

CEILINGS AND CONCEALED SPACES

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1.0 SCOPE

This data sheet identifies those combinations of ceiling and floor or roof deck that need protection, and recommends the type of protection needed. It also includes recommendations for drop-out ceilings. Ceilings used in a fire-rated assembly are not discussed in this document (see Data Sheet 1-21, *Fire Resistance of Building Assemblies*, and the Specification Tested Products Guide Section of the *Approval Guide*, a publication of FM Approvals). For reflective ceiling insulation, refer to Data Sheet 1-17, *Reflective Ceiling Insulation*.

1.1 Changes

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

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

Ceilings are sometimes provided under the structural deck and 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 ceilings can vary considerably, ease of ignition, flame spread characteristics, and rate of burning can differ significantly. As a result, these construction materials are divided into four categories:

1. Class 1 materials
2. Class 2 materials
3. Drop-out ceilings
4. Ceilings needing special protection

Class 1 materials may be:

- Cementitious boards with inorganic or limited organic reinforcement
- Materials that are FM Approved for use without sprinkler protection
- Most non-plastic ceiling materials not FM Approved, but with an ASTM E-84 flame spread rating of 25 or less

Class 1 materials do not, by themselves, warrant sprinkler protection.

Class 2 materials usually warrant sprinkler protection.

2.2 Construction and Location

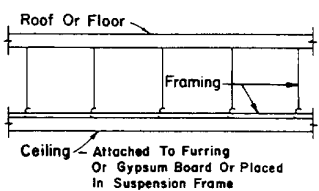
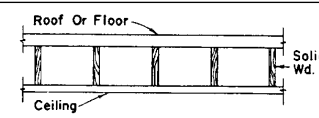
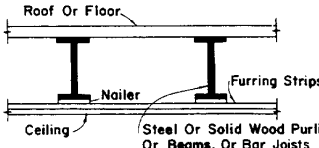
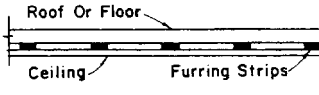
2.2.1 Use Table 1 to determine protection for various combinations of ceiling and roof or floor construction.

2.2.2 **Provide** fire-stops for ceiling spaces where recommended in Table 1, at intervals not exceeding 2000 ft² (186 m²). Provide fire-stops within combustible walls at each floor level and horizontally at maximum intervals of 10 ft (3 m), **except as otherwise noted**.

Ensure fire stops completely close off the space they are within, and consist of gypsum board, mineral wool, or ceramic fiber insulation. Where wood construction is used, fire-stops may consist of solid wood members at least as thick as the joists or studs they are abutting.

2.2.3 Provide protection around items penetrating fire-stops (such as pipes, conduit, and ducts) using cement, ceramic fiber, mineral wool insulation, or FM Approved penetration seals.

Table 1. Conditions Where Sprinklers Are Needed to Protect Insulating and Acoustic Ceilings

Construction		Sprinklers Needed ¹	
		Under Ceiling	In Concealed Space
 <p>Suspended ceiling</p> <p>Note: Treat ceiling attached to bottoms of trusses the same as suspended ceiling.</p>	Roof or floor: Noncombustible ²		
	Ceiling framing: Noncombustible		
	Ceiling: Class 1	No	No ³
	Class 2	Yes ⁴	No ^{3,5}
	Roof or floor: Noncombustible ²		
	Ceiling framing: Combustible		
	Ceiling: Class 1	No	No ^{3,6}
	Class 2	Yes ⁴	No ^{3,6,5}
	Roof or floor: Combustible ⁷		
	Ceiling Framing: Noncombustible or combustible		
Ceiling: Class 1	No	Yes ⁸	
Class 2	Yes	Yes ⁸	
 <p>Ceiling attached to wood joists supporting roof or floor.</p>	Roof or floor: Combustible ⁷ Ceiling: Class 1 or II	Yes	No ⁵
 <p>Ceiling attached to purlins supporting roof or floor</p>	Roof or floor: Noncombustible ²		
	Ceiling: Class 1	No	No
	Class 2	Yes ⁴	No ⁵
	Roof or floor: Combustible		
	Ceiling: Class 1 or II	Yes	No ⁵
 <p>Ceiling attached to roof or floor deck</p>	Roof or floor: Noncombustible ²		
	Ceiling: Class 1	No	
	Class 2	Yes ⁴	
	Roof or floor: Combustible		
	Ceiling: Class 1 or II	Yes	

- When a ceiling is the only combustible warranting sprinkler protection, a suitable alternative is to replace the ceiling with a Class 1 material.
- Including roof or floor framing.
- Sprinklers needed if concealed space contains continuous combustibles.
- Exception: Sprinklers may be omitted if area is limited to 2,000 ft² (186 m²) by means of noncombustible or one-hour rated partitions extending from floor below to roof or floor above.
- Provide fire stops every 2,000 ft² (186 m²).
- Sprinklers are needed if ceiling framing consists of combustible members 3 ft (0.9 m) or less on centers
- Where combustible roof or floor framing consists of built-up members with plywood webs, see Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.
- Where the installation of sprinklers is impractical due to space limitations, provide fire-stops every 2,000 ft² (186 m²).

2.2.4 Install FM Approved Class 1 insulated steel deck roofs.

2.2.5 When drop-out suspended ceilings are used below automatic sprinklers, adhere to all of the following recommendations:

2.2.5.1. Ensure ceiling tiles are FM Approved and used only in the metal frame for which they are Approved.

2.2.5.2. Use drop-out ceilings only in light-hazard occupancies.

2.2.5.3. Do not use hold-down clips unless they are FM Approved specifically for this purpose. Do not glue ceiling tiles to their supporting frame.

2.2.5.4. If un Approved hold-down clips are used on drop-out ceiling tiles to prevent uplift during gaseous extinguishing systems discharge, replace the tiles with Class 1 ceiling tiles (such as gypsum, mineral tile or glass fiber) and drop sprinklers below the new ceiling. Determine the need for sprinklers above the new ceiling per Table 1 and Recommendation 2.3.5.

Alternatively, hold-down clips can be removed from the drop-out tiles and the capacity of the gaseous extinguishing systems system can be increased to include the volume of the space above the ceiling. Ensure this space is cut off, tightly sealed, and HVAC systems are interlocked to shut down (see Data Sheet 4-8N, *Halon 1301 Extinguishing Systems*, and Data Sheet 5-32, *Electronic Data Processing Systems*).

2.2.5.5. Do not use drop-out ceilings in conjunction with dry-pipe sprinkler systems.

2.2.5.6. Do not locate drop-out ceilings more than 5 ft (1.5 m) below automatic sprinklers.

2.2.5.7. Use drop-out ceilings only in a horizontal arrangement. Ensure they are not sloped.

2.2.5.8. Ensure drop-out ceilings are not painted or coated, unless FM Approved that way.

2.2.5.9. Do not place insulation above drop-out ceiling tiles, even if cut to be slightly smaller than the tile dimensions.

2.2.5.10. Do not use drop-out tiles as a suspended ceiling with sprinklers below the ceiling only.

2.2.6 Use noncombustible or limited combustible (Class 1) construction where concealed spaces are not accessible by the public fire service. Use noncombustible materials where the construction is above the fire service's reach.

2.2.7 Do not penetrate combustible walls, floors, or ceilings with metal chimneys or other hot stacks. For existing installations, provide protection in accordance with Data Sheet 1-13, *Chimneys*.

2.2.8 Install batt insulation tightly against the underside of wood roof decks so as not to create a void space, which can allow fire to spread above sprinklers that are shielded by the insulation. Remove insulation or provide fire-stops according to Section 2.2.2 for existing installations where such spaces exist.

2.2.9 Protect **new** exterior cavity walls using **one** of the following methods:

- A. Use FM Approved Class 1, expanded glass insulation in cavity walls, or
- B. Use FM Approved Class 1, foil-faced polyisocyanurate insulation in cavity walls, or
- C. Use combustible insulation over a noncombustible substrate, but eliminate the air space so the thermal barriers are in direct contact with the insulation on both surfaces, or
- D. Use combustible insulation over a noncombustible substrate in conjunction with fire stops to divide the wall cavities into areas not exceeding 2000 ft² (186 m²).

In all cases, ensure the exterior wall veneer and the substrate for the insulation are noncombustible. Do not directly attach combustible insulation to wall studs.

2.2.10 Use caution where hot work is conducted within or near wall, floor/ceiling, or roof/ceiling spaces where combustibles are present. For additional information, see DS 1-0, *Safeguards During Construction, Alteration and Demolition*.

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

2.3 Protection

2.3.1 Provide automatic sprinkler protection for balconies with combustible construction whenever any of the following conditions exist:

- a) Combustible floors
- b) Combustible roofs or ceilings
- c) Combustible walls that extend the full story height

Use a dry-pipe sprinkler system or anti-freeze system installed in accordance with Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.3.2 Provide automatic sprinkler protection where exterior walls are combustibile and canopies or overhanging eaves are combustibile and are greater than 30 in. (0.8 m) wide, with or without an attic space present.

Provide automatic sprinkler protection on a dry-pipe system or anti-freeze system below the combustibile overhangs in accordance with Data Sheet 2-0.

2.3.3 Provide protection for overhanging eaves with attic spaces where exterior walls are combustibile using one of the following methods:

- a) Provide automatic sprinkler protection on a dry-pipe or anti-freeze system just below the eave, and 4 to 12 in. (100 to 300 mm) away from the wall, or
- b) Provide automatic sprinkler protection on a dry-pipe or anti-freeze system in accordance with Data Sheet 2-0 throughout the attic area.

2.3.4 Provide automatic sprinkler protection on a dry-pipe system or anti-freeze system (according to Data Sheet 2-0) below combustibile mansard roof decks such as are used at the perimeter of shopping plazas.

2.3.5 Provide automatic sprinkler protection above ceilings when the floor or roof deck above is combustibile or the space contains combustibles capable of sustaining a spreading fire.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Loss Experience

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

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

3.1.1 Illustrative Losses

Combustibile Cavity Wall Insulation is Ignited

The exterior façade of a building under construction used extruded foam polystyrene insulation against a non-combustibile 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.

Careless Smoking Ignites Combustibile Roof Deck

Contractors working on top of a roof discarded cigarette butts into a PVC plastic roof drain. The PVC was ignited and in turn ignited the combustibile roof deck from the underside. One sprinkler operated and controlled the fire. This loss demonstrates the need for safe smoking practices, the capability of plastic roof drains to spread fire, and the need for sprinklers below combustibile roof decks.

3.2 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 Fig. 1. For a side-by-side comparison of the two assemblies, see Fig. 2. Each assembly used non-combustibile panels on each outer face. One assembly used 4 in. (100 mm) of expanded glass (EG), which is a moisture-resistant, noncombustibile insulation. The other assembly used 4 in. (100 mm) of expanded polystyrene (EPS) insulation, which is a moisture-resistant, combustibile insulation.

- Both foams were adhered to a noncombustibile 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 noncombustibile 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.
- 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. 1. Fire Test of cavity wall assembly using foam polystyrene insulation



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

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 was 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 Global

Data Sheet 1-0, Safeguards During Construction, Alteration and Demolition

Data Sheet 1-13, Chimneys

Data Sheet 1-17, Reflective Ceiling Insulation

Data Sheet 1-21, Fire Resistance of Building Assemblies

Data Sheet 1-57, Plastics in Construction

Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers

Data Sheet 4-8N, Halon 1301 Extinguishing Systems

Data Sheet 5-31, Cables and Bus Bars

Data Sheet 5-32, Electronic Data Processing Systems

Approval Guide, a publication of FM Approvals

4.2 Other

American Society of Testing and Materials (ASTM). *Standard Test Method for Surface Burning Characteristics of Building Materials E84*. Latest Edition.

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. 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. Some are highly compressed; others have low density. Some 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.

Drop-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.

FM Approved: References to "FM Approved" in this data sheet mean the product or service has satisfied the criteria for FM Approval. Refer to the Approval Guide for a complete listing of products and services that are FM Approved.

APPENDIX B DOCUMENT REVISION HISTORY

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.