Twenty years ago, laminated steel faced insulated metal panels (IMPs) with block expanded polystyrene foam cores were commonly used in the construction of cold storage/food processing buildings. Even then, however, Factory Mutual Approved Class 1 foamed-in-place polyurethane core IMPs were preferred and used extensively, but capacity was limited and the few plant locations made shipping costs prohibitive to some key regions of the country. Today, there are continuous Class 1 polyurethane panel lines located in every region of the country, thusly eliminating any freight disadvantages, and EPS panels now make up a very small percentage of the IMP marketplace.

Foamed-in-place polyurethane panels are stronger than typical 1.0 pcf density EPS panels with 2.1-2.5 pcf closed-cell core densities. Additionally, polyurethane panels provide almost twice the R-Value per inch of thickness and incorporate technically superior hidden faster roll-formed joineries. Most importantly, Factory Mutual 4880 Class 1 Approved polyurethane panels are proven, through rigorous full scale fire testing, to perform far better than EPS core panels when it comes to fire resistivity. Some might wonder why a fire would happen in a cooler or freezer, but it does happen. In fact, there have been enough fires involving EPS panels that the insurance industry has become well aware of the risk levels compared with Class 1 polyurethane panels. FM Global Property Loss Prevention Data Sheet 1-57 is pretty clear on the limited use options for EPS metal faced “sandwich panels” under sections 2.5, especially with sprinklers, fastening and height limitations. This is important not only from a building and life safety perspective, but also when considering insurance premiums. In the litigious times we live in, it seems difficult to make a compelling argument for the use of laminated EPS panels over foamed in place Class 1 polyurethane panels.

Attachment: FM Property Loss Prevention Data Sheet 1-57
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1.0 SCOPE

This data sheet provides recommendations for the use and fire protection of selected plastic building materials. Materials included are:

- fiberglass reinforced plastic (FRP).
- polyvinyl chloride (PVC) plastic.
- polymethyl methacrylate (PMMA) and polycarbonate (PC) plastics.
- polyurethane (PU) and polyisocyanurate (PIR) insulated panels.
- expanded and extruded polystyrene (EPS) insulated panels.
- spray-applied insulations including polyurethane (PU) foam, cellulose, and icynene.
- plastic structural members.

Some of the applications specifically covered in this standard include wall and ceiling panels, sandwich panels used for roof construction, spray-applied polyurethane, guidance on outdoor storage tanks, and elastomeric insulation.

Heated plastic tanks, ductwork, piping, and exterior exposure protection of plastic panels are not covered in this data sheet.

References to polyurethane also apply to polyisocyanurate, unless specifically noted otherwise. References to EPS apply to both expanded and extruded polystyrene. For recommendations on plastic ductwork, see Data Sheet 7-78, Industrial Exhaust Systems. For recommendations on wind resistance for exterior wall and roof panels, see Data Sheet 1-28, Wind Design. For recommendations on cavity wall construction, see Data Sheet 1-12, Ceiling and Concealed Spaces. For recommendations on exterior fire exposure, see Data Sheet 1-20, Protection Against Exterior Fire Exposure.

For FM Approved products, refer to any limitations highlighted within the Approval Guide, a publication of FM Approvals. A listing of FM 4910 materials can be found in the Approval Guide.

1.1 Changes

April 2014. Clarification was provided for protection of spray-on polyurethane insulation covered with an FM Approved fire-retardant coating (Section 2.4.1.3).

1.2 Hazard

Plastic materials are used frequently in building construction because they provide many advantages. What often is not recognized, however, is that all plastic materials are combustible and burn with varying degrees of intensity. Automatic sprinklers installed to protect the occupancy are not always adequate to protect against a fire involving walls and ceilings made of plastic materials. With some burning plastics, fire can propagate faster than standard automatic sprinklers can operate. In industries particularly sensitive to smoke and contamination, such as food, semiconductor and pharmaceutical, even a small fire involving plastic materials can cause a large monetary loss. And certain plastics such as polycarbonate used in skylights, may soften and sag, obstructing automatic sprinklers below.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

2.1.1 Noncombustible materials are preferred in all cases.

2.1.2 Where plastic construction materials are needed, use FM Approved (see Appendix A for definition) Class 1 materials for all new construction and retrofit applications. Also, use FM Approved sprinklers for all new protection installations. Use all products within the limits of their FM Approval. FM Approved 4882 panels are available for use in smoke sensitive occupancies. FM Approved materials are required to have the Approval mark on the packaging or the material itself. Materials without proper labeling are not FM Approved; do not treat them as such.

2.1.3 Do not use individual comparative testing, such as ASTM E84 (USA) single burning item (SBI), ignition resistance, and/or heat of combustion-type testing or results as the sole means of classifying plastic building
materials. Unless noted otherwise, disregard these tests for all plastics. Similarly, ignore performance observed when exposed to match-scale ignition sources in non-standard testing (testing methods and standards that are not recognized). These tests do not reliably predict the fire behavior of plastic building materials. Also, ignore tests specifically done for life safety purposes only and not property protection. (See Data Sheet 1-4, Fire Tests.)

2.1.4 Provide ceiling sprinklers beneath any faced combustible ceiling (polyurethane, polyisocyanurate, EPS, etc., with a metal, aluminum foil, or plastic facer) even if the occupancy is noncombustible due to the combustibility of the ceiling involved and the potential for it to be ignited and propagate fire spread. (This does not apply to FM Approved panels that do not require sprinklers.)

2.1.5 Do not use exposed foam plastic panels (polyurethane, polyisocyanurate, EPS) on walls and/or ceilings; these require a thermal barrier or a panel facer material. (Note that this is also typically a building code requirement.)

2.2 FRP Panels

2.2.1 Unbacked Single-Layer FRP Panels

2.2.1.1 Construction and Location

2.2.1.1.1 Non-FM Approved single-layer FRP building panels installed on the walls and/or roof can remain at existing sprinklered locations if the installed panels meet all of the following criteria:

a) Panels are not backed by any other material, combustible or noncombustible. An air space of a few feet between the panel and backing, where the heat cannot be continuously vented, is not sufficient to consider the product unbacked. The plastic panel must be able to vent to the atmosphere or a large plenum area (which will inhibit fire spread along the surface of the plastic panel) in order to be considered unbacked. Backings prevent heat dissipation by which the rapid flame spread is usually controlled.

b) Thickness 1/16 in. (1.6 mm) maximum.

c) Weight 8 oz/ft$^2$ (2.4 kg/m$^2$) maximum.

d) Chopped strand or continuous non-woven glass reinforcement fiber is used. If translucent, the reinforcement will be visible.

e) The panels are FR-treated, as demonstrated by having a low flame spread rating (e.g., ASTM E-84 flame spread rating of 25 or less, or other equivalent test).

f) Panels are installed at a maximum height of 30 ft (9.1 m) on the walls (this includes a maximum of 30 ft (9.1 m) vertical band at an elevated wall height).

g) Sprinkler protection is provided and meets the minimum performance criteria detailed under Section 2.2.1.2.

2.2.1.2 Protection for Unbacked FRP Panels

2.2.1.2.1 When sprinklers are recommended in this data sheet to protect FRP building materials on the walls and ceiling, or in the void space above a ceiling, design the system as outlined below, unless specific parameters are given in the recommendation:

a) Ensure sprinklers are 165°F (74°C), with K5.6 (K80). For existing installations, the use of 286°F (141°C) sprinklers is acceptable provided the required sprinkler design can be met.

b) Ensure the sprinkler system and water supply are capable of providing 0.20 gpm/ft$^2$ (8 mm/min) over 2,000 ft$^2$ (186 m$^2$), including a 250 gpm (950 L/min) hose allowance.

c) If the occupancy requires different protection, use the more stringent design and follow occupancy-specific installation guidelines.

2.2.1.2.2 When the occupancy does not require sprinklers, or when existing sprinklers cannot meet the above design and FRP building materials are used on the walls only (noncombustible or Class 1 ceiling/roof), the following protection may be used for the FRP material itself as an alternate to recommendation 2.2.1.2.1:
a) Provide a horizontal line of quick response sprinklers at the ceiling/roof 2 ft ± 3 in. (0.6 m ± 90 mm) from each wall. Space sprinklers on a wet system 10 ft (3 m) on center maximum along each line and ensure they are 165°F (74°C) rated, with K5.6 (K80). This is suitable for building heights up to 30 ft (9.1 m). For greater heights, see Section 2.4.2.4 about providing intermediate-level sprinklers.

b) Ensure the sprinkler system and water supply is capable of providing a minimum of 20 gpm (76 L/min) per head with the 10 most hydraulically remote sprinklers flowing. Balance that demand with the ceiling sprinkler system.

2.2.1.2.3 If a dry-pipe sprinkler system is used, as may be necessary in cold storage areas, ensure it meets a 30-second water delivery time. Equip the system with a quick-opening device if needed. See Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers, for installation details. Sprinklers may also be arranged on a suitable antifreeze sprinkler system. Sprinkler systems with calculations providing a water delivery time of less than 30 seconds are also acceptable.

2.2.1.2.4 For protection recommendations above suspended ceilings, refer to Data Sheet 1-12, Ceilings and Concealed Spaces. If sprinklers are needed, design them to provide 0.20 gpm/ft² (8 mm/min) over 2000 ft² (186 m²).

2.2.2 Backed FRP Panels

2.2.2.1 Construction and Location

2.2.2.1.1 Ensure Non-FM Approved single-layer backed FRP panels on walls and/or ceilings are sheathed with a suitable thermal barrier as detailed in Section 2.4.1.2. An alternative to a thermal barrier is to provide one of the sprinkler protection options highlighted in Section 2.2.2.2.1.

2.2.2.1.2 Mechanically secure backed FRP panels on ceilings with metal fasteners at a fastener spacing of 16 in. (406 mm) on center. This results in a fastener pattern of 16 fasteners (4 vertical and 4 horizontal rows) for a 4 ft x 8 ft (1.2 m x 2.4 m) panel.

2.2.2.2 Protection for Backed FRP Panels

2.2.2.2.1 Protect backed FRP wall panels (on a noncombustible smooth backing) used with any type of ceiling construction with one of the following methods:

a) Provide a line of perimeter ceiling sprinklers designed per Section 2.2.1.2.2, and provide standard-response ceiling sprinkler protection per Section 2.2.1.2.1.

b) For ceiling heights not exceeding 10 ft (3 m), provide FM Approved quick-response sprinklers designed for 0.30 gpm/ft² (12 mm/min) over 2000 ft² (186 m²) including a 250 gpm (950 L/min) hose allowance. Sprinklers should be 165°F (74°C), with K5.6 (K80). For existing installations, the use of 286°F (141°C) quick-response sprinklers is acceptable provided the required sprinkler design can be met.

c) For ceiling heights greater than 10 ft (3 m) and up to 30 ft (9.1 m), provide quick-response FM Approved K-11.2 sprinklers designed for 0.40 gpm/ft² (16 mm/min) over 2000 ft² (186 m²), including a 250 gpm (950 L/min) hose allowance. Sprinklers should be 165°F (74°C). For existing installations, the use of 286°F (141°C) quick-response sprinklers is acceptable provided the required sprinkler design can be met.

d) For ceiling heights over 30 ft (9.1 m) with panels installed, protect them per Section 2.4.2.4 utilizing intermediate-level sprinklers.

2.2.2.2.2 At locations where plastic laminated sandwich panels (including FRP against EPS core and FRP against polyurethane/polyisocyanurate core) have been installed, or double plastic panels with an air or filled space between the faces have already been installed, the hazard can be tolerated without running flammability testing if all of the following conditions are met:

a) The occupancy is of low hazard and adequately sprinklered for the occupancy, (Class 1 commodity stored to 25 ft (8 m) or Class 2 commodities to 15 ft [5 m] high). See also Data Sheet 8-1, Commodity Classification.
b) An extra line of perimeter ceiling, wet 165°F (74°C) quick response sprinklers is placed within 2 ft ± 3 in. (0.6 m ± 90 mm) of the wall, with sprinklers 10 ft (3 m) on center. The water supply and sprinkler system must be capable of producing 30 gpm (114 L/min) per head with the hydraulically most remote 10 sprinklers flowing, including a 250 gpm (950 L/min) hose allowance. This demand is in addition to that required simultaneously by the occupancy. Balance that demand with the ceiling sprinkler system.

c) The product is used on the walls only, to a maximum height of 30 ft (9.1 m). The roof or ceiling is noncombustible.

2.2.2.2.3 Perimeter ceiling sprinklers were found to be a solution in protecting EPS sandwich panels, but they can also be used as a solution to protect other non-FM Approved panels such as FRP in lieu of thermal barriers.

2.2.3 FRP—Structural Applications

2.2.3.1 Protect buildings constructed entirely with FRP structural components with a deluge sprinkler system. This includes the area under FRP-grated mezzanines in these buildings. The spacing of the FM Approved detectors must not exceed one-half the maximum Approved linear spacing. For example, if the detector is FM Approved for 30 × 30 ft (9.1 × 9.1 m) spacings, it must be installed at a maximum spacing of 15 × 15 ft (4.6 × 4.6 m). In addition to the ceiling sprinklers, provide sprinklers at the perimeter on the inside of the building every 15 ft (5 m) vertically. Ensure the intermediate levels are installed under horizontal wall girts. Base hydraulic design on a minimum density of 0.20 gpm/ft² (8 mm/min) with all sprinklers flowing with a 250 gpm (950 L/min) hose allowance. Limit such buildings to 100,000 ft² (9300 m²) per floor area. Ensure the perimeter sprinkler design is as detailed in section 2.2.1.2.2.

2.2.3.2 Only noncombustible wall/roof constructions or FM Approved plastic building panels are acceptable for these buildings.

2.2.3.3 Ensure structural design of FRP members is performed by a design professional experienced in the use of these materials.

2.2.3.4 Automatic sprinkler protection is not necessary in otherwise noncombustible occupancies that utilize FRP grating for walkways.

2.3 Rigid PVC Panels

2.3.1 Unbacked PVC Panels

2.3.1.1 Construction and Location

2.3.1.1.1 Non-FM Approved PVC panels can remain on the walls in existing installations if they meet the following criteria:

a) Panels are not backed by any other material, combustible or noncombustible. An air space of only a few feet between the panel and backing, where the heat cannot be continuously vented, is not sufficient to consider the product unbacked. The plastic panel must be able to vent to the atmosphere or a large plenum area (which will inhibit fire spread along the surface of the plastic panel) in order to be considered unbacked.

b) Thickness is limited to approximately 3⁄16 in. (4 mm) maximum.

c) Panels are installed at a maximum height of 30 ft (9.1 m) on the walls.

d) Sprinkler protection is provided and meets the design criteria under Section 2.2.1.2.

e) If panels are installed over 30 ft (9.1 m) in height, they are protected per Section 2.4.2.4 utilizing intermediate-level sprinklers.

2.3.1.2 Protection for Unbacked PVC Panels

2.3.1.2.1 Protect Unbacked PVC Panels per Section 2.2.1.2

2.3.2 Backed PVC Panels

2.3.2.1 Construction and Location
2.3.2.1.1 Sprinkler protection as detailed in Section 2.3.2.2 is a suitable alternative to a thermal barrier over the PVC panels. However, if one of these sprinkler protection options has not been met, ensure Non-FM Approved backed PVC panels on walls and/or ceilings are sheathed with a suitable thermal barrier as detailed in Section 2.4.1.2.

2.3.2.1.2 Backed PVC panels are acceptable for installation on ceilings as well as walls for ceiling heights not exceeding 10 ft (3 m). For ceiling heights exceeding 10 ft (3 m), PVC panels may be used on walls and additionally on ceilings provided ceiling sprinklers are designed per Section 2.3.2.2.d.

2.3.2.1.3 Mechanically secure backed PVC panels on ceilings with metal fasteners at a fastener spacing of 16 in. (406 mm) on center spacing. This results in a fastener pattern of 16 fasteners for a 4 ft x 8 ft (1.2 m x 2.4 m) panel. The use of “pharma heat welded seams” and simply adhering the ceiling panels is an acceptable alternative to mechanical fastening. Having PVC panels tucked within lights and HVAC duct vents is a beneficial feature to supporting the ceiling from delamination in fire conditions.

2.3.2.2 Protection for Backed PVC Panels

Protect backed PVC panels (on a noncombustible smooth backing) using one of the following options:

a) Provide a line of perimeter ceiling sprinklers designed per Section 2.2.1.2.2 and provide standard-response ceiling sprinkler protection per Section 2.2.1.2.1.

b) For any type of ceiling construction with ceiling heights not exceeding 10 ft (3 m), provide FM Approved quick-response sprinklers designed for 0.30 gpm/ft² (12 mm/min) over 2000 ft² (186 m²), including a 250 gpm (950 L/min) hose allowance. Sprinklers should be 165°F (74°C), K5.6 (K80). For existing installations, the use of 286°F (141°C) quick-response sprinklers is acceptable provided the required sprinkler design can be met.

c) For ceiling heights greater than 10 ft (3 m) and up to 30 ft (9.1 m) with a Class 1 or noncombustible ceiling, provide quick-response FM Approved K-11.2 sprinklers designed for 0.40 gpm/ft² (16 mm/min) over 2000 ft² (186 m²), including a 250 gpm (950 L/min) hose allowance. Sprinklers should be 165°F (74°C). For existing installations, the use of 286°F (141°C) quick-response sprinklers is acceptable provided the required sprinkler design can be met.

d) For ceiling heights greater than 10 ft (3 m) and up to 30 ft (9.1 m) with PVC ceiling panels, provide sprinkler protection utilizing a combination of ceiling sprinklers and perimeter ceiling sprinklers as detailed in Section 2.3.2.2(a).

An acceptable alternative to the combination of ceiling sprinklers and perimeter ceiling sprinklers is to provide specially designed large escutcheon plates around the quick response ceiling sprinklers. Make the escutcheon plates from stainless steel with a minimum outside diameter of 6.5 in. (195 mm), an inside diameter of 2.6 in. (80 mm) and a thickness of 1/16 in. (1.6 mm). The provision of these over-sized escutcheon plates will prevent the PVC ceiling material from wrapping around and obstructing ceiling sprinklers. See Figure 1 for a picture of a typical escutcheon plate. This arrangement will allow PVC panels to be used on the ceiling without the need for perimeter ceiling sprinklers.

e) For ceiling heights over 30 ft (9.1 m) with panels installed, protect them per Section 2.4.2.4 utilizing intermediate-level sprinklers.

2.4 Plastic Sandwich Panels with Polyurethane or Polyisocyanurate Insulation

2.4.1 Construction and Location

Plastic sandwich panels include polyurethane, and polyisocyanurate panels with facings. The facings could be metal (steel or aluminum), rigid plastic (FRP or PVC) or aluminum foil. An aluminum-foil-faced foam panel is also often referred to as a sheathing panel.

A plastic panel laminated onto a wood, cellulose, or mineral board is not a sandwich panel but a backed plastic panel. Also, a thin film such as a vinyl of a few mils (not mms) thickness on a backer is considered to have the combustibility of the backer.

2.4.1.1 Non-FM Approved metal-faced panels can remain on the walls and/or ceiling/roof at existing sprinklered locations if they meet all the following criteria:
2.4.1.1.1 They have a minimum 26 ga (0.5 mm) steel or 0.032 in. (0.8 mm) aluminum facing in intimate contact with the core. The facing is rigidly attached to the support frame. Any one of the following are acceptable means of panel securement:

- Inner panel skin is held tight to the horizontal or vertical structural members of the building framing, such as with exterior wall panels (see Figure 2 for example).
- Panels are through-fastened.
- Panels have the inner skin positively secured to the outer skin.
- Panel facer is secured with sheet metal screws spaced 3 ft (0.9 m) on center.
- Panels use channels and angles fastened to the panel facing on each side at panel's top/bottom in combination with fasteners as needed to secure the channels or angles to the steel roof framing or concrete floor.
2.4.1.2 They are used only at heights of 30 ft (9.1 m) or lower.

2.4.1.3 Sprinkler protection is provided per minimum criteria in Section 2.2.1.2.

2.4.1.4 Seal all ends of insulated sandwich panels with combustible cores where they are exposed either inside or outside a building. Additionally, seal any significant holes in metal facers of the sandwich panels. Use metal facer material or FM Approved firestop material to seal the panels as needed.

2.4.1.2 If a metal facing is not installed or is thinner than noted above, provide one of the following surface treatments or thermal barriers for sprinklered installations:

a) Minimum 26 ga (0.5 mm) steel or 0.032 in. (0.8 mm) aluminum in contact with the existing facing or foam core. The metal must be rigidly attached to the support frame or through fastened. Joints in the metal must be overlapped at least \( \frac{1}{2} \) in. (15 mm) and fastened with sheet metal screws at 3 ft (0.9 m) on center. Metal banding is also acceptable as a means of securing the thermal barrier.
b) For smooth surface panels, gypsum board can be used as a thermal barrier. Minimum ½ in. (15 mm) gypsum board with taped joints can be used at unlimited heights. If a clean, washable surface is needed, any thickness of metal or an FM Approved interior finish material can then be applied over the gypsum board.

2.4.1.3 Polyurethane/Polyisocyanurate Sandwich Panels—Unsprinklered Installations

2.4.1.3.1 Apply one of the following thermal barriers over these non-FM Approved panels:

a) An FM Approved fire retardant coating, suitable for the foamed plastic. Follow the limitations of the FM Approval. Use of this option requires the original facing to be removed and the coating applied directly to the foamed plastic.

These coatings are not intended as substitutes for automatic sprinklers. That is, sprinkler protection for the occupancy is needed per the applicable Data Sheet. If a building is unsprinklered and does not require sprinklers based on the occupancy and construction features involved, then sprinklers are not needed solely based on the presence of spray-on polyurethane insulation covered with an approved fire-retardant coating regardless if the foam is walls only, ceiling only, or both walls and ceiling. The use of coatings is particularly applicable in low hazard areas having very limited combustible materials.

b) A ½ in. (15 mm) thick layer of Portland cement plaster on metal lath secured to the building structure.

c) For smooth surface panels, minimum ½ in. (15 mm) thick gypsum board with metal batten joints can be secured through the panels to the structure using sheet metal screws.

2.4.1.3.2 FM Approved spray-applied thermal barriers are not recommended in occupancies that would allow for an accumulation of combustible deposits on the surface. Also, do not use cellulose-based coatings in high humidity occupancies.

2.4.1.3.3 Ensure panel joints are tongue and groove type or battened/fastened (see Figs. 2-5 for details). When joint fastening is used, place fasteners no more than 3 ft (0.9 m) on center. If the panel spans less than 10 ft (3 m) between supports, and is held tight to the structural supports (similar to Fig. 2), additional battening/joint fastening generally is not needed. If panel securement is provided by a cam-lock arrangement, then no additional joint battening is needed. Fasteners are typically No. 14 self-tapping or self-drilling sheet metal screws.
2.4.2 Protection for Polyurethane/Polyisocyanurate Sandwich Panels

2.4.2.1 Provide sprinkler protection for these panels as detailed in Section 2.2.1.2 when the panels are installed on walls and/or ceilings.

2.4.2.2 Perimeter ceiling sprinklers were found to be a solution in protecting EPS sandwich panels, but they can also be used as a solution to protect other non-FM Approved panels, such as polyurethane/polyisocyanurate, in lieu of thermal barriers.

2.4.2.3 Balance the ceiling sprinkler demand with the perimeter ceiling sprinkler demand.

2.4.2.4 When intermediate-level sprinklers are required to protect the polyurethane, polyisocyanurate, EPS, FRP, or PVC panels, these must be located under horizontal wall girts and thus will be closer than 2 ft (0.6 m) from the wall. When provided on more than one level, ensure the system is capable of providing a minimum of 20 gpm (76 L/min) per head with 14 sprinklers on the top level and 6 sprinklers on the next lower level flowing. For heights greater than 30 ft (9.1 m), ensure the intermediate lines are evenly spaced vertically, and do not exceed 30 ft (9.1 m) between lines. Balance that demand with the ceiling sprinkler system. Recognize that, for a tall wall, you may be dealing with the need to consider ceiling sprinkler demand and ceiling perimeter sprinkler demand as well as intermediate wall sprinkler demand.

When only one level of intermediate-level sprinklers is provided, ensure the system provides a minimum of 20 gpm (76 L/min) per head with 10 sprinklers flowing.

For intermediate levels of sprinklers, use IRAS and position them directly under the horizontal wall girts. This will shield the lower sprinklers from the water from sprinklers above, and allow for support of the sprinkler piping. If wall girts are not installed, provide water shields for the sprinklers.

2.5 EPS Sandwich Panels

2.5.1 Construction and Location

2.5.1.1 Non-FM Approved EPS core, metal faced sandwich panels can remain on the walls only at existing sprinklered locations provided they meet the following criteria. For other installations on walls and ceilings, see Section 2.5.2.1.

a) The amount of EPS is no more than 0.67 lbs/ft\(^2\) (3.27 kg/m\(^2\)). This generally equates to 8 in. (200 mm) of expanded EPS in the density most commonly encountered. **Note:** EPS lb/ft\(^2\) (kg/m\(^2\)) is determined by multiplying density by thickness. Example: 3 in. (76 mm) thick with a density of 1.25 lbs/ft\(^3\) (20 kg/m\(^3\)).

(3 in./12 in. per ft)x(1.25 lbs/ft\(^3\)) = 0.31 lbs/ft\(^2\) (1.52 kg/m\(^2\)).

b) The panel facing should be minimum 26 ga (0.5 mm) steel or 0.032 in. (0.8 mm) aluminum in contact with the panel core.

c) The ceiling/roof is noncombustible or Class 1.
d) Sprinkler protection is on a wet system and is provided per the criteria in Section 2.2.1.2.1. An alternative to this is to provide perimeter sprinklers per Section 2.5.2.1.

e) The panel height is no more than 30 ft (9.1 m).

2.5.1.2 Installations meeting all conditions of 2.5.1.1 except that panels are installed on the walls and ceiling/roof can remain if the ceiling/roof panels are covered with a thermal barrier per 2.4.1.2(b) or 2.4.1.3.1. This could include gypsum board or an FM Approved fire retardant coating. If a clean, washable surface is needed, any thickness of metal can be applied over the gypsum board.

2.5.1.3 Installations meeting all conditions of 2.5.1.1 and/or 2.5.1.2 except that the sprinkler protection is on a dry system but cannot meet 2.5.2, can remain if all EPS panels are covered with a thermal barrier per 2.4.1.2(b) or 2.4.1.3.1. This could include gypsum board or an FM Approved fire retardant coating.

2.5.1.4 Installations meeting all conditions of 2.5.1.1 (except Item d) plus wall/ceiling applications can remain in existing unsprinklered construction if all EPS panels are covered with a thermal barrier per 2.4.1.3.1.

2.5.1.5 Where construction and/or protection does not comply with that above, see Section 2.5.2.1. This section includes details on “sprinklers only” solutions to protect EPS materials.

2.5.1.6 For protection of plastic-faced, EPS core panels or installations refer to Section 2.2.2.2.2 for acceptability criteria.

2.5.1.7 Provide panel securement and joint details for EPS core sandwich panels per Section 2.4.1 and 2.5.2.1a.

2.5.1.8 Seal all ends of insulated sandwich panels with combustible cores where exposed either inside or outside of the building. Additionally, seal any significant holes in metal facers of the EPS sandwich panels. Use metal facer material or FM Approved firestop material to seal the panels as needed.

2.5.2 Protection for EPS Sandwich Panels

This section provides “sprinkler only” solutions for EPS panels.

2.5.2.1 Non-FM Approved EPS core, min 26 ga (0.5 mm) steel or 0.032 in. (0.8 mm) aluminum faced sandwich panels can remain on the walls and roof/ceiling at existing sprinklered locations provided they meet the criteria in Table 1 (including footnotes) and the criteria listed below:

a) The panels are maximum 30 ft (9.1 m) high and through-bolted with a minimum of 2 steel bolts per panel (one near the top and one near the bottom) Alternatively, provide steel channels or angles at the top and bottom of the EPS sandwich panels, and fasten the channels or angles to the concrete floor below and the roof framing structure above. Secure the metal panel facings on both sides to the respective flanges of the channels or angles with self-drilling steel screws at a maximum fastener spacing of 16 in. (0.4 m) on center, but a minimum of two fasteners per panel section.

b) Where perimeter ceiling sprinklers are needed per Table 1, install a line of wet, quick-response, 165°F (74°C) sprinklers spaced a maximum of 10 ft (3 m) on center and 2 ft ± 3 in. (0.6 m ± 90 mm) from the walls. Provide a minimum of 30 gpm (114 L/min) per head with a minimum of 10 sprinklers discharging. Balance that demand with the ceiling sprinkler system. They must be staggered with respect to sprinklers in the field of the room. The first head will be located 2 ft (0.6 m) in each direction from the corner, and the following sprinklers will be located midway between existing ceiling sprinklers. Where it is not practical to use wet, dry pendant or non-freeze protection, use a dry perimeter ceiling sprinkler system meeting the outlined criteria below. For dry systems base the sprinkler demand on 14 sprinklers operating, as opposed to 10 sprinklers.

c) Perimeter ceiling sprinklers have been found to be a solution in protecting EPS sandwich panels. However, they also can be used as a solution to protect other non-FM Approved plastic panels in lieu of thermal barriers.

d) The perimeter ceiling sprinkler system may be dry (double interlock system), but ensure it is fed separately from other systems and delivers water to the most hydraulically remote point within 30 seconds after the first sprinkler operates. Perimeter sprinklers may also be arranged on a suitable antifreeze sprinkler system.
Arrange the detection system for the double interlock valve so that, if a fire starts near a wall, the detector will trip no later than the time required for the quick response (QR) head to operate (RTI = 50). Locating the detector near the wall ceiling juncture should meet this intent.

Base the perimeter system demand on 14 sprinklers operating at 30 gpm (114 L/min). Add and balance this demand simultaneously with the ceiling, in-rack, and hose demands. The sprinklers may be K = 11.2 gaL/min/[psi]^{1/2} (K = 161), or large orifice (\(17/32\) in. [13.5 mm], K = 8.0 gaL/min/[psi]^{1/2} (K = 115)).

Design the perimeter system according to the guidelines for refrigerated systems per Data Sheet 8-29, Refrigerated Storage (air dryers, etc).

e) Protect areas above suspended ceilings with a wet pipe sprinkler system with a minimum density of 0.20 gpm/ft^2 (8 mm/min) over 2000 ft^2 (186 m^2). This demand is not simultaneous with the below-ceiling demand. If the walls and roof above the ceiling are Class 1 or noncombustible, a dry sprinkler system with the above density/area available is tolerable for the space above the EPS insulated suspended ceiling.

f) Provide a minimum 250 gpm (950 L/min) hose stream allowance.

g) If the EPS is on the walls only, the roof is Class 1 or noncombustible, and perimeter ceiling sprinklers are provided to protect the walls, the sprinkler system density beneath the field of the roof need only be adequate for the occupancy (although must be a minimum of 0.20 gpm/ft^2 [8 mm/min] over 2000 ft^2 [186 m^2]).

h) For ceiling heights over 30 ft (9.1 m) with panels installed, protect per Section 2.4.2.4 utilizing intermediate-level sprinklers.

Table 1. Protection for Non-FM Approved EPS Core Panels on Walls and Ceiling/Roof

<table>
<thead>
<tr>
<th>EPS Amount lb/ft^2 (kg/m^2)</th>
<th>Available Sprinkler Protection</th>
<th>Density (Note 2) gpm/ft^2 (mm/min)</th>
<th>Type</th>
<th>Perimeter Ceiling Sprinklers Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than or equal to 0.33 (1.64) (^3)</td>
<td>≥ 0.38 (15)</td>
<td>Wet</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 0.38 (15)</td>
<td>Wet</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>greater than 0.33 (1.64) (^3)</td>
<td>less than or equal to 0.83 (4.12) (^4,5)</td>
<td>≥ 0.45 (18) (^5)</td>
<td>Wet</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>&lt; 0.45 (18)</td>
<td>Wet</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>less than or equal to 0.83 (4.12) (^4,5)</td>
<td>≥ 0.20 (8)</td>
<td>Dry</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

1 Other pertinent criteria in 2.5.2.1 also must be met.
2 The minimum operating area is 2000 ft^2 (186 m^2) for wet and dry systems. The minimum duration is 60 minutes. In all cases, the sprinkler design and duration also must be adequate for the occupancy and be a minimum of 0.20 (8). Storage sprinklers providing the required densities can be utilized.
3 Four in. (100 mm) of 1pcf (16 kg/m^3) EPS or 2 in. (50 mm) of 2pcf (32 kg/m^3) EPS = 0.33 lb/ft^2 (1.64 kg/m^2)
4 Ten in. (250 mm) of 1pcf (16 kg/m^3) EPS or 5 in. (125 mm) of 2pcf (32 kg/m^3) = 0.83 lb/ft^2 (4.12 kg/m^2)
5 EPS amounts up to 1 lb/ft^2 (4.96 kg/m^2) may be tolerated for existing installations with no unfavorable factors. This is an extrapolation from the tested quantity of 0.83 lb/ft^2 (4.12 kg/m^2), therefore, no further extrapolation of quantity should be made.
6 The first line of sprinklers adjacent to the EPS insulated walls must be quick response. If the available density is 0.60 gpm/ft^2 (24 mm/min), existing standard sprinklers may remain.

2.5.2.2 For protection of plastic laminated panels over an EPS core (i.e., FRP faced–EPS panels) see Section 2.2.2.2.

2.6 Plastic Skylights/Rooflights and Wall Light-Bands

2.6.1 Construction and Location

2.6.1.1 Use less-combustible plastic materials for rooflights and wall light-bands in new construction. These include materials such as polycarbonate, PET, or PVC.

2.6.1.2 Arrange PMMA (acrylic) or non-FR-treated FRP rooflights and wall light-bands as follows:

a) Do not use PMMA or non-FR-treated FRP for rooflights and wall light-bands in new construction. The flammability characteristics (low critical heat flux) are such that these materials are easy to ignite and fire spreads rapidly.
b) Replace existing PMMA rooflights and wall light-bands with more suitable materials, or, in existing sprinkler-protected buildings, reduce the maximum dimension of PMMA rooflights to 8 ft (2.4 m). Separate adjacent rooflights and wall light-bands with a minimum 16 ft (4.8 m) of noncombustible or Class 1 material.

c) In existing sprinkler-protected buildings, non-FR-treated FRP rooflights and wall light-bands can remain without any limit on the maximum dimensions.

2.6.1.3 In unsprinklered areas, non-FM Approved FRP light bands and skylights meeting 2.2.1.1.1(a)-(e) can remain as noted below:

a) FRP light bands of unlimited length are acceptable for use on the walls if they are not more than 8 ft (2.4 m) high. Separate multiple light bands vertically with noncombustible material at least twice as high as the light band.

b) FRP skylights (roof applications) are acceptable if the maximum dimension is approximately 8 ft (2.4 m) and adjacent skylights are separated by 16 ft (5 m) of noncombustible or Class 1 materials.

2.6.2 Plastic Skylights/Rooflights Sprinkler Obstructions

2.6.2.1 To prevent thermoplastic rooflights (acrylic, PVC, and polycarbonate) from obstructing sprinklers by softening and sagging onto them in a fire, use one of the following protection alternatives. Thermoset plastic rooflights, such as FRP, do not pose this hazard.

a) For new sprinkler installations, engineer the sprinklers around the rooflights so the sagging rooflights do not obstruct them in accordance with Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers. To engineer the position of the sprinklers there are three major factors to consider: (1) spacing between sprinklers; (2) distance from the underside of the ceiling; (3) obstructions to the water spray pattern.

b) For new construction, replace sections of the skylight material with wired-glass or FR-treated FRP, and locate the sprinklers beneath those minimum 18 in. (450 mm) wide rooftop sections. Ideally, locate the sprinklers away from the skylights.

c) Fit an FR-treated FRP liner sheet, minimum 0.04 in. (1 mm) thick, beneath the thermoplastic rooflight. The liner should either be fitted close to and follow the contour of the rooflight, or be a continuous flat sheet within the same plane as the ceiling.

d) Fit a metal plate with minimum dimensions of 18 in. (450 mm) x 18 in. (450 mm) above each sprinkler head. If there is difficulty encountered constructing such a metal plate above each sprinkler head, the use of an in-rack sprinkler head with a protective water shield is a tolerable arrangement.

FM Approved plastic skylights/rooflights do not require sprinkler protection and have no dimension limitations.

FM Approved thermoplastic rooflights (acrylic, PVC, and polycarbonate) could also pose an obstruction hazard to sprinklers from softening and sagging.

2.7 Other Plastics in Construction Applications

2.7.1 Spray-Applied Polyurethane

Treat products such as Icynene or other spray-applied insulation products the same as spray-applied polyurethane.

2.7.1.1 Spray-applied polyurethane may be used to insulate an existing structure by covering the exterior of walls, exterior duct work, windows, etc., if all of the following is true:

a) The polyurethane does not significantly increase the continuity of combustibles. For example, only short sections (no more than 50 ft [15.2 m]) of roof-mounted duct work may be covered. The insulated duct work must not extend into other fire areas. For an exterior building application, limit the polyurethane to no more than 3 in. (90 mm) thickness, and coverage area to no more than 2000 ft\(^2\) (186 m\(^2\)). Provide a 25 ft (7.6 m) distance of noncombustible construction between application areas.

b) Windows are no bigger than approximately 60 ft\(^2\) (5.6 m\(^2\)) and are separated by at least 16 ft (5 m) of noncombustible construction. Cover larger windows or openings with materials per sections 2.4.1.2 or 2.4.1.3.1, as appropriate.
c) The wall material and the sprinkler protection meet the criteria described in Sections 2.4.1.2 or 2.4.1.3, as appropriate. If an appropriate thermal barrier is not provided, sprinklers must be provided on a minimum design 0.20 gpm/ft$^2$ (8 mm/min) over 2000 ft$^2$ (186 m$^2$), including a 250 gpm (950 L/min) hose allowance.

When polyurethane is applied to the exterior surface of a roof, a combustible (Class 2 steel deck) is created unless an FM Approved polyurethane recover system is used.

2.7.1.2 Polyurethane spray applied to the interior of a building (with or without sprinkler protection) should be protected with an FM Approved fire retardant coating or plaster thermal barrier as described in section 2.4.1.3.1.

2.7.1.3 Ensure mixing and application of spray-in-place polyurethane is done only by trained, experienced mechanics. The thickness of the applied foam must be controlled to prevent excessive heat buildup. Large amounts of overspray must be removed daily. When spraying outside, equipment must be adjusted regularly according to temperature changes to ensure the proper composition and density.

2.7.1.4 Provide a 15 lb (6.8 kg) dry chemical extinguisher for each spraying operation.

2.7.2 Outdoor Steel Storage Tank Applications

2.7.2.1 Ensure insulated tanks with flammable gases or ignitable liquids with a flash point below 100°F (38°C) are insulated with noncombustible materials, or have the plastic insulation protected by a fire protective coating suitable for the particular plastic and outdoor use. Another option is to use FM Approved Class 1 materials for tank cladding.

2.7.2.2 Do not use any plastic insulation on tanks that store oxidizing materials.

In addition, do not use plastic insulation on tanks storing hazardous materials with a reactivity of 2 or greater.

2.7.2.3 Ensure plastic insulated tanks are used only in process areas that are essentially free of instrumentation, cable trays, and control tubing. One approach is to locate these on separate structures away from the insulated tanks.

2.7.2.4 Separate plastic insulated tanks from other tanks and buildings by a distance of no less than one tank radius or by the applicable distances specified in Data Sheet 7-88, Ignitable Liquid Storage Tanks, whichever is greater.

2.7.2.5 For recommendations regarding plastic tanks and plastic lined tanks with immersion heaters, refer to Data Sheet 7-6, Heated Plastic and Plastic-Lined Tanks.

2.7.2.6 Protect any indoor plastic insulated steel storage tank applications with the same approach as outlined above, with the exception that any fire protective coating used does not need to be suitable for outdoor use.

2.7.3 Elastomeric Insulation

Elastomeric insulation is used to wrap both pipes and ducts as an exterior insulation material. It is found in either tubular shape wrapping round materials or in flat sheets wrapping rectangular materials. In some cases it is also used to line the underfloor of subfloor spaces. The heat of combustion of this material is considerably higher than that of wood and is within the range of typical polyurethanes.

2.7.3.1 For new installations, use noncombustible or FM Approved pipe or duct insulation. However, even FM Approved insulations that have been tested and perform well from a flame spread standpoint could still generate significant smoke. For occupancies that are highly susceptible to smoke damage, use insulations such as expanded glass or foil-faced phenolic.

2.7.3.2 For existing unsprinklered installations, replace the materials with a noncombustible or FM Approved insulation.

2.7.3.3 Existing sprinklered installations may be considered acceptable provided all of the following conditions are met:

- Sprinkler protection is on a wet-pipe system using 165°F (74°C) sprinklers with K5.6 (K80). Ensure the sprinkler system and water supply are capable of providing 0.20 gpm/ft$^2$ (8 mm/min) over 2,000 ft$^2$ (186 m$^2$) including a 250 gpm (950 L/min) hose allowance. If the occupancy requires different protection, use the more stringent design.

- Limit vertical runs of insulated pipes or ducts to 10 ft (3 m) or less.
c) Limit horizontal width of ducts or pipe clusters to 4 ft (1.2 m).

d) Ensure horizontal runs of ducts or pipe clusters are separated from each other a minimum distance of 10 ft (3 m).

e) For widths greater than 4 ft (1.2 m), provide wet pipe sprinklers below the elastomeric insulation as well as above at the ceiling since the ceiling coverage may be obstructed.

2.7.3.4 As an alternative to recommendation 2.7.3.3 in existing sprinklered installations and to avoid the need to limit the vertical and horizontal runs, sheath the pipes or ducts with minimum 26 ga (0.5 mm) steel or 0.032 in. (0.8 mm) aluminum. Another approach is to provide an FM Approved fire retardant coating listed as suitable for use over polystyrene, which should also be effective with elastomeric insulation depending on normal adhesion. Remove any facing on the insulation for direct application and follow the manufacturer’s specifications to ensure proper adhesion of the coating to the insulation.

A metal sheathing or fire-retardant coating can be used to completely encase the pipes or ducts, or can be used as a means to break up the continuity of the insulation as outlined in recommendation 2.7.3.3.

2.7.3.5 For existing installations of elastomeric insulation sheets lining the underfloor of subfloor spaces that are unsprinklered, replace the material as outlined in recommendation 2.7.3.2. An alternative is to provide sprinkler protection in the subfloor space per 2.7.3.3(a).

2.7.4 Cellulosic Insulation

2.7.4.1 Treat cellulosic insulation the same as any other non-inert faced insulation material. As a result, ceiling sprinklers alone may not be sufficient to adequately protect this insulation material; a thermal barrier may be needed.

2.8 Miscellaneous

2.8.1 Human Element

2.8.1.1 For buildings under construction, limit storage of plastic building materials as outlined in Data Sheet 1-0, Safeguards During Construction, Alteration and Demolition.

2.8.2 Ignition Source Control

2.8.2.1 Explore alternatives to all hot work on roofs with plastic skylights or at roof level on the inside of the building, as well as in areas where plastic building materials have been installed. Hot work is the most common ignition source of a fire involving plastic skylights. Much of this hot work occurs during construction, alteration, or demolition (see Data Sheet 1-0). If there is no alternative to hot work in the proximity of plastic building materials, use the FM Global hot work permit system.

3.0 SUPPORT FOR RECOMMENDATIONS

Small scale and large scale fire testing by FM Global Research has shown that non-approved plastic building materials will ignite easily and burn rapidly. Some plastics may tend to char, whereas others such as polystyrene will tend to melt forming an ignitable liquid. In sprinklered applications, the use of thermal barriers and/or metal sheathing will delay ignition for 10 to 15 minutes allowing the sprinklers time to control the fire.

Further details on the behavior of plastic building materials in a fire and the rationale behind the protection approaches for this fire challenge are outlined in UTH Publication Plastics in Construction (P0242).

3.1 Behavior of Plastic Materials in a Fire

3.1.1 Polyurethane

Fire retardant additives can markedly improve the performance in comparative fire tests, such as ASTM E84, of foamed plastic. Large-scale corner testing has indicated, however, that the performance of foamed plastic under actual fire conditions is not significantly affected by the use of these additives. Consequently, claims for fire retardancy based on the ASTM E84 tunnel test and similar comparative tests should be disregarded for foamed plastic.
Polyurethane is a combustible material that exhibits certain properties under fire conditions which make a comparison of its performance to ordinary combustibles, through the use of most small-scale test procedures, very unreliable. However, plastics that burn vigorously in bench-scale ignition source tests can be expected to present a severe hazard.

When exposed to fire or sufficient heat, polyurethane decomposes at approximately 450°F (230°C) and ignition occurs at 600°F to 700°F (315°C to 370°C). Ignition results in the production of dense acrid smoke, and flames can flash rapidly across the surface of the material.

The use of inert facings, such as steel or 0.032 in. (0.8 mm) aluminum in FM Approved polyurethane insulated sandwich panels allows the properly formulated foam core to char when exposed to an ignition source. This charring helps protect the remaining foam and keeps fire propagation to within acceptable limits.

3.1.2 EPS

EPS will melt at temperatures lower than 400°F (205°C), forming an ignitable liquid. The peak rate of polystyrene decomposition and volatilization occurs at 687°F (364°C). At this temperature the vapor release will cause rapid flame spread across the exposed surface. Automatic sprinklers are not always effective in confining the fire to a small area. EPS does not tend to smolder or char.

EPS has a heat content in the range of 16-18,000 BTU/lb (37-42,000 kJ/kg). Because it melts, forming an ignitable liquid, the amount of fuel available to a building fire from EPS products is directly related to the amount of EPS present (thickness times density).

EPS can be ignited by open flame and will burn in the presence of a flame generated by other fuels. It tends to shrink away from heat sources prior to ignition. To maintain burning, the heat source must be either sufficiently large or follow the shrinking material. For this reason, attempts to maintain ignition of EPS with a stationary match or Bunsen Burner may not be successful. Thus, this phenomenon allows EPS to obtain relatively low flame spread values via the ASTM E84 test method. However, in a larger fire, such as one involving a small amount of building contents, the heat source will be sufficient to sustain intense burning.

Burning EPS emits a very dense black smoke containing oily, sooty particulate matter. Thus, a relatively small fire involving EPS in food warehouses, freezers, or electronic equipment areas can result in contamination of the entire area.

As with polyurethane, additives do not significantly affect the burning characteristics, except that they may delay ignition. However, FM Approved EPS sheathing products employ specific formulations and limited product density and thicknesses to achieve a lower hazard than would normally be expected. The ignition of these products is sufficiently delayed so that foam rapidly shrinks away from the heat source without propagating flame spread. This allows the sprinklers, required by the FM Approval, sufficient time to fuse and gain control of the fire.

3.1.3 Thermal Barriers and Metal Skins for Polyurethane, Polyisocyanurate, and EPS

The intent of thermal barriers and/or metal sheathing (not foil facing) in sprinklered applications is to delay ignition of the plastic for 10 to 15 minutes to allow sprinklers time to control the fire. In noncombustible occupancies, thermal barriers (not metal skins) allow non-FM Approved plastic building materials to remain without sprinkler protection. For the thermal barrier to be effective, it must remain in contact with the foam (or the panel skin).

When EPS or board stock polyurethane sheathing or sandwich panels are used, the smooth surface will allow the use of board stock thermal barriers. These barriers are not suitable for polyurethane or icynene that is sprayed in place. The uneven surface resulting from this application will not allow proper contact with the sheathing. FM Approved coatings or Portland cement plaster, ½ in. (13 mm) thick, will provide an adequate thermal barrier for polyurethane or EPS. To ensure adhesion, metal lath secured to the building structure is used with cement plaster.

Plastic sheets (FRP or PVC) are sometimes adhered directly to an EPS or polyurethane core to give a clean, washable surface. This does not provide a suitable thermal barrier. Since the laminate itself may be prone to rapid flamespread, the combination may be particularly hazardous even if the underlying foam does not need a thermal barrier. During a fire, flames can flash across the plastic surface. As the facing burns through, the foam becomes rapidly involved and conditions worsen. Normal sprinkler arrangements used in full-scale tests have been unable to control fires involving some plastic laminates on foam plastic.
3.1.4 Plastic Building Panels

All plastic panels, whether fire retardant treated or not, are combustible. Full-scale tests by FM Global showed that many non-FM Approved panels ignite easily and burn rapidly, producing intense flaming and high ceiling temperatures, even when automatic sprinklers are used. Panels that burn through within approximately 2 minutes after ignition allow heat to escape. Once the temperature at the ceiling drops, flame propagation stops.

Analysis of the successful tests indicates that several factors contribute to the acceptable performance. These are noted below:

1. Backing — The panels must be unbacked. Backings prevent heat dissipation, negating the main method by which the rapid flamespread is usually controlled in older panels.
2. Automatic sprinklers — Sprinklers slow the horizontal flamespread, lower ceiling temperatures, and provide rapid extinguishment after the heat is dissipated.
3. Fire retardants — Even though the flamespread is initially very rapid, fire retardants prevent even faster spread. They also contribute to the tendency of burning to stall once the heat is dissipated.
4. Panel thickness — Panels must be 1/16 in. (1.6 mm) or less, and weigh approximately 8 oz/ft² (2.4 kg/m²) or less, allowing for fairly rapid burn-through. Thicker sheets delay burn-through, generally resulting in more extensive flame spread.
5. Reinforcement — Chopped strand or non-woven, with a glass content of under 50% by weight, gives the panel very little rigidity during a fire, allowing holes to develop. Panels of interwoven fiber mats do not usually react this way; this type of reinforcement is not acceptable.

If the product does not meet the above criteria, the flamespread may be so fast, or burn-through so slow, that a fire could cause an excessive number of sprinklers to open. The sprinklers may fuse behind the traveling flame front, without effectively preventing spread; hindering control of the occupancy fire.

While FRP panels may be acceptable for use as roofing panels, they are not acceptable as the deck component in insulated deck construction, unless qualified by FM Approval testing. The internal fire spread potential of this type of construction is greater than that for steel deck or the panel itself. There also is the potential for collapse, as the panel would not maintain its integrity during a fire.

3.1.5 Outdoor Storage Tanks

Polyurethane is often used to insulate outdoor storage tanks. If such tanks contain an ignitable liquid, the polyurethane could allow the fire to spread from the exterior of the tank to the liquid within. Burning of the insulation could also raise the temperature of a reactive material sufficiently to cause a violent reaction. Temperature-sensitive materials could be rendered useless by a fire and/or subsequent loss of insulation. Oxidizing agents can, in the event of leakage, react with the polyurethane insulation, causing spontaneous ignition.

Tanks often are instrumented for process control. Wires, cables, cable trays, control tubing, etc., are exposed to possible damage from a fire in polyurethane insulation, resulting in an interruption to production.

4.0 REFERENCES

4.1 FM Global

Data Sheet 1-0, Safeguards During Construction, Alteration and Demolition
Data Sheet 1-4, Fire Tests
Data Sheet 1-12, Ceilings and Concealed Spaces
Data Sheet 1-20, Protection Against Exterior Fire Exposure
Data Sheet 1-28, Wind Design
Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers
Data Sheet 3-26, Fire Protection Water Demand for Nonstorage Sprinklered Properties
Data Sheet 7-6, Heated Plastic and Plastic-Lined Tanks
Data Sheet 7-7, Semiconductor Fabrication Facilities
Data Sheet 7-78, Industrial Exhaust Systems
APPENDIX A GLOSSARY OF TERMS

The glossary should be reviewed prior to the recommendations, as the terms used have very specific meanings.

Architectural sandwich panel: Sandwich panels that form the building envelope (outside surface of the building). They are secured to horizontal and/or vertical structural members. Compare to free-standing sandwich panels.

Backed: Any solid material, combustible or noncombustible, to which plastic interior finish materials are applied.

Barrel vault: A curved rooflight. Typically the vertical rise is 1/6 of the span.

Cast: The term used to describe the solid form of PMMA sheet material. The manufacturing process is either continuous cast or cell cast.

Double glazed: Two sheets of material separated by an air gap and assembled as a rooflight unit, e.g., double glazed barrel vault rooflight.

Elastomeric insulation: A polymer with the property of elasticity. The term is often used interchangeably with the term rubber and has a primary use for seals, adhesives, and molded flexible parts.

EPS: In the context of this data sheet, EPS includes expanded and extruded polystyrene.

FM Approved: References to “FM Approved” in this data sheet mean the product and services have satisfied the criteria for FM Approval. Refer to the Approval Guide, a publication of FM Approvals, for a complete listing of products and services that are FM Approved.

FR: Fire retardant

Free standing sandwich panel: Panel systems that do not utilize separate structural supports. A typical use is in walk-in coolers/freezers constructed within a building. They typically incorporate locking devices within the panel joints. See Figure 6. The ceiling panels, however, may be suspended on rods.
Foamed plastic: Materials including polyurethane, polyisocyanurate, foamed melamine, phenolic foam, and EPS.

FRP: Fiberglass reinforced plastic, one type of interior finish or building panel consisting of a glass reinforcement and resin. FRP is a thermoset material. In some countries this is referred to as GRP.

Multi-wall: Used to describe acrylic and polycarbonate extruded sheet materials that have a cellular structure. The most common type is twin-wall, which is extruded in thicknesses ranging from 0.24 to 0.64 in. (6 to 16 mm) thick. Multi-wall also is extruded as tri-wall, four-wall, five-wall, and six-wall in thicknesses up to 1.4 in. (35 mm) thick.

MMM: Methyl methacrylate monomer. Used as resin in some FRPs.

Northlight: The glazed section of a saw-tooth roof. It is referred to as a northlight in the northern hemisphere, as the glazed section points approximately north to avoid direct sunlight entering the building.

PC: Polycarbonate. This is made in extruded multi-wall and solid sheet form.

PET: Polyethylene terephthalate. Made only in a solid sheet form.

Plastic building panel: a rigid plastic sheet (FRP, polycarbonate or PVC), usually corrugated, applied to the exterior of the structural framing without backing. It forms the building envelope; see Figures 7 and 8.

Compare to plastic interior finish material.
Plastic building materials: All materials within the scope of this data sheet.

Plastic interior finish material: Rigid (not foamed or expanded) plastic sheets (usually FRP or PVC) that are applied to a backing material such as concrete block. Compare to plastic building panel.

PMMA: Polymethyl methacrylate. Also commonly referred to as acrylic. This is made in extruded multi-wall and solid sheet, and also in continuous and cell cast form.

PVC: Polyvinyl chloride, a thermoplastic polymer used as the basis for some interior finish or building panels. PVC-based panels are usually not reinforced.

PVC: Polyvinyl chloride. Made only in solid sheet form. In some countries the term UPVC, is used, as the PVC has low plasticiser content. In this data sheet the generic term PVC has been adopted.

Saddle: A continuous rooflight which is installed above the roof line, forming a triangular shape in cross-section.

Sandwich panel: A wall or ceiling/roof panel usually consisting of a polyurethane, polyisocyanurate or EPS core, faced on both sides with metal or rigid plastic.

Sheathing panel: An insulating panel (typically made from EPS products) similar to a sandwich panel, except no facer or a thin aluminum foil facer is used. Sheathing panels are applied to the inside building walls and/or ceiling.

Solid: Sheet material that does not have a cellular structure.

Thermal barrier: A board stock material or coating material applied over a combustible foam insulation that is designed to delay ignition of the insulation for 10 to 15 minutes in a sprinklered application.

Thermoplastic: Materials that soften when heated and harden when cooled. This process is reversible provided the material is not heated sufficiently to decompose. Examples are PVC, EPS, polycarbonate, PET, PMMA, polypropylene, and polyethylene.

Thermoset: Materials that cure or “set” irreversibly when heated during manufacture. Examples are polyurethane, polyisocyanurate, FRP, phenolic foam, melamine, and UP.

Unbacked: Any solid plastic panel that is not attached to any substrate and can freely vent in a fire.

UP: Unsaturated polyester. Most common resin in FRPs. Unsaturated polyesters show good weathering resistance and light stability.

APPENDIX B DOCUMENT REVISION HISTORY

April 2014. Clarification was provided for protection of spray-on polyurethane insulation covered with an FM Approved fire-retardant coating.

February 2013. Revised protection guidance for both backed FRP panels and backed PVC panels as a result of research and testing. In addition, PVC panels are now permitted to be installed on ceilings under certain conditions. Other clarification points for various recommendations were added.

April 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global’s loss prevention recommendations for ignitable liquid hazards.

May 2010. Replaced all references to Data Sheet 2-8N, Installation of Sprinkler Systems (NFPA), with references to Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers.

January 2009. Extensive revisions were made to differentiate between various plastic construction materials, and revised recommendations were developed for the protection of FRP Faced/foam Plastic Core insulation panels. Recommendations were added on protection of elastomeric insulation.

November 2008. Extensive revisions were made to differentiate better between various plastic construction materials, and revised guidance was developed for the protection of FRP faced/foam plastic core insulation panels. Guidance was added on protection of elastomeric insulation.

May 2008. Minor editorial changes were made.

September 2007. Minor editorial changes were made.

May 2007. This document was revised to clarify guidance on PVC panels and include minor editorial changes.
May 2005. This document received various editorial corrections and was reorganized for easier usability. Zonolite 3306 fire retardant coating is now FM Approved. Partial solutions for EPS panels using baffles and the acceptability of perimeter ceiling sprinklers under certain conditions have also been highlighted.

Section 3.0, Support for Recommendations, was expanded to include additional detail on the hazards associated with plastics in construction.

May 2004. Clarification was made to recommendation 2.3.1(a).

September 2003. The guidelines for dry perimeter ceiling sprinklers to protect EPS wall and ceiling panels were added.

APPENDIX C PROPERTIES OF PLASTIC MATERIALS AND FIRE TESTS

C.1 FM Global Corner Tests

For descriptions and discussion of the 25 ft (7.6 m) and 50 ft (15.2 m) high corner test and smaller scale fire tests, refer to Data Sheet 1-4, Fire Tests and FM Approval Standard 4880.

The characteristic of rapid flamespread across the exposed surface of polyurethane, even with automatic sprinkler protection, prompted the development of the 25 ft (7.6 m) FM Global Corner Test. The test has been adopted to determine the performance of various plastic materials in combination with various surface treatments. The test procedure is designed to simulate the exposure that would be expected in an essentially noncombustible occupancy (i.e., an isolated stack of pallets). The procedure also has been used with various combustible occupancies as the ignition source to determine if combustible building panels will require greater sprinkler protection than the occupancy itself.

The FM Global Corner Test is intended as a test method to evaluate fire propagation only. No limits are placed on the amount of smoke produced. Plastic building materials, FM Approved and not FM Approved, may produce large amounts of smoke when burned. PVC materials produce corrosive fumes when burned. The maximum FM Approved height granted via this test method is 30 ft (9.1 m) as a 5 ft (1.5 m) extension is added using judgment.

The 50 ft (15.2 m) high corner test is used to further evaluate materials for FM Approval at heights greater than the 30 ft (9.1 m) maximum height which can be granted via the 25 ft (7.5 m) test.

The test array consists of a simulated building corner, each wall being 20 ft (6.1 m) long by 50 ft (15.2 m) high. All other aspects of the test are the same as the 25 ft (7.6 m) test.

During the test, if ignition does not occur on the ceiling, FM Approval can be granted for unlimited height. If ignition occurs on the ceiling, but fire does not propagate to the ends of the corner, FM Approval can be granted to a maximum 50 ft (15.2 m) height. Refer to FM Approval Standard 4880 for additional details.

C.2 Flammability Characterization Test

In the case of inert-faced, thermoset core panels, the flammability characterization test can be substituted for the 25 ft (7.6 m) corner test. This sophisticated small-scale test measures the following properties of the foam core: chemical heat of combustion, convective heat of combustion, effective heat of gasification, critical heat flux for ignition, chemical heat release rate, thermal response parameter and convective flame spread parameter.

From the evaluation of these properties, combined with an inert face, performance in the 25 ft (7.6 m) corner test can be accurately predicted. Refer to FM Approval Standard 4880 for additional details.

C.3 Polyurethane

Polyurethane can be supplied as prefabricated boards or can be sprayed-in-place; the end products are chemically the same. Polyurethane is produced by an exothermic reaction of an isocyanurate and a polyol resin. Increasing the ratio of isocyanurate to polyol resin and adding various catalysts produces polyisocyanurate foam, containing varying amounts of polyurethane. The properties of spray-applied polyurethane can be affected by the application method and conditions at the time of application. Density can vary from 1.7 to 4 pcf (27.2 to 64 kg/m³).
C.4 Expanded and Extruded Polystyrene (EPS)

EPS is commonly used for building insulation and ceiling panels. It is supplied as board stock at densities of 0.8 to 3.0 pcf (12.8 to 48.0 kg/m$^3$). Expanded polystyrene is formed from beads that are molded to the desired shape. Expanded products generally have a density less than 1.5 pcf (24 kg/m$^3$). Extruded polystyrene is formed by a foaming process. The density is usually greater than 1.5 pcf (24 kg/m$^3$).

EPS sheathing boards often are used to insulate freezers and cold storage rooms. They usually are installed in one or more layers on walls, floors, and ceiling (or roofs).

FM Approved EPS ceiling panels are used as suspended ceilings below automatic sprinklers. In the presence of fire, the panels will quickly shrink and drop out of place. This allows for unobstructed distribution of sprinkler discharge. They are limited to 1 in. (30 mm) in thickness and their use is limited to Hazard Category 1 (HC-1) occupancy as defined in Data Sheet 3-26, *Fire Protection Water Demand for Nonstorage Sprinklered Properties*.

C.5 Rigid Plastic Panels

Rigid plastic panels have been FM Approved for two end uses: interior finish materials and plastic building panels. Plastic building panels are popular in the papermaking and chemical process industries. Interior finish panels typically are used in the food processing industry. FM Approved interior finish materials consist of flat sheets that are installed over a noncombustible backing; currently they are not FM Approved for use over combustible backings. Plastic building panels usually are corrugated and typically are fastened directly to the exterior of the building framing. These panels may be reinforced (FRP) or unreinforced (PVC based). They are not intended nor FM Approved for use against a backing.