PLASTICS IN CONSTRUCTION

Table of Contents

List of Figures

List of Tables

1.0 SCOPE

This data sheet provides recommendations on the use, construction, and fire protection for select plastic building materials and their application, with respect to interior fire exposure, unless otherwise noted. This data sheet does not include natural hazard exposures and recommendations.

Examples of topics included in this data sheet are, but not limited to, the following:

- Single layer panels, including fiberglass reinforced (FRP) and polyvinyl chloride (PVC)
- Foil-faced insulation boards
- Insulated metal panels with polyurethane, polyisocyanurate and polystyrene cores
- Spray-applied foams
- Plastic skylights and plastic light bands
- Metal composite material (MCM) exterior wall assemblies and interior panels
- Insulation on metal storage tanks containing noncombustible contents
- Polystyrene Geofoam
- Elastomeric insulations
- Insulated wall curtains
- Wall-Mounted, Building-Integrated Photovoltaic (BIPV) Façade Systems

See Section 4.1 for other data sheets that could provide design information and guidance for plastics in construction. A list of FM Approval standards is provided by topic but is not considered all inclusive.

1.1 Hazards

The use of plastic materials in construction can provide many advantages over traditional construction materials (steel/wood/concrete), due to their lighter weight, cleanability and ability to resist decomposition, corrosion, or rust. The increased use of plastics is likely to continue.

While plastic construction materials can be beneficial, all plastic materials are combustible and burn with varying degrees of intensity. When plastic burns, it can produce copious amounts of thick black smoke. Some plastic products, such as PVC, also produce an acid byproduct that can be carried by smoke particles and deposited on surfaces. Surfaces such as electronics or metal components can be damaged by the deposition of these corrosive particles leading to increased cleanup time.

A false sense of fire safety may be provided by complying with building code requirements when it comes to plastic materials. Many of the fire tests required by building codes do not adequately test plastic products based on actual installation or performance in a fire.

Using FM Approved materials is a way to ensure resiliency in building design, as FM Approved materials will not propagate a fire. FM Approved materials are also available for use in smoke sensitive occupancies.

1.2 Changes

April 2026. Interim revision. The data sheet has been modified to provide guidance on Wall-Mounted, Building-Integrated Photovoltaic (BIPV) Façade Systems. Additional definitions have been added to Appendix A.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 General

2.1.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

2.1.2 When using FM Approved products or materials, provide sprinkler protection for the occupancy in accordance with the applicable data sheet.

2.1.3 Replace non-FM Approved materials where practical with FM Approved materials, including partial replacement or as part of repairs.

2.1.4 Protect existing non-FM Approved materials in accordance with this data sheet.

2.1.5 Provide a thermal barrier, per Table 2.1.5-1, over exposed foam plastics (polyurethane, polyisocyanurate, polystyrene) or replace with FM Approved materials. The use of an intumescent paint is not considered a thermal barrier.

Table 2.1.5-1. Thermal Barrier and Sheathing Materials[1]

Material	*Thickness*	*Special Considerations and/or Fastening*
	Thermal Barriers[2]	
Gypsum Board	½ in. (13 mm)	• Fasten per manufacturer recommendations (e.g., 16 fasteners per 4 ft x 8 ft [1.2 m x 2.4 m] board) or 1 fastener per 2 ft^2 (0.18 m^2). • Cover joints with tape and joint compound. • An alternative to taped joints is metal batten bars (minimum 1/2 in. [13 mm] overlap of joint) secured through the gypsum board into the substrate at maximum 3 ft (0.9 m) on center.
FM Approved Coatings[3]	In accordance with FM *Approval Guide* (for material to be covered)	
Portland Cement (e.g., stucco)	½ in. (13 mm)	• Secure metal lath to the substrate or structure. • Apply Portland cement over metal lath.
FM Approved Spray Applied Coatings[3]	In accordance with FM *Approval Guide*	• Not permitted in occupancies susceptible to an accumulation of combustible or oily deposits. • Do not use cellulose-based coatings in high humidity occupancies.
	Sheathing materials	
Steel	26 gauge (0.5 mm)	• Provide sprinklers based on this data sheet or the occupancy specific data sheet, whichever is greater. Provide fastening per the data sheet.
Aluminum	0.032 in. (0.8 mm)	
Cement board	Minimum of ¼ inch	• Fasten directly into support structure every 16 in. (40 cm) on center
FM Specification Tested MCM panel		• Provide sprinklers adequate for the occupancy

Note 1: Thermal barriers and sheathing must be in direct contact with plastic foam insulations. Use unfaced fiberglass or mineral wool to fill any voids. Thermal barriers are not a substitute for sprinklers required for the occupancy. Existing insulated metal panels are considered sheathed if they meet the minimum sheathing thickness requirements.
Note 2: When using a thermal barrier, the need for sprinklers is based on the occupancy.
Note 3: Some FM Approved coatings are not considered thermal barriers. Review Approval standards to determine if sprinklers are required as part of the Approval.

2.1.6 Protect concealed spaces containing plastic materials with sprinklers, using the ceiling sprinkler protection in Table 2.1.6-1. See FM Loss Prevention Data Sheet 1-12, *Ceilings and Concealed Spaces*, for additional criteria.

Table 2.1.6-1. Ceiling Sprinklers, Perimeter Ceiling, and Intermediate Wall Sprinklers Design and Location[1]

Design Criteria for Ceiling Sprinklers			
Ceiling Sprinklers: Provide a minimum ceiling density of 0.2 gpm/ft^2 (8 mm/min) over 2,000 ft^2 (186 m^2)			
Design Criteria for Perimeter ceiling and intermediate wall sprinklers[2]			
	Number of Levels	Min. Design Flow per Sprinkler	Design Number of Sprinklers
Perimeter Ceiling Sprinklers (quick response sprinklers installed next to the wall) Needed for all ceiling heights	One	20 gpm [76 L/min] (all except EPS core)	10 sprinklers (all except EPS core)
Intermediate Wall Sprinklers (quick response sprinklers). In addition to perimeter ceiling sprinklers are needed for Ceiling heights greater than 30 ft (9.1 m)	One	20 gpm (76 L/min)	10 sprinklers
	Two or more	20 gpm (76 L/min)	20 sprinklers 14 sprinklers on top level and 6 sprinklers on next lower level
Location of Perimeter Ceiling and intermediate wall sprinklers			
Perimeter Ceiling Sprinklers	Locate perimeter ceiling sprinklers at the ceiling and within, 2 ft +/-3 in. (60 cm +/- 8 cm) from all walls and corners. Space a maximum of 10 ft (3 m) apart and stagger between sprinklers located in the main field of the ceiling sprinkler system. See Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers, regarding spacing and mitigation.		
Intermediate Wall Sprinklers	Locate between the ceiling and floor every 30 ft (9.1m) or less vertically and a maximum of 1 ft (0.3 m) from the wall. For ceiling heights greater than 30 ft (9.1m), evenly space intermediate lines vertically, and not to exceed 30 ft (9.1 m) between lines). Place sprinklers under mid height supports or horizontal wall girts. If mid height supports or wall girts are not provided, use in-rack sprinklers with water shields.		

Note 1. Balance perimeter ceiling sprinklers or intermediate wall sprinkler system demands with ceiling protection, in-rack systems, and hose stream demand.
Note 2. Perimeter ceiling and intermediate wall sprinklers are based upon the installation of upright or pendant sprinklers.

2.1.7 Provide ceiling sprinklers, plus perimeter ceiling and intermediate wall sprinklers, per Table 2.1.6-1 when recommended elsewhere in this data sheet.

2.1.8 Installation of dry sprinkler system to protect plastic construction materials is acceptable when water delivery time does not exceed 30 seconds.

2.1.9 Provide a hose stream allowance of 250 gpm (950 L/min) in all designs for a minimum duration of 60 minutes.

2.2 Plastics in Construction

2.2.1 Insulated Metal Panels

A primary goal of this data sheet is to ensure insulated metal panel construction does not add fuel to an occupancy fuel load by ensuring the panel remains intact to work with sprinkler protection. Insulated metal panel protection and joint securement, plus sprinkler protection is provided to minimize the opportunity of fire getting behind the metal panel facing and into the foam insulation. Specifically:

- The metal facing will remain intact to cover the foam insulation.
- Sprinklers operate quickly to control the fire.
- Panel securement keeps the panel in place and connected to the structure.
- Joints remain connected and intact to prevent fire entry

2.2.1.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approvals Examination Standards:

- FM 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*
- FM 4881, *Class 1 Exterior Wall Systems*
- FM 4882, *Class 1 Interior Wall and Ceiling Materials or System for Smoke Sensitive Occupancies*

2.2.1.2 Protect existing non-FM Approved insulated metal panels with either polyurethane or polyisocyanurate core by meeting the following criteria:

- Provide sheathing materials per Table 2.1.5-1.
- Provide ceiling sprinklers, perimeter ceiling and intermediate wall sprinklers per Table 2.1.6-2.

2.2.1.3 When existing polyurethane or polyisocyanurate core non-FM Approved insulated metal panels are installed on the walls only and the occupancy does not require sprinkler protection, provide perimeter ceiling, and intermediate wall sprinklers per Table 2.1.6-1.

2.2.1.4 When existing non-FM Approved polyurethane or polyisocyanurate core insulated metal panels are installed on the ceiling only, provide ceiling sprinklers per Table 2.1.6-1.

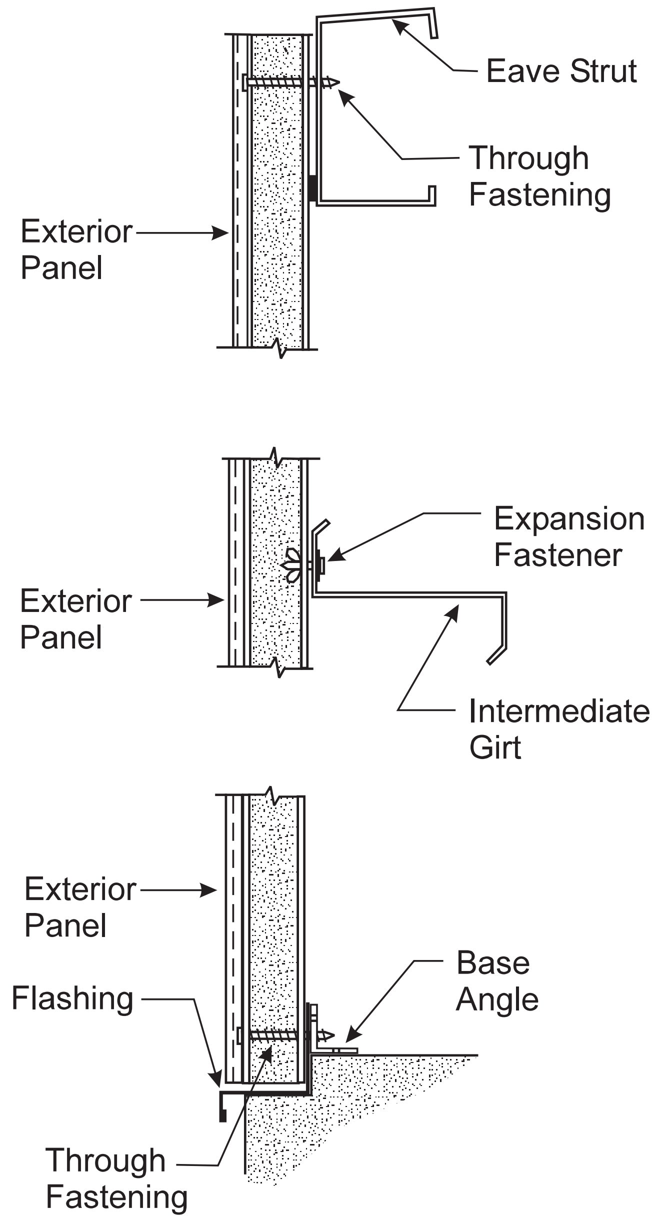
2.2.1.5 Secure existing non-FM Approved insulated metal panel walls with either polyurethane or polyisocyanurate core in accordance with Figures 2.2-2 through 2.2-4 **and** one of the options in Table 2.2-1, if applicable.

Fig. 2.2.1.5 Angles provided for securement

2.2.1.6 Protect existing non-FM Approved polystyrene core insulated metal panels by providing a thermal barrier in accordance with Table 2.1.5-1.

2.2.1.7 Secure existing non-FM Approved polyurethane or polyisocyanurate core insulated panels vertically (Figure 2.2-2) by through fastening (bolts or screws) at the top and bottom of each panel and then fastening at the intermediate members of the inner skin every 10 ft (3 m) vertically. Europe (or non-wind zones) panels may span up to 27 ft (8 m) horizontally and are secured at the building columns only. This is considered acceptable if joint securement is also provided.

2.2.1.8 Secure existing non-FM Approved polyurethane or polyisocyanurate core insulated panels with panel securement (Figure 2.2-3) to the structural framework every 10 ft (3 m) or less (horizontally) and at each structural upright. Europe (or non-wind zones) panels may span up to 27 ft (8 m) horizontally and are secured at the building columns only. This is considered acceptable if joint securement is also provided.



NOTES:
1. If supports (girts) are 10 ft (3 m) OC or less (approx) then no additional panel joint securement (battens, stitch screws, etc.) is needed.
2. If panel joints are metal tongue and groove no additional joint securement is needed.

Fig. 2.21.7. Wall panel securement with through fastening

2.2.1.9 Secure existing non-FM Approved polyurethane and polyisocyanurate core insulated metal panels vertically with channel securement by fastening at the top and bottom of each panel and fastening at the intermediate members of inner skin a maximum of every 10 ft (3 m) vertically (Figure 2.2-4). Europe (or non-wind zones) panels may span up to 27 ft (8 m) and are secured at the building columns only. This is considered acceptable if joint securement is also provided.

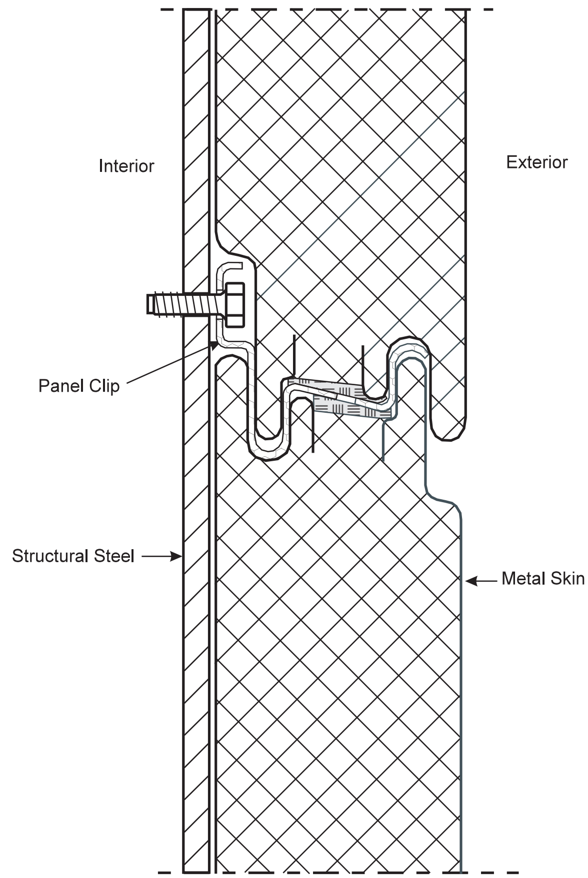


Fig. 2.2.1.8. Panel clip with tongue and groove joint

2.2.1.10 Provide joint securement per Table 2.2-1 when not secured in accordance with 2.2.1.7 throughout 2.2.1.9 or as recommended elsewhere in this data sheet.

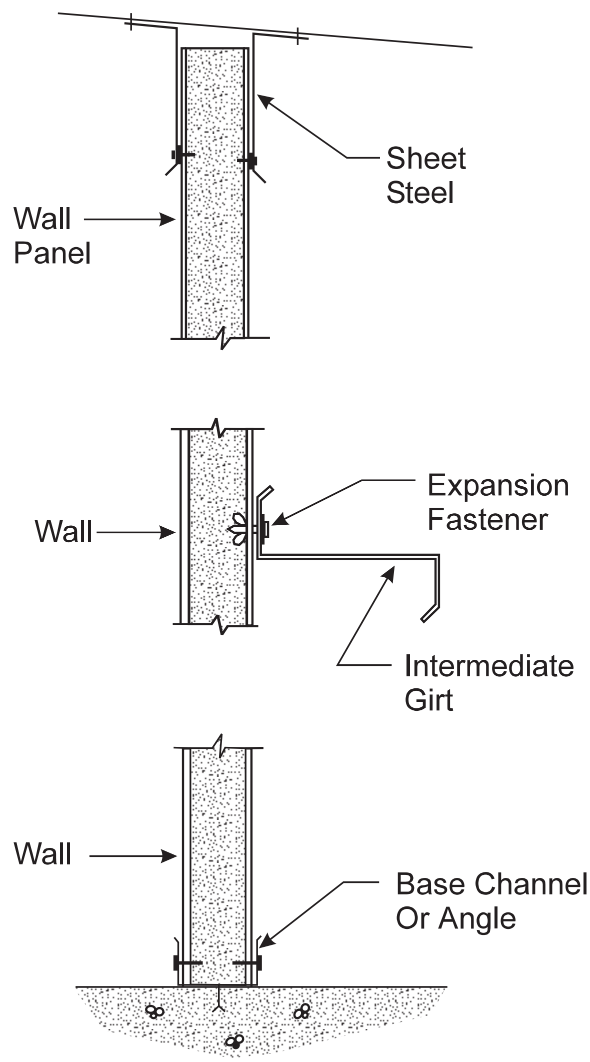


Fig. 2.2.1.9. Wall panel with channel securement at the top and bottom

Table 2.2-1. Panel Joint Securement Options

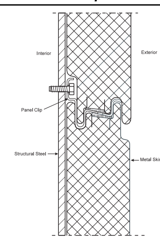
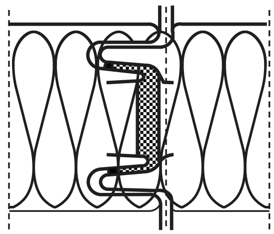
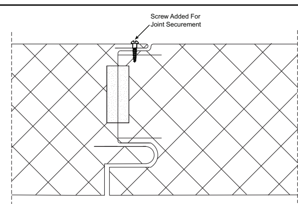
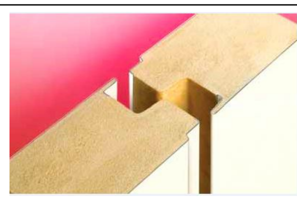
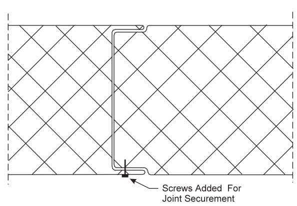
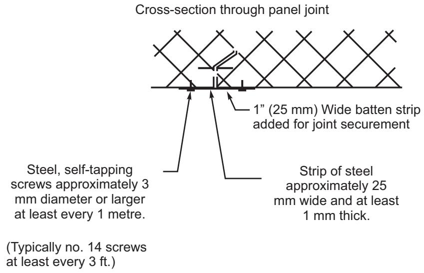
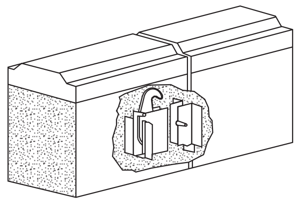
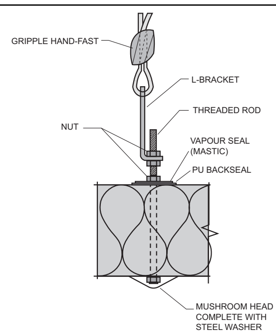
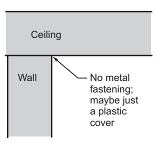
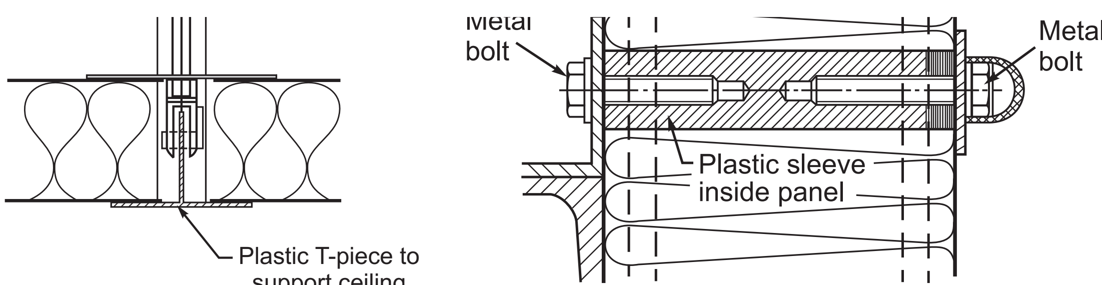
Type of Joint or Securement	*Examples*	*Securement Guidance*
Double Tongue & Groove or double overlap	 	No additional fastening required.
Single Tongue & Groove		**> 30 ft (9.1 m) in height:** Secure joints with self-tapping No. 6 screws (approximately 3 mm diameter) every 10 ft (3 m) vertically.
Overlap	 	**> 30 ft (9.1 m) in height:** Secure joints with self-tapping No. 6 screws (approximately 3 mm diameter) every 3 ft (0.9 m) vertically.
Butt Joint		**> 10 ft (3 m)** Provide a metal batten strip (minimum 1 in. [25 mm] wide) overlapping the joint on each side by at least ½ in. (13 mm). Secure in place on both sides of the joint vertically every 3 ft (0.9 m) using self-tapping metal screws No. 6 screws (approximately 3 mm diameter).

Table 2.2-1. Panel Joint Securement Options (cont'd)

Type of Joint or Securement	*Examples*	*Securement Guidance*
Cam Locks		**> 30 ft (9.1 m) in height:** Secure joints per this table.
Ceiling Grid	 Above fastening of an insulated metal panel ceiling.  Figure on the left shows the ceiling sitting on top of the wall. It may or may not be secured. The use of angles at the top and bottom will provide wall securement up to 30 ft (9.1 m) in height. Beyond 30 ft (9.1 m) intermediate wall securement is necessary.	Secure the ceiling for the particular joint, a minimum of 10 ft (3 m) horizontally from the wall/ ceiling intersection. Securement to the structure can be completed with threaded rod, wire or cable hanging system, angled steel or other structural system that will ensure the panel remains in place. This is accomplished by connecting the securement to the roof or floor framing or structure. No further assessment of the ceiling (> 10 ft [3 m]) is needed, if provided with adequate sprinkler protection.

2.2.1.11 Avoid the use of exposed plastic securement systems. For thermal bridging use a metal fastener with a thermal plastic sleeve (See Figure 2.2.1.11).



This fastening system is unacceptable This fastening system is acceptable

Fig. 2.2.1.11. Plastic securement components – acceptable and not acceptable

2.2.1.12 Arrange the insulated metal panels to avoid obstructed or concealed spaces.

2.2.1.13 For existing non-FM Approved insulated metal panels with either polyurethane or polyisocyanurate core construction creating concealed spaces, provide adequate ceiling sprinkler protection. For shielded spaces, provide additional sprinkler protection to provide adequate water spray. Design sprinkler protection per Table 2.1.6-1 or a greater density per the appropriate data sheet if combustibles are present in the concealed space.

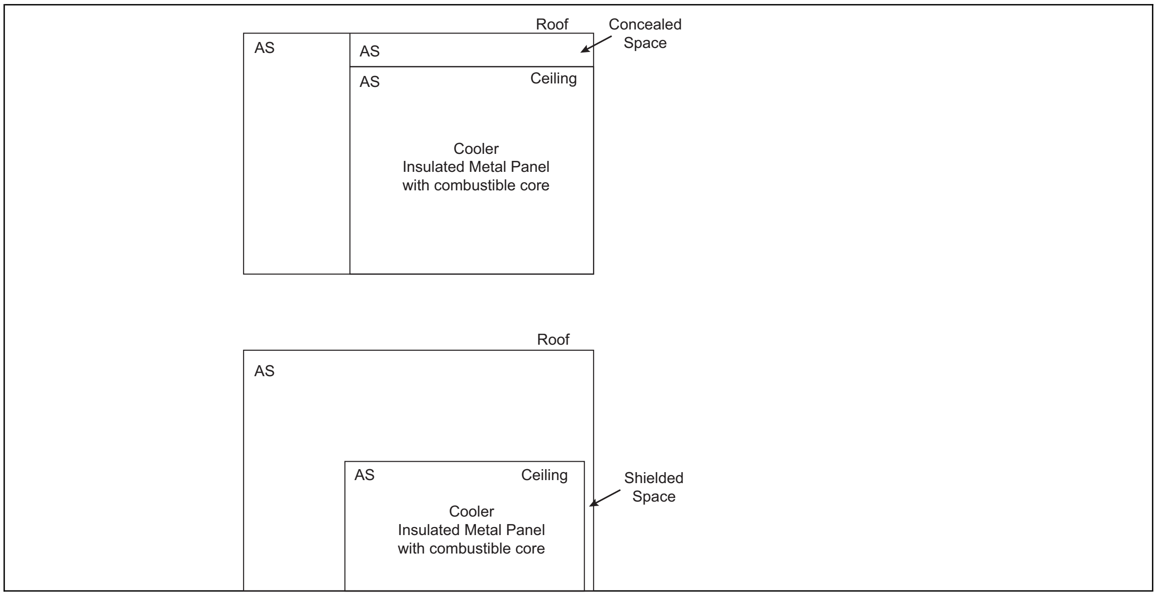


Fig. 2.2.1.13 Section view of concealed or shielded spaces in a building

2.2.2 Foil Faced Insulation Boards and Small Walk-in Coolers

Foil Faced Insulation Boards

2.2.2.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approvals Examination Standards:

- FM 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*
- FM 4882, *Class 1 Interior Wall and Ceiling Materials or System for Smoke Sensitive Occupancies*

2.2.2.2 Provide a thermal barrier over foil-faced polystyrene insulation boards in accordance with Table 2.1.5-1.

2.2.2.3 For existing non-FM Approved construction limit foil faced insulation boards made of polyurethane or polyisocyanurate to less than 2 in. (50 mm) in thickness and installed on the ceiling only. Provide ceiling sprinklers per Table 2.1.6-1.

Small Walk-In Coolers

2.2.2.4 Small walk-in coolers less than 10 ft (3 m) high and 1,000 ft^2 (93 m^2) in plan area with varying heights of unobstructed space above may be protected in accordance with this section. Protect larger walk-in coolers in accordance with Section 2.2.1 for insulated metal panels.

2.2.2.5 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approvals Examination Standards:

- FM 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*
- FM 4882, *Class 1 Interior Wall and Ceiling Materials or System for Smoke Sensitive* Occupancies

2.2.2.6 Provide sprinkler protection inside the cooler based on the appropriate data sheet for the occupancy.

2.2.2.7 Provide ceiling sprinkler protection over the walk-in cooler and extending 20 ft (6 m) beyond. Design ceiling protection per Table 2.1.6-1 or the surrounding occupancy.

2.2.3 Single Layer Unbacked FRP or PVC Panels

2.2.3.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

- FM Approval 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*
- FM Approval 4882, *Class 1 Interior Wall and Ceiling Materials or System for Smoke Sensitive Occupancies*
- FM Approval 4910, *Cleanroom Materials*

2.2.3.2 Secure existing non-FM Approved single layer unbacked FRP or PVC panels to the structural framing system with corrosion-resistant metal fasteners. Provide at least two fasteners per panel and one every 16 in. (40 cm) in width (horizontally), along all structural members.

2.2.3.3 For existing non-FM Approved single layer FRP or PVC panels provide ceiling sprinklers, plus perimeter ceiling and intermediate wall sprinklers per Table 2.1.6-1.

2.2.3.4 Provide a specially designed escutcheon plate around ceiling sprinklers to provide protection from deforming PVC ceiling panels. Design escutcheon plates to meet the following criteria:

- Construct the plate from stainless steel, a minimum of 1/16 in. (1.6 mm) thick
- Ensure minimum outside diameter of 6.5 in. (195 mm) and inside diameter of 2.6 in. (80 mm)
- Secure the plate to the backing material with a minimum of four evenly spaced screws

2.2.4 Single Layer Backed FRP or Backed PVC Panels

2.2.4.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approvals Examination Standards:

- FM 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*
- FM 4882, *Class 1 Interior Wall and Ceiling Materials or System for Smoke Sensitive Occupancies*
- FM 4910, *Cleanroom Materials*

2.2.4.2 Protect existing non-FM Approved single layer FRP or PVC panels installed on noncombustible backing with ceiling sprinklers, plus perimeter ceiling and intermediate wall sprinklers in accordance with Table 2.1.6-1.

2.2.4.3 Provide a specially designed escutcheon plate around ceiling sprinklers to provide protection from deforming PVC ceiling panels. Design escutcheon plates to meet the following criteria:

- Construct the plate from stainless steel, a minimum of 1/16 in. (1.6 mm) thick.
- Ensure minimum outside diameter of 6.5 in. (195 mm) and inside diameter of 2.6 in. (80 mm).
- Secure the plate to the backing material with a minimum of four evenly spaced screws.

2.2.4.4 Mechanically fasten non-FM Approved panels to a noncombustible backing using corrosion-resistant metal fasteners. Drive fasteners through the single layer panel into the noncombustible backing at 16 in. (406 mm) on center, resulting in a total of 18 fasteners (3 along the short side and 6 along the long side of a 4 ft x 8 ft (1.2 m x 2.4 m) panel. Provide metal batten bars overlapping the joints by ½ in. (13 mm) on each side. Secure the batten bar on both sides of the joint vertically every 3 ft (0.9 m) using No. 6 (approximately 3 mm) self-tapping metal screws.

2.2.5 Double Layer FRP/PVC Panels and Insulated FRP/PVC Panels

2.2.5.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approvals Examination Standards:

- FM 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*
- FM 4882, *Class 1 Interior Wall and Ceiling Materials or System for Smoke Sensitive* Occupancies
- FM 4884, *Panels Used in Data Processing Center Hot and Cold Aisle Containment Systems*
- FM 4910, *Cleanroom Materials*

2.2.5.2 Replace existing non-FM Approved double layer FRP or PVC panels (two panels with an air space between) and insulated single layer FRP or PVC panels with FM Approved panels or noncombustible panels. An alternative is to provide a thermal barrier per Table 2.1.5-1.

2.2.6 Spray Applied Foam

Treat spray applied products such as polyurethane, icynene and other spray-applied insulation products the same.

2.2.6.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approvals Examination Standards:

- FM 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*
- FM 4881, *Class 1 Exterior Wall Systems*
- FM 4882, *Class 1 Interior Wall and Ceiling Materials or System for Smoke Sensitive Occupancies*
- FM 4910, *Cleanroom Materials*
- FM 4924, *Pipe and Duct Insulation*

2.2.6.2 Protect existing non-FM Approved exposed spray applied foam with a thermal barrier per Table 2.1.5-1 or sheathing and sprinklers in accordance with Tables 2.1.5-1 and 2.1.6-1.

2.2.6.3 When using spray applied foam roof covers, use FM Approved materials (FM Approval 4470). See Data Sheet 1-15, *Roof-Mounted Solar Photovoltaic Panels*, for exterior fire exposure from roof mounted solar panels when using spray applied foam roof covers.

2.2.7 Plastic Light Bands and Skylights

2.2.7.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approvals Examination Standards:

- FM 4431, *Skylights*

2.2.7.2 Replace non-FM Approved PMMA (acrylic) or non-FR-treated FRP for wall light bands. The flammability characteristics (low critical heat flux) show these materials are easy to ignite and rapidly spread fire.

2.2.8 Insulated Wall Curtains

2.2.8.1 Use noncombustible or FM Approved products for new installations and install in accordance with the listing.

FM Approvals Examination Standards:

- FM 4883, *Insulated Wall Curtains*

2.2.8.2 Replace existing non-FM Approved insulated wall curtains containing polyethylene bubble wrap with FM Approved insulated wall curtains.

2.2.8.3 Protect existing non-FM Approved insulated wall curtains ≤ 30 ft (9.1 m) high with perimeter ceiling sprinklers on both sides in accordance with Table 2.1.6-1.

2.2.8.4 Provide at least 10 ft (3 m) of clearance to any storage and manufacturing on both sides of non-FM Approved insulated wall curtain.

2.2.8.5 Do not install non-FM Approved insulated wall curtains greater than 30 ft (9.1 m) in height.

2.2.8.6 Do not install non-FM Approved insulated wall curtains under combustible ceiling construction.

2.2.8.7 Do not install non-FM Approved insulated wall curtains against walls.

2.2.9 Acoustical Panels

Acoustic panels are strategically placed in rooms to improve sound quality by absorbing or mitigating background noise transmission. These panels can be made from impregnated fiberglass, polyurethane foams, PET, polyester, tectum material or recycled plastic. Avoid acoustical sound panels constructed of plastic materials.

For Anechoic Chamber panels, see Data Sheet 1-53, *Anechoic Chambers*.

2.2.9.1 For new installations use noncombustible or limited combustible materials for acoustical panels, provide sprinklers and do not obstruct sprinklers. Do not use plastic materials, such as PET (polyethylene terephthalate) or polyester.

2.2.9.2 Replace existing acoustical panels if constructed of plastic materials, such as covered foams, PET or polyester.

2.2.10 Cellulosic Insulation

Cellulosic insulation sprayed on walls and ceilings is treated similar to other combustible insulations. Do not use in high humidity areas or occupancies that would allow for an accumulation of combustible deposits on the surface. This section does not cover cellulosic insulation blown into attics.

2.2.10.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approval Standard:

- FM Approval 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*

2.2.10.2 Cover existing non-FM Approved cellulosic insulation with a thermal barrier in accordance with Tables 2.1.5-1 or sheathing material per Table 2.2.10.2-1 and sprinklers per Table 2.1.6-1.

2.2.10.2.1 Cover existing non-FM Approved cellulosic insulation with a FM Approved fire-retardant coating and install in accordance with the listing.

Table 2.2.10.2-1. Sheathing Material Securement for Cellulosic and Elastomeric Insulations

Sheathing Material	*Fastening Criteria*[1]
Steel minimum of 26 gauge (0.5 mm) Aluminum 0.032 in (0.8 mm)	• Overlap sheathing materials material or joints with batten bars by at least 1 in. (25 mm) • Fasten sheathing or batten bars vertically every 3 ft (0.9 m) on center. Fasten batten bars on both sides of the joint

Note 1. Ensure there are no voids from wrapping or overlapping materials. Add extra fasteners, as necessary.

2.2.11 Elastomeric Insulation

2.2.11.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approved Standards:

- FM Approval 4910, *Cleanroom Materials*
- FM Approval 4924, *Pipe and Duct Insulation*

2.2.11.2 Replace existing non-FM Approved elastomeric insulation with FM Approved products or materials

2.2.12 Insulation of Outdoor and Indoor Metal Storage Tanks with Noncombustible Contents

2.2.12.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approved Standards:

- FM Approval 4880, *Class 1 Fire Rating of Building Panels or Interior Finish Materials*
- FM Approval 4881, *Class 1 Exterior Wall Systems*
- FM Approval 4882, *Class 1 Interior Wall and Ceiling Materials or System for Smoke Sensitive Occupancies*

2.2.12.2 For existing non-FM Approved installations provide a thermal barrier in accordance with Table 2.1.5-1.

2.2.13 Polystyrene Geofoam Fill

2.2.13.1 Protect Polystyrene Geofoam materials with a layer of aggregate material. Do not leave Polystyrene Geofoam exposed.

2.2.13.2 Do not install or use Polystyrene Geofoam fill blocks in areas exposed to:

- High-water table
- 100-year or 500-year flood zone or
- Storm water runoff collection areas.

See Data Sheet 1-40, *Flood*, for additional information.

2.2.13.3 See Data Sheet 1-35, *Vegetative Roof Systems, Occupied Roof Areas and Decks* for guidance when installing Polystyrene Geofoam as part of a vegetative roof.

2.2.14 Metal Composite Material (MCM) Interior Wall Panels

2.2.14.1 Use noncombustible, FM Approved products or FM Specification Tested materials for new installations and install FM Approved products in accordance with their listing.

FM Specification Tested Materials:

- Building Materials, FM Approvals Cleanroom Materials Flammability Test Protocol (Class Number 4910) - (e.g., MCM Interior Wall Panels).

2.2.14.2 Provide sprinklers for the occupancy.

2.2.15 Metal Composite Material (MCM) Exterior Wall Assemblies

2.2.15.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approved Standards:

- FM Approval 4411, *Cavity Wall Systems* (e.g., MCM exterior wall assemblies)

2.2.16 High Pressure Laminate (HPL) Exterior Wall Assemblies

2.2.16.1 Use noncombustible or FM Approved products for new installations and install FM Approved products in accordance with their listing.

FM Approved Standards:

- FM Approval 4411, *Cavity Wall Systems* (e.g., HPL exterior wall assemblies)

2.2.17 Other High-Performance Building Envelopes (Exterior Wall Systems)

High-performance building envelopes are designed to separate the exterior and interior elements. These envelopes are specifically designed to stop air leaks, drafts and moisture infiltration. This design is achieved mainly by delineating and installing a weather resistant barrier to control infiltration and moisture. Most high-performance building envelopes contain an air gap, insulation (exterior and interior), and a weather resistant barrier. A properly designed, high-performance building envelope assists in reducing heating and cooling demands, thereby reducing energy consumption.

2.2.17.1 Use noncombustible or FM Approved systems for new installations. Install in accordance with their listing.

FM Approval Standard: FM Approval 4411, *Cavity Wall Systems*

2.2.17.1.1 A noncombustible, high-performance building envelope is one that uses a noncombustible cladding or rainscreen, noncombustible insulation (meeting FM noncombustible rating, part of ANSI/FM 4880); and the weather resistant barrier is covered by the noncombustible insulation.

Note: Materials such as glass-glass building integrated photovoltaics, or MCMs made of noncombustible materials and adhesives (bonded laminates) are considered combustible. An example of a noncombustible rain screen is one constructed from solid metal.

2.2.18 FRP Grating

2.2.18.1 Sprinkler protection is not necessary if the only combustible material is an FRP grating for walkways.

2.2.19 Concrete Walls Filled with Foam Insulation

2.2.19.1 Use FM Approved polyisocyanurate or polyurethane foam when insulating concrete walls.

2.2.20 Polyester Batt Insulating Materials

2.2.20.1 Protect vertical unfaced polyester batt insulation with a thermal barrier or sheathing in accordance with Table 2.1.5-1 and ceiling sprinklers per Table 2.1.6-1.

2.2.21 Heating, Ventilation and Air Conditioning (HVAC) Systems

FM Approvals Examination Standards:

- FM 4924, *Pipe and Duct Insulation* (exterior of duct)
- FM 4925, *Fabric Ducts and Insulation Lined HVAC Ducts* (interior of duct, including anti-microbial or other materials)

2.2.21.1 Use noncombustible or FM Approved products for new ductwork installations, including liners. Install FM Approved products in accordance with their listing.

The installation of noncombustible or FM Approved products includes the insulation and liners installed on either the exterior or interior of ducts.

The use of anti-microbial, acrylic or other coatings can substantially change the fire performance. Ensure these coatings have been tested as part of an FM Approved product.

2.2.21.2 Do not use prefabricated or pre-insulated ducts.

2.2.21.3 Fabric Ducts

2.2.21.3.1 Fabric ducts can be a potential obstruction to ceiling sprinkler discharge during a fire. Install fabric ducts as close to the ceiling as possible and centered between adjacent sprinklers. See Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, for additional recommendations.

2.2.21.4 Combustible Filters Used in HVAC Systems

2.2.21.4.1 Provide sprinkler protection in large combustible filter systems with capacities of 5,000 ft^3/min (142 m^3/min) or greater. Arrange the sprinklers to wet the entire surface of the filters. Provide drainage to a safe location, if necessary.

2.2.21.5 Fire Protection of HVAC Ducts

2.2.21.5.1 Provide protection in accordance with Table 2.2.21.5 for non-FM Approved ducts, fabric ducts, exterior insulation and liners based upon their hazard.

Table 2.2.21.5. Fire Protection for HVAC Duct Systems

Class A (FM Approved or metal)*	*Duct with Interior Fire Hazard (nonmetallic or ducts with linings)*	*Duct with Exterior Fire Hazard (fabric ducts /exterior insulation)*	*Prefabricated or Pre-Insulated Ducts or Similar*
	• Provide fire and smoke dampers actuated by duct smoke detectors to limit fire and smoke, and • Provide interior sprinklers (8 heads operating at 15 gpm [57L/min]).	• Provide exterior ceiling sprinklers per Table 2.1.6-1.	• Replace material or: • Provide fire and smoke dampers actuated by duct smoke detectors to limit fire and smoke, and • Provide exterior ceiling sprinklers per Table 2.1.6-1.
* Duct is metal with no insulation, or liners. Follow other guidance, as applicable, in Data Sheet 1-57, *Plastics in Construction*. See Data Sheet 5-40 for additional guidance on smoke detector placement/installation.			

2.2.21.6 Provide screens for fresh air intakes when required by Data Sheet 9-19, *Wildland Fire*.

2.2.22 Phenolic Insulation (Reserved)

2.2.23 Insulated Concrete Forms (Reserved)

2.2.24 Structural Insulated Panels (Reserved)

2.2.25 Wall Mounted Building-Integrated Photovoltaic (BIPV) Façade Systems

2.2.25.1 Use FM Approved, wall-mounted BIPV façade systems. Install FM Approved products in accordance with their listing.

FM Approvals Examination Standards:

- FM 4483, *Examination Standard for Wall Mounted Building Integrated Photovoltaic Systems (BIPV)*

2.3 Operations and Maintenance

2.3.1 Maintain thermal and sheathing material barriers free of punctures, holes or other damage that exposes the insulation.

2.3.2 Repair thermal barriers and sheathing materials by placing a similar material or a metal plate over the damaged area. If using sheathing materials, overlap the damaged area by at least 1 in. (2.54 cm) and secure in place with self-tapping screws. Fill small penetrations with an FM Approved firestopping material.

2.4 Human Factor

2.4.1 For buildings under construction, limit storage of plastic building materials, as outlined in Data Sheet 1-0, *Safeguards During Construction, Alteration, and Demolition*. Store any combustible materials away from building as outlined in Data Sheet 1-20, *Protection Against Exterior Fire Exposure*.

2.4.2 Do not use temporary fencing constructed of self-supporting steel and polystyrene panels.

2.5 Ignition Source Control

2.5.1 Do not conduct hot work around plastic construction materials since these areas are considered a high risk. Use the FM Hot Work Permit System to supervise hot work operations in accordance with Data Sheet 10-3, *Hot Work Management*.

2.5.2 Do not place electrical equipment directly on plastic construction materials or insulated metal panels. Provide a noncombustible material, such as gypsum board or cement board between the equipment and plastic construction materials or insulated metal panels. See Data Sheet 5-4, *Transformers*, 5-19 *Switchgear and Circuit Breakers*, 7-39, *Material Handling Vehicles*, for guidance on spacing and mounting on or near plastics or combustible construction.

3.0 SUPPORT FOR RECOMMENDATIONS

Plastics are commonly used in building construction and in some cases have certain advantages in particular uses. Non-FM Approved plastics are considered to be highly combustible. Once ignited, plastic material will burn vigorously and release large amounts of heat and black smoke. The smoke development and spread are as much a concern as the fire spread. While the use of sprinklers is important to control a fire, sprinklers are generally designed for occupancy fires and not for building construction materials. In some cases, the sprinklers, although activated may not be able to control the high heat release from burning plastic, allowing the fire to propagate faster than ceiling sprinklers can operate. This could result in extensive property damage or loss of an entire facility.

Many building codes and standards accept the use of plastic construction features subject to achieving an ASTM E84 flame-spread rating in the US and other small-scale tests in other countries. Many of these tests are used to determine flame spread in a small-scale test, and the results are not representative of the way a plastic material behaves in an actual fire. Consequently, claims for fire retardancy based on the ASTM E84 and other similar comparative tests should be disregarded.

ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials

The ASTM E84 test is a comparative test and should not be considered a fire test. The ASTM standard is clear, in that the results of the test are used to describe the response of materials but does not by itself incorporate all the factors required for fire hazard or fire risk assessment of the material under fire conditions. Further, this test does not take into account the aggravated flame spread behavior resulting from proximity of combustible walls and ceilings. The junction of the wall and ceiling is key to fire spread. In plastic materials, it is this junction that can accelerate a fire due to the reentrant corner and heat flux reflection at the junction.

As a comparative test, a sample is placed in the apparatus (20 in. X 25 ft [7.87 cm x 7.6 m] long tunnel test) on just the ceiling of the tunnel. The sample is placed on the ceiling of the tunnel. It must be capable of being self-supporting or held in place, as allowed by the standard. The sample is exposed to a gas flame under regulated fuel and draft conditions. The two main results from an E84 test are: flame spread and smoke developed. The main benchmarks (materials compared) are cement-asbestos board, which has a flame spread of 0 and red oak, which has a flame spread of 100. The smoke developed is compared to smoke from a pan of heptane, which has a flame spread of 100.

A product is considered to have passed an ASTM E84 test, if the fire does not propagate to the end of the tunnel (25 ft [7.6m]) within the 10-minute exposure, by visually observing the behavior along the sample. A formula is then used to compare the area of fire spread to the benchmarks and assign a fire spread index (FSI) number. The two measurements do not necessarily have a relationship. Many plastics that melt, drip, or delaminate to such a degree that the continuity of the flame front is destroyed results in lower flame spread indices (better result) and do not relate to indices of products that remained in place. Since this is a horizontal test, once the product is installed vertically the results are very questionable, as it is known fire behaves differently in the vertical orientation than the horizontal orientation. Building codes commonly use this test as the benchmark for interior finish even though it is well known there are concerns about the test applicability with respect to plastics.

FM considers the ASTM E84 test to be inaccurate method for identifying flame spread for the following reasons:

- Comparative test

- Melting or shrinking plastics can result in a favorable test
- Tested horizontally, but can be installed vertically
- Result is aggravated when product is installed and meets at both the ceiling and wall joint.

Do not use individual comparative testing, such as ASTM E84 (USA), single burning item (SBI), ignition resistance, small-scale fire tests (UL94) and/or heat of combustion-type testing as the sole means of classifying plastic building materials. The use of these tests is suspect when testing plastic materials and often can provide a misleading positive test result. (See Data Sheet 1-4, *Fire Tests*, for more information).

MCM Exterior Wall Assembly Tests

The use of metal composite material exterior wall assemblies is prevalent in new building design and renovation projects. Using MCM exterior wall assemblies provides a modern looking façade while providing continuous insulation for the building walls, and energy savings through continuous insulation.

While the use of MCM exterior wall assemblies is increasing, it is important to understand the limitations of existing standards relative to fire safety in this area. Prominent large-scale tests available include National Fire Protection (NFPA) 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components* and British Standard (BS) 8414, *Fire Performance of External Cladding Systems*.

NFPA 285 is designed using a two-story test apparatus that evaluates an external wall façade under a spill plume from a flashover fire scenario. This test is 15 minutes in duration. During the test, the heat flux to the wall is gradually increased from 10 kW/m^2 to 40 kW/m^2. The temperatures measured by thermocouples, are placed in front of the wall, inside the air cavity and inside the insulation. To pass the test, the measurement of the temperatures cannot exceed 1000°F, horizontal flame spread cannot reach the sides of the apparatus, and vertical flame spread cannot exceed 10 ft (3 m). Concerns with this large-scale test standard are the use of a lower heat flux exposure than is currently realistic of a modern post flashover fire, lack of an exterior corner fire exposure, lack of a cavity fire test and the ability for non-tested combinations of materials to be used based upon a desk top review.

BS 8414 is a similar test to NFPA 285. BS 8414 has two different tests. The test chosen is based upon the backing material (masonry vs. steel stud). BS 8414 includes a wing wall, which adds radiative heat back into the fire test and uses a more realistic fire size of 75 kW/m^2; but this is still below what is considered a modern post flashover fire. Like NFPA 285, temperatures are measured in front of the wall, inside the air cavity and inside insulation. Concerns with this test include a lower heat flux exposure than is currently realistic, issues with repeatability due to the ignition source (unconditioned wood crib), lack of exterior fire exposure and lack of cavity fire test.

EN 13823, Reaction to Fire Tests for Building Products

The small burn item (SBI) test (aka EN 13823) was developed in Europe for reaction-to-fire product classification. This small burn item test is used for a variety of products. For Data Sheet 1-57, it will focus on wall and ceiling panels and skylights.

The test involves a small corner test structure which is placed within two walls to form a corner without a ceiling. The walls extend 20 in. (50 cm) (short) and 40 in. (101 cm) (long) and have a height of 60 in. (150 cm). The ignition source is a 20-minute test using a 30 kW propane gas burner as the source.

Performance criteria includes heat production, smoke production, lateral flame spread and falling flaming droplets and particles. The SBI has a maximum sample thickness of 8 in. (20 cm) and when testing a product greater than 8 in. (20 cm). When it is trimmed to fit the test the goal is to test in the configuration installed. The manufacturer is responsible for selecting, building, and submitting an assembled product for testing.

FM considers the SBI test to be an inaccurate method for identifying flame spread for the following reasons:

- Small corner test, which is much smaller than a standard room corner test (such as NFPA 286 or ISO 9705)
- No ceiling provided
- Products are assembled by manufacturer and submitted
- Concerns on mounting in field vs. in the apparatus

- Maximum thickness is 8 in. (20 cm)

UL 94, Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliance Testing

UL 94 tests were originally designed for testing small plastic parts for use in appliances and similar products. The test is not applicable to materials whose thickness exceeds 0.5 in (13 mm). This test is not intended for building materials. These tests are sometimes used for products, such as insulation and reinforced plastic panels. The result is used to guide the manufacturer and not meant to provide an indication of hazard to the buyer. (See Data Sheet 1-4, *Fire Tests*, for more information.)

FM considers the UL 94 test to be an inaccurate method for identifying flame spread for the following reasons:

- Not intended for building materials
- Limited thickness can be tested

ISO 1716, Reaction to Fire Tests for Products

Heat of combustion is an industry-standard material characterization test. The total heat of combustion of a material is calculated using ISO 1716. This is only one part of a series of tests used by FM to determine if a material is noncombustible. This small-scale test is a 500 mg sample completely burned under oxygen atmosphere and high pressure in a constant volume chamber.

FM considers the heat of combustion as one part to determine noncombustiblity. The results can only provide a comparison to the typical heat of combustion of ordinary combustibles or plastics. This only indicates that it has a similar heat of combustion, but not how it behaves in a fire.

Intumescent Paint Over Spray Polyurethane Foam

The use of intumescent paints over foam plastics is growing in the United States. The buildings codes allow this product to be installed over foam, as a barrier. We do not recognize the use of intumescent paints over foam for the following reasons:

- There is no FM Approved intumescent paint for use over foam plastics.
- It is a barrier product, not a thermal barrier. The paints are designed to provide a 10 to 15-minute barrier against ignition.

  - To be effective per the manufacturer testing, it requires a minimum wet film thickness. This thickness is generally not measured. At best it is based on gallons per square foot (sq m) of area.
- Typically, the paints do not adhere well over time. Some manufacturers require a primer to be used first.
- These are tested to NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth or ISO 9705, Reaction to fire tests − Room corner test for wall and ceiling lining products, which is a room corner test. The ceiling height is 8 ft (2.4 m), which is usually much lower than installed.
- Any work that requires removal or cutting of the spray foam will require re-application of intumescent paint to protect it.

Burning Behavior of Plastics

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 a polyisocyanurate and a polyol resin. Increasing the ratio of polyisocyanurate to polyol resin and adding various catalysts produces polyisocyanurate foam, which contains 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/m^3).

Polyurethane and polyisocyanurate are thermoset materials, which ignite in the range of 650°F to 1000°F (340°C to 525°C) and tend to burn and char. Dense, acrid smoke is produced, and flames may spread quickly across the material’s surface.

Fire-retardant additives can markedly improve the performance of foamed plastic in comparative fire tests such as ASTM E84. 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.

The use of inert facings, such as steel 26 gauge (0.032 in.) or aluminum (0.8 mm), in FM Approved polyurethane insulated panels will allow a properly formulated core to char when exposed to an ignition source. This charring helps protect the remaining foam and keeps fire propagation to within acceptable limits.

Polystyrene is a thermoplastic and will typically melt at temperatures lower than 400°F (205°C), forming an ignitable liquid. The peak rate of polystyrene decomposition and volatilization occurs around 687°F (364°C), and the vapor release will cause rapid flame spread across the exposed surface. Polystyrene does not tend to smolder or char.

Polystyrene has a heat content in the range of 16,000 to 18,000 Btu/lb (37-42,000 kJ/kg). As it melts, it forms an ignitable liquid pool fire; the amount of fuel available to a building fire from polystyrene products is directly related to the amount of polystyrene present. As with polyurethane, additives do not significantly affect the burning characteristics, except that they may delay ignition.

Polystyrene achieves a low flame-spread rating in many U.S. and international fire tests because of its tendency to shrink away from the small heat source. In larger fires, such as a fire involving a building's contents, polystyrene burns intensely with rapid flame spread across its surface and melts and flows like an ignitable liquid pool fire. As it burns, it generates thick, black smoke, leaving oily particles on exposed surfaces. For this reason, a relatively small fire involving polystyrene in food warehouses, freezers, or electronic equipment areas can result in contamination of a large area.

Expanded polystyrene typically is white with a bead-like structure molded to the desired shape with a density in the range of 1.0-1.25 lb/ft^3 (16-20 kg/m^3). Extruded polystyrene typically is blue, gray, pink or green with a more uniform (foam) texture and a density in the range of 1.8-2.0 lb/ft^3 (29-32 kg/m^3).

Polystyrene 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). Polystyrene 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).

3.1 Loss Experience

Losses involving plastic construction material from a recent 10-year period showed that FM clients had more than 106 fire losses involving plastic in construction with sprinkler protection that operated, and the average gross loss was US$5.7 million. In the same period, FM clients had 419 fires involving plastics in construction without sprinkler protection and the average gross loss dollar was US$8.56 million.

3.1.1 Illustrative Losses

3.1.1.1 A fire occurred at sprinklered testing lab, but the fire occurred in a non-sprinklered salt fog test chamber. The fire appears to have been caused by a portable charger undergoing testing. The salt fog test chamber was approximately 10 ft X 9 ft X 8.5 ft (3 m x 2.7 m x 2.5 m). The salt fog test chamber was constructed of insulated metal panels with polyurethane foam. The interior of the test chamber was lined with fiberglass reinforced plastic and contained PVC piping. Fire did not appear to involve the insulated metal panels and polyurethane foam. The fire involved the fiberglass reinforced plastic panels and PVC piping. Two suppression mode ceiling sprinklers operated outside the test chamber and helped contain the fire from spreading beyond the salt fog test chamber. The fire department fought the fire with hose streams and sprinklers for approximately two hours.

3.1.1.2 A fire occurred in this unsprinklered bio converter-composting plant. The fire was believed to have started in a fan. The post-composting building had polyurethane foam panels with a thin foil covering installed on the ceiling and walls. The polyurethane foam panels were installed 12 in. (30 cm) from the wall and roof, which created a void space. These panels and the void space played a crucial role in the fire spread. The noncombustible construction of adjacent buildings and lack of combustible loading helped limit fire spread to some of the adjacent buildings.

3.1.1.3 A fire occurred in this unsprinklered food manufacturing facility. The fire was believed to have started on a plastic conveying line. As the product proceeded into the cooling cell, which was constructed of insulated metal panels the fire spread. Additional combustible walls and plastic skylights contributed to the fire. The fire spread throughout the facility causing significant damage.

3.1.1.4 A fire occurred in this unsprinklered automatic nickel-plating line and adjacent buildings. The fire is believed to have started in or around the plastic tanks and baths. The fire was spread by the plastic ductwork and scrubber, to the combustible roof construction, insulated metal panels and plastic skylights. The installation of plastic construction materials significantly contributed to the fire spread.

3.1.1.5 A fire occurred in this unsprinklered food processing facility. The ceiling was constructed of fiberglass reinforced plastic panels attached to the underside of the steel roof joists. The roof is concrete on exposed steel and the walls are of concrete block. The equipment in the room was noncombustible. The fire started in the ductwork for the oven and spread igniting the fiberglass reinforced plastic panels attached to the underside of the steel joists. Prior to the arrival of the fire department, the fire was out because the panels were completely consumed. The fire did not spread further due to the noncombustibility in the area.

3.1.1.6 A fire occurred in this unsprinklered floor-covering products manufacturing facility. This manufacturing facility included: a spinning mill, tufting and weaving, dyeing, finishing and warehousing areas. The fire started in an enclosure constructed of FM Approved insulated metal panels, which did not extend to the roof deck leaving an opening to the building. The enclosure contained storage of waste rags, minor rack storage, old UPS (Uninterruptible Power Supply) batteries and old computer equipment. The fire started in this enclosure; the most probably cause was the storage of waste rags in a plastic bin. This facility was unattended over the weekend. The smoke detection operated around 1pm on Saturday, but the alarm was never transmitted and was discovered by an employee around 5 am on Sunday morning. The fire did not spread outside this enclosure. Other plastic materials melted adjacent, but did not ignite. The use of FM Approved panels, noncombustible roof and limited adjacent combustibles help prevent a devastating fire.

3.1.1.7 The Grenfell Tower fire is a prominent example of a unsprinklered residential building with a highly combustible exterior facade. MCM panels were applied to the exterior of the building, and comprised of a polyethylene core, ventilated cavity and polyisocyanurate foam behind the panel. The fire started within an unsprinklered dwelling unit and ultimately created a post flash over fire which spread through the window framing to the exterior facade. Once the exterior MCM panels were exposed to the fire, fire spread rapidly up the building exterior. As the fire spread vertically, the fire spread into the building and ultimately to the entire exterior of the façade. The use of polyethylene core panel, combustible insulation and the ventilated cavity led to the rapid-fire spread.

3.2 Plastics in Construction

3.2.1 Insulated Metal Panels

Metal-faced insulated panels can be deceiving because they may all look the same once installed. However, based on the actual construction they can react and behave very differently in a fire. Once installed, determining the insulation used in the core, type of joints and overall securement of the panels to the building structure is difficult. These are all important and can affect fire performance. The core, joint and securement to the building are all components and part of understanding the fire hazard.

3.2.1.1 Thermal, Sheathing Material Barriers Polyurethane, Polyisocyanurate, and EPS Foam Cores

The intent of a sheathing material in sprinklered applications is to delay ignition of the plastic core to allow sprinklers time to control a fire. In noncombustible occupancies, the thermal barrier (Table 2.1.5-1) allows non-FM Approved plastic building materials to remain in place without sprinkler protection.

Approved plastic building materials can remain in place without sprinkler protection.

Single layer plastic laminate sheets (FRP or PVC) can be adhered directly to a foam core, such as polystyrene, polyisocyanurate or polyurethane core, which will provide a clean, washable surface. The use of FRP or PVC laminate over the foam core does not provide a barrier. The laminate itself may be prone to rapid flame spread and the combination may be particularly hazardous. Occupancy sprinkler protection used in full-scale tests have been unable to control fires involving some plastic laminates on foam plastic.

When determining the core material, look for areas of damage and the color of the core material. If a sample needs to be cut from the insulated panel to determine the core, consider taking the sample over a joint. This will provide information about the joint and the insulation at the same time. Taking the sample over a joint will identify not only the insulation material used in the core but will clarify the type of joint used in the panels. This core sample can generally be taken using a drill and a 4-in. (10 cm) drill coring bit. Figure 3.2.1.1-1 is an example of a polyurethane foam, Figure 3.2.1.1-2 is an example of polystyrene and Figure 3.2.1.1-3 is an example of polyisocyanurate.

Fig. 3.2.1.1-1. Polyurethane foam core example (usually a yellow color)

Fig. 3.2.1.1-2. Expanded Polystyrene Foam Core Example (usually white in color)

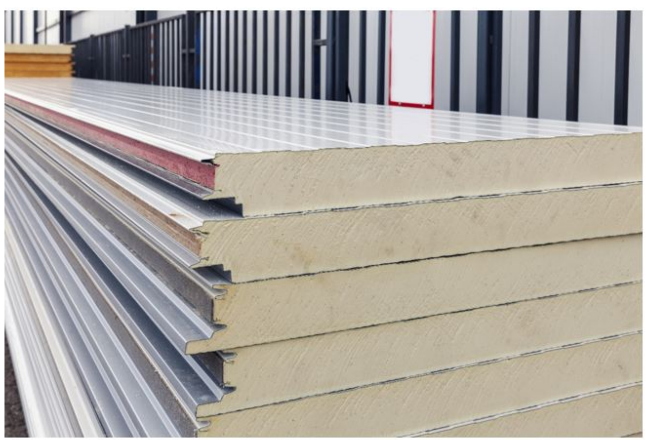


Fig. 3.2.1.1-3. Polyisocyanurate Foam Core Example (usually off-white in color)

3.2.1.4 Concealed Spaces

3.2.1.4.1 (Reserved)

3.2.1.5 Foil Faced Insulation Boards

A thin aluminum foil is sometimes used to cover foam insulation boards, which are referred to as foil faced insulation boards. This thin foil can sometimes act as a barrier with a limited thickness of foam insulation. Foil faced polystyrene is not acceptable. Automatic sprinkler protection is necessary to protect foil faced foam.

3.2.2 Small Walk-in Coolers

Small walk-in coolers are typically installed inside of buildings, as a box-within-a-box arrangement. This generally leaves a large unobstructed space above the small walk-in cooler open to a ceiling sprinkler system. These coolers are generally limited in size, and typically no taller than 10 ft (3 m) high. The unobstructed space above small walk-in coolers can vary in size.

3.2.3 Single Layer Plastic Building Panels (FRP/PVC)

All plastic panels (FRP/PVC), whether treated with fire retardant or not, are combustible. Full-scale tests by FM showed that many non-FM Approved panels ignite easily and burn rapidly, producing intense flames and high ceiling temperatures, even with sprinklers. Single layer panels (unbacked) 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 the following factors contributed to acceptable performance of unbacked panels:

- Backing: Backings prevent heat dissipation, negating the main method by which the rapid flame spread is usually controlled.
- Automatic sprinklers: Sprinklers slow the horizontal flame spread, lower ceiling temperatures, and provide rapid extinguishment after the heat is dissipated.
- Fire retardants: Even though the flame spread is initially very rapid, fire retardants prevent even faster spread. They also help burning to stall once the heat is dissipated.
- Panel thickness: Panels must be 1/16 in. (1.6 mm) or less and weigh approximately 8 oz/ft^2 (2.4 kg/m^2) or less. This combination allows for fairly rapid burn-through. Thicker sheets delay burn-through, generally resulting in more extensive flame spread.

A plastic panel laminated onto a gypsum board, wood, cellulose, or mineral board backing 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.

FRP/PVC panels are sometimes fastened using a drive rivet, which has a short mandrel that protrudes from the head. Once the drive rivet is inserted into a hole, the mandrel is driven in with a hammer or other implement to flare out the end of the rivet to provide securement.

Single layer or rigid plastic panels have been FM Approved for two end uses: interior finish materials and plastic building panels. 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. Plastic building panels are popular in the papermaking and chemical process industries. 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.

Fiberglass reinforced panels are generally thin, flexible plastic panels made from resins reinforced with fiberglass. These can be installed by themselves or with a backing, such as gypsum board. These panels are available in a variety of colors and textures and are generally used in wet environments or areas required to be wet cleaned. FRP panels are commonly found in kitchens, restaurants, food processing plants, and cleanrooms.

3.2.4 Single Layer Backed

3.2.4.1 (Reserved)

3.2.5 Double Layer FRP/PVC and Insulated FRP/PVC Panels

3.2.5.1 (Reserved)

3.2.6 Spray-Applied Foam

3.2.6.1 (Reserved)

3.2.7 Plastic Light Bands and Skylights

Light bands are typically installed to allow additional day light into manufacturing and storage buildings. These light bands are typically near the eave line and limited in vertical length.

3.2.8 Insulated Wall Curtains

3.2.8.1 Insulated wall curtains have two external faces and a core. Typically, the outside is constructed of a PVC, fabric, or similar facing material and a core material of polyester, thermoplastic bubble wrap, fiberglass, carbon fiber or other insulating material. These are commonly used as dividers in areas needing different temperatures (e.g., food processing) or to separate warehouse areas such as automatic storage and retrieval systems from areas that employees occupy. Insulated wall curtains may be used on a temporary or permanent basis, as a less expensive and more flexible alternative to constructing a solid wall or partition. Some insulated wall curtains provide access for forklifts and can have overhead doors installed. Insulated wall curtains are not expected to be installed along walls as extra insulation or in a room with a suspended ceiling.

3.2.9 Acoustical Panels

3.2.9.1 Virgin and recycled plastics (especially polyester and PET) are now being used for acoustical purposes. These plastic materials are required to pass ASTM E84 comparative testing. Due to the nature of this test, these materials easily pass. The ASTM E84 test does not accurately predict the fire spread in these materials and installations.

3.2.10 Cellulosic Insulation

Cellulose insulation is typically made by milling wastepaper, treating it with flame retardant chemicals (generally boric acid), mixing it with water, and spraying it onto a wall or ceiling. When installed on the walls or ceiling, spray-applied cellulosic insulation behaves similar to plastics and is therefore covered in this standard. Spray-applied cellulosic insulation can collect combustibles in the air turning a fire-retardant material into a combustible coating. Therefore, it should not be used in areas with fine oil mists (machine shops) which would impregnate the material.

Blown-in cellulosic insulation, typically found in attics, is not evaluated in this operating standard.

3.2.11 Elastomeric Insulation

Elastomeric insulation is commonly used to insulate water pipes or heating, ventilating and air condition pipes and/or ducts. Elastomeric insulation provides a great R value and is generally not affected by moisture. Elastomeric insulation is considered non-absorbent and fiber-free, so it resists mold growth.

3.2.12 Insulation of Outdoor and Indoor Metal Storage Tanks

Polyurethane and polystyrene can be used to insulate outdoor storage tanks. Tanks containing an ignitable liquid are not covered by this standard.

A fire involving tank insulation could raise the temperature of the contents and affect temperature-sensitive materials (i.e., wine, grape juice). This is especially a concern with polystyrene insulation which might fully burn away but create a pool fire. Slight changes in temperature can ruin contents (food products) even if the insulation chars and does not fully burn away.

Instrumentation and process control equipment, along with its wiring, cables, cable trays, control tubing, and other components can receive damage due to fire exposure, which can result in an interruption to production.

3.2.13 Polystyrene Geofoam Fill

Polystyrene Geofoam blocks are made of polystyrene and are typically about 100 ft^3 (2.8 m^3) in size. These blocks are used for fill material in a variety of locations, such as tiered seating, courtyards, bridges, roof top parks, etc. They are lightweight and easy to move. These are far more inexpensive than normal fill materials. The typical block can be carried and placed by hand. The foam blocks are buoyant, so they present concerns when used below the water table, in a known flood zone, or in areas of storm water run-off.

3.2.14 Metal Composite Material (MCM) Interior Wall Panels

MCM interior walls are becoming popular in the clean room or pharmaceutical environment. These are easy to install, maintain and clean. Building codes require passing the ASTM E84 test. The use of MCM interior walls in clean room environment can lead to a large loss due to the smoke release associated with the plastic core materials. Use FM specification tested MCM panels for interior application.

3.2.15 Metal Composite Material (MCM) Exterior Wall Panel Testing

Metal composite panels are made from three common materials: aluminum, steel, and zinc. Sandwiched between the two metals is a composite core, which is made from plastics. Aluminum is the most common and these are referred to as ACM panels (aluminum composite material) by the industry. These assemblies generally include both insulation and a weather resistive barrier (Figure 3.2.15-1), as well as the ACM/MCM panels. FM uses the term MCM to cover all three metals. Information on testing of zinc panels is not available, but zinc will have a lower melting point than aluminum.

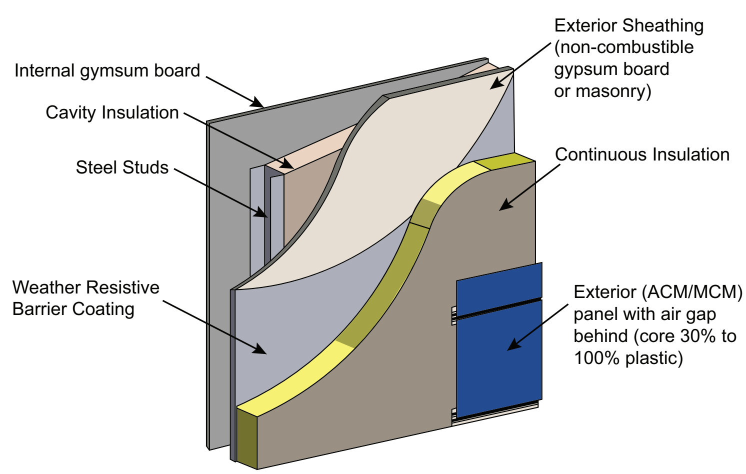


Fig. 3.2.15-1. Example of a complete cladding assembly system

3.2.16 High Pressure Laminates

3.2.16.1 (Reserved)

3.2.17 Other High Performance Building Envelopes (Exterior Wall Assemblies)

3.2.17.1 (Reserved)

3.2.18 Fiber-Reinforced Plastic (FRP) Grating

FRP grating is generally used in corrosive environments as walkways or equipment platforms where metal grating would corrode. FRP grating is tested to ASTM D635, *Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position*. Building codes require FRP grating to pass E84 testing, which is a comparative test, not indicative of fire performance.

3.2.19 Concrete Walls Filled with Foam

3.2.19.1 The use of insulation to fill concrete walls (block and tilt-up) is expected to increase over time with a focus on energy efficiency. Polyurethane or polyisocyanurate foam insulations will char and are better from a fire perspective than polystyrene. A positive feature is the foam materials are covered with the aggregate, which will help minimize fire exposure. Exterior fire exposures can be a concern.

Loss history has shown that EPS/XPS, which is popular in tilt-up wall construction, is not always completely sealed in the concrete. In addition, some construction techniques modify the thickness of the concrete between interior and exterior walls. The varied thickness of the walls is concerning with regard to exterior storage near or against the wall.

3.2.20 Polyester Batt Insulation Materials

3.2.20.1 (Reserved)

3.2.21 Heating, Ventilation and Air Conditioning Systems

3.2.21.1 This data sheet applies to air duct systems that move air mechanically and are used for heating, cooling and ventilation. It does not apply to systems used for the removal of fumes, particulates or hazardous materials (see Data Sheet 7-78).

An air conditioning system consists of fans, ducts, controls, dampers, filters, intakes, and heating and/or cooling apparatus that remove used air from occupied spaces and recondition it. The air is then circulatedback to occupied spaces to provide comfort to occupants or to provide a specific set of environmental conditions within the conditioned space. The air conditioning system provides the simultaneous control of temperature, humidity, air motion, noise level, air cleanliness and quality of ventilation.

3.2.21.2 Fire and Smoke Hazards

The principal hazard associated with air-handling systems is the propagation of fire and/or smoke through the air movement channels.

3.2.21.2.1 Smoke in untenable concentrations can migrate to remote parts of a building in a matter of minutes via air-handling systems. On numerous occasions, fire has been confined to its area of origin with limited fire damage; but smoke has spread through the air conditioning system to other areas, causing extensive damage and hampering manual fire-fighting efforts. Central systems, therefore, have the potential to spread smoke far beyond the origin of the fire.

3.2.21.3 Pre-Fabricated and Pre-Insulated Ducts

3.2.21.3.1 Fibrous glass duct materials (a.k.a. pre-fabricated ducts) of low combustibility have previously been FM Approved. Some of the fire tests conducted on this material have shown that, under fire exposure, the duct will spread fire and collapse.

Prefabricated ducts can consist of low-density, noncombustible glass fibers and a small quantity of resin binder, preformed or prefabricated into units of circular and rectangular cross-sections, having an exterior

Fig. 3.2.21.3-1. Pre-insulated board duct.

jacket of aluminum foil or pigmented film. Today, prefabricated ducts can also be constructed of polyisocyanurate, phenolic or other combustible insulations, thereby increasing the fire hazard.

3.2.21.4 Fabric Ducts (Reserved)

3.2.21.5 Dampers (Reserved)

3.2.21.6 Ducts (Reserved)

3.2.21.7 Filters (Reserved)

3.2.22 Phenolic Insulation

Phenolic insulation is used for pipe insulation, roof insulation, and insulated wall panels. However, phenolic insulation can corrode metal products that touch it. As such is not appropriate as a roof insulation because of the metal roof fasteners.

3.2.23 Insulated Concrete Forms

Insulated concrete forms (Figure 3.2.23-1) are generally made of lightweight and inexpensive polystyrene which are easy to set, do not require removal and provide added insulation to create a foundation. The forms can also provide a necessary air/vapor barrier, and their use can eliminate drafts in exterior walls. These are more common in single family homes, but are gaining popularity in multi-story, industrial and commercial buildings. This product is promoted as a green construction material and saves money by reducing labor costs.

3.2.24 Structural Insulated Panels

Structural insulated panels are a building system used for light commercial application (typically up to 4 stories). These panels consist of a foam core (typically polystyrene) sandwiched between two structural facings, typically oriented strand board (OSB). These panels are manufactured for specific buildings and constructed under controlled factory conditions with the goal of saving time and money.

Fig. 3.2.23-1. Insulated concrete form (made from EPS/XPS foam blocks)

3.2.25 Wall-Mounted, Building-Integrated Photovoltaic (BIPV) Façade Systems

Unlike roof-mounted photovoltaics (PV), wall-mounted BIPVs are integrated into the façade construction of the building. These BIPV modules are similar in appearance and mounting details to MCM panels, which include an air cavity behind the module. Flexible BIPV panels that adhere directly to existing facades, without an air cavity, are also available.

The PV modules mounted on the wall of facades are commonly referred to as BIPV façade systems. The term BIPV can also be used for curtain wall glass systems or skylights that have photovoltaics constructed within the unit.

Some countries will complete fire testing of BIPV modules using a combination of small bench scale component testing and/or unrepresentative sloped roof testing. These tests are not adequate to determine the fire hazard of a wall-mounted façade system.

No standardized testing is globally available for BIPV facades systems. In the USA, the International Building Code 2024 requires testing of PV modules to UL 1703, which is the photovoltaic sloped-roof fire test. The code allows installation of tested PV modules in a vertical position to construct BIPV facades, which have greater fire propagation risk than a roof top system as tested under UL 1703. (See FM Data Sheet 1-15, *Roof-Mounted Solar Photovoltaic Panels.*)

A recent external study using large-scale SP-105 façade test standard with glass-plastic BIPV module over gypsum backing and a 2.6 in (65 mm) cavity resulted in a failure. The flames reached the top of the setup approximately 30 minutes from the ignition and produced falling debris. Falling debris is common with BIPV panels, as the glass breaks due to heat fluxes. Glass breakage of PV panels on a facade will expose the combustible core encapsulants and cells, contributing to fire growth within the cavity.

FM Research conducted a project to investigate fire propagation with respect to BIPV facades using the 16 ft Parallel Panel Test (PPT) of FM Approval Standard 4411. The research project focused on wall-mounted BIPV façade systems, including cavity-wall systems and flexible BIPV modules.

The following test data is provided for information only. Table 3.2.25-1 shows the module size, thickness of the panel, encapsulant and the current fire testing certifications. BIPV modules typically consist of a solar cell encapsulated between high strength tempered glass layers, with each glass layer approximately 2 to 6 mm thick.

Table 3.2.25-1. Testing of BIPV Façade Panels

Sample and Tech	*Module Sizem x m*	*Total Thickness (mm) Superstrate Thickness (mm) Substrate Thickness (mm)*	*Encapsulant and Thickness (mm)*	*Fire Testing Certifications*
a–4mm (sc-Si)	1.6 x 0.7	Total: 9 Glass Superstrate: 3.9 Glass Substrate: 3.9	POE, PET, PE, PPE Superstrate: 0.6 Substrate: 0.6	DIN EN13501-1: B-s1, d0
b–3mm (CIGS)	1.6 x 0.7	Total: 5.5 Glass Superstrate: 3 Glass Substrate: 2.1	POESuperstrate: 0.2 Substrate: 0	UL 790: Class C DIN EN13501-1: B-s2, d0
g–4mm (sc-Si)	1.7 x 1.0	Total: 9.8 Glass Superstrate: 4 Glass Substrate: 4	EVA Superstrate: 0.9 Substrate: 0.9	UL 1703 passed EN 13501-1
g–6mm (sc-Si)	1.7 x 1.0	Total: 13.8 Glass Superstrate: 6 Glass Substrate: 6	EVA Superstrate: 0.9 Substrate: 0.9	UL 1703 passed EN 13501-1
FlexPV (CIGS)	2.6 x 1.0	Total: 1 PET Superstrate: 0.4 PET Substrate: 0.4	TPO Superstrate: 0.2 Substrate: 0	UL 1703: Class A

Note: sc-Si: single-crystal silicon
CIGS: Copper-indium-gallium-diselenide
mc-Si: multi-crystalline silicon
POE: Polyolefin
PET: Polyethylene terephthalate
PE: Polyethylene
PPE: Polyphenylene ether
EVA: Ethylene vinyl acetate
ETFE: Ethylene Tetrafluoroethylene
TPO: Thermoplastic POE

Table 3.2.25-2 provides information collected during the FM Research testing program, showing the peak heat release rate, cavity thermal couple (CTC), surface thermal couple (STC), peak heat flux (HFG) and peak burnt heights. Table 3.2.25-1 and Table 3.2.25-2 are connected to show product information and testing results. FM Research conducted tests with BIPV modules in both uncharged (open-circuit – OC) and maximum power (MP) charged states. Charging a BIPV module can increase fire-spread hazards but is dependent upon factors such as, glass thickness, cavity restrictors and the module type (double-sided glass or flexible). However, tests on non-propagating BIPV system show minimal differences between charged and uncharged. This difference indicates that the charge status may not have a clear effect on non-propagating BIPV modules and systems.

Table 3.2.25-2: Compilation of the 16-ft PPT Results, Including Uncharged and Charged Tests

Sample and Configuration	*Peak HRR (kW)*	*Peak CTC @12 ft (3.7 m) °F (°C)*	*Peak STC @15 ft (4.6 m) °F (°C)*	*Peak HFG @16 ft (4.9 m) (kW/m²)*	*Peak Burnt Height ft (m)*		*Pass/ Fail*
					Cavity	Exterior	
a–4mm OC	1400	1070 (576)	80 (27)	10	16 (4.9)	14 (4.3)	Fail
a–4mm MP	2300	1340 (727)	440 (227)	20	16 (4.9)	16 (4.9)	Fail
b–3mm OC	1150	1286 (697)	350 (176)	10	16 (4.9)	16 (4.9)	Fail
g–4mm OC	1600	1178 (637)	458 (237)	30	16 (4.9)	16 (4.9)	Fail
g–4mm MP	2450	1214 (657)	368 (187)	20	16 (4.9)	16 (4.9)	Fail
g–6mm OC	780	242 (117)	206 (97)	< 2	< 8 (2.4)	< 8 (2.4)	Pass
g–6mm MP	850	260 (127)	206 (97)	< 2	< 8 (2.4)	< 8 (2.4)	Pass
FlexPV OC	11000	NA	--	180	NA	16 (4.9)	Fail
FlexPV MP	10900	NA	1700 (927)	180	NA	16 (4.9)	Fail

Note: OC – Open Current
MP – Maximum Power
CTC – cavity thermal couple
STC – surface thermal couple
HFG – Peak heat flux

All BIPV panels tested were comprised of a glass-glass module with mineral wool insulation in the cavity. Primary fire hazards are related to shattering of the glass, cavity fire spread, and the burning of cables and plastic encapsulants. This variability confirms the need to assess the entire system, such as panels, electrical cables, insulation, air cavity and mounting systems, as these can affect the outcomes. The research resulted in a new FM Approvals Examination Standard (see FM 4483 for performance criteria).

The 16-ft PPT results for uncharged BIPV cavity-wall façade systems effectively captured the fire spread dynamics. During the tests, propane flames from the burner shattered the bottom BIPV glass modules, allowing flames to enter the cavity. Fire propagation within the cavity was driven by pyrolysates from cables and plastic encapsulants released after the shattering of substrate glass. As the fire spread up the cavity, flames spilled over the exterior through various joint openings, eventually causing the adhesives (used to mount modules) to burn and significant flaming debris to fall onto the burner. The falling and shattering of BIPV modules onto the propane burner ignited the combustible plastic encapsulants, causing further Heat Release Rate (HRR) spikes. The results highlighted the need to evaluate the complete BIPV façade system using a relevant, large-scale façade fire test such as the 16-ft PPT.

The results from the flexible BIPV tests revealed accelerated flame spread, with a maximum flame height much higher than the 16 ft (4.9 m) height of the setup. The peak HRR measured approximately 11 MW within 100 seconds of ignition for both OC and MP tests. Unlike the double-sided glass BIPV cavity-wall systems, the flexible BIPV's laminated plastic superstrate allowed surface flame spread to dominate the vertical fire growth.

4.0 REFERENCES

4.1 FM

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 1-17, *Reflective Wall and Ceiling Insulation*
Data Sheet 1-20, *Protection Against Exterior Fire Exposure*
Data Sheet 1-28, *Wind Design*
Data Sheet 1-29, *Roof Deck Securement and Above-Deck Roof Components*
Data Sheet 1-31, *Panel Roof Systems*
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*
Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*
Data Sheet 7-6, *Heated Plastic and Plastic-Lined Tanks*
Data Sheet 7-7, *Semiconductor Fabrication Facilities*
Data Sheet 7-78, *Industrial Exhaust Systems*
Data Sheet 7-88, *Outdoor Ignitable Liquid Storage Tanks*
Data Sheet 8-1, *Commodity Classification*
Data Sheet 10-3, *Hot Work Management*

4.2 Others

ANSI/ASHRAE/IES Standard 90.1, *Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings*.

ANSI/ASHRAE/IES Standard 90.2, *Energy-Efficient Design of Low-Rise Residential Buildings*.

British Standards Institute (BSI). BS 8414, *Fire Performance of External Cladding Systems*.

National Fire Protection Association (NFPA). *NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems*.

National Fire Protection Association (NFPA). NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*.

National Fire Protection Association (NFPA). NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components*.

Underwriters Laboratories (UL). UL 586, *Standard for High Efficiency, Particulate, Air Filter Units*.

Underwriters Laboratories (UL). UL 900, *Standard for Air Filter Units*.

APPENDIX A GLOSSARY OF TERMS

Air gap: The void between the inner surface of the exterior façade and insulation or sheathing within a cavity wall.

Aggregate material: Materials, such as cement, sand, gravel, and mineral rock mixed to form a noncombustible barrier.

Approval Guide: An online resource of FM Approvals that lists FM Approved products and services.

Backed: Any solid material, combustible or noncombustible, to which plastic interior finish materials are applied. Examples are FRP, or PVC panel adhered or mechanically fastened to plywood, gypsum board or FM Approved insulation board.

Barrel vault: A curved roof light. 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.

Cavity: The distance between the interior surface of the exterior façade and the interior structure of a cavity wall. The cavity may be partially filled with insulation, air retarders or other cavity wall components.

Cavity wall system: Exterior wall constructions typically consisting of two layers of wall surfacing or sheathing separated by a cavity which contains an air gap. Rainscreen assemblies are a type of cavity wall system where the exterior facade is ventilated siding (i.e., ACM or MCM panels) that allows for drainage and evaporation inside the cavity. Components that may be present inside the cavity include, but are not limited to, insulation, thermal barriers, weather resistant barriers, and air and moisture retarders (a.k.a MCM Exterior Wall System).

Ceiling sprinklers: (As referenced in FM Data Sheet 1-57) A sprinkler system installed at the ceiling level, providing the minimum density outlined in Table 2.1.6-1.

Cement board: A combination of cement and reinforcing fibers formed into sheets.

Composite metal hybrid sub-framing system: A hybrid support system used in the exterior façade to hold a rain screen in place. This hybrid system is a combination of fiberglass reinforced plastic with metal supports. The goal of this system is to eliminate thermal bridging. (An example is a product green girts.)

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

Double skin façade: A multi-layered building enclosure with an outer glass layer and an inner glass layer (usually allows a person to see through the component to the outside), along with a ventilated air cavity in between. The air cavity space between the glass is generally 8 inches to 79 inches (20 cm to 2m) and can use a mechanical, natural or hybrid approach to ventilating the cavity space. This cavity space acts as a buffer to improve thermal insulation, reduce noise, and control solar gain. Glass used in double skin facades can be photovoltaic, electro chromatic, thermochromic, transparent solar panels or tempered glass. (Note: This definition is provided to clearly distinguish wall-mounted BIPV façades or high-performance building envelopes from a double skin façade).

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.

Expanded polystyrene (EPS) insulation: A rigid foam-plastic insulation made from small polystyrene beads that are expanded with steam and fused together.

Extruded polystyrene (XPS) insulation: A rigid, foam-plastic insulation known for its high compressive strength, which is manufactured by melting polystyrene and compressing it into board form. Expanded polystyrene (EPS) insulation: A rigid foam-plastic insulation made from small polystyrene beads that are expanded with steam and fused together.

FM Approved: Products and services that have satisfied the criteria for FM Approval. Refer to the *Approval Guide*, an online resource of FM Approvals, for a complete listing of products and services that are FM Approved.

Free standing sandwich panel: Panel systems that do not use separate structural supports. Typically used for walk-in coolers/freezers constructed within a building, they often incorporate locking devices within the panel joints (see Figure A-1). The ceiling panels, however, may be suspended on rods.

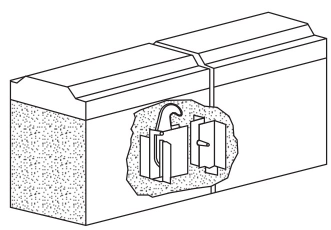


Fig. A-1. Cooler panel locking joint (Courtesy of Mid-South Industries)

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 (glass reinforced plastic).

Geofoam: A lightweight polystyrene product used in place of fill (usually obtained in 4 ft X 4 ft X 8 ft [1.2 m X 1.2 m X 2.4 m] pieces). Geofoam is light enough to be placed without the use of machinery.

Gypsum board: A product mainly composed of gypsum as its core with a paper facing on both sides of the core. Gypsum provides a natural fire resistive material. (See ASTM C11, *Standard Terminology Relating to Gypsum and Related Building Materials and Systems* for more information).

High-performance building envelopes: The exterior of the building from the sheathing outward. These envelopes are designed to separate the exterior and interior elements with the intent to stop air leaks, drafts and moisture infiltration. Most high-performance building envelopes contain an air gap, insulation (exterior and interior) and a weather resistant barrier.

High pressure laminate: A composite material made of multiple layers of paper or wood fibers (~70%) bonded together by a fire-resistant thermoset resin (~30%) under high heat and pressure and includes an intumescent material.

Intermediate sprinklers: (As referenced in FM Data Sheet 1-57) A wall-mounted sprinkler system installed between the ceiling sprinklers and the floor level, providing the minimum requirements outlined in Table 2.1.6-1.

Limited combustible: A material meeting one of the following (1) or (2) conditions:

(1) The material meets criteria a and either b or c below.

a. The material, in the form in which it is used, exhibits a potential heat value not exceeding 3,500 Btu/lb (8141 kJ/kg) when tested in accordance with NFPA 259, *Standard Test Method for Potential Heat of Building Materials*; and

b. The material shall have a structural base of noncombustible material with a surface coating not exceeding a thickness of 1/8 in (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* (e.g., gypsum board with a paper facing) or

c. The material shall be composed of materials that in the form and thickness used neither exhibit a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested with ASTM E84. The composition of all surfaces that would be exposed by cutting through the material on any plane would neither exhibit a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E84.

(2) Where tested in accordance with ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, at an incident heat flux of 75 kW/m^2 for a 20-minute exposure, and both the following conditions are satisfied.

a. The peak heat release rate shall not exceed 150 kW/m^2 for longer than 10 seconds.
b. The total heat released shall not exceed 8 MJ/m^2.

Metal composite material exterior wall assemblies: Wall assemblies that contain any of the following components: metal composite panel, air gap, continuous insulation, and weather resistant barrier(s).

Metal insulated panel: A sandwich panel that forms the building envelope (outside surface of the building) or can be used for internal wall partition. A foam core is faced with a metal panel on both sides. They are secured to horizontal and/or vertical structural members. Compare to free-standing sandwich panels.

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 can be extruded as tri-wall, four-wall, five-wall, and six-wall in thicknesses up to 1.4 in. (35 mm) thick.

Net-Zero building: achieving a balance between the greenhouse gases put into the atmosphere and those taken out. It is sometimes referred to as carbon neutral, or for situations where no emissions were produced. (e.g., produce enough electricity through PV, wind, etc. to operate lights, heat, etc. in a building.)

Noncombustible material: A material that complies with any one of the following:

(1) The material, in the form in which it is used, and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.

(2) The material is reported as passing ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*.

(3) The material is reported as complying with the pass/fail criteria of ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer*, at 750°C.

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.

Perimeter sprinklers: (As referenced in FM Data Sheet 1-57) A sprinkler system installed at the ceiling level within 2 ft (60 cm) +/- of the wall, providing the minimum requirements outlined in Table 2.1.6-1.

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

Plastic building panel: Plastic building panel: a rigid plastic sheet (fiber reinforced plastic, polycarbonate, or PVC), usually corrugated, applied to the exterior of the structural framing without backing. It forms the building envelope; see Figures A-2 and A-3. Compared to plastic interior finish material.

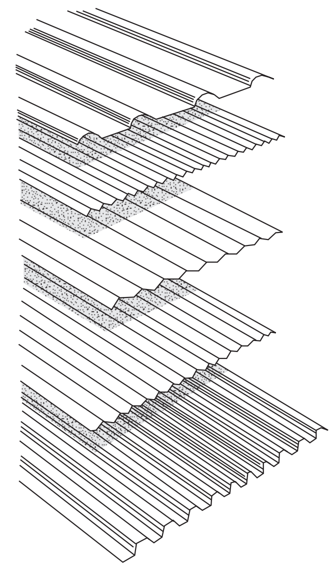


Fig. A-2. Typical plastic building panels

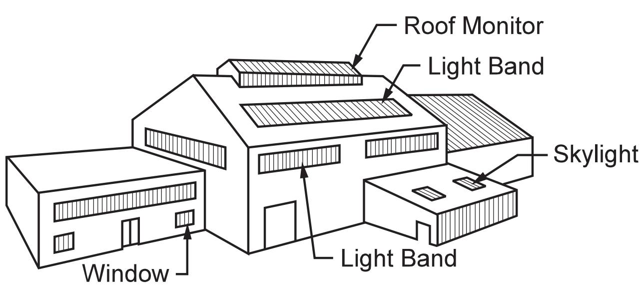


Fig. A-3. Typical usage of reinforced plastic building panels

Plastic interior finish material: Rigid (not foamed or expanded) plastic sheets (usually fiber reinforced plastic 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.

Prefabricated or pre-insulated ducts: A prefabricated or pre-insulated duct system has insulation already integrated into it. They are often made from rigid materials like fiberglass, foam boards, mineral wool, phenolic or rubber insulation. These ducts are often wrapped on the outside with a lightweight aluminum facer. This facer is sometimes found on the inside but can be replaced with antimicrobial cloths or other materials.

PVC: Polyvinyl chloride, a thermoplastic polymer used as the basis for some interior finish or building panels. PVC-based panels are usually not reinforced. Made only in solid sheet form. In some countries, the term UPVC, is used, as the PVC has low plasticizer content. In this data sheet, the generic term PVC has been adopted.

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

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

Structural insulated panels: A building product, generally used for the exterior of a building that is comprised of insulation sandwiched between two pieces of wood. Typically constructed of oriented strand board (OSB) with polystyrene sandwiched between the OSB.

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 polyvinyl chloride, polystyrene, polycarbonate, polyethylene terephthalate, polymethyl methacrylate, polypropylene, and polyethylene.

Thermoset: Materials that cure or "set" irreversibly when heated during manufacture. Examples are polyurethane, polyisocyanurate, fiber reinforced plastic, phenolic foam, melamine, and unsaturated polyester.

Thermal barrier: A material that will prevent ignition.

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

APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

April 2026. Interim revision. The data sheet has been modified to provide guidance on Wall-Mounted, Building-Integrated Photovoltaic (BIPV) Façade Systems. Additional definitions have been added to Appendix A.

April 2025. Interim revision. The data sheet has been modified to provide guidance and new information relative to liners and insulated ducts for heating, ventilation and air conditioning systems. Guidance has been provided for high-pressure laminates (HPL) and high-performance building envelopes.

January 2024. Interim revision. The data sheet has been modified to provide clarifications and add new information on concrete walls filled with foam and polyester batt insulation.

January 2023. The data sheet has been reformatted for ease of use, reconfigured for new and existing construction protection options and protection criteria has been updated.

January 2018. This document has been completely revised. The following significant changes were made:

A. Clarified recommendations to emphasize the use of FM Approved plastic construction materials.

B. Simplified recommendations for intermediate wall sprinklers.

July 2015. Interim revision. Clarification was provided for the securement of metal faced plastic sandwich panels.

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.