CEILINGS AND CONCEALED SPACES

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1.0 SCOPE

This data sheet identifies those combinations of wall, ceiling, and floor or roof deck that need protection, and recommends the type of protection needed. It also includes recommendations for drop-out ceilings.

Determination of fire rating of building assemblies is not discussed in this document; see Data Sheet 1-21, *Fire Resistance of Building Assemblies*, and the Specification Tested Products Section of the *Approval Guide*, an online resource of FM Approvals.

For reflective ceiling insulation, refer to Data Sheet 1-17, *Reflective Wall and Ceiling Insulation*.

For recommendations related to raised floors in data centers, refer to Data Sheet 5-32, *Data Centers and Related Facilities*.

See Data Sheet 1-57, *Plastics in Construction*, for installations of foamed-on rigid plastics that are not FM Approved.

1.1 Hazards

The presence of combustible construction concealed within walls, ceilings, and floors in a building without adequate protection provides a means by which fire may spread in an uncontrolled manner. Initiation of fires often goes unnoticed due to the inherent concealed nature of these spaces.

For more details, refer to FM's Understanding the Hazard (UTH) brochure *Combustible Concealed Construction* (P0114).

1.2 Changes

April 2025. Interim revision. Minor editorial changes were done.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

Combustible concealed spaces in ceilings, subfloors, and walls are sometimes provided under the structural deck, floor, and wall framing system to provide thermal insulation, appearance, and/or sound control. Suspended ceilings usually are installed for decorative purposes or to conceal piping, duct work, lighting fixtures, etc.

Because the physical composition of combustible concealed spaces can vary considerably, ease of ignition, flame spread characteristics, and rate of burning can also differ significantly. As a result, these construction materials are divided into three categories:

- Class 1 materials
- Class 2 materials
- Melt-out ceiling panels

Class 1 materials typically do not, by themselves, warrant sprinkler protection, but Class 2 materials usually do. See Appendix A for more detailed definitions of Class 1 and Class 2.

Use FM Approved equipment, materials, and services whenever they are applicable and available. For a list of products and services that are FM Approved, see the Approval Guide and/or RoofNav, as applicable.

2.2 Construction and Location

2.2.1 General

2.2.1.1 Use noncombustible or FM Approved (Class 1) construction.

2.2.2 Combinations of Ceiling, Roof or Floor Construction

2.2.2.1 Refer to Figures 2.2.2-1 and 2.2.2-2 and Table 2.2.2 to determine protection for various combinations of ceiling and roof or floor construction.

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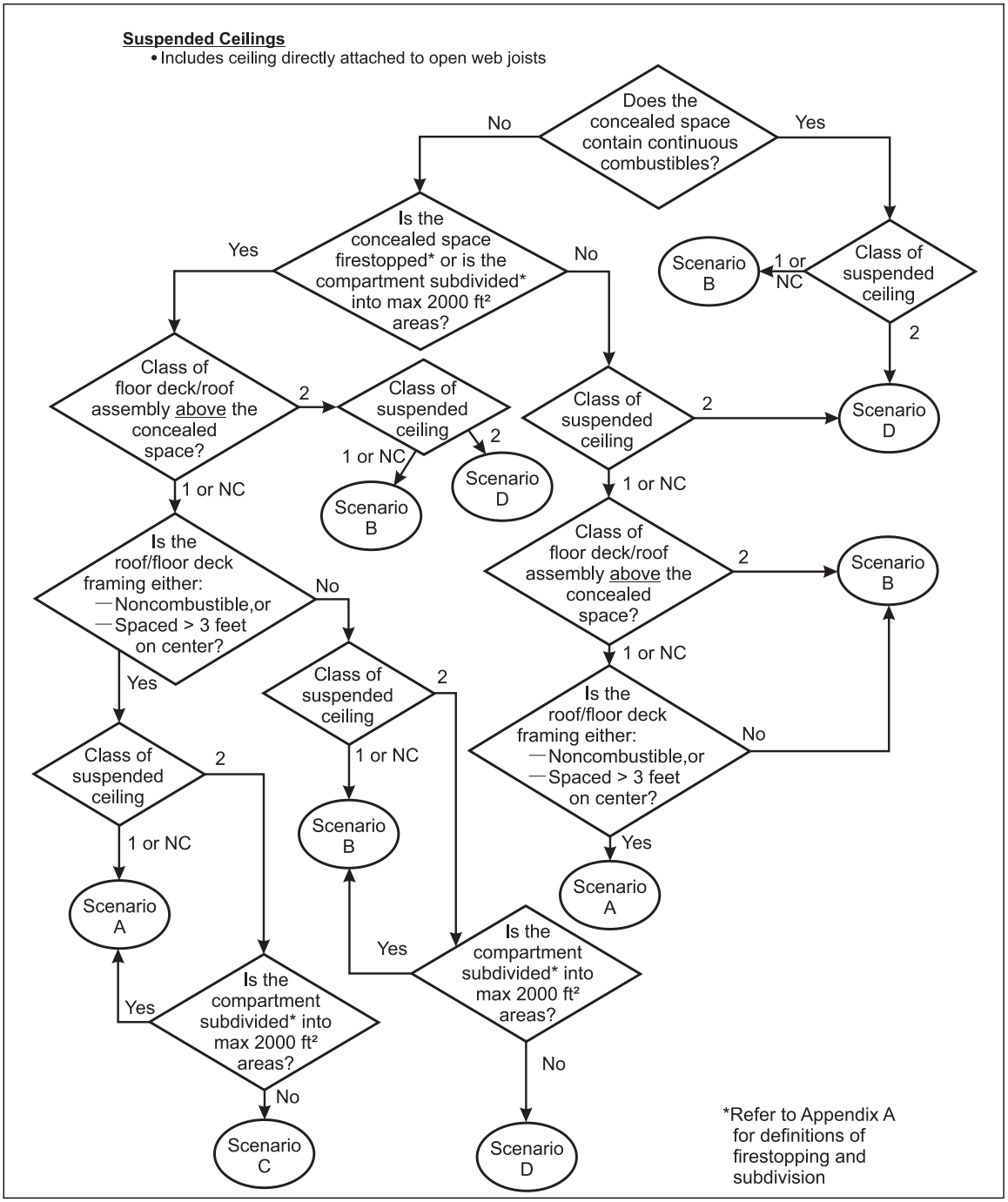

Fig. 2.2.2-1 Suspended ceilings

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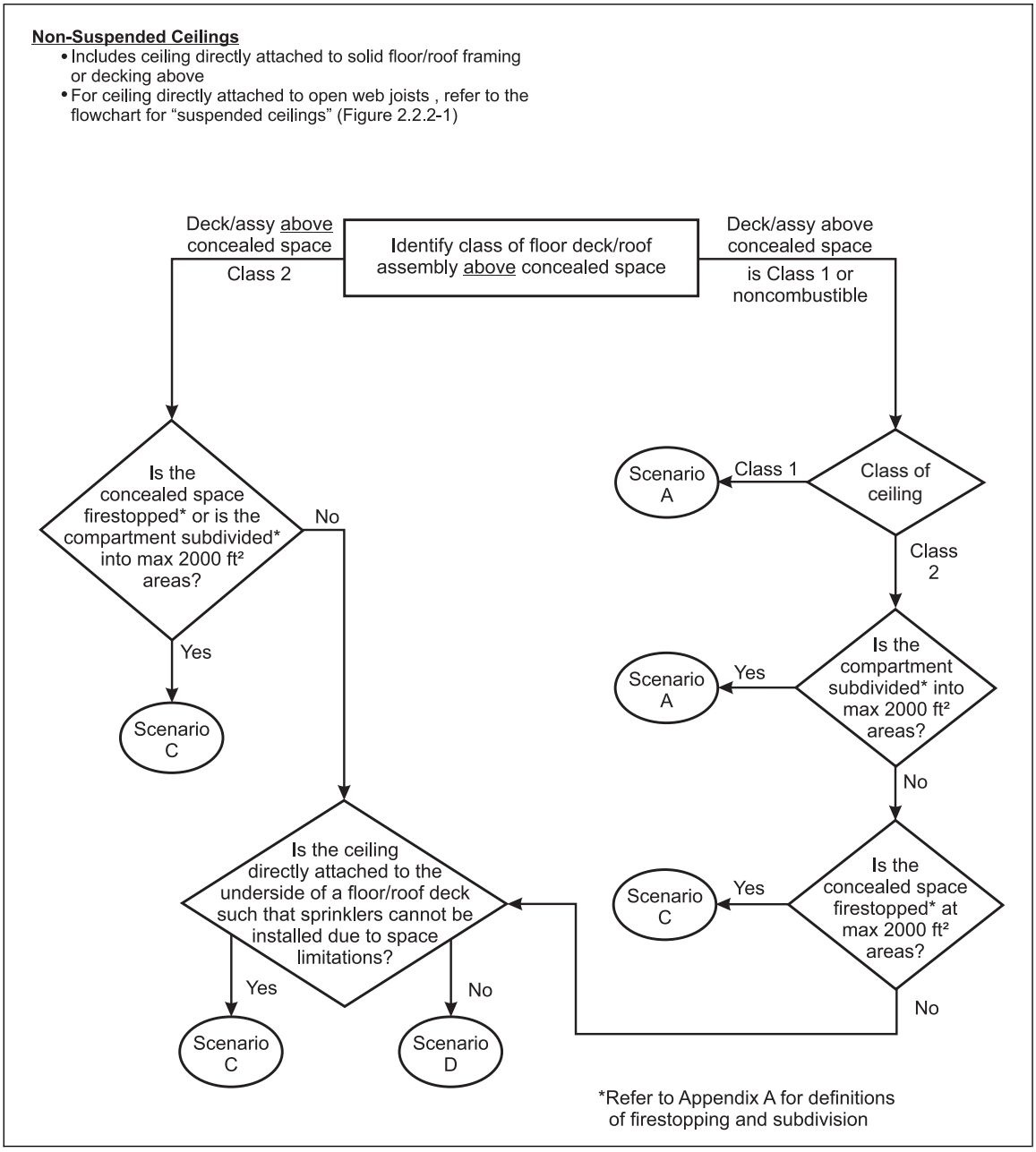

Fig. 2.2.2-2 Non-suspended ceilings

Table 2.2.2. Scenario Cross Reference

Scenario Cross Reference	*Sprinklers Needed*	
	Under Ceiling	Concealed Space
A	NO	NO
B	NO	YES
C	YES	NO
D	YES	YES

2.2.2.1.1 Treat gridded ceilings that do not meet the definition for open-grid in Data Sheet 2-0 as suspended ceilings with concealed spaces above.

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2.2.2.1.2 Construct cloud ceilings using noncombustible or FM Approved Class 1 materials and treat them as obstructions in accordance with DS 2-0.

2.2.3 Firestops

2.2.3.1 Install firestops for all floor, wall, and ceiling penetrations.

2.2.3.2 Install firestops or subdivide the compartment where recommended in Figures 2.2.2-1 and 2.2.2-2, at intervals not exceeding 2000 ft^2 (186 m^2).

2.2.3.3 Install firestops within combustible walls at each floor level and horizontally at maximum intervals of 10 ft (3 m), except as otherwise noted. Ensure firestops completely close off the space they are within, and consist of gypsum board, mineral wool, or ceramic fiber insulation.

2.2.3.4 Where wood-frame construction is used, install firestops of solid wood members at least as thick as the joists or studs they are abutting.

2.2.3.4.1 Do not use composite wood members as firestops or as elements of a partition subdividing a compartment.

2.2.4 When installing FM Approved melt-out suspended ceiling systems below automatic sprinklers, adhere to all of the following recommendations:

2.2.4.1 Install melt-out ceilings only in Hazard category 1 (HC-1) occupancies.

2.2.4.2 Do not install melt-out ceilings in conjunction with dry-pipe sprinkler systems.

2.2.4.3 Install melt-out ceilings maximum 5 ft (1.5 m) below automatic sprinklers.

2.2.4.4 Install melt-out ceilings only in a horizontal arrangement. Ensure they are not sloped.

2.2.4.5 Do not paint or apply coatings on melt-out ceilings unless they are FM Approved in that manner.

2.2.4.6 Do not place insulation above melt-out ceiling tiles, even if cut slightly smaller than the tile dimensions.

2.2.4.7 Do not install melt-out ceiling tiles as a suspended ceiling with sprinklers below the ceiling only.

2.2.5 If walls, floors, or ceilings are penetrated with metal chimneys or other hot stacks, install protection in accordance with Data Sheet 7-78, *Industrial Exhaust Systems*.

2.2.6 Install batt insulation tightly against the underside of wood roof decks.

2.2.7 If air spaces are required between insulation and the underside of a wood roof deck for roof venting, install lateral firestops according to Section 2.2.3 to prevent fire spread in that direction.

2.2.8 Construct exterior cavity walls using one of the following:

A. FM Approved cavity wall systems

B. Noncombustible or FM Approvals Standard 4880 Class 1 construction materials

2.2.9 Use caution if hot work is conducted within or near wall, floor/ceiling, or roof/ceiling spaces where combustible materials are present. For additional information, see DS 1-0, *Safeguards During Construction, Alteration, and Demolition*, and DS 10-3, *Hot Work Management*.

2.2.10 Install electrical wiring within concealed spaces in accordance with DS 5-31, *Cables and Bus Bars*.

2.3 Protection

2.3.1 Install automatic sprinkler protection in accordance with Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, and Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*.

2.3.2 Install automatic sprinkler protection for all of the following exterior building features:

A. Balconies with any of the following features constructed of combustible elements: floors, roofs, ceilings, or full-story height walls.

B. Canopies or overhanging eaves of combustible construction greater than 30 in. (0.8 m) wide in combination with a combustible exterior wall exposure.

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C. Overhanging eaves, regardless of width, with both an adjoining attic/concealed space and a combustible exterior wall exposure.

D. Underside-exposed combustible mansard roof decks. (e.g. some styles of strip mall/shopping plazas).

2.3.2.1 Install automatic sprinkler protection on a dry-pipe or anti-freeze system where recommended per DS 3-26. Refer to Data Sheet 9-18, *Prevention of Freeze-Ups*, for recommendations related to freeze potential of fire protection systems.

2.3.2.2 For additional information on mitigating and protecting exterior construction elements from exposure to wildland fire, see DS 9-19, *Wildland Fire*.

2.3.3 Install automatic sprinkler protection where recommended in Figures 2.2.2-1 and 2.2.2-2.

2.3.4 Install automatic sprinkler protection for exposed composite wood joists greater than 22 in (559 mm) deep that consist of webs made from engineered wood products consisting of wood strands, fibers, wafers, or veneers (e.g., plywood, OSB) as follows:

• For joists over 22 in. (559 mm) deep, install a sprinkler in every joist bay by staggering sprinklers on the branch lines. Space branch lines up to the maximum allowed by the occupancy.

2.3.5 If plastic construction materials are used within a concealed space, install protection in accordance with Data Sheet 1-57, *Plastics in Construction*.

2.3.6 If process duct work passes through a concealed space, install protection in accordance with DS 7-78. Provide access to the concealed space for inspection and maintenance purposes.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Commentary

The following table contains additional explanatory material related to some recommendations in Section 2.0. The specific section or recommendation number to which the commentary applies is identified within the table.

Table 3.1. Commentary for Section 2.0 Loss Prevention Recommendations

Section Number	*Commentary*
2.2.3.4.1	Typical wood products used in the webs of composite joists burn more readily than solid sawn lumber. As a result composite wood joists are not suitable for consideration as blocking or within the construction of a partition intended to subdivide a compartment.
2.2.6	Void spaces between batt insulation and the underside of wood roof decks creates a situation whereby fire can spread above sprinklers due to shielding resulting from the insulation. If void spaces are provided for roof ventilation, upslope fire spread may not be preventable. Therefore prevention of lateral flame spread is vital to prevent involvement of the entire roof.
2.3.2.D	The perimeter of some shopping plazas is a possible example of a combustible mansard roof deck requiring automatic sprinkler protection.

3.2 Loss Experience

Loss experience shows that the lack of sprinklers in concealed, combustible spaces above ceilings can result in uncontrolled fires, delayed detection, and difficult manual firefighting.

Losses involving combustible insulation in cavity walls are most likely to occur during construction or alteration operations in which hot work is performed.

Additional loss information can be found in the FM Understanding the Hazard brochure *Combustible Concealed Spaces*, publication number P0114.

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3.2.1 Illustrative Losses

3.2.1.1 Combustible Cavity Wall Insulation is Ignited

The exterior facade of a building under construction used extruded foam polystyrene insulation against a noncombustible substrate, with an approximate 1 in. (50 mm) air space between it and a brick veneer. The brick veneer was not completed when heat from a grinding operation ignited the polystyrene. The fire spread through the polystyrene upward for eight stories to the top of the building. Damage included the insulation, several windows, several light fixtures, and portions of the brick veneer at the upper portion of the building.

3.2.1.2 Fire in Wall Cavity and Unsprinklered Attic Space

A college dormitory building consisted of a two-story, steel frame on a concrete slab with unfilled, masonry block interior walls and exterior walls of brick separated from interior walls by wood lathe siding and a tar paper vapor barrier. The roof was constructed of a wood truss roofing system covered with wood decking, felt paper, and asphalt shingles.

At the time of loss, a contractor was installing a new exterior platform and metal stairs. Employees of the contractor saw smoke emanating from one of the wall cavities and unsuccessfully attempted to extinguish the fire. The fire subsequently spread to the unsprinklered attic space which substantially damaged the attic and second floor of the structure. The entire structure was demolished due to the extensive damage from the event.

This loss demonstrates the need for sprinklers in combustible concealed spaces even where significant portions of the remaining structure is noncombustible.

3.2.1.3 Impairment of Sprinkler Protection in Combustible, Concealed Spaces

A fire in a sawmill spread from the point of origin into an exterior wall cavity then into a sprinklered combustible, concealed space. The sprinklers in the concealed space controlled fire spread until a sprinkler feed main was ruptured during removal of exterior wall cladding to extinguish hot spots. Once the feed main was ruptured, fire spread became uncontrolled.

Subsequent firefighting was complicated by the presence of multiple combustible concealed spaces, and exterior metal cladding combined with manual firefighting from the building exterior only. The fire was not fully extinguished until four days later.

Structural damage from the fire resulted in collapse of a five-ton crane and second floor office space as well as subsequent demolition of nearly 20k square feet of the remaining building.

Production at the mill experienced 100% interruption with an estimated downtime of 6-8 months.

This loss demonstrates the effectiveness of sprinkler protection in combustible concealed spaces as well as the consequences of an impairment.

3.3 Cavity Walls

Recommendations are practical for new construction, particularly where the occupancy is susceptible to smoke damage.

A side-by-side fire test of two different cavity wall assemblies was conducted. For an illustration of the extent of burning and smoke liberation for the EPS assembly, see Figure 3.3-1. For a side-by-side comparison of the two assemblies, see Figure 3.3-2. Each assembly used noncombustible panels on each outer face. One assembly used 4 in. (100 mm) of expanded glass (EG), which is a moisture-resistant, noncombustible insulation. The other assembly used 4 in. (100 mm) of expanded polystyrene (EPS) insulation, which is a moisture-resistant, combustible insulation.

Both foams were adhered to a noncombustible substrate using a water-based adhesive. In each case, a 12 ft (3.7 m) high x 12 ft (3.7 m) wide assembly was used with a 2 in. (50 mm) air space between the foam insulation and the noncombustible sheathing on the other side.

The fire exposure consisted of one standard cellu-cotton igniter soaked in 8 oz (237 ml) of gasoline for each assembly.

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There was almost no involvement of the assembly containing expanded glass (EG). The assembly using EPS insulation burned to the end of the test array, yielded considerable black smoke, and the test was considered a failure.

Fig. 3.3-1. Fire Test of cavity wall assembly using foam polystyrene insulation

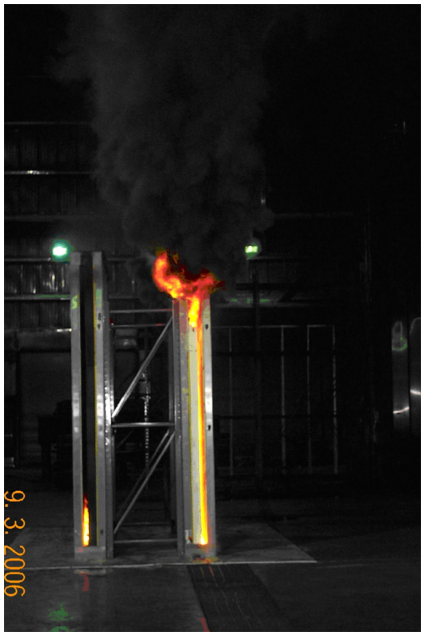

Fig. 3.3-2. Side-by-side comparison of EG assembly (on the left) and EPS assembly (on the right)

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The test was repeated using two different brands of 2 in. (50 mm) extruded polystyrene insulation in the cavity. In both cases, considerable flaming and smoke liberation were noted and the foam was consumed across the entire length of the top of the assembly.

A similar test was conducted using FM Approved, 4 in. (100 mm) thick, foil-faced polyisocyanurate insulation. The test was successful.

4.0 REFERENCES

4.1 FM

Data Sheet 1-0, *Safeguards During Construction, Alteration and Demolition*
Data Sheet 1-17, *Reflective Wall and Ceiling Insulation*
Data Sheet 1-21, *Fire Resistance of Building Assemblies*
Data Sheet 1-45, *Air Conditioning and Ventilating Systems*
Data Sheet 1-57, *Plastics in Construction*
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*
Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*
Data Sheet 4-8N, *Halon 1301 Extinguishing Systems*
Data Sheet 5-31, *Cables and Bus Bars*
Data Sheet 5-32, *Data Centers and Related Facilities*
Data Sheet 7-78, *Industrial Exhaust Systems*
Data Sheet 10-3, *Hot Work Management*

The *Approval Guide*, an online resource of FM Approvals

RoofNav, an online resource of FM Approvals

FM Approvals Standard 4880, *Approval Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials*.

Understanding the Hazard: *Combustible Concealed Spaces*. Publication number P0114.

Understanding the Hazard: *Class 2 (Combustible) Roof Assemblies*. Publication number P0228.

4.2 Other

ASTM International. ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*.

ASTM International. ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*.

APPENDIX A GLOSSARY OF TERMS

Cavity wall: An exterior wall that includes an approximate 2 in. (50 mm) deep air space between the interior surface of the exterior wall veneer and the exterior surface of the insulation. The insulation is usually adhered to a continuous layer of gypsum board or other thermal barrier that separates the cavity insulation from the building occupancy. The exterior wall veneer is typically a fire-resistive material, such as brick.

Ceilings needing special protection: Installations of foamed-on rigid plastics that are not FM Approved. Protection guidelines can be found in Data Sheet 1-57, *Plastics in Construction*.

Class 1 materials: Materials that are noncombustible or of limited combustibility including but not limited to a specific combination of components comprising an assembly that has been FM Approved as Class 1. Typical ceiling products are made of mineral fiber, gypsum, cement, asbestos, glass fiber, or combinations of these materials. They are manufactured with varying densities and many surface treatments. Some of the products have a paper or vinyl covering or backing, or may be treated with fire retardant chemicals, but they do not contribute significantly to the spread of fire.

Class 2 materials: Materials that are combustible to the degree that they can present a fire hazard. Typical products are made of wood fiber, cane fiber, or cork (low density or highly compressed), plastic insulating materials without a metal facer, fiber-reinforced plastic (FRP), hard surface plastic panels, and spray-applied

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cellulosic and foam materials. Some of these materials are combined with noncombustible materials or have a fire-retardant surface treatment, but all will contribute to the spread of fire and can generate considerable heat.

Cloud ceilings: A suspended ceiling that covers only a portion of a room or space below, typically to hide mechanical equipment or for aesthetic or acoustic purposes.

Firestopping: A passive means of protection whereby fire and smoke is prevented from spreading from one space to another. This is achieved by installing a physical barrier consisting of fire-resistant materials such that spaces are effectively separated from one another. A concealed space firestop typically divides a concealed space into separate areas but does not include physically separating areas adjacent to the concealed space. Refer to “subdivision” for this type of separation. Firestop material include gypsum board, mineral board, mineral wool, or ceramic fiber insulation. For wood-framed construction, this also includes solid wood members with a thickness at least equal to that of the abutting framing. For penetrations, firestop materials include cement, ceramic fiber, mineral wool, as well as FM Approved penetration seals.

FM Approved: Reference to “FM Approved” in this data sheet indicate a product or service that has satisfied the criteria for such designation by FM Approvals. Refer to the *Approval Guide* and RoofNav for a complete listing of products and services that are FM Approved.

Furring: Thin strips of material, typically wood or metal channel, used to level, add an air space, and/or provide a surface to attach a subsequent wall/ceiling covering.

Melt-out ceilings: PVC or expanded polystyrene suspended panels designed to be heat sensitive and, when exposed to high heat, to drop out of their suspension frame quickly enough to minimize interference with the operation of automatic sprinklers above. Because there is an inherent time delay for these tiles to drop out, restrictions on their use have been incorporated into the recommendations in this data sheet to avoid cumulative time delays, which could adversely affect sprinkler operation.

Noncombustible material: A material that will not ignite, burn, support combustion, or release ignitable vapors when subjected to fire or heat. Materials are classified as noncombustible if they meet the passing criteria of one of the following:

(1) The optional requirements for noncombustible core rating in FM Approvals Standard 4880, *Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings, and Exterior Wall Systems*

(2) ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*

(3) ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*

Subdivision: Dividing areas into wholly separate areas by installing physical barriers that extend between similar barriers. In the context of this document, a subdivided area would consist of a barrier that extends from the floor deck below the concealed space, through the concealed space to the floor/roof deck above (e.g. a fire-rated wall extending from floor deck to floor/roof deck above). Such subdivision prevents the spread of fire and smoke between separated concealed spaces as well as between the separated spaces adjacent to the concealed space.

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 2025. Interim revision. Minor editorial changes were done.

July 2020. Interim revision. Reference to Data Sheet 1-57 for information on debris barriers was removed.

April 2020. This document has been revised. Significant changes include the following:

A. Added recommendations for cloud ceilings.

B. Added recommendations for the use of plastic-based construction materials.

C. Replaced the table for determining sprinkler requirements with two flowcharts and a cross-reference table to simplify the process.

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May 2008. Added guidelines for the construction of cavity walls.

May 2003. Minor editorial changes were made for this revision.

January 2003. The title was changed from “Ceilings” to Ceilings and Concealed Spaces”. Changes regarding combustible walls were made to recommendation 2.2.2.

May 2002. Minor editorial changes were made and emphasis was put on the use of noncombustible materials and the protection of combustible materials.

September 1998. The document was reformatted.

June 1985. Additional guidance was added regarding the installation of drop-out ceiling tiles.

March 1979. The document was first written as the data sheet for “Ceilings”. It superseded page 5-7 of the Handbook of Industrial Loss Prevention.

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