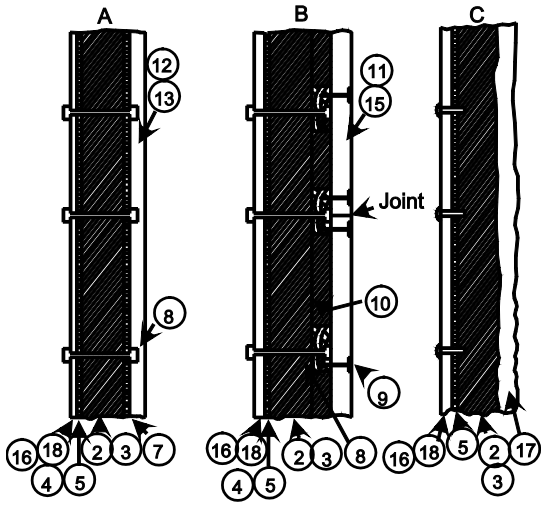

Figure 3. Polystyrene Or High Flamespread Polyurethane Foam Applied To Interior Of Metal Wall.

Ceiling Construction Acceptance Considerations

Prefabricated Panels

Panels listed in any of the following categories are acceptable in ceiling constructions if the listings indicate applicability and do not, in themselves, require automatic sprinklers:

- Underwriters Laboratories Online Certifications Program, UL Category Code OEQX
- FM Approvals Online Approval Guide - “Building Insulations – Walls and Ceilings”

Roof Construction Acceptance Considerations

Three factors must be considered in determining the acceptability of roof-deck-insulation systems: external fire exposure and internal fire exposure, and wind uplift. Table 4 indicates various uses of cellular plastics in roof-deck constructions where the foam is applied to the topside of the roof deck and the acceptability of each from the fire standpoint.

Any roofing system using foam plastic should be tested and listed to either FM 4450 or UL 1256.

Other Constructions Utilizing Cellular Plastics Applied to Underside of Ceiling or Roof Deck

Figure 4 (See Table 1 for construction notes) shows acceptable arrangements of thermal barriers to protect various types of cellular-plastic-insulated constructions other than acceptable prefabricated panels previously indicated. (**Note**: See Table 3 for a summary of acceptable constructions.)

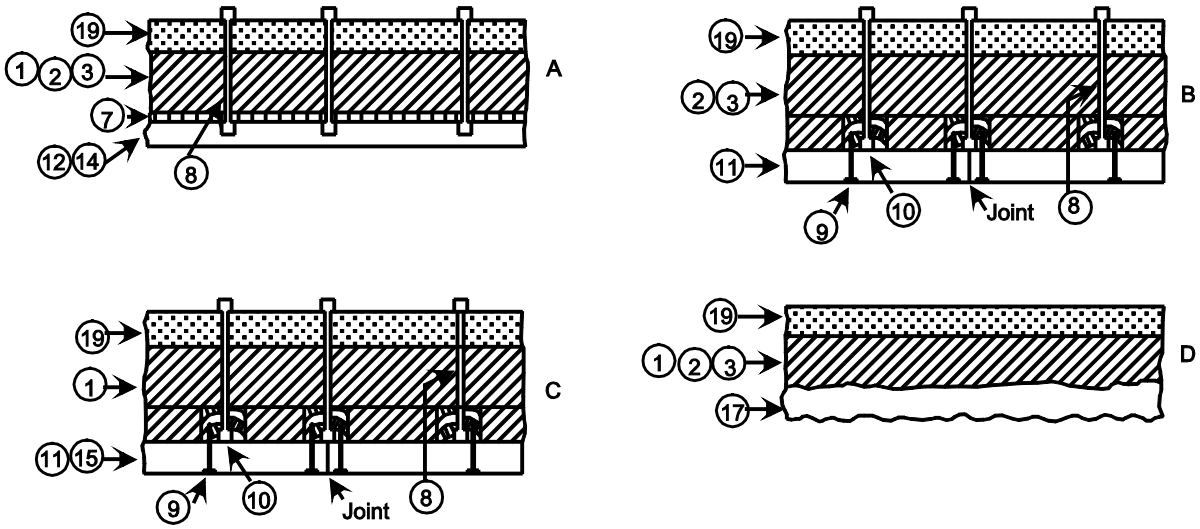

Figure 4. Foam Applied To Underside Of Ceiling Or Roof Deck.

TABLE 1
Construction Drawing Notes
For Figures 1-4

1. Polyurethane or polyisocyanurate foam, ASTM E 84 Flamespread ≤ 25 (Note 1)
2. Polyurethane foam, ASTM E 84 Flamespread > 25 (Note 1)
3. Polystyrene foam (regardless of ASTM E 84 flamespread)
4. Steel (minimum 26 gage [0.47 mm]) or aluminum (minimum 0.032 in. [0.81 mm])
5. Steel (less than 26 gage [0.47 mm]) or aluminum (less than 0.032 in. [0.81 mm])
6. Masonry wall
7. Metal lath
8. Through-fastener
9. Nail
10. Wood nailer (2 in. × 2 in. [50 × 50 mm] nominal minimum)
11. ½ in. (12.7 mm) gypsum board (joints placed over nailers and taped)
12. ½ in. (12.7 mm) gypsum plaster
13. ⅝ in. (15.9 mm) Portland cement plaster
14. ½ in. (12.7 mm) “Noncombustible” plywood (joints placed over nailers or covered with batten strips)
15. ¾ in. (19 mm) “Noncombustible” plywood (joints placed over nailers or covered with batten strips)
16. ¼ in. (6.4 mm) “Noncombustible” exterior grade plywood (joints placed over nailers or covered with batten strips)
17. Acceptable spray-on coating
    a. Listed by Underwriters Laboratories’ *Online Certificate*- “Interior Building Constructions” (OEQX) - “Cementitious Materials (OERS)”
    b. Listed by FM Approval’s Online *Approval Guide* - “Fire Retardant Coatings.” The coating listed must be applied over **only** the type of foam plastic specified in the listing for the coating.
18. ¼ in. (6.4 mm) flat reinforced cement board
19. Roof or ceiling deck

Note 1. This numerical flamespread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

TABLE 2
Summary Of Acceptable Wall Constructions Utilizing Cellular Plastics

Polyurethane or Polyisocyanurate Foams (Flamespread ≤ 25 [Note 1])

Interior Exposure

1. Acceptable Panel (Note 2)
2. Acceptable Thermal Barrier
   a) ½ in. (12.7 mm) Gypsum board (Figures 1-C, 2-B & E) (Note 3)
   b) ½ in. (12.7 mm) Gypsum plaster on metal lath (Figures 1-A, 2-A & D) (Note 4)
   c) ⅝ in. (15.9 mm) Portland Cement Plaster on metal lath (Figures 1-A, 2-A, & D) (Note 4)
   d) ½ in. (12.7 mm) Noncombustible plywood (Figures 1-C, 2-B & E) (Notes 3 & 5)
   e) Acceptable coating listed by UL as "Interior Building Constructions (OEQX) - Cementitious Material (OERS)" or FM as "Fire Retardant Coatings" applied only over the specific type of foam plastic indicated. (Figures 1-D, 2-C & F).

Exterior Exposure

1. Acceptable Panel (Note 2)
2. Acceptable Flame Barrier
   a) 0.032 in. (0.8 mm) Aluminum (Figures 2-A, B & C) (Note 3)
   b) 26 Gage (0.47 mm) steel (Figures 2-A, B & C) (Note 3)
   c) ¼ in. (6.4 mm) Noncombustible exterior grade plywood (Notes 3 & 5)
   d) ¼ in. (6.4 mm) Flat cement-asbestos board (Figures 2-D, E & F) (Note 3)

Polyurethane (Flamespread > 25 [Note 1]) or Polystyrene Foams

Interior Exposure

Acceptable Thermal Barrier

   a) ½ in. (12.7 mm) Gypsum board (Figures 1-B, 3-B) (Note 3)
   b) ½ in. (12.7 mm) Gypsum plaster on metal lath (Figures 1-A, 3-A) (Note 4)
   c) ⅝ in. (15.9 mm) Portland Cement Plaster on metal lath (Figures 1-A, 3-A) (Note 4)
   d) ¾ in. (19 mm) Noncombustible plywood (Figures 1-B, 3-B) (Notes 3 & 5)
   e) Acceptable coating listed by UL as "Interior Building Constructions (OEQX) - Cementitious Material (OERS)" or FM as "Fire Retardant Coatings" applied only over the specific type of foam plastic indicated. (Figures 1-D, 3-C).

Exterior Exposure

Acceptable Thermal Barrier

   a) ¼ in. (6.4 mm) Noncombustible exterior grade plywood (Figure 3) (Notes 3 & 5)
   b) ¼ in. (6.4 mm) Flat cement-asbestos board (Figure 3) (Note 3)

Note 1. This numerical flamespread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

Note 2. See text - Wall Construction Acceptance Considerations, Prefabricated Metal Panels.

Note 3. Nailed to wood nailers (2 in. × 2 in. [50 mm × 50 mm] nominal minimum) spaced 16 in. (400 mm) maximum on centers and imbedded in the foamed plastic so that the face of the studs and, therefore, the thermal barrier are flush with the foamed plastic. Joints to be placed over nailers and filled and taped. Nailers to be securely attached to building wall upon which foam is applied with through-fasteners.

Note 4. Metal lath to be securely attached to building wall upon which the foam is applied with through-fasteners.

Note 5. Classified by UL as having flamespread, (Note 1) fuel contributed, and smoke developed values of 25 or less and having been subjected to tests of 30 min duration during which the flamespread did not exceed 25 and with no indication of significant progressive combustion.

TABLE 3

Summary Of Acceptable Ceiling Constructions With Cellular Plastics Installed On The Underside Of Ceiling Or Roof Deck

Polyurethane or Polyisocyanurate Foams (Flamespread ≤ 25 [Note 1])

1. Acceptable Panel (Note 2)
2. Acceptable Flame Barrier
   a) ½ in. (12.7 mm) Gypsum board (Figure 4-C) (Note 3)
   b) ½ in. (12.7 mm) Gypsum plaster on a metal lath (Figure 4-A) (Note 4)
   c) ⅝ in. (15.9 mm) Portland Cement Plaster on metal lath (Figure 4-A) (Note 4)
   d) ¾ in. (9 mm) Noncombustible plywood (Figure 4-C) (Notes 3 & 5)
   e) Acceptable coating listed by UL as "Interior Building Constructions (OEQX) - Cementitious Material (OERS)" or FM as "Fire Retardant Coatings" applied only over the specific type of foam plastic indicated (Figure 4-D).

Polyurethane (Flamespread > 25 [Note 1]) and All Polystyrene Foams

   a) ½ in. (12.7 mm) Gypsum board (Figure 4-B) (Note 3)
   b) ½ in. (12.7 mm) Gypsum plaster on metal lath (Figure 4-A) (Note 4)
   c) ⅝ in. (15.9 mm) Portland Cement Plaster on metal lath (Figure 4-A) (Note 4)
   d) Acceptable coating listed by UL as "Interior Building Constructions (OEQX) - Cementitious Material (OERS)" or FM as "Fire Retardant Coatings" applied only over the specific type of foam plastic indicated (Figure 4-D).

Note 1. This numerical flamespread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

Note 2. See text - Ceiling Construction Acceptance Considerations, Prefabricated Metal Panels.

Note 3. Nailed to wood nailers (2 in. × 2 in. [50 mm × 50 mm] nominal minimum) spaced 16 in. (406 mm) maximum on centers and imbedded in the foamed plastic so that the face of the studs and, therefore, the thermal barrier are flush with the foamed plastic. Joints to be placed over nailers and filled and taped. Nailers to be securely attached to building wall upon which foam is applied with through-fasteners.

Note 4. Metal lath to be securely attached to building wall upon which the foam is applied with through-fasteners.

Note 5. Classified by UL as having flamespread, (Note 1) fuel contributed, and smoke developed values of 25 or less and having been subjected to tests of 30 min duration during which the flamespread did not exceed 25 and with no indication of significant progressive combustion.

TABLE 4
Summary Of Acceptable Roof Constructions With
Cellular Plastics Installed On The Topside Of The Roof Deck

Polyurethane or Polyisocyanurate (Flamespread $\leq$ 25 [Note 1])
Interior Fire Exposure
1. Roofing system classified as "Fire Classified" by UL (Note 2)
2. Roofing system classified as "Noncombustible," "Class 1" or "Lightweight (Insulated), Low Fire Hazard" by FM (Note 2)
3. Foam applied over any of the follow:
   a) existing "Fire Classified" roof (Note 2)
   b) ¾ in. (19 mm) noncombustible plywood roof deck(Note 3)
   c) precast concrete roof planks (Note 4)
   d) reinforced concrete roof decks without joints
4. Foam applied over any of the following which are applied over a metal deck:
   a) ½ in. (12.7 mm) gypsum board
   b) ½ in. (12.7 mm) poured, lightweight gypsum concrete
   c) 1 in. (25.4 mm) fiberboard
   d) ¾ in. (19 mm) mineral or perlite board

Exterior Fire Exposure
All roofing-foam combinations should be listed by UL as a Class A covering.

Polyurethane (Flamespread > 25 [Note 1]) and All Polystyrene Foams
Interior Fire Exposure
1. Roofing system classified as "Fire Classified" by UL (Note 2)
2. Roofing system classified as "Noncombustible," "Class 1," or "Light weight (Insulated), Low Fire Hazard" by FM.
3. Foam applied over any of the following:
   a) existing "Fire Classified" roof (Note 2)
   b) ¾ in. (19 mm) noncombustible plywood roof deck(Note 3)
   c) precast concrete roof planks (Note 4)
   d) reinforced concrete roof decks without joints
4. Foam applied over any of the following which are applied over a metal deck:
   a) ½ in. (12.7 mm) gypsum board
   b) ½ in. (12.7 mm) poured, lightweight gypsum concrete
   c) 1 in. (25.4 mm) fiberboard
   d) ¾ in. (19 mm) mineral or perlite board

Exterior Fire Exposure
All roofing-foam combinations should be listed by UL as a Class A covering.

Note 1. This numerical flamespread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

Note 2. Classified by UL as having flamespread, (Note 1) fuel contributed, and smoke developed values of 25 or less and having been subjected to tests of 30 min duration during which the flamespread did not exceed 25 and with no indication of significant progressive combustion.

Note 3. Joints should be either tongue and groove, lapped, or grouted, or should be placed over beams or purlins such that there is no exposed foamed plastic.

Note 4. Some foamed plastic systems may be applied directly to a metal deck and are "fire classified" by UL or classified as "Class 1" by FM. Caution: Only the exact system components — i.e., vapor barrier, adhesive, foam, plys, or top coat — may be used. Any substitution will void the acceptance.

DISCUSSION

Foamed plastics are derived from petroleum-based materials and are organic chemical compounds. For this reason, **All** foam plastics will burn under some condition.

Advances in chemical formulations and methods of utilization of the materials have resulted in constructions that can be used without unduly jeopardizing the fire security of the structure. The fire tests described in this section were developed over the years in an attempt to measure the burning characteristics of these and other building materials. These tests assume a level of localized fire exposure that would be encountered in an occupancy not normally requiring sprinkler protection. The tests are designed to show that a particular construction will not materially add to a fire involving the building or its contents. The fire security of a building is dependent upon the identification of the hazards of the contents, the protection provided for those hazards, and the susceptibility of the construction materials to damage from fire. All of these factors must be considered in deciding if a

particular test is applicable to a particular situation. The presence of cellular plastics in building assemblies should be considered when deciding if “borderline” protection schemes are acceptable.

Fire Behavior Of Cellular Plastics In Building Applications

Polyurethane foams, when exposed to a fire, degrade and evolve combustible gases that eventually reach the autoignition temperature and burn with intense heat and copious quantities of smoke. This degradation occurs in a period of time that varies with the type of polyurethane foam, but is a matter of a few minutes some cases, before sprinklers can operate.

Advances in chemical formulations of the cellular polyurethanes and polyisocyanurates have resulted in development of material, which produce a heavy char upon burning. This char acts as a heat barrier and limits the amount of degradation products. Polystyrene foams, in addition to forming degradation products of flammability similar to those from polyurethane foams melt very quickly. Because of this melting property of the polystyrene foams, the facings readily fall away and expose larger quantities of the foam to the fire.

Tests For Wall And Wall/Ceiling Constructions

A number of years ago, a test was developed to evaluate the performance of cellular plastics in a building configuration. It was designed to simulate the maximum exposure likely to be encountered in an industrial building that would normally not require sprinklers. A 5 ft (1.5 m) stack of wood pallets in the corner of a building was chosen to represent this exposure. In the test (See Figure 5), the materials to be investigated are used to construct a building corner, with the adjoining walls 25 to 50 ft (6.1 to 12.2 m) long and 25 to 30 ft (6.1 to 9.2 m) high. A noncombustible ceiling or the test material is placed over this corner to bank the heat produced from the exposure fire and burning cellular plastic. The exposure, a 5 ft (1.5 m) high stack of pallets (FM) or a 4 ft (1.2 m) high wood crib (UL) is placed in the corner, one foot from each wall, and ignited. Thermocouple readings are taken at various points along the panel walls, at the eave line, and across the ceiling. The flame-travel along the panels and the damage sustained during the test are noted. This full-scale corner test is used by Underwriters Laboratories to qualify constructions containing cellular plastic. This test is also used by FM Approvals as **one** of the tests to qualify cellular plastic containing constructions in their category.

In the corner test, it usually takes about 3 to 4 min for the fire in the crib to develop and to affect the construction sample. Typically, the foam in urethane foam constructions ignites soon after this initial period either on the face of bare foam or at the joint of a panel. In the case of bare foam, flames usually race to the ceiling and out along both eave lines. After the initial flash, a thermal barrier of char is formed and the flames then usually subside and burn directly behind the crib where the temperature is in the vicinity of 1000°F (538°C). Depending upon the stability of the panel facings, the fire development in panels is much slower than for bare foam and, in many cases, the flames do not propagate more than about 10 ft (3 m) from the corner.

Corner tests of polystyrene foams have thus far involved only panel configurations under sprinkler protection. These tests have indicated that when the polystyrene foam begins to melt, ignition occurs at the panel joint. The flame propagation is rapid, both in the vertical direction and horizontally at the eave line, and the temperature produced at the eave line is much greater than with a polyurethane core with the same facing.

Another test, originally developed by the National Institute of Science and Technology, has been used for a number of years by various code groups to qualify constructions containing cellular plastic. This test, now generally known as the “Enclosed Room/Corner Test” (See Figure 6), is performed in a room 8 ft (2.4 m) wide by 12 ft (3.7 m) long by 8 ft (2.4 m) high. The test sample materials are placed in one corner of the room and compose the walls and ceiling of a corner configuration 8 ft × 8 ft × 8 ft (2.4 m × 2.4 m × 2.4 m) high. The 8 ft (2.4 m) wall opposite the test sample wall contains a doorway that is the only opening into the room. A 30 lb (13.6 kg) wood crib is placed in the corner and flames from this crib impinge upon both walls. Thermocouple readings are taken at various points along the panel walls, at the eave line, and across the ceiling. The flame travel along the sample and the damage sustained are noted. Underwriters Laboratories utilizes this test in

classifying constructions containing cellular plastic as “Interior Building Constructions.” We believe that the heat flux exposure to the sample in this test is at least as severe as the full-scale corner test.

FM Approvals utilize a number of tests to qualify building constructions containing cellular plastics for listings other than the full-scale corner test mentioned previously. For example, they will list a panel to be used on walls on the basis of a series of tests including a channel test and an ASTM E 84 flamespread test. The FM Channel Test (see Figure 7) utilizes a 24 ft (7.3 m) long inverted channel constructed of gypsum board. The test material is installed on the side walls of the channel. A 1 ft^2 (0.093 m^2) pan of heptane is placed in a wind shroud at one end. The test is run for 15 min. At the end of this period, there can be no evidence of sustained flame propagation and flaming cannot reach the end of the channel. This channel test is capable of determining if a panel's construction features, such as the facing thickness and joint design, will prevent flame propagation. This series of tests is not used to qualify panels for walls **and** ceiling constructions. Only the full-scale corner test is used for this application. For a panel construction, the channel test will provide an exposure to the sample at least as severe as is encountered in the full-scale corner test or enclosed room/corner test.

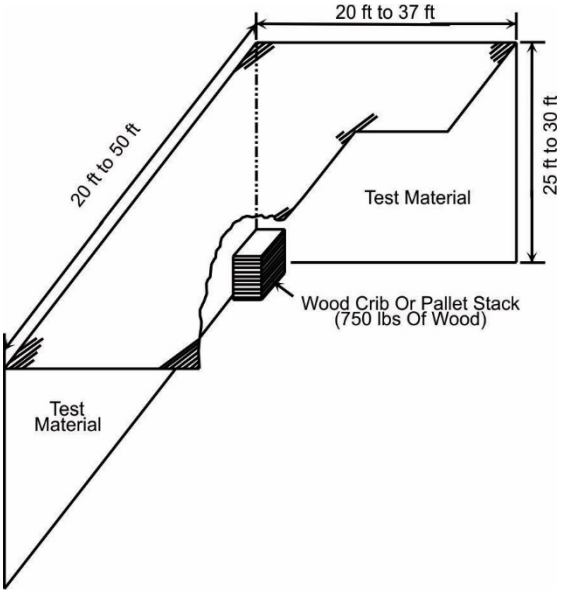

Figure 5. FM Full Scale Corner Test Arrangement.

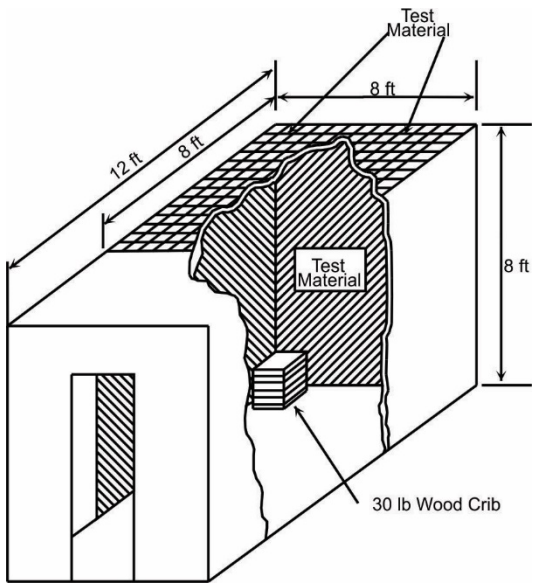

Figure 6. Enclosed Room/Corner Test.

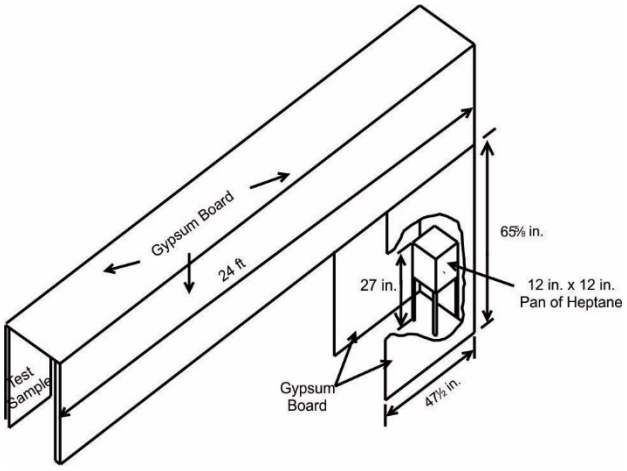

Figure 7. FM Channel Test.

To qualify thermal barrier coatings over cellular plastics under the Fire Retardant Coatings for Interior Finish and Insulation category, FM Approvals uses the construction materials calorimeter test apparatus. The construction materials calorimeter is a horizontal furnace of rectangular cross section, having a firing chamber at one end, a test panel exposure chamber and a flue at the other end. The

4½ × 5 ft (1.4 x 1.5 m) test sample is placed on the top of the furnace and the furnace firing is a time-temperature curve which reaches 1200°F (649°C) in 2 min and about 1300°F (704°C) in 4 min. The test is run for 10 min. To qualify as an acceptable thermal barrier over cellular plastics, the coating must remain intact, not peel away exposing the foam, and provide sufficient resistance to thermal conductivity such that no more than 1% of the 4 ft × 4 ft (1.2 m × 1.2 m) specimen area is decomposed during the test period. This test provides a heat flux to the sample in excess of that provided by the corner tests.

Tests for Exterior Fire Exposure of Wall Insulation Systems

The two methods of testing as indicated previously are the NFPA 285 tests and Factory Mutual Full Scale Corner Test. The Factory Mutual corner test has been discussed under the **"Test For Wall And Wall/Ceiling Constructions"** section.

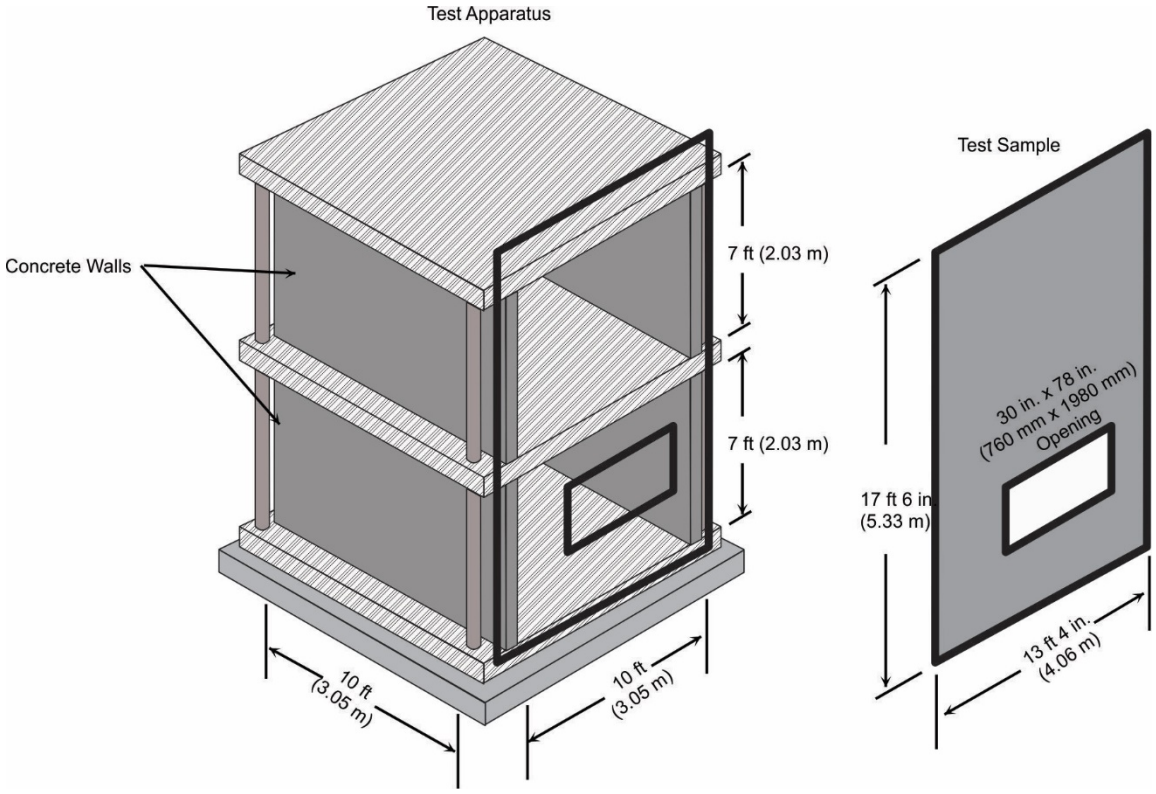

Figure 8. NFPA 285 Fire Test Arrangement.

The NFPA 285 test protocol uses a two story structure (See Figure 8). The second floor and top slab are 7 ft (2.03 m) apart. The first floor and top slab are a 6 in (152 mm) thick reinforced concrete slab. The second floor is an 8 in. (203 mm) thick reinforced concrete slab. The three walls of the test rooms are constructed of 8 in (203 mm) concrete blocks. The test sample is in a frame measuring 13 ft 4 in. (4.06 m) wide by 17 ft 6 in. (5.33 m) high. There is a 30 in. (780 mm) × 78 in. (1980 mm) opening on the first floor, 30 in. (780 mm) from the bottom. There are two gas burners used in this test. The first is a 5 ft (1.54 m) wide burner installed 6 ft (1.83 m) from the back of the test room and 2.5 ft (0.8 m) above the floor. The second gas burner is placed in the opening of the test sample. The test is considered a success if:

- A temperature of 1000°F (538°C) is measured by any one of the thermocouples at the top of the sample.
- Flames emitting from the surface of the exterior face of the test specimen reach a height of 10 ft (3.05 m) or greater above the top of the window opening.

- Flames emitting from the surface of the exterior face of the test specimen reach a horizontal distance of 5 ft (1.52 m) or greater from the vertical centerline of the window opening.
- The temperature 1 in. (25 mm) from the interior surface of the second floor does not exceed 350°F (194°C) above ambient.
- Flames do not enter the second floor.
- Flames do not occur beyond the intersection of the test specimen and the side walls of the test apparatus.

Roof Deck - Internal Fire Exposure Evaluations

The basic purpose of the internal-exposure test is to determine if a localized fire within an **unsprinklered** building will cause the propagation of flame in the roof assembly outside the immediate fire area.

Roof-deck assemblies are evaluated by UL and FM for internal fire exposure. UL uses a modified Steiner Tunnel Test (UL 1256). This test uses the same time-temperature curve as in the usual Tunnel Test except that the test is run for 30 min rather than the usual 10 min. The assembly tested is rated “Fire Classified” by UL if the fire does not propagate beyond set limits during the test.

FM Approvals use their calorimeter test to determine the hazard when a roofing system is internally exposed. Ratings of “Noncombustible,” “Light-Weight (Insulated), Low Fire Hazard” and “Class 1” are given to assemblies that pass this test.

Roof Coverings - External Fire Exposure Evaluations

Underwriters Laboratories lists roof-covering materials as Class A, B, or C with respect to external fire exposure. Their roof coverings listings are evaluated for external exposure only and not for a fire exposure inside the building. FM approved roof systems have also been evaluated for external fire exposure.