FIRE PROTECTION FOR NONSTORAGE OCCUPANCIES

Table of Contents

Page

1.0 SCOPE....2
1.1 Hazards....2
1.2 Changes....2
1.2.1 Superseded Information....2
2.0 LOSS PREVENTION RECOMMENDATIONS....2
2.1 Introduction....2
2.2 Occupancy....2
2.3 Protection....4
2.3.1 General....4
2.3.2 Automatic Sprinkler Systems....5
2.3.3 Water Mist Systems....6
2.3.4 Work in Process Storage....7
2.3.4.1 Incidental....7
2.3.4.2 Low-Piled....8
2.3.4.3 Racks....10
2.3.4.4 High-Density Movable Shelving Units....10
2.3.5 Residential Occupancies....10
2.4 Ignition Source Control....10
3.0 SUPPORT FOR RECOMMENDATIONS....11
3.1 General....11
3.1.1 Hazard Categories....11
3.2 Nonstorage Occupancy Fire Protection....11
3.3 High-Density Movable Shelving Units....11
3.4 Desalination Plants....13
3.5 Nonstorage Protection Research....14
3.5.1 Residential Occupancies....14
4.0 REFERENCES....14
4.1 FM....14
4.2 Other....14
APPENDIX A GLOSSARY OF TERMS....15
APPENDIX B DOCUMENT REVISION HISTORY....16
APPENDIX C HAZARD CATEGORY EXAMPLES....20

List of Figures

Fig. 2.2.1. Flowchart for determining appropriate use of Data Sheet 3-26....3
Fig. 3.3-1. High-density movable shelving unit....12
Fig. 3.3-2.High-density movable shelving unit....13

List of Tables

Table 2.2.2. Hazard Categories Based on Predominant Occupancy....3
Table 2.3.2.7 Sprinkler Design Demands for Hazard Categories....6
Table 2.3.4.1.5. Incidental Storage of Ignitable Liquids in HC-1 Occupancies in Containers of Any Construction....8
Table 2.3.4.2.3 Sprinkler Protection Guidelines for Low-Piled Storage....9
Table C-1. Nonstorage, Non-Manufacturing Occupancies and their Associated Fire Hazard Categories....20
Table C-2. Manufacturing Occupancies and Their Associated Fire Hazard Categories....22

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1.0 SCOPE

This data sheet provides recommendations for fire protection in nonstorage occupancies. A nonstorage occupancy is an area or building consisting of equipment, processes, and / or materials that are not maintained in a storage arrangement. These materials may be combustible or noncombustible. The occupancy may contain industrial or manufacturing processes as well as non-manufacturing operations such as office, retail, or residential occupancies.

This data sheet also provides recommendations for the protection of incidental storage and low-piled storage (see Appendix A for a definition of these two terms) where Class 1, 2 or 3 commodities are stored to a maximum height of 10 ft (3.0 m), or where Class 4 or plastic commodities are stored to a maximum height of 6 ft (1.8 m).

1.1 Hazards

Nonstorage occupancies, such as manufacturing areas, typically have limited storage, but the storage that is present, in combination with the equipment, processes, and materials used, still creates a fire hazard. Automatic sprinklers in these occupancies work to limit the fire size and protect the building. The protection designs covered in this data sheet are not intended for occupancies with the following due to the increased fire hazard:

- Ignitable liquid storage or use in HC-1 occupancies in excess of the quantities considered incidental
- Combustible dust or lint collected on horizontal surfaces
- Plastic construction elements
- Concealed/shielded spaces with combustible construction or content
- Storage heights or areas that are greater than that provided in incidental storage

The situations listed above may need additional sprinkler coverage, enhanced sprinkler designs, or other loss prevention measures. Always refer to hazard-specific data sheets, when applicable, for additional recommendations.

Refer to Understanding the Hazard (UTH): *Lack of Automatic Sprinklers (P0037)* for detailed information on the hazards associated with this data sheet.

1.2 Changes

October 2026. Interim revision. Significant changes include the following:

A. Reorganized Section 2.3, Protection.

B. Updated Section 2.3.2.8 to reference Data Sheet 2-0 for minimum design pressures.

C. Revised Section 2.3.3 to align with Data Sheet 4-2 regarding water mist protection in HC-2 and HC-3 occupancies.

D. Added Section 2.3.4.1.6 to address the amount of ignitable liquid incidental storage for HC-2 and HC-3 occupancies.

E. Updated Table 2.3.4.2.3 for low-piled storage.

F. Added dry pipe sprinkler protection options for low-piled storage in Section 2.3.4.2.2.1.

1.2.1 Superseded Information

This document supersedes Data Sheet 2-5, *Installation Guidelines for Automatic Sprinklers in Residential Occupancies*, and Engineering Bulletin EB 04-12, *New Protection Guidance for Extended Coverage Sprinklers for Nonstorage Applications*, which have been incorporated into the data sheet.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

2.1.1 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*, an online resource of FM Approvals.

2.2 Occupancy

2.2.1 There may be guidance and recommendations in other data sheets that supersede those within Data Sheet 3-26. Use Figure 2.2.1 to determine the appropriate treatment of storage in Data Sheet 3-26 or the appropriate data sheet to use when the storage falls outside what is considered incidental and low-pile storage.

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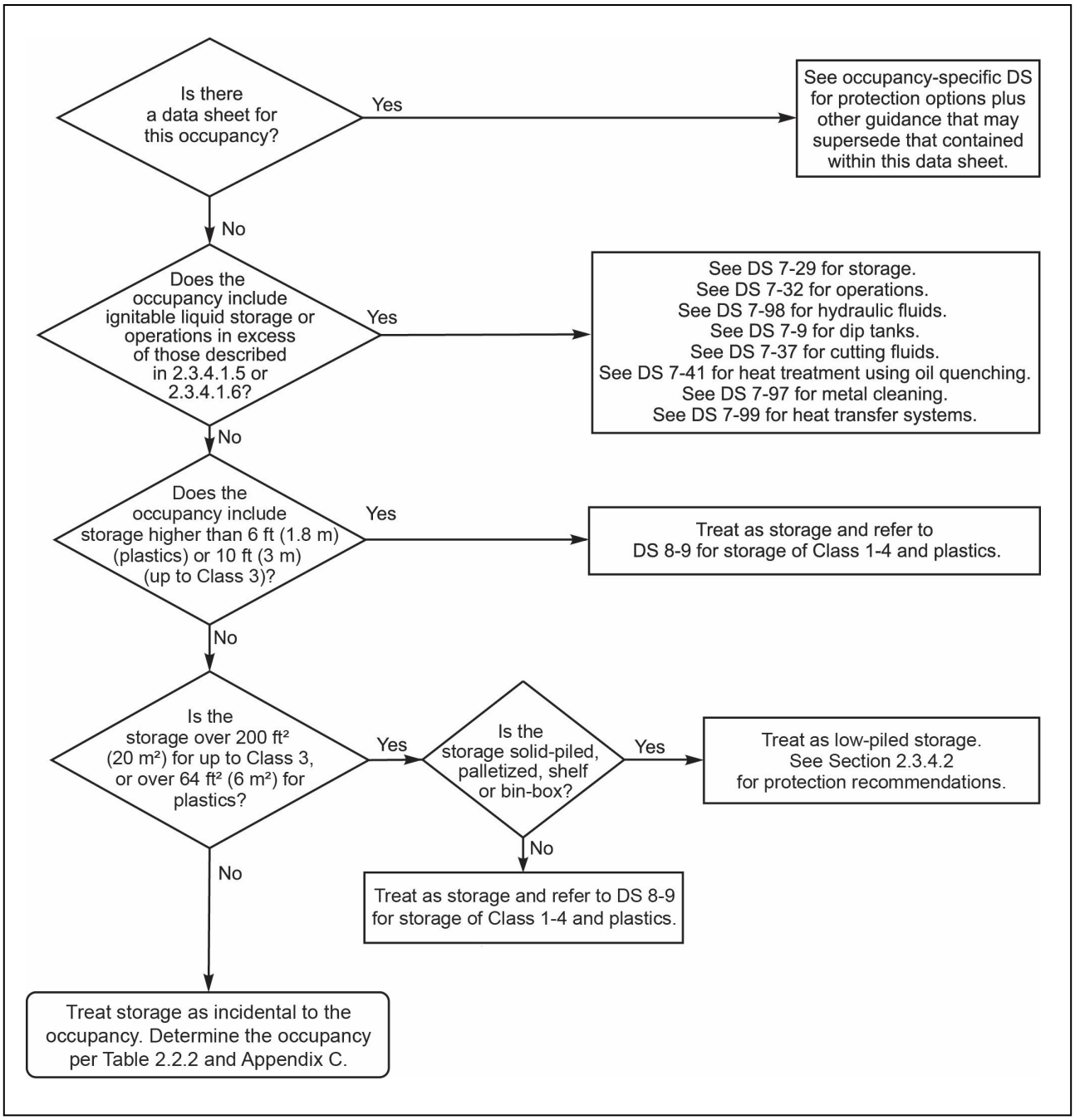


Fig. 2.2.1. Flowchart for determining appropriate use of Data Sheet 3-26

2.2.2 Use Table 2.2.2 to determine the hazard category (HC) based on the predominant occupancy. See Appendix C For specific examples of HC-1, HC-2, and HC-3 occupancies.

Table 2.2.2. Hazard Categories Based on Predominant Occupancy

Hazard Category	*Predominant Occupancy*
HC-1	Areas with light overall combustible loading with limited combustibles used in processes, or operations of low hazard. This includes combustible furnishings that are typically noncontinuous in well-subdivided areas. This hazard category does not include any incidental storage of plastics, or plastics used in the construction of walls and / or ceilings. This hazard category can have incidental amounts of ignitable liquids in accordance with Section 2.3.4.1.5. Examples include residential, offices, noncombustible manufacturing, and hospitals.

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***Table 2.2.2. Hazard Categories Based on Predominant Occupancy* (continued)**

Hazard Category	*Predominant Occupancy*
HC-2	Areas with moderate continuous combustible loading with combustibles in processes, or operations of moderate hazard due to limited quantities of plastics or ignitable liquids in accordance with Section 2.3.4.1.6. Examples include manufacturing, such as machine shops, woodworking, and electronic assembly, as well as retail, theatres, and food production.
HC-3	Areas with generally continuous heavier combustible loading with limited quantities of ignitable liquids in accordance with Section 2.3.4.1.6 and / or heavier amounts of plastics. Examples include plastic manufacturing, vehicle manufacturing and assembly, and printing plants.

Note: Refer to Appendix C, Tables C-1 and C-2, for considerations when applying a hazard category. The examples listed here are typical for each hazard category but may need to be adjusted to a higher or lower category based on the specific occupancy details. Refer to the relevant hazard/occupancy-specific data sheets, if applicable.

2.2.3 Classify buildings that are of wood construction but otherwise contain no combustible materials as HC-1 occupancies.

2.2.4 Identify spaces concealed from ceiling sprinklers that have combustible construction features or contain combustible material and provide sprinkler protection in those spaces. Concealed spaces can include equipment with combustible material; areas obstructed by ductwork, light fixtures, or hoods; and hidden combustible construction.

2.2.4.1 Protect combustible concealed spaces as HC-1 in accordance with FM Data Sheet 1-12, *Ceilings and Concealed Spaces*.

2.2.5 For locations with mixed occupancy hazards that are not separated by fire partitions, protect for the greatest hazard or see Data Sheet 2-0 for other protection options.

2.2.6 Establish and implement a housekeeping program to minimize accumulations of lint, dust, and other combustible materials.

2.3 Protection

2.3.1 General

2.3.1.1 Protect nonstorage occupancies with automatic sprinklers or water mist systems.

2.3.1.2 See Data Sheet 1-57, *Plastics in Construction*, for protection guidance when building construction contains plastic.

2.3.1.3 Install protection in concealed / shielded spaces that contain combustible materials.

A. Where a data sheet relevant to these hazards or occupancies exists, adhere to the recommendations in that data sheet.

B. Otherwise, protect underneath the shielded area with sprinklers that provide the same density as the ceiling system.

Examples of concealed or shielded spaces include the following:

- Solid or grated mezzanines
- Ovens with combustible materials or deposits
- Plastic ducts or ducts with combustible deposits
- In and around equipment like printing presses, spray booths, banbury mixers, etc.
- Machine covers
- Plastic tanks
- Conveyors

2.3.1.4 In addition to the recommendations in this data sheet, refer to Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*, for facilities located in earthquake-prone regions.

2.3.1.5 Base water demands for single-interlocked preaction systems on either wet-pipe or dry-pipe systems, depending on the spacing of the heat detection devices located at the ceiling. See Data Sheet 5-48, *Automatic Fire Detection,* to determine the system type based on detector spacing. Base the design for all other preaction sprinkler system types on the designs indicated for dry-pipe systems.

2.3.1.6 Provide a hose stream allowance of 250 gpm (950 L / min) for HC-1 and HC-2 occupancies, and a hose stream allowance of 500 gpm (1900 L / min) for HC-3 occupancies.

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2.3.1.7 Ensure a water supply capable of providing the design sprinkler discharge flow rate plus hose stream for 60 minutes for all hazard categories.

2.3.1.8 Arrange the ventilation system to limit smoke spread. This can be accomplished by ventilation shutdown, dampers, etc. upon activation of automatic fire protection alarms (ex. smoke detection, water flow alarm, etc.).

2.3.2 Automatic Sprinkler Systems

2.3.2.1 Install sprinklers in accordance with Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.3.2.2 Follow installation and obstruction guidance in FM Property Loss Prevention Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, for Nonstorage occupancies when either Storage or Nonstorage sprinklers are installed.

2.3.2.3 Install a wet pipe, dry pipe, pre-action, or antifreeze sprinkler system to protect nonstorage occupancies.

2.3.2.4 Use wet-pipe sprinkler systems unless the protected area is refrigerated or unheated, and the temperature can fall below 40°F (4°C). See Data Sheet 2-0, Section 2.4, for further information. For wet-pipe sprinkler systems, use the following sprinklers:

- Sidewall (HC-1 and HC-2 occupancies only); unless it is a K14EC (K200EC), which can be used in HC-1, HC-2 and HC-3 occupancies), pendent, upright, or dry-pendent.
- Nominal 160°F (70°C) temperature rating. Only use sprinklers with a nominal temperature rating of 212°F (100°C) where the ambient temperature is in excess of 100°F (38°C).
- Standard coverage or extended coverage.
- Standard response or quick response. Do not use standard response sprinklers when ceiling heights are greater than 60 ft (18 m).

2.3.2.4.1 Use the following sprinklers for dry-pipe sprinkler systems:

- Upright or dry-pendent. Dry sidewall can be used under certain conditions; see Data Sheet 2-0.
- Nominal 280°F (140°C) temperature rating. Nominal 165°F (70°C) sprinklers are acceptable for HC-1 and HC-2 occupancies.
- Standard coverage.
- Standard response. Quick-response sprinklers are acceptable for HC-1 and HC-2 occupancies.

2.3.2.4.2 For dry-pipe and equivalent sprinkler systems, if a maximum water delivery time is not specified in an occupancy-specific data sheet, use one of the following water delivery times:

- 60 seconds with the operation of the single most remote sprinkler
- 40 seconds with the operation of the most remote four sprinklers (two sprinklers on two lines)

2.3.2.5 Treat anti-freeze sprinkler systems as wet-pipe systems. See Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, for additional guidance antifreeze solution sprinkler systems.

2.3.2.6 Use minimum sprinkler K-factors and recommended minimum and maximum sprinkler spacings for each hazard category and ceiling height in accordance with FM Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.3.2.7 Design the sprinkler system in accordance with Table 2.3.2.7, based on the applicable hazard category. These designs are not intended for areas with the following conditions (see the applicable data sheets listed for further guidance):

A. Ignitable liquid storage or use in excess of the quantities considered incidental. (See Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*, or Data Sheet 7-32, *Ignitable Liquid Operations*.)

B. Combustible dust or lint collected on horizontal surfaces within the occupancy. (See Data Sheet 7-1, *Fire Protection for Textile Mills*; Data Sheet 7-76, *Combustible Dusts*; or other data sheets as applicable.)

C. Plastic construction elements. (See Data Sheet 1-57, *Plastics in Construction*.)

D. Concealed/shielded spaces with combustible construction or content. (See Data Sheet 1-12, *Ceilings and Concealed Spaces*, or Section 2.2.4 in this data sheet.)

E. Storage amounts or areas greater than that provided in incidental storage. (See Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.)

Additional sprinkler coverage, enhanced sprinkler designs, or other loss prevention measures may be needed for these situations.

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Table 2.3.2.7 Sprinkler Design Demands for Hazard Categories

Hazard Category	Maximum Ceiling Height of 30 ft (9 m)		Maximum Ceiling Height of 45 ft (13.5 m)		Maximum Ceiling Height of 60 ft (18 m)		Maximum Ceiling Height of 100 ft (30 m)[Note 3]	
	(gpm/ft²)/ft² [(mm/min)/m²]							
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
HC-1	0.1/1500 (4/140)[Note 1]	0.1/1500 (4/140)	0.2/2500 (8/230)	0.2/3500 (8/330)	0.2/2500 (8/230)	0.2/3500 (8/330)	0.6/1200 (24/110)	Design guidance currently unavailable
HC-2	0.2/2500 (8/230)[Note 2]	0.2/3500 (8/330)	0.2/2500 (8/230)	0.2/3500 (8/330)	0.2/2500 (8/230)	0.2/3500 (8/330)	0.6/1200 (24/110)	
HC-3	0.3 / 2500 (12 / 230)[Note 2]	0.3/3500 (12/330)	0.3/3600 (12/340)	0.3/4600 (12/430)	0.5/3000 (20/280)	0.5/4000 (20/370)	0.6/1200 (24/110)	

Note 1. The demand area for dormitories, residential, and dwelling type areas may be based on the largest room area, but not less than four sprinklers provided fire compartmentation with a minimum one hour fire rating is present. Treat corridors as rooms in making this determination.

Note 2. For HC-2 and HC-3 occupancies with ceiling heights not in excess of 30 ft (9 m) and protected by wet sprinkler systems, the designs for these occupancies can be reduced to the following when 160ºF (70ºC) K11.2EC (K160EC) upright or 160ºF (70ºC) K14.0EC (K200EC) upright sprinklers are being installed:

- K11.2EC: 0.30 gpm/ft² over 1500 ft² (12 mm/min over 140 m²). Ensure a minimum of 6 sprinklers in the design
- K14.0EC: 0.30 gpm/ft² over 1000 ft² (12 mm/min over 90 m²). Ensure a minimum of 4 sprinklers in the design

Note 3. The designs for a maximum ceiling height of 100 ft (30 m) are limited to the use of K14.0 (K200) and greater K-factor sprinklers, per Section 2.3.2.7.1.

2.3.2.7.1 Protection designs for a maximum ceiling height of 100 ft (30 m) are limited to the use of K14.0 (K200) and greater K-factor sprinklers.

2.3.2.8 Regardless of the design demands in Table 2.3.2.7, provide a minimum design pressure at the most remote sprinkler in accordance with Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.3.2.9 Manufacturing and assembly of large, contiguous components, such as large aircraft, boats, and wind turbine blades, create the potential for shielded fires. The presence of these operations represents an increased fire hazard beyond typical HC-2 or HC-3 occupancies. For ceilings below 60 ft (18 m) use Table 2.3.2.7. For ceilings above 60 ft (18 m) protect these areas with K25.2 (K360) sprinklers using a design of 12 sprinklers at 50 psi (3.5 bar).

2.3.3 Water Mist Systems

2.3.3.1 Use an FM Approved water mist system listed for HC-1, HC-2, or HC-3 occupancy category as appropriate.

2.3.3.2 Install and design the water mist system in accordance with the recommendations in this section and the following:

- the FM Approval Guide listing for the specific hazard category
- the manufacturer's FM Approved design, installation, operation and maintenance manual
- Data Sheet 4-2, *Water Mist Systems*

2.3.3.2.1 Install water mist systems within the associated limitations specified in their FM Approval.

2.3.3.2.2 These occupancy protection designs are not intended for the following conditions:

A. Combustible dust or lint collected on horizontal surfaces within the occupancy. (See Data Sheets 7-1, *Fire Protection for Textile Mills*, and Data Sheet 7-76, *Combustible Dusts*.)

B. Low height high-density moveable shelving units.

C. Storage or commodity type not in accordance with incidental storage for the hazard category.

D. Storage of any amount (incidental or greater) of uncartoned plastics.

E. Areas exposed to outdoor conditions (wind, temperatures, etc.), such as open parking garages.

A thorough review and assessment needs to be conducted of the occupancy hazard for the presence of the conditions identified above to provide a water mist system that is FM Approved for an HC-1, HC-2, or HC-3 category. The presence of the conditions may necessitate the use of a water mist system that is FM Approved for a different category (e.g.,

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enclosures with machinery, storage of ignitable liquids, etc.) or may determine the system cannot provide protection at all. For example, a bakery that is considered an HC-2 occupancy with an accumulation of dust or that has plastics in construction would not be an appropriate application for an FM Approved water mist system under the HC-2 category. Whereas, if the dust and plastics in construction were not present, then the FM Approved water mist system under the HC-2 category would be considered an appropriate application for the bakery.

2.3.3.2.3 Provide occupancies with concealed / shielded spaces or mezzanines (grated or solid) with protection in / below those obstructions if combustibles are present. The ability to install water mist nozzles in these areas will depend on the FM Approval listing and the manufacturer's installation rules.

2.3.3.2.4 Limit the use of water mist systems to wet-pipe systems in accordance with Data Sheet 4-2, *Water Mist Systems*.

2.3.3.3 Provide a water supply capable of supporting the greatest rate of flow and terminal nozzle pressure for the demand area when water mist nozzles of different hazard categories are used on the same system to provide coverage in different areas.

2.3.3.4 Determine the design area for water mist systems FM Approved for use in HC-1 occupancies with unrestricted enclosure areas using whichever of the following is **greater**:

A. The hydraulically most remote nine (9) automatic nozzles

B. All automatic nozzles within a 1500 ft^2 (140 m^2) demand area

2.3.3.5 Determine the design area for water mist systems FM Approved for use in HC-1 occupancies with specified maximum compartment area to supply all automatic nozzles within the compartment.

2.3.3.6 Use a design area of the hydraulically most remote number of automatic nozzles as specified in the FM Approval listing for water mist systems FM Approved for HC-2 and HC-3 occupancies.

2.3.3.7 Use a design area of maximum five (5) automatic nozzles for the demand area for water mist systems in corridors that can be protected by one row of nozzles.

2.3.3.8 Provide a hose stream allowance of 250 gpm (950 L / min) for HC-1 and HC-2 occupancies, and a hose stream allowance of 500 gpm (1900 L / min) for HC-3 occupancies.

2.3.3.9 Ensure a water supply capable of providing the maximum water mist system demand for the design area plus hose stream allowance for 60 minutes for all hazard categories.

2.3.4 Work in Process Storage

2.3.4.1 Incidental

2.3.4.1.1 Treat solid-piled, palletized, rack, shelf, or bin-box storage of Class 1-3 commodities up to 10 ft (3 m) high and no more than 200 ft^2 (20 m^2) in area as incidental to the occupancy.

2.3.4.1.2 In HC-2 and HC-3 occupancies, treat solid-piled, palletized, rack, shelf, or bin-box storage of plastic commodities up to 6 ft (1.8 m) high and no more than 64 ft^2 (6 m^2) in area (approximately four pallets) as incidental to the occupancy.

2.3.4.1.3 Multiple areas of storage within the limits listed in Sections 2.3.4.1.1 and 2.3.4.1.2 may still be considered as incidental to the occupancy if separated by aisles not less than 8 ft (2.4 m) wide.

2.3.4.1.4 Where the storage height limitations in Section 2.3.4.1.1 and 2.3.4.1.2 are exceeded, protect the storage area in accordance with Data Sheet 8-9, *Storage of Class 1, 2, 3, and 4 and Plastic Commodities*.

2.3.4.1.5 Evaluate the storage / use of ignitable liquids in sprinklered HC-1 occupancies with noncombustible construction in accordance with the following and Table 2.3.4.1.5:

A. Do not store any ignitable liquids in stairwells, aisles, or any area in which foot traffic is expected.

B. Locate larger quantities or container sizes, regardless of bottle construction, outside the building in FM Approved ignitable liquid cabinets or safety cans.

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Table 2.3.4.1.5. Incidental Storage of Ignitable Liquids in HC-1 Occupancies in Containers of Any Construction

Liquid Type	*Maximum Container Size*	*Total Quantity of Ignitable Liquid*	*Location*
Non-water-miscible	8 oz (240 ml)	8 oz (240 ml)	Anywhere
	Any	> 8 oz (240 ml)	Outside building / FM Approved ignitable liquid cabinets or safety cans
Group 1 water-miscible	1 gal (3.8 L)	1 gal (3.8 L)	Anywhere
	5 gal (19 L)	5 gal (19 L)	Storage rooms with noncombustible walls or regular metal cabinets
Group 2-4 water-miscible	5 gal (19 L)	5 gal (19 L)	Anywhere
	5 gal (19 L)	20 gal (76 L)	Storage rooms with noncombustible walls or regular metal cabinets

2.3.4.1.6 Limit incidental storage and use of ignitable liquids in protected HC-2 and HC-3 occupancies to 70 gal (265 L).

2.3.4.1.7 Provide protection using Table 2.3.2.7 for automatic sprinklers or using an FM Approved water mist system for the occupancy hazard category. Note the use of water mist systems is limited to cartoned plastic commodities.

2.3.4.2 Low-Piled

2.3.4.2.1 Protect solid-piled, palletized, shelf, and bin-box storage exceeding the area and height limitations in Sections 2.3.4.1.1 and 2.3.4.1.2 in accordance with Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities.*

2.3.4.2.2 Where solid-piled, palletized, shelf, and bin-box storage exceeds the area limitations in Section 2.3.4.1.1 and 2.3.4.1.2 but not the height limitations, treat it as low-piled storage.

2.3.4.2.3 Provide automatic sprinkler protection in accordance withTable 2.3.4.2.3. and the installation and obstruction requirements for Storage sprinklers per Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers.*

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Table 2.3.4.2.3 Sprinkler Protection Guidelines for Low-Piled Storage

Wet System[1], Pendent or Upright Sprinklers, 160°F (70°C), Number of AS @ psi (bar)														
Commodity	Max. Ceiling Height, ft (m)	Quick-Response							Standard-Response					
		K11.2 (K160)	K14.0 (K200)	K14.0EC (K200EC)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360)	K25.2EC (K360EC)	K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K19.6 (K280)	K25.2 (K360)	K25.2EC(K 360EC)
Class 1 to 3	60 (18)	25 @ 7 (0.5)	25 @ 10 (0.7)		25 @ 10 (0.7)	25 @ 15 (1.0)	25 @ 15 (1.0)	6 @ 52 (3.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 16 (1.1)	25 @ 7 (0.5)	
CUP and CEP	30 (9.0)	25 @ 7 (0.5)	25 @ 10 (0.7)	6 @ 73 (5.0)	25 @ 10 (0.7)	25 @ 15 (1.0)	25 @ 15 (1.0)	6 @ 52 (3.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 16 (1.1)	25 @ 10 (0.7)	
	45 (14)	25 @ 16 (1.1)	25 @ 10 (0.7)		25 @ 10 (0.7)	25 @ 15 (1.0)	25 @ 15 (1.0)	6 @ 52 (3.5)						
	60 (18)	25 @ 16 (1.1)	25 @ 10 (0.7)		25 @ 10 (0.7)	25 @ 15 (1.0)	25 @ 15 (1.0)	6 @ 52 (3.5)						
UUP	30 (9.0)	25 @ 50 (3.4)	10 @ 62 (4.3)		10 @ 43 (3.0)	14 @ 24 (1.7)	14 @ 19 (1.3)	12 @ 38 (2.6)	25 @ 50 (3.4)	25 @ 32 (2.2)		25 @ 16 (1.1)	25 @ 10 (0.7)	25 @ 50 (3.4)
	45 (14)		10 @ 62 (4.3)		10 @ 43 (3.0)	14 @ 24 (1.7)	14 @ 19 (1.3)							
	60 (18)					10 @ 50 (3.4)	10 @ 40 (2.8)							
UEP	10 (3.0)	12 @ 10 (0.7)	12 @ 10 (0.7)		12 @ 10 (0.7)	9 @ 20 (1.4)	9 @ 20 (1.4)	6 @ 20 (1.4)	12 @ 10 (0.7)	12 @ 7 (0.5)		12 @ 16 (1.1)	12 @ 7 (0.5)	
	30 (9.0)		9 @ 100 (6.9)		9 @ 70 (4.8)	9 @ 50 (3.5)	9 @ 40 (2.8)							

[1] For dry-pipe system designs, see Section 2.3.4.2.3.1.

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2.3.4.2.3.1. Increase the number of sprinklers recommended in Table 2.3.4.2.3 by 30%, always rounding up, if a dry sprinkler system is used.

2.3.4.2.4 Provide water mist system protection as follows:

A. Use FM Approved HC-2 water mist systems to protect low-piled storage of Class 1-3 commodities with a ceiling height no greater than listed for the system.

B. Use FM Approved HC-3 water mist systems to protect low-piled storage of CUP and CEP commodities with a celing height no greater than listed for the system.

C. Do not use water mist system protection for low-piled storage of UUP and UEP.

2.3.4.3 Racks

2.3.4.3.1 Protect rack storage in accordance with Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.

2.3.4.4 High-Density Movable Shelving Units

2.3.4.4.1 Protect high-density movable shelving units up to 8 ft (2.4 m) high as an HC-3 occupancy when both of the following conditions are met:

A. Storage of commodities does not exceed Class 3 hazard.

B. Shelving units are noncombustible with side panels.

See Section 3.3 for supporting information and example photographs of high-density movable shelving units.

2.3.4.4.2 Maintain a minimum sprinkler clearance from the top of storage in accordance with the following:

A. Provide 20 in. (510 mm) clearance for sprinklers (excluding Extended-Coverage).

B. Provide 6 in. (150 mm) clearance for Extended-Coverage sprinklers.

2.3.4.4.3 Provide noncombustible longitudinal dividers (e.g., a backside panel) between shelving units.

2.3.4.4.4 Provide bumpers to maintain a minimum of 1 in. (25 mm) flue space between all moving units when pushed together.

2.3.4.4.5 Install FM Approved smoke detection that sends an alarm to an attended location.

2.3.4.4.6 Limit storage of combustibles around the shelving units.

2.3.4.4.7 When the high-density mobile shelving units do not meet the recommendations in this section, see Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.

2.3.5 Residential Occupancies

2.3.5.1 Treat residential occupancies as HC-1 Occupancies.

2.3.5.2 Use FM Approved residential sprinklers or FM Approved quick-response, Nonstorage sprinklers. The *Approval Guide* lists residential sprinklers as “Residential Mode Sprinklers.”

2.3.5.3 Use FM Approved sprinkler system components, including valves, piping, and piping connections.

2.3.5.4 Install residential sprinklers in accordance with this section and their listing in the *Approval Guide*. Do not install sprinklers on a spacing of less than 8 ft (2.4 m).

2.3.5.4.1 For installation guidance, refer to Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.3.5.5 Design the density of residential sprinkler systems in accordance with Table 2.3.2.7.

2.3.5.6 Provide sprinkler protection in combustible concealed areas per Data Sheet 1-12, *Ceilings and Concealed Spaces*.

2.4 Ignition Source Control

2.4.1 Establish a hot work policy as part of a safe work program.

2.4.1.1 Relocate any hot work to a hot work designated area or pursue cold work alternatives.

2.4.1.2 Use a documented permit system in accordance with Data Sheet 10-3, *Hot Work Management*.

2.4.2 Install metal halide, high-intensity discharge (HID) lighting in accordance with the following:

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A. Provide fixtures and lamps that meet UL 1598, Luminaires, or the equivalent, acceptable International Electrotechnical Commission (IEC) or local standard.

B. Protect lamps or enclosed fixtures with borosilicate or tempered soda lime glass external shields.

C. Provide enclosed fixtures where ignition sources must be strictly controlled due to the presence of highly combustible materials.

D. Avoid the use of acrylic plastic external shields.

2.4.3 Follow ignition source control guidance in Data Sheet 7-32, *Ignitable Liquid Operations*, when ignitable liquids are in use.

2.4.4 Prohibit smoking within the facility and around all combustibles.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 General

3.1.1 Hazard Categories

This data sheet recommends sprinkler protection based on the expected fire hazard of a building or area. The fire hazard depends on the occupancy, exposure, and combustible loading. This data sheet approximates an area's fire hazard by assigning a hazard category (HC) to the area, where HC-1, HC-2, and HC-3 represent an increasing hazard level with the potential for a more severe fire event.

A nonstorage occupancy is an area or building consisting of equipment, processes, and / or materials that are not maintained in a storage arrangement. These materials may be combustible or noncombustible. The operation may include industrial or manufacturing processes, as well as nonmanufacturing locations such as offices or residential occupancies. Other codes and standards may refer to these areas as "light hazard" or "ordinary hazard" occupancies.

3.2 Nonstorage Occupancy Fire Protection

Automatic, water-based protection is the best defense against a fire. Sprinklers have proven to be the most practical and reliable means of controlling a fire in business and industry. Sprinkler protection minimizes not only fire damage, but also nonthermal damage, and allows for quick resumption of normal operations. Sprinklers are needed wherever the building construction or occupancy is combustible.

Water mist systems have ceiling height limitations associated with their FM Approval. This is a critical parameter in the design of water mist systems to ensure adequate protection is provided. This parameter may limit the use of a water mist system for a particular occupancy such that it cannot be provided even though being FM Approved for the hazard category. In addition, the parameter in the FM Approval listing for application of a manufacturer's water mist system in an "unrestricted" space as compared to an "enclosure" needs to be properly applied for the occupancy and hazard being protected. If the limitations of water mist systems are adhered to, these systems minimize not only fire damage, but also nonthermal damage, and allow for quick resumption of normal operations.

The majority of fires in nonstorage occupancies in buildings with lower ceiling heights are controlled or extinguished as long as a sufficient sprinkler density is provided over a reasonable operating area. Variations in attributes such as temperature rating, RTI, orientation, and orifice size, among others, have had a limited effect on sprinkler performance in nonstorage occupancy fires, provided no critical deficiencies exist (e.g., obstruction to sprinkler discharge, a lack of sprinklers underneath obstructions or within concealed spaces).

If the fire hazard exceeds that of a typical nonstorage occupancy, enhanced sprinkler protection may be needed, and the sprinkler system's performance may become more sensitive to specific automatic sprinkler attributes. Examples of these increased fire hazards include the following:

- The presence of ignitable liquid storage or use in excess of the quantities considered incidental
- The presence of combustible deposits such as dust, lint, oil, or other residues
- The presence of plastic construction elements
- The presence of concealed/shielded spaces with combustible construction or content
- The presence of solid or grated mezzanines
- The presence of storage

3.3 High-Density Movable Shelving Units

High-density movable shelving units are usually found in office spaces, health care facilities, universities, and libraries for file and archive storage. The shelving units are typically installed on tracks so each unit can move to create an aisle

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as needed. This allows for a high-density storage area with only one aisle space to access any part of the storage. Examples of this storage type are shown in Figures 3.3-1 and 3.3-2.



Fig. 3.3-1. High-density movable shelving unit

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Fig. 3.3-2.High-density movable shelving unit

The main challenge for fire protection with high-density movable shelving units is the shielded condition inherently created by the unit's design. The compact fuel, such as books and paper files, can have a high heat retention, which may delay the operation of sprinklers. Therefore, it is important to have smoke detection in these areas as the smoke detector will operate much faster than a sprinkler. Fire tests with this type of storage typically had first sprinklers activating around 20 minutes after ignition when the storage was open with fires toward the aisle spaces, and in more than 45 minutes after ignition when the fire was located within the storage. It will also be difficult for sprinklers to obtain final extinguishment given the shielded conditions.

Therefore, manual response will be needed for final extinguishment and potentially during cleanup as reignition can occur or intensify any residual burning when fresh air is introduced.

3.4 Desalination Plants

Desalination plants are constructed in a multitude of sizes to fit the application, and consist of pumps, reverse osmosis trains, piping, and tanks. Plants being built today are typically designed to handle 40-50 million gallons of water per day. Typical hazards include various plastic components such as piping and tanks in the reverse osmosis area of the facility. The wall of the pipes and tanks are usually thick enough to support combustion should a fire occur; despite being filled with water. System components are usually full of water unless maintenance is being performed, in which case the portion of the system undergoing maintenance is drained. Multiple trains can be down for maintenance at any time. Since the trains are not filled with water during maintenance, they are more vulnerable to fire and represent a greater hazard than when they are filled with water.

The protection of reverse osmosis trains is based on limiting the fire spread to one train and preventing the involvement of surrounding trains. The fire spreading vertically up the pipes is the main challenge as this will be faster than the horizontal spread along the pipes. The more congested the pipes, the greater the hazard. The reverse osmosis trains are highly vulnerable to smoke damage. If smoke can move freely throughout the space, the smoke can damage additional trains.

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3.5 Nonstorage Protection Research

3.5.1 Residential Occupancies

FM has been involved in the development of the residential sprinkler since the United States Fire Administration (USFA) began its program in 1976. FM continues to conduct testing on residential sprinklers in an effort to determine the minimum criteria that will ensure there is no fire spread or loss of property beyond the room in which a fire starts (see Section 4.1).

FM conducted a study to examine the impact of automatic fire sprinkler technology on environmental sustainability. The work included an evaluation of risk factors, such as fires, on the total lifecycle carbon emissions of a typical single- or two-family home, as well as quantification of the environmental benefits achieved when automatic fire sprinklers are used. Large-scale fire tests were conducted using identically constructed and furnished residential living rooms. In one test, fire extinguishment was achieved solely by fire service intervention, and in the other, a single residential automatic sprinkler was used to control the fire until fire extinguishment was achieved by the fire service. Comparisons of the total greenhouse gas production, quantity of water required to extinguish the fire, quality of water run-off, potential impact of wastewater runoff on groundwater and surface water, and mass of materials requiring disposal between the two tests were made. The results showed that, in addition to providing life safety and limiting property damage, the use of automatic sprinklers is a key factor in achieving sustainability.

4.0 REFERENCES

4.1 FM

Data Sheet 1-12, *Ceilings and Concealed Spaces*
Data Sheet 1-57, *Plastic in Construction*
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*
Data Sheet 5-4, Transformers
Data Sheet 5-12, *Electric AC Generators*
Data Sheet 5-19, Switchgear and Circuit Breakers
Data Sheet 5-23, *Design and Protection for Emergency and Standby Power Systems*
Data Sheet 7-4, *Paper Machines and Pulp Dryers*
Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*
Data Sheet 7-32, *Ignitable Liquid Operations*
Data Sheet *7-64 / 13-28, Aluminum Industry*
Data Sheet 7-78, Industrial Exhaust Systems
Data Sheet 7-93N, *Aircraft Hangars*
Data Sheet 7-96, *Printing Plants*
Data Sheet 7-98, *Hydraulic Fluids*
Data Sheet 8-3, *Rubber Tire Storage*
Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*
Data Sheet 8-21, *Roll Paper Storage*

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

Understanding the Hazard (UTH) *Lack of Automatic Sprinklers* (P0037).

Bill Jr., Robert G., and Hsiang-Cheng Kung, Scott Anderson, and Richard Ferron (FM). “A New Test to Evaluate the Fire Performance of Residential Sprinklers.” Fire Technology (2002): 101–124.

Wieczorek, C., B. Ditch, and R. Bill, Jr. *Environmental Impact of Automatic Fire Sprinklers*. FM Technical Report, March 2010.

Wieczorek, C. *Environmental Impact of Residential Fires Review*. FM Technical Report, 2021.

4.2 Other

European Committee for Standardization (CEN). EN 12845, *Fixed Firefighting Systems – Automatic Sprinkler Systems – Design, Installation and Maintenance.*

National Fire Protection Association (NFPA). NFPA 13, *Standard for the Installation of Sprinklers*.

National Fire Protection Association (NFPA). NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*.

National Standard of the People’s Republic of China. GB 50084, *Code of Design for Sprinkler Systems*.

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Underwriters Laboratories (UL). UL 1598, *Luminaires*.

APPENDIX A GLOSSARY OF TERMS

Approval Guide: An online resource of FM Approvals that provides a guide to equipment, materials, and services that have been FM Approved for property conservation.

Bin-box storage: A storage arrangement that typically consists of solid shelves in combination with solid full-height wooden or metal vertical barriers. Each bin-box storage unit typically has a solid backing, but not always. This type of storage arrangement typically shields direct water application to the burning commodity maintained with each bin-box storage unit. However, the relatively low-tier height between solid shelves, coupled with the full-height vertical barriers, help reduce the heat release rate of the fire and severely delay its potential for horizontal fire growth.

Combustible occupancy: An occupancy that contains sufficient combustible materials to allow horizontal fire spread throughout a given area in the absence of sprinkler protection; or an occupancy that contains a sufficient concentration of combustibles to cause significant damage to a building.

Commodity: A combination of material, external packaging (e.g., container), and material handling aids (e.g., pallets). The purpose of assigning a commodity classification is to determine the proper level of fire protection. A commodity classification is dependent on how the commodity burns and how the burning commodity responds to the application of sprinkler discharge. Refer to Data Sheet 8-1, *Commodity Classification*, for further information on specific commodities.

Compartmented: A building space that is divided and separated into smaller areas.

Corridor: An area in a building that acts as an exit path or passageway. It has walls on both sides, no contiguous storage or combustible loading, and entrances to compartments or rooms.

Demand area: The expected area of sprinkler operation, based on the hazard being protected, used for hydraulic design purposes. In English units it is expressed in ft^2; in metric units, m^2 (1 ft^2 = 0.093 m^2).

Dry-pipe sprinkler system: A sprinkler system that is located downstream of a dry-pipe valve. It is filled with a pressurized gaseous medium (typically air or an inert gas such as nitrogen) for the purpose of maintaining the dry-pipe valve closed. Upon sprinkler actuation, the pressure within the sprinkler system begins to drop until the pressure becomes too low to keep the dry-pipe valve closed. At this time the dry-pipe valve opens (trips) allowing water to fill the sprinkler system and discharge through any sprinklers that have been actuated. A dry-pipe sprinkler system is typically used in areas where the presence of water within the sprinkler system is not suitable.

Density: The amount of water applied by sprinklers over a given area in a certain amount of time. In English units, it is expressed in gpm / ft^2; in metric units, in mm / min (1 gpm / ft^2 = 40.74 mm / min).

Duration or system duration: Water supply system duration is a defined time period between when a fire initially activates a sprinkler system and when the fire is extinguished. Fire extinguishment usually is accomplished by the manual firefighting efforts of public fire service personnel, facility fire service personnel, or facility emergency response team personnel. Duration takes into consideration the commodity hazard's expected fire size in the presence of the system's specific sprinklers and bases the design, as well as manual extinguishment by either one or two applied hose streams.

Extended-coverage sprinklers: The physical characteristics of extended-coverage (EC) sprinklers are similar to those of sprinklers for use with standard spacing. However, the deflector designs are enhanced to ensure proper uniformity and effectiveness of water distribution for the spacing and design pressures for which they are FM Approved.

FM Approved: Products and services that meet the requirements for FM Approval. See the *Approval Guide* for a list of products and services that are FM Approved.

Hose demand: The water flow required for hoses (common sizes are 2-1 / 2 in. and 1-1 / 2 in.). In English units it is expressed in gpm; in metric units, L / min.

Incidental storage: Solid-piled, palletized, rack, shelf, or bin-box storage that is normal for an occupancy (e.g., small amounts of packaging, raw materials, or the products being made). This is likely to be at the start or end of a production line.

Library stack rooms: Rooms that house typical library bookshelves of approximately 8 ft (2.4 m) in height, containing books stored vertically on end, held in place in close association with each other, with aisles wider than 30 in. (762 mm).

Low-piled storage: Solid-piled, palletized, shelf or bin-box storage that is in excess of the area limitations for incidental storage but does not exceed the height limitations. This is likely to be found at the end of multiple manufacturing lines or in a loading dock area.

Nonstorage automatic sprinkler: A sprinkler that has been categorized by FM as acceptable for protecting nonstorage occupancies and / or any other low to moderate heat-release-rate fires as recommended in an applicable occupancy-specific data sheet.

Nonstorage occupancy: An occupancy consisting of combustible or noncombustible materials that are not maintained in a standard storage arrangement. May contain incidental storage.

Palletized storage: A storage arrangement that consists of unit loads (i.e., pallet loads) stored one on top of another. Due to the vertical gap between unit loads created by the pallet (or built-in pallet), horizontal flame spread can occur

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more quickly than with solid-piled storage, making this storage arrangement more challenging to a sprinkler system. In addition, this storage arrangement is not structurally supported and has the potential to readily collapse during a fire.

Quick-response (QR) sprinklers: QR sprinklers are similar to standard-response sprinklers, except they use a fast-response, heat-actuated element.

Rack storage: Storage in racks that use combinations of vertical, horizontal and diagonal members, with or without solid shelves, to support stored material. Racks may be fixed-in-place or portable. Loading may be conducted either manually, using lift trucks, stacker cranes or hand placement; or automatically, using machine-controled storage and retrieval systems.

- Single-row racks are up to 6 ft (1.8 m) deep, as defined by minimum 4 ft (1.2 m) aisles, and typically do not have longitudinal flue spaces.
- Double-row racks are up to 12 ft (3.6 m) deep, as defined by minimum 4 ft (1.2 m) aisles, and typically have longitudinal flue spaces.
- Multiple-row racks are racks that do not meet the definition of single-row or double-row racks. Multiple-row racks can be drive-in, drive-through, flow-through, push-back or double-deep standard racks. The rack depth of more than 12 ft (3.6 m) is the determinant.

Residential occupancy: A highly compartmented space with low combustible loading. Examples include one- and two-family dwellings, manufactured homes, dormitories, residence halls, and other dwelling type areas.

Shelf storage: Storage on a structure where solid shelves are less than 30 in. (0.8 m) deep, measured from aisle to aisle, and usually less than 2 ft (0.6 m) apart vertically.

Solid-piled storage: On-floor storage, without pallets or other material handling devices. Unit loads are placed on top of each other, leaving no vertical gaps between them. The lack of vertical gaps between unit loads slows horizontal flame spread within this type of storage arrangement when compared to palletized storage.

Sprinkler demand: The amount of water flow required for sprinkler protection. In English units it is expressed in gpm; in metric units, L / min (1 gpm = 3.79 L / min).

Waterflow alarm: A device that is installed on a sprinkler system and arranged to provide an alarm when one or more sprinklers operate.

Total water demand: The water flow required for both sprinklers and hoses (i.e., total water demand is equal to sprinkler demand plus hose demand). Hose demand is not always provided by the sprinkler system. In English units it is expressed in gpm; in metric units, L / min.

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).

October 2026. Interim revision. Significant changes include the following:

A. Reorganized Section 2.3, Protection.

B. Updated Section 2.3.2.8 to reference Data Sheet 2-0 for minimum design pressures.

C. Revised Section 2.3.3 to align with Data Sheet 4-2 regarding water mist protection in HC-2 and HC-3 occupancies.

D. Added Section 2.3.4.1.6 to address the amount of ignitable liquid incidental storage for HC-2 and HC-3 occupancies.

E. Updated Table 2.3.4.2.3 for low-piled storage.

F. Added dry pipe sprinkler protection options for low-piled storage in Section 2.3.4.2.2.1.

April 2025. Interim revision. Added new Section 2.4, Ignition Source Control.

October 2024. Interim revision. Significant changes include the following:

A. Added a sentence to the scope, Section 1.0, to address incidental and low-piled storage covered in this data sheet.

B. Clarified which sprinkler discharge pattern obstruction rules to follow in Section 2.3.1.2.2.

C. Added applicable occupancy use for K14EC (K200EC) sidewall sprinklers in Section 2.3.1.5.

D. Changed Table 2.3.1.10 headings to specify the maximum ceiling height for the designs provided.

E. Limited the protection designs in Table 2.3.1.10 to K14.0 (K200) or greater sprinklers for a maximum ceiling height of 100 ft (30 m).

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F. Revised Section 2.3.1.11 to specify the minimum design pressure at the most remote sprinkler.

G. Added guidance in Section 2.3.1.15 for ventilation system shutdown upon activation of fire alarms.

H. Deleted Section 2.3.2.5, as it was relocated to FM Property Loss Prevention Data Sheet 7-112, *Lithium-Ion Battery Manufacturing and Storage*.

I. Added guidance for low-piled storage protection under ceiling heights less than 30 ft (9 m) in Section 2.3.3.1.1.

J. Revised Table 2.3.3.1 for low piled storage per the following:

1. Changed protection for CEP under a 30 ft ceiling for the SR K25.2 (K360) pendent sprinkler.

2. Changed protection for UUP under a 30 ft ceiling for the SR K25.2 (K360) pendent and upright sprinklers.

3. Added protection for UUP under a 30 ft ceiling for the QR K25.2EC (K360EC) pendent, SR K14.0 (K280) pendent, SR K19.6 (K280) pendent, and QR K25.2EC (K360EC) upright sprinklers.

K. Deleted Section 2.3.3.2, as it was relocated to Data Sheet 7-112.

L. Deleted Section 3.3, as it was relocated to Data Sheet 7-112.

M. Added the following information to Table C-1:

1. HVDC stations with HC-3 hazard category to Description under Energy Service Providers

2. AC/DC Switchyard Building with HC-2 hazard category to Description under Energy Service Providers

3. FM Property Loss Prevention Data Sheet 5-25, *High Voltage Direct Current Converter Stations*, to Data Sheets to Consider under Energy Service Providers

4. Added Li-ion Battery Charging Stations (Level 1 and 2) with HC-3 hazard category to Description under Transport and Logistics.

N. Updated Low-piled storage definition in Appendix A.

October 2021. Interim revision. Significant changes include the following:

A. Incorporated guidance from Data Sheet 2-5, *Installation Guidelines for Automatic Sprinklers in Residential Occupancies*. Data Sheet 2-5 has been made obsolete.

B. Clarified acceptable storage arrangements for incidental and low-pile storage (Sections 2.3.2, 2.3.3, 3.3.3, 3.3.4, and Appendix A).

C. Added lithium-ion battery protection guidance (Sections 2.3.2.5 and 2.3.3.2) and clarified that battery manufacturing in Table C-1 includes lithium-ion batteries.

D. Added water mist protection guidance for HC-2 and HC-3 occupancies (Section 2.3.5).

E. Added protection guidance for high-density movable shelving (Section 2.3.7).

F. Clarified when to adjust hazard category for theaters (Table C-1).

G. Changed hazard category and description of car workshops to HC-3 with the description updated to car manufacturing/assembly (Table C-2).

H. Added protection guidance for desalination plants (Table C-2 and Section 3.3).

I. Added the removal of Table 4 to the changes in Appendix B, April 2019 revision.

J. Renumbered tables and figures to match the section in which they are located.

January 2021. Interim revision. Revised the hazard category for parking garage and car parks to HC-3 from HC-2 and clarified the application of Note 2 in Table 2.

October 2020. Interim revision. Added guidance on defining incidental storage / use of ignitable liquids in HC-1 occupancies.

April 2019. This document has undergone a complete revision. Significant changes include the following:

A. Changed the title of the data sheet from *Fire Protection Water Demand for Nonstorage Sprinklered Properties* to *Fire Protection for Nonstorage Occupancies*.

B. Incorporated Engineering Bulletin 04-12, New Protection Guidance for Extended Coverage Sprinklers for Nonstorage Applications.

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C. Moved hazard category examples from Table 1 to Appendix C and expanded them.

D. Added hazard category guidance in Appendix C for recycling, waste processing, and energy from waste facilities (and the treating of incoming waste material).

E. Added a new flowchart (Figure 1) detailing the proper application of Data Sheet 3-26, including where other data sheets should be used, and how to treat incidental and low-piled storage.

F. Added protection recommendations for the manufacture and assembly of large, contiguous components that present the hazard of a shielded fire (Section 2.3.1.14).

G. Changed recommended system durations to 60 minutes for all hazard categories (Section 2.3.1.13).

H. Removed Table 4, Minimum Sprinkler K-Factors for Hazard Categories. The table was replaced with a reference to existing tables in Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, to reduce duplication of information across data sheets.

I. Changed recommendations on work-in-process storage. Added new guidance based on testing of low-piled storage to Table 3. This guidance is engineered toward the levels of storage common to nonstorage occupancies. The area limitations for up to Class 3 commodities remain 200 ft^2 (20 m^2). The area limitation for plastic-containing commodities has been reduced from 200 ft^2 (20 m^2) to 64 ft^2 (6 m^2, equivalent to four pallet loads).

April 2014. Table 2a, *Sprinkler Design Demands for Hazard Categories with Ceiling Heights up to 100 ft (30 m)*: The design listed for the K25.2EC (K360EC) sprinkler has been revised to provide the same design density as listed for the K25.2 (K360) design. Additionally, Table 2a has been revised include both upright and pendent sprinkler applications.

July 2011. Minor editorial changes and clarifications to Recommendations 2.1.1.1 and 2.1.1.10.1 were made for this revision.

January 2011. This document has been updated. The following is a list of the changes:

- Realigned atriums, school & university classrooms, gymnasiums, metalworking and fabrication shops with non-hydraulic operations, and mineral operations to a more suited hazard category of HC-1 based on their light loading occupancy description.
- Re-evaluated Extended Coverage sprinkler design guidelines based on full scale fire test results.
- Added Extended Coverage Sprinklers K11.2EC (K160EC) and K14.0EC (K200EC) with a temperature rating of 160°F (70°C) as options for new installations in HC-2 & HC-3 occupancies with ceiling heights up to 30 ft (9 m).
- Deleted design requirement to supply the hydraulically most remote 9 sprinklers when using EC sprinklers for HC-1 and HC-2 occupancies.
- Reduced the wet and dry sprinkler design demand areas for HC-3 occupancies with ceilings up to 30 ft (9 m).
- Reduced the minimum water demand duration to 60 minutes for HC-2 occupancies.
- Removed any and all references to HC-4 categories due to vague occupancy description not fitting any comparable manufacturing sites.
- Reduced the minimum sprinkler K-Factors for new installations to K8.0 (K115) for HC-2 occupancies with ceiling heights up to 60 ft (18 m).
- Added protection option for HC-3 occupancies over 60 ft (18m) and up to 100 ft (30 m).
- Added guidelines covering acceptability for using storage sprinklers in mixed storage and Nonstorage occupancies.
- Added protection guidelines for use of water mist systems.

March 2010. This document has been completely rewritten. The following is a list of major changes:

- Added a table of hazard categories based on occupancy.
- Added a table of sprinkler design demands based on ceiling height and type of sprinkler system for each hazard category.
- Added design information on extended-coverage sprinklers for light- and ordinary-hazard occupancies.
- Added sprinkler protection design criteria for nonstorage and nonmanufacturing facilities with ceilings higher than 60 ft (20 m) and up to 100 ft (30 m).
- Added sprinkler protection design criteria for manufacturing facilities with ceilings up to 60 ft (20 m) high.
- Revised loss history.
- Updated Appendix A, Glossary of Terms.

July 2008. References to FM Loss Prevention Data Sheet 7-96, *Printing Plants*, were added to Table 1.

May 2008. Clarifications were made to the recommendations 2.1.1.1 and 2.1.2.1.2.

January 2008. The following changes were made:

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1. Combined Tables 2 through 10 to simplify the recommendations for sprinkler system water demand.

2. Replaced Table 1, which described temperature ratings for sprinklers, with a recommendation to use 160°F (70°C) and 280°F (140°C) temperature-rated sprinklers for wet and for dry systems respectively.

3. Added sprinkler system water demand information for assembly facilities manufacturing fiberglass boats.

January 2006. Clarification was made to the recommendation 2.1.2.3.1 and Table 11.

January 2005. Protection criteria has been provided for light, moderately and heavily loaded nonstorage areas with floor to ceiling clearances up to 60 ft (18.3 m). Storage type, storage and building height and corresponding protection criteria are provided in Table 11.

January 2001. The protection requirements for the spray application of flammable liquids, including catalytic spraying have been removed from this data sheet and are included in Data Sheet 7-27, *Spray Application of Flammable and Combustible Materials*.

The protection requirements for hydraulic equipment using hydraulic fluids have been removed from this data sheet. The protection requirements are in Data Sheet 7-98, *Hydraulic Fluids*.

September 2000. This revision of the document was reorganized to provide a consistent format.

October 1992. The following changes were made for this revision:

1. Flammable Liquids

Water demand criteria for flammable liquids in open and closed tanks are not contained in this revision of Data Sheet 3-26. In the previous revision of this data sheet, the occupancies were titled Flammable Liquids In Open Tanks and Containers and Flooding Systems and Flammable Liquids in Closed Containers, Except Drum Storage. Water demand criteria for these occupancies are incorporated with the flammable liquid data sheets.

2. Woodworking Occupancy

Water demand criteria for the general occupancy, Woodworking, are not in this revision of Data Sheet 3-26. Data Sheet 7-10, *Wood Processing and Woodworking Facilities*, has been revised (June 1991). Water demand information is now included in Data Sheet 7-10.

3. Textile Occupancy

Water demand criteria for the textile occupancy are not in this revision of Data Sheet 3-26. Data Sheet 7-1, *Fire Protection for Textile Mills*, has been revised. Water demand information is now included in Data Sheet 7-1.

4. Miscellaneous Occupancies

The section titled "Miscellaneous Occupancies" is included to provide guidelines for occupancies that are not found within the specific occupancies.

5. Miscellaneous Nonmanufacturing

The title "Miscellaneous Nonmanufacturing" is used in place of "Light Hazard Occupancy." The new title better defines the various occupancies involved.

6. Office Occupancies

Guidelines in Data Sheet 3-26 for office occupancy are in Table 2, within the section titled Miscellaneous Nonmanufacturing. Loss data (see Support for Recommendations) and fire test data indicate that a water supply capable of providing a density of 0.10 gpm / ft^2 (4 mm / min) over an area of 1500 ft^2 (140 m^2) will provide adequate protection for an office occupancy.

7. Electronic-Electrical Manufacturing and Assembly

A separate occupancy category for electronic and electrical manufacturing and assembly occupancies has been added.

8. Plastics Processing

Recent fire tests indicate that ordinary, intermediate or high temperature rated sprinklers over 2500 ft^2 (230 m^2) (dry system: 3500 ft^2) will provide adequate protection over this occupancy.

9. Quick Response Automatic Sprinklers (QRAS)

This data sheet includes guidance on the use of QRAS. The recommendations are based on the results of fire tests comparing QRAS and conventional response automatic sprinklers.

10. Title Change

The title change to include "Nonstorage" better describes the occupancies included within this data sheet.

11. International and National Fire Protection Association Standards

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APPENDIX C HAZARD CATEGORY EXAMPLES

Table 2.2.2 of this data sheet provides a description of what a typical HC-1, HC-2, and HC-3 occupancy may include, but this table should not be viewed as an all inclusive list. Judgment is needed when determining an occupancy's hazard category.

Tables C-1 and C-2 provide specific examples of different occupancies and their associated hazard category, as well as any further guidance that may be applicable.

It should be noted that although a location may have a predominant occupancy of HC-1 or HC-2, consideration should be given to areas that owing to a higher hazard process or presence of higher hazard materials (such as plastics), may need to be afforded a greater level of protection such as HC-2 or HC-3 respectively. For example, an HC-2 metal manufacturing facility may have plating operations that would necessitate an HC-3 level of protection in those areas.

Table C-1. Nonstorage, Non-Manufacturing Occupancies and their Associated Fire Hazard Categories

Occupancy	*Description*	*Hazard Category*	*Considerations*
Healthcare Facilities	- Hospitals and Hospital Laboratories - Nursing or Convalescent Homes - Kitchens - Care Homes - Penal Institutions (Jailhouses, etc.)	HC-1	- 1-3, *High-Rise Buildings* - 1-12, *Ceilings and Concealed Spaces* - 1-24, *Protection Against Liquid Damage in Light-Hazard Occupancies* - 5-23, *Design and Protection for Emergency and Standby Power Systems* - 6-4, *Oil or Gas Fired Single-Burner Boilers* - 6-5, *Oil or Gas Fired Multiple Burner Boilers* - 7-15, *Garages*
	- Hospital Utility Plants	HC-2	
	- Storage Room / Pharmacies with Storage	HC-3	
Business Facilities & Apartments	- Offices - Hotels - Flats / Apartments - Residential Buildings	HC-1	- 1-3, *High-Rise Buildings* - 1-12, *Ceilings and Concealed Spaces* - 1-24, *Protection Against Liquid Damage in Light-Hazard Occupancies* - 7-15, *Garages*
	- Utility Rooms	HC-2	
Educational Facilities	- Universities - Schools - Kindergartens - Colleges - Dormitories and Residence Halls - Prisons - Detention centers	HC-1	- 1-3, *High-Rise Buildings* - 1-12, *Ceilings and Concealed Spaces* - 1-24, *Protection Against Liquid Damage in Light-Hazard Occupancies* - 5-23, *Design and Protection for Emergency and Standby Power Systems* - 7-15, *Garages*
	- Utility Rooms	HC-2	
Transport & Logistic	- Airport Terminal - Bus Stations - Train Stations - Ferry Port - Cruise Terminal - Bicycle Parks	HC-1	- 7-11, *Conveyors* - 7-15, *Garages* - 7-29, *Ignitable Liquid Storage in Portable Containers* - 7-32, *Ignitable Liquid Operations* - 7-93, *Aircraft Hangars, Aircraft Manufacturing and Assembly Facilities, and Protection of Aircraft Interiors During Assembly* - 8-3, *Rubber Tire Storage* - 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*
	- Parking Garage - Car Parks	HC-3	
	- Car-Sized Vehicle Repair Garages and Assembly Operations Where Unfueled Vehicles are Repaired, Tested or Assembled - Truck Loading Docks - loading and unloading canopies - Package Delivery / Distribution Hubs - Cross docking areas - Aircraft Hangar, - Li-ion Battery Charging Stations (Level 1 and 2) - Zeppelin Hangar	HC-3	

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***Table C-1. Nonstorage, Non-Manufacturing Occupancies and their Associated Fire Hazard Categories* (continued)**

Occupancy	*Description*	*Hazard Category*	*Considerations*
Energy Service Providers	- Gas and Oil Stations / Service Provider - Battery Stations - Solar Plant - Wind Turbines - Photo Voltaic Farms - HVDC Stations	HC-3	- 13-10, *Land-Based Wind Turbines and Farms* - 5-25, High Voltage Direct Current Converter Stations
	- AC / DC Switchyard Building	HC-2	
Leisure Facilities & Public Assembly	- Museums and Monuments - Restaurants (Seating Areas) - Gyms - Places of Worship - Ski Lift Station - Zoo / Aquarium - Auditoriums - Aquatic Center (Swimming Pool / Spa) - Cinemas - Convention Centers - Theme Parks - Libraries	HC-1	- Areas that have high combustible loading (e.g., foam seating, acoustic material on walls, large amounts of plastic) or that have the potential to display products that have high amounts of plastic and / or have concealed spaces should be considered HC-3.
	- Sport Arena - Theaters - Casinos - Night Clubs	HC-2	
	- Exhibition Halls - Convention Centers	HC-3	
Mercantile Facilities	- Department Stores - front of house - Shopping Malls - Retail and Mercantile Areas - Supermarkets	HC-2	- In general storage at these locations is retail items on display to less than 6 ft (1.8 m) (or as high as can be reached without equipment). - Back of house and bulk storage areas, wholesale / big-box stores, should be analyzed in line with Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.
Incoming Waste Material at Recycling / Waste Processing / Energy from Waste Facilities	- Mixed household / business waste or recyclables including metal, glass, cellulosic materials and small amounts of plastics	HC-2	- The storage of incoming waste material should not be considered low-piled storage per Table 2.3.4.2.3; the sprinkler design should be based on either an HC-2 or an HC-3 occupancy per the adjacent description. The fire scenario is a relatively small fire spreading across the surface of the waste pile rather than involving the entire pile depth at one time. Therefore, basing protection on the height and / or size of the waste pile would be inappropriate. - For baled waste paper storage see Data Sheet 8-22. - For other baled commodities like plastics, see Data Sheet 8-9. - For energy from waste facilities, refer to Data Sheet 6-13.
	- Pre-sorted and / or shredded household / business waste or recyclables including metal, glass, cellulosic materials and also plastic material.	HC-3	

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***Table C-1. Nonstorage, Non-Manufacturing Occupancies and their Associated Fire Hazard Categories* (continued)**

Occupancy	*Description*	*Hazard Category*	*Considerations*
Telecommunication, Film Studios, and Research Centers	- Laboratories - Control Rooms for monitoring operations or network operations center, broad cast facilities, telecommunication	HC-1	- 1-56, *Cleanrooms* - 1-57, *Plastics in Construction* - 5-19, *Switchgear and Circuit Breakers* - 5-23, *Design and Protection for Emergency and Standby Power Systems* - 5-32, *Data Centers and Relating Facilities*
	- IT Facilities - I / O Distribution Room - Control Rooms - Electrical Rooms	HC-2	
	- Film and TV Studios	HC-3	

Table C-2. Manufacturing Occupancies and Their Associated Fire Hazard Categories

Occupancy	*Description*	*Hazard Category*	*Considerations*
Mechanical Engineering or Assembly Plants	- Sheet Metal Product Factories - Metal-Working - Electric and Electronics Equipment Factories - White Goods Factories (Washing Machine, Dishwashing Machine, Refrigerator, Oven and Similar) - Circuit Board Manufacturing - Mobile Phone Production - Electrical and Electronic Testing Areas	HC-2	- 7-6 *Heated Plastic and Plastic Lined Tanks* - 7-21, *Rolling Mills* - 7-29, *Ignitable Liquid Storage in Portable Containers* - 7-32, *Ignitable Liquid Operations* - 7-37, *Cutting Fluids* - 7-41, *Oil Quenching and Molten Salt Baths* - 7-64, *Aluminum Industry* - 7-76, *Combustible Dusts* - 7-93, *Aircraft Hangers, Aircraft Manufacturing and Assembly Facilities, and Protection of Aircraft Interiors During Assembly* - 7-97, *Metal Cleaning* - 7-98, *Hydraulic Fluids* - 7-104, *Metal Treatment Process* - 7-108, *Silane*
	- Aluminum Manufacturing - Injection-Molding Machines (Plastics) for PP / PE / PS or Similar - Electric and Electronics Equipment Factories with Large Amounts of Plastic Boxes - Manufacturing / Assembly of Wind Turbines - Manufacturing / Assembly of Aircraft - Manufacturing / Assembly of Boats, Highway Trailers, Trucks, Boxcars, Mobile Homes, or Similar - Manufacturing / Assembly of cars - Mixed Manufacturing Buildings with No Dominate Occupancy - All Battery Manufacturing (including lithium-ion) with and without plastic - Plating / etching / Anodizing with plastic tanks	HC-3	
Textiles and Clothing	- Leather Goods Factories - Carpet Factories (Excluding Rubber and Foam Plastics) - Cloth and Clothing Factories Fiber-Board Factories, Footwear Factories (Excluding Plastics and Rubber) - Knitting Factories, Linen Factories - Mattress Factories (Excluding Foam Plastics) - Sewing Factories, Weaving Mills - Woolen and Worsted Mills - Rope Factories	HC-2	- 7-1, *Fire Protection for Textile Mills* - 7-29, *Ignitable Liquid Storage in Portable Containers* - 7-32, *Ignitable Liquid Operations* - 7-76, *Combustible Dusts* - 7-98, *Hydraulic Fluids* - 8-22, *Baled Storage* - 8-23, *Rolled Nonwoven Fabric Storage*
	- Washing, Bleaching, Dyeing, Printing and Fabric Chemical Treatment - Mattress Factories (Including Foam Plastics)	HC-3	

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***Table C-2. Manufacturing Occupancies and Their Associated Fire Hazard Categories* (continued)**

Occupancy	*Description*	*Hazard Category*	*Considerations*
Food and Beverages	- Abattoirs, Meat Factories - Rendering Plants - Bakeries - Biscuit Factories - Breweries - Chocolate Factories - Confectionery - Dairies Factories - Animal Feed Factories - Slaughter Houses - Seafood - Butchery - Corn Mills - Dehydrated Vegetable and Soup Factories - Sugar Factories - Alcohol Distilleries - Tobacco Processing - Beverage Bottling Plants - Snack Food	HC-2	- 1-57 *Plastics in Construction* - 7-2, *Waste Solvent Recovery* - 7-13, *Mechanical Refrigeration* - 7-20, *Oil Cookers* - 7-29, *Ignitable Liquid Storage in Portable Containers* - 7-32, *Ignitable Liquid Operations* - 7-74, *Distilleries* - 7-76, *Combustible Dusts* - 7-98, *Hydraulic Fluids* - 2-0, *Installation Guidelines for Automatic Sprinklers*
	- Blow Molding (Plastic and / or PET) - Plastic Packaging - Distilleries; Storage Rooms	HC-3	
Paper	- Paper Factories (Pulp and Paper Making) - Washing, Bleaching and Chemical Treatment - Paper Making Machine Area - Book-Binding Factories - Cardboard / Corrugate Factories	HC-2	- 6-21, *Chemical Recovery Boilers* - 7-2, *Waste Solvent Recovery* - 7-4, *Paper Machines and Pulp Dryers* - 7-29, *Ignitable Liquid Storage in Portable Containers* - 7-32, *Ignitable Liquid Operations* - 7-58, *Chlorine Dioxide* - 7-76, *Combustible Dusts* - 7-96, *Printing Plants* - 7-98, *Hydraulic Fluids* - 7-103, *Turpentine Recovery in Pulp and Paper Mills* - 8-21, *Roll Paper Storage* - 8-22, *Baled Storage* - 8-27, *Storage of Wood Chips* - 8-28, *Pulpwood and Outdoor Log Storage*
	- Coating and Printing	HC-3	
Timber and Wood	- Woodworking Factories (Sawmills, Planer Mills, Plywood, Particle Board) - Furniture Factories - Furniture Showrooms - Upholstery Factories - Wood Wool Manufacture - Prefab-Home Manufacturing (excluding plastic insulation)	HC-2	- 7-10, *Wood Processing and Woodworking Facilities* - 7-76, *Combustible Dusts* - 7-98, *Hydraulic Fluids*
	- Modular Building Subassemblies	HC-3	
Metals, Glass, and Ceramics	- Glass Factories- Mineral Processing such as: Glass, Cement, Ore Treating, Gypsum Processing, etc. (without Ignitable Liquids) - Cement Factories - Brick and Clay Factories - Molten Metal Products	HC-1	- 7-25, *Blast Furnace Ironmaking and Basic Oxygen Steelmaking* - 7-26, *Glass Plants* - 7-33, *Molten Metals and Other Materials* - 7-41, *Oil Quenching and Molten Salt Baths* - 7-104, *Metal Treatment Process*

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***Table C-2. Manufacturing Occupancies and Their Associated Fire Hazard Categories* (continued)**

Occupancy	*Description*	*Hazard Category*	*Considerations*
Rubber and Plastic	- Floor Cloth and Linoleum Manufacture - Rubber Goods Factories	HC-2	- 7-24, *Blowing Agents* - 7-29, *Ignitable Liquid Storage in Portable Containers* - 7-32, *Ignitable Liquid Operations* - 7-76, *Combustible Dusts* - 7-98, *Hydraulic Fluids* - 7-99, *Heat Transfer Fluid Systems* - 8-30, *Storage of Carpets*
	- Synthetic Fiber Factories - Carpet Factories Including Unexpanded Plastics - Footwear Factories, Including Plastics and Rubber Soles - Cable Factories for PP / PE / PS or Similar - Plastics Factories and Plastic Goods - Printing Works (Plastic and Rubber) - Rubber Tire Manufacturing - Coating Process (Electrostatic, Thermal or Bath) - Production of Unexpanded Plastic or Rubber Products - Injection Molding (Plastics) for PP / PE / PS or - Plastics Grinding - Production of Expanded Plastic or Rubber Products - Extrusion Involving Flammable Blowing Agents - Manufacturing and Assembly of Boats, Highway Trailers and Trucks, Boxcars, Mobile Homes, or Similar Metal Vehicles with Combustible Interiors with the Potential for a Shielded Fire	HC-3	
Mining & Carbon Manufacturing	- Carbon Kilns - Carbon and Coke Storage - Carbon Furnaces, Crushing and Extruding	HC-3	- 7-12, *Mining and Ore Processing Facilities*
Chemicals and Pharmaceuticals	Laboratories	HC-1	- 6-21, *Chemical Recovery Boilers* - 7-2, *Waste Solvent Recovery* - 7-14, *Fire Protection for Chemical Plants* - 7-28, *Energetic Materials* - 7-29, *Ignitable Liquid Storage in Portable Containers* - 7-32, *Ignitable Liquid Operations* - 7-34, *Electrolytic Chlorine Process* - 7-36, *Pharmaceutical Operations* - 7-38, *Loss Prevention in Ethanol Fuel Production Facilities* - 7-46, *Chemical Reactors and Reactions* - 7-76, *Combustible Dusts* - 1-56, *Cleanrooms*
	- Chemical Factories - Photographic Film - Dye Works - Soap Factories - Match Manufacturing - Pharmaceuticals Manufacturing - Health and Beauty Aids - Cosmetics and Perfumes - Biotechnology - Medical Care / Infusion	HC-2	
	- Fire-Lighter Manufacture - Cigarette Lighter - Resin, Lamp Black and Turpentine - Rubber or Substitute Manufacture	HC-3	
Desalination Plants	- Reverse Osmosis Trains	HC-3	- 1-12, *Ceilings and Concealed Spaces* - *1-57, Plastic in Construction* - *5-4, Transformers* - *5-19, Switchgear and Circuit Breakers* - *7-78, Industrial Exhaust Systems* - *7-98, Hydraulic Fluids*

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