

Memorandum



ENGINEERING BULLETIN 04-12 (Supplement to Data Sheet 3-26)

Date: March 2, 2012
To: Distribution
From: Angèle Morcos
At: Engineering Standards
Subject: New Protection Guidance for Extended Coverage Sprinklers for Nonstorage Applications

Scope

This engineering bulletin provides new design options for extended coverage (EC) and standard coverage sprinklers. In addition it clarifies existing recommendations for extended coverage (EC) sprinklers in nonstorage occupancies. The recommendations in this EB supersede all other recommendations for the use and installation of EC sprinklers in nonstorage occupancies.

Loss Prevention Recommendations

The following protection recommendations are to be used in conjunction with Data Sheet 3-26, Section 2.1.1.10.

1. The table below replaces Table 2 in the July 2011 version of DS 3-26. It has been updated to include new protection options for ceiling heights from 30 to 45 ft (9 to 13.5 m), which are highlighted in red. The sprinkler design demand options listed in Table 2 only apply to standard coverage sprinklers.

DS 3-26 Table 2. **Standard Coverage** Sprinkler Design Demands for Hazard Categories

Hazard Category	Standard Coverage Sprinkler Design Demand (gpm/ft ²)/ft ² (mm/min)/m ²							
	Ceiling Height up to 30 ft (9 m)		Ceiling Height 30–45 ft (9–13.5 m)		Ceiling Height 45–60 ft (13.5–18 m)		Ceiling Height 60–100 ft (18–30 m)	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
HC-1	0.1/1500 (4/140)	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)	See Table 2a	Not an option
HC-2	0.2/2500 (8/230)	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)	See Table 2a	Not an option
HC-3	0.3/2500 (12/230)	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)	See Table 2a	Not an option

2. FM Approved **pendent or upright EC sprinklers with a nominal K-factor of 5.6EC (80EC) or 8.0EC (115EC)** are only to be used in wet systems to protect HC-1 occupancies with ceiling heights up to 30 ft (9 m). For these applications, a sprinkler design demand of 0.1 gpm/ft² over 1500 ft² (4 mm/min over 140 m²) should be provided.
3. FM Approved **EC sprinklers with a nominal K-factor of 11.2 (160) or 14.0 (200)** can be used to protect HC-1, HC-2, and HC-3 occupancies. The table below replaces the notes associated with Table 2 in the July 2011 version of DS 3-26. This new table provides design demands for each hazard category for wet systems only. In addition to meeting the density and area requirements listed in the table, the design for K11.2EC (K160EC) sprinklers should not include fewer than six sprinklers or have a design pressure of less than 12 psi (0.8 bar); similarly the design for K14.0EC (K200EC) sprinklers should not include fewer than four sprinklers or have a design pressure of less than 18 psi (1.2 bar).

Extended Coverage Sprinkler Design Demands for all Hazard Categories for Wet Systems

Max. Ceiling Height ft (m)	Hazard Category 1				Hazard Category 2				Hazard Category 3			
	Pendent Sprinklers 160°F (70°C)		Upright Sprinklers 160°F (70°C)		Pendent Sprinklers 160°F (70°C)		Upright Sprinklers 160°F (70°C)		Pendent Sprinklers 160°F (70°C)		Upright Sprinklers 160°F (70°C)	
	K11.2EC (K160EC)	K14.0EC (K200EC)	K11.2EC (K160EC)	K14.0EC (K200EC)	K11.2EC (K160EC)	K14.0EC (K200EC)	K11.2EC (K160EC)	K14.0EC (K200EC)	K11.2EC (K160EC)	K14.0EC (K200EC)	K11.2EC (K160EC)	K14.0EC (K200EC)
30 (9)	0.1/1500 (4/140)	0.1/1500 (4/140)	0.1/1500 (4/140)	0.1/1500 (4/140)		0.2/2500 (8/230)	0.3/1500 (12/140)	0.3/1000 (12/90)		0.3/2500 (12/230)	0.3/1500 (12/140)	0.3/1000 (12/90)
45 (13.5)			0.2/2500 (8/230)	0.2/2500 (8/230)			0.2/2500 (8/230)	0.2/2500 (8/230)			0.3/2500 (12/230)	0.3/2500 (12/230)

4. The design demands currently listed in the July 2011 version of DS 3-26, Table 2a, “Sprinkler Design Demands for Hazard Categories with Ceilings from 60 ft (18 m) to 100 ft (30 m)” continue to be applicable for ceiling heights up to 100 ft (30 m) for all hazard categories. Additionally, where design demands are not available in the new table above, the demands listed in Table 2a can be applied if EC sprinklers are preferred over standard coverage sprinklers. To clarify the application of Table 2a, it will be renamed “K25.2 Sprinkler Design Demands for all Hazard Categories with Ceiling Heights up to 100 ft (30 m)” at the next revision of DS 3-26 to indicate that the protection options apply to all ceiling heights up to and including 100 ft (30 m).
5. Nonstorage sprinklers should be installed in accordance with DS 2-0, *Installation Guidelines for Automatic Sprinklers*. Additional spacing requirements for EC sprinklers with K-factors of 11.2EC (160EC) and 14.0 EC (200EC) are included in the tables below, which are supplements to Tables 3, 4, and 5 of DS 2-0.

Supplement to DS 2-0 Table 3. Spacing of Ceiling-Level Pendent and Upright Nonstorage Sprinklers for Hazard Category No. 1

Ceiling Height ft (m)	Ceiling Type	K-Factor	Orientation	Response	Linear Spacing, ft (m)		Area Spacing, ft ² (m ²)	
					Min.	Max.	Min.	Max.
Over 30 (9)	Noncombustible Unobstructed	11.2EC (160EC) 14.0 EC (200EC)	Upright	Quick	10 (3.0)	20 (6.0)	100 (9.0)	400 (36.0)

Supplement to DS 2-0 Table 4. Spacing of Ceiling-Level Pendent and Upright Nonstorage Sprinklers for Hazard Category No. 2

Ceiling Height ft (m)	K-Factor	Orientation	Response	Linear Spacing, ft (m)		Area Spacing, ft ² (m ²)	
				Min.	Max.	Min.	Max.
Over 30 (9)	11.2EC (160EC) 14.0 EC (200EC)	Upright	Quick	10 (3.0)	16 (4.8)	100 (9.0)	256 (25.0)

Supplement to DS 2-0 Table 5. Spacing of Ceiling-Level Pendent and Upright Nonstorage Sprinklers for Hazard Category No. 3

Ceiling Height ft (m)	K-Factor	Orientation	Response	Linear Spacing, ft (m)		Area Spacing, ft ² (m ²)	
				Min.	Max.	Min.	Max.
Over 30 (9)	11.2EC (160EC) 14.0 EC (200EC)	Upright	Quick	10 (3.0)	16 (4.8)	100 (9.0)	256 (25.0)

Support for Recommendations

FM Global has completed two research projects to evaluate the performance of EC sprinklers for nonstorage applications. Large-scale fire tests were conducted to evaluate the use of FM Approved upright and pendent EC sprinklers for 30 ft (9 m) and 45 ft (13.5 m) high ceilings. Large-scale fire tests were also conducted with standard coverage sprinklers in order to provide additional protection options for nonstorage occupancies having ceiling heights from 30 to 45 ft (9 to 13.5 m).

FIRE PROTECTION WATER DEMAND FOR NONSTORAGE SPRINKLERED PROPERTIES

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1.0 SCOPE

This data sheet provides water demand recommendations for automatic sprinklers and hoses in nonstorage occupancies.

Refer to the applicable occupancy-specific data sheet for detailed sprinkler protection design guidelines. See the definition of "occupancy-specific data sheet" in Appendix A for a list of data sheets organized by subject matter.

Refer to Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, for detailed sprinkler installation guidelines such as obstructions, Nonstorage sprinkler spacing tables, etc.

1.1 Changes

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.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Protection

Automatic sprinkler 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. Refer to the applicable occupancy-specific data sheet for detailed sprinkler protection guidelines. See the definition of "occupancy-specific data sheet" in Appendix A for a list of data sheets organized by subject matter.

2.1.1 Automatic Sprinkler Systems

2.1.1.1 For new installations of wet-pipe sprinkler systems in Hazard Categories 1, 2, or 3 (HC-1, HC-2, or HC-3) occupancies with ceiling heights up to 60 ft (18 m), use FM Approved upright or pendent, standard or quick-response, standard-coverage or extended-coverage, nonstorage automatic sprinklers with a temperature rating of 160°F (70°C), where applicable. See Table 2 for sprinkler design demands for hazard categories. Sprinklers with a temperature rating of 212°F (100°C) may be used in locations where the ambient temperature is in excess of 110°F (43°C). For locations prone to extremely cold and freezing conditions, use dry-pipe sprinkler systems with upright, standard response, standard-coverage sprinklers with a temperature rating of 280°F (140°C).

2.1.1.2 To determine the complete sprinkler system design, do the following:

- A. Use Table 1 to identify the hazard category based on occupancy.
- B. Use Table 2 to find the sprinkler design demand required for that hazard category.
- C. Use Table 3 to determine the hose demand and duration needed for the sprinkler system design.
- D. Use Table 4 to determine the minimum sprinkler K-Factor for that hazard category.
- E. Use the ceiling-level sprinkler spacing guidelines for nonstorage occupancies in Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, to determine maximum area spacing for sprinkler.

2.1.1.3 Protection recommendations in the tables of this data sheet are intended for new installations and are based on complete sprinkler protection where needed, with no serious occupancy or protection deficiencies. Correct major deficiencies in occupancy or protection that could increase sprinkler demand. Such deficiencies include poor housekeeping, accumulations of lint or other combustible dust, obstructed sprinklers, and dry-pipe systems in certain hazardous areas. A strong water supply is no substitute for correcting these deficiencies.

Table 1. Hazard Categories Based on Occupancy

Occupancy	Description of Occupancy	Exceptions	Hazard Category
<ul style="list-style-type: none"> - Apartments - Atriums - Churches - Concealed spaces - Gymnasiums - Hospitals and hospital laboratories - Hotel rooms - Institutions - Kitchens - Libraries - Meeting rooms in convention centers and hotels - Metalworking shops with non-hydraulic cutting operations - Mineral processing such as: glass, cement, ore treating, gypsum processing, etc. - Museums - Nursing or convalescent homes - Offices - Restaurant seating areas - Schools and universities classrooms - Unused attics 	<p>Lightly loaded nonstorage and nonmanufacturing areas with ordinary combustibles.</p> <p>Expect fires with relatively low rates of heat release in these occupancies.</p>	<p>Libraries with stack rooms larger in size than defined in Appendix A; Facilities with storage of electronic and plastic media (see DS 8-9).</p> <p>Hospital laboratories where exposed storage and processing of flammable liquids is considered excessive (see the applicable flammable liquids data sheet).</p> <p>Facilities with operations involving hydraulic fluid or flammable liquid, see DS7-32, DS 7-29, and DS 7-98; and for storage, see DS 7-32, DS 7-29, and DS 7-98.</p>	HC-1
<ul style="list-style-type: none"> - Auto parking garages - Back stage of theaters and auditoriums - Boat mfg. and assembly - Boiler buildings - Casinos - Clubs - Convention centers - Display halls - Electronic-electrical mfg. and assembly - Food processing - Leather tanning and working - Mercantile areas - Metalworking shops with hydraulic operations - Movie and TV Studios - Paper processing - Retail areas - Rubber processing - Sports Arenas - Theater & auditoriums* - Utility and equipment rooms 	<p>Lightly and moderately loaded nonstorage, nonmanufacturing, and manufacturing areas with ordinary combustibles.</p> <p>Occupancies with fire hazards equivalent to in-process Class 2 commodities no more than 6 ft (1.8 m) high, or lesser hazard (e.g., mostly wood, cardboard products and small amounts of plastic, including foam plastic found in the seat cushion of a chair or plastic trim in an exhibit display booth).</p> <p>Manufacturing occupancies with movable picking racks not higher than 6 ft (1.8 m) containing rigid plastic open top containers. Do not allow expanded plastic inside the containers. Additionally, if the racks/carts are not separated by at least a distance equal to the least dimension of the rack/cart, treat as storage per DS 8-9.</p>	<p>Operations involving hydraulic fluid or flammable liquid (see DS 7-32, DS 7-29, and DS 7-98); aluminum rolling mills (see DS 7-64/13-28); paper machine areas that involve inks with flashpoints below 110°F (42°C) (see DS 7-4 and DS 7-96); aircraft hangars (see DS 7-93N).</p> <p>Oil cookers and distilling operations (see the applicable flammable liquid data sheet).</p> <p>Bulk retailers where merchandise is displayed on racks typically found in warehouses (see DS 8-9 and DS 8-3).</p> <p>Telephone switchgear rooms and generator rooms (see DS 5-12, DS 5-14, or DS 5-23).</p>	HC-2
<ul style="list-style-type: none"> - Cable manufacturing - Car-sized vehicle repair garages and assembly operations where vehicles are repaired, tested, or assembled with relatively small amounts of fuel in tanks - Interior loading docks - Modular building subassembly - Plastics processing and molding - Highway trailers, trucks, boxcars, some mobile homes or similar metal vehicles with combustible interiors with the potential for shielded fire 	<p>Heavily loaded areas with or without plastics.</p> <p>Manufacturing and nonmanufacturing facilities with higher concentrations of combustibles or shielding of combustibles where the fire hazard could approach the equivalent of nominal 5 ft (1.5 m) high in-process storage of cartoned unexpanded plastic commodities.</p>	<p>Facilities that use hydraulic and flammable liquids (see DS 7-98).</p> <p>For electronic media storage see DS 8-9.</p> <p>For haul-truck repair shops or manufacturing facilities housing vehicles that may contain several hundred gallons of flammable liquids, see DS 7-12 or DS7-32, as applicable.</p>	HC-3

Table 2. Sprinkler Design Demands for Hazard Categories

Hazard Category	Sprinkler Design Demand (gpm/ft ²)/ft ² (mm/min)/m ²					
	Ceilings up to 30 ft (9 m)		Ceilings from 30 to 60 ft (9 to 18 m)		Ceilings from 60 to 100 ft (18 to 30 m)	
	Wet	Dry	Wet	Dry	Wet	Dry
HC-1	0.1/1500 (4/140)	0.1/1500 (4/140)	0.2/2500 (8/230)	0.2/3500 (8/330)	See Table 2a	Not an option
HC-2	*0.2/2500 (8/230)	0.2/3500 (8/330)	0.2/2500 (8/230)	0.2/3500 (8/330)	See Table 2a	Not an option
HC-3	*0.3/2500 (12/230)	0.3/3500 (12/330)	0.5/3000 (20/280)	0.5/4000 (20/370)	See Table 2a	Not an option

* For HC-2 and HC-3 occupancies with ceilings up to 30 ft (9 m), reduce sprinkler design demand to 0.3/1500 (gpm/ft²)/ft² (12/140) (mm/min)/m² for wet-pipe systems when using K11.2EC (K160EC) upright sprinkler with temperature ratings of 160°F (70°C).

* For HC-2 & HC-3 occupancies with ceilings up to 30 ft (9 m), reduce sprinkler design demand to 0.3/1000 (gpm/ft²)/ft² (12/90) (mm/min)/m² for wet-pipe systems when using K14.0EC (K200EC) upright sprinkler with temperature ratings of 160°F (70°C).

* Although the sprinkler system protection guidelines use density over demand area as a design format, when using extended coverage sprinkler in facilities with ceilings up to 30 ft (9 m) high ensure the number of sprinklers does not drop below a minimum of 6 sprinklers for K11.2EC (K160EC) and 4 sprinklers for K14.0EC (K200EC).

Table 2a. Sprinkler Design Demands for Hazard Categories with Ceiling Height up to 100 ft (30 m)

No. of AS @ psi (bar)		
Wet System, QR 160°F (70°C)		
Hazard Category	K25.2 (K360)	K25.2EC (K360EC)
HC-1	12 @ 7 (0.5)	6 @ 20 (1.4)
HC-2	12 @ 7 (0.5)	6 @ 27 (1.9)
HC-3	12 @ 7 (0.5)	6 @ 27 (1.9)

2.1.1.4 Regardless of sprinkler demands, design pendent and upright Standard Coverage sprinklers to provide a minimum pressure of 7 psi (0.5 bar) at the most remote sprinkler. Design Extended Coverage sprinklers to provide a minimum pressure of 12 psi (0.8 bar) for K11.2EC (K160EC) sprinklers, and not less than 18 psi (1.2 bar) for K14.0EC (K200EC) sprinklers.

Table 3. Hose Demand and Duration

Hazard Category	Hose Demand, gpm (L/min)		Duration, min
	Ceilings Under 60 ft (18 m)	Ceilings Over 60 ft (18 m)	
HC-1	250 (950)	500 (1900)	60
HC-2	250 (950)	500 (1900)	60
HC-3	500 (1900)	500 (1900)	90

Table 4. Minimum Sprinkler K-Factors for Hazard Categories

Hazard Category	Ceiling Height, ft (m)		
	Up to 30 ft (9 m)	30-60 ft (9-18 m)	Over 60 ft (18 m)
HC-1	5.6 or 5.6EC (80 or 80EC)	8.0 (115)	25.2 or 25.2EC (360 or 25.2EC)
HC-2	8.0 or 11.2EC (115 or 160EC)	8.0 (115)	25.2 or 25.2EC (360 or 25.2EC)
HC-3	11.2 or 11.2EC (160 or 11.2EC)	11.2 (160)	25.2 or 25.2EC (360 or 25.2EC)

2.1.1.5 Use the applicable occupancy-specific storage data sheet to determine the water demand design requirements when an area of in-process storage at manufacturing facilities is 200 ft² (20 m²) or greater

(defined by minimum 8 ft wide aisles, and a storage height of either 5 ft (1.5 m) or greater for materials containing plastic, or 10 ft (3.0 m) or greater for cellulose-type material).

2.1.1.6 For new or existing Nonstorage occupancies, it is acceptable to use storage sprinklers to protect all areas of mixed storage and manufacturing, and Nonstorage. Determine the water demand design requirements and evaluate obstructions based on the applicable occupancy-specific storage data sheet.

2.1.1.7 Flammable liquids found in lift trucks do not affect the sprinkler system design criteria. See DS 7-32 for protection guidelines for occupancies where flammable liquids are used, and DS 7-29 for protection guidelines for occupancies where flammable liquids are stored.

2.1.1.8 Generally, if the demand area is equal to or less than 1500 ft² (140 m²), the water demand duration of 60 minutes is recommended because a medium-sized, controlled fire is expected. However, if the design area is larger, the size of the controlled fire is expected to be larger; thus, the 90 minute water demand duration is recommended. Water demand duration and hose demand may be increased up to 50% based on local occupancy or construction conditions. Examples of such conditions include:

A. Increase Water Demand Duration for:

1. Areas relatively inaccessible for manual firefighting
2. Potentially persistent fires
3. Areas with lack of drainage in low-flash-point flammable liquid occupancies

B. Increase Hose Demand for HC-1 and HC-2 Occupancies for areas with shielded fire potential. Such areas include combustibles, concealed spaces in walls, floors, or ceilings; ducts; and wide shelves or enclosures. In hollow joisted or wood-frame construction, increase hose demand by 250 gpm (950 L/min).

2.1.1.9 Quick-Response (QR) Sprinklers

2.1.1.9.1 Use quick-response (QR) nonstorage sprinklers in wet systems only.

2.1.1.9.2 Do not use QR sprinklers where rapidly spreading fire may occur or where there are accumulations of oil, dust, lint or other combustible residue on ceilings, structural members, sprinkler piping, large machines, or hoods.

2.1.1.10 Extended-Coverage (EC) Sprinklers

2.1.1.10.1 Extended-coverage (EC) nonstorage sprinklers may be used to protect Hazard Category 1 (HC-1) and Hazard Category 2 (HC-2), and Hazard Category 3 (HC-3) occupancies with ceiling height under 30 ft (9 m), in wet systems only. Except in the following:

- Spray application of flammable liquids
- Hydraulic equipment using flammable hydraulic fluids
- Any other occupancy involving flammable or combustible liquids
- Storage other than that defined in Section 2.1.1.5
- Retail/wholesale warehouse stores
- Stock rooms in retail stores
- Vehicle assembly or repair areas where there is fuel in fuel tanks
- Mobile/modular/manufactured home assembly or other occupancies with large areas shielded from sprinkler discharge

2.1.1.10.2 Install EC sprinklers in accordance with the recommendations in DS 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.1.1.10.3 Adhere to the following design criteria when using EC sprinklers:

A. Design Area

1. For sidewall EC sprinklers in rooms with a maximum compartmented area of 1600 ft² (150 m²), design the sprinkler system to supply all sprinklers within the compartment.

2. For all types of EC sprinklers in corridors that can be protected by one row of sprinklers, design the sprinkler system to supply all sprinklers in a 1500 ft² (140 m²) area, or a maximum of 5 sprinklers, whichever is less. For corridors smaller than 1500 ft² (140 m²) in area, use the actual area. Note that there are no limitations the size of corridor areas when EC sidewall sprinklers in this fashion.

B. Design Density/Pressure

1. Design EC sidewall sprinklers for the minimum pressure indicated in Table 5 for the sprinkler spacing. Minimum design pressures for EC sidewall sprinklers are a function of both the distribution characteristics of the sprinkler and the spacing. Ensure spacing does not exceed that indicated in Table 5. The "width" dimension is measured along the wall on which the sprinkler is mounted. The minimum design pressure ensures the water will effectively reach the far end of the sprinkler coverage area. Interpolations of pressure for different length dimensions are allowable; however, if the sprinklers are spaced less than 16 ft (5 m) apart, use the minimum pressure for 16 ft (5 m).

Table 5. Minimum Design Pressures for EC Sidewall Sprinklers

<i>K-Factor and Orifice Size, in. (mm)</i>	<i>Maximum Spacing, ft (m) Width x Length</i>	<i>Minimum Design Pressure, psi (bar)</i>
K5.6 (K80) 1/2 (13)	16 x 16 (5 x 5)	22 (1.5)
	16 x 18 (5 x 5.5)	29 (2.0)
	16 x 20 (5 x 6)	35 (2.4)
K8.0 (K115) 17/32 (15)	16 x 16 (5 x 5)	16 (1.1)
	16 x 18 (5 x 5.5)	20 (1.4)
	16 x 20 (5 x 6)	25 (1.7)
	16 x 22 (5 x 7)	30 (2.1)
	16 x 24 (5 x 7)	36 (2.5)

C. Water Supply and Duration

Ensure the water supply is capable of supplying the maximum sprinkler system demand, plus 250 gpm (950 L/min) for the hose demand, for a duration of 60 minutes.

2.1.1.11 Where anti-freeze systems are prohibited by the authority having jurisdiction (AHJ), provide a dry-pipe automatic sprinkler system using dry pendent, standard response, nonstorage sprinklers for small loading docks, covered platforms, ducts, or similar small, unheated areas. Sprinklers may also extend through the wall from wet sprinkler piping in an adjacent heated area using dry pendent or sidewall sprinklers.

Where possible, extend the dry pendent sprinkler down at a 45° angle as shown in Figure 1. Do not exceed the width of the area to be protected by more than 7.5 ft (2.3 m). Do not space sprinklers more than 12 ft (3.7 m) apart.

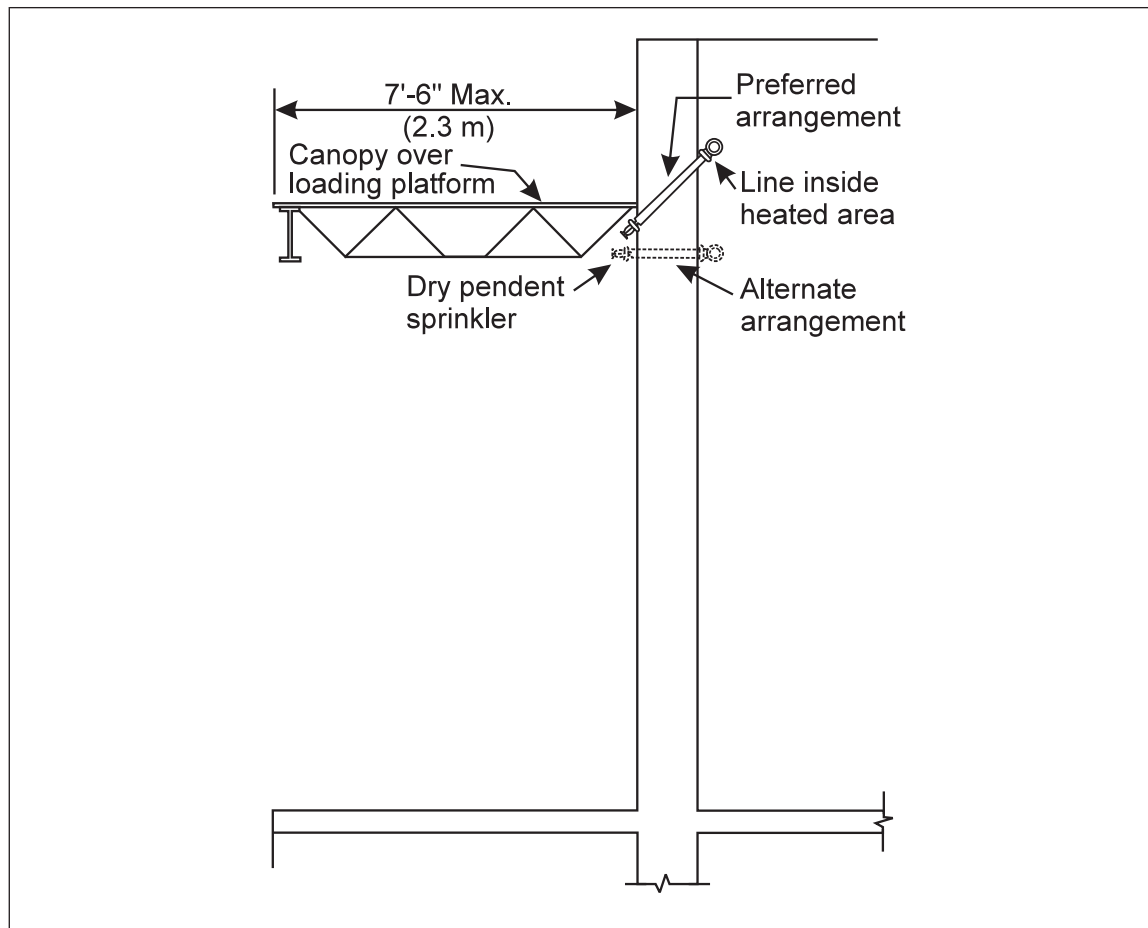


Fig. 1. Dry pendent sprinkler extended down at a 45° angle

2.1.1.12 Water Mist Systems

2.1.1.12.1 Water mist systems with FM Approval for Light Hazard Occupancies may be used to provide Hazard Category 1 (HC-1) Occupancies protection via wet systems with automatic nozzles only.

2.1.1.12.2 Do not use water mist systems to protect HC-2 or HC-3 occupancies.

2.1.1.12.3 Limit use of water mist systems to HC-1 occupancies with the following types of smooth, flat ceilings and with ceiling slopes not exceeding 1 in/ft (83 mm/m), unless specifically identified otherwise in their FM Approval Guide listing:

- Flat slab, pan-type reinforced concrete
- Smooth, monolithic ceilings attached to the underside of wood joists, wood trusses and bar joists
- Suspended ceilings

2.1.1.12.4 Install water mist systems in accordance with all recommendations in Data Sheet 4-2, *Water Mist Systems*.

2.1.1.12.5 Adhere to the following criteria when providing water mist systems with automatic nozzles:

A. Ceiling Height

Limit the maximum ceiling height and maximum nozzle to ceiling distance to that specified by the FM Approval Guide listing.

B. Design Area

1. Adhere to the following criteria for design area:

- For systems FM Approved for an unrestricted enclosure area, design the water mist system to supply whichever is greater:
 - the hydraulically most remote nine (9) automatic nozzles
 - all automatic nozzles within a 1500 ft² (140 m²) demand area
- For systems FM Approved with a specified maximum enclosure area, design the water mist system to supply all automatic nozzles within the compartment.

2. Install each water mist system automatic nozzle with a maximum linear spacing of 16 ft (4.9 m) or in accordance with the FM Approval Guide listing, whichever is less.

3. Install each water mist system automatic nozzle in accordance with its FM Approval Guide listing for:

- Minimum linear spacing
- Maximum distance from the wall
- Maximum enclosure area

4. For systems FM Approved in corridors that can be protected by one row of nozzles, design the water mist system to supply, whichever is less:

- a maximum of five (5) automatic nozzles
- as an unrestricted enclosure area, supply all automatic nozzles within a 1500 ft² (140 m²) demand area.

For corridors smaller than 1500 ft² (140 m²) in area, use the actual area.

C. Pressure

Ensure the minimum water operating pressure at each automatic water mist nozzle is not less than that specified in its Approval Guide listing.

D. Water Supply and Duration

Ensure the water supply is capable of supplying the maximum water mist system demand for the design area, plus 250 gpm (950 L/min) for hose streams, for a duration of 60 minutes.

3.0 SUPPORT FOR RECOMMENDATIONS

Hazard categories are based on occupancy, exposure, and combustible loading.

4.0 REFERENCES

4.1 FM Global

Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*

Data Sheet 5-12, *Electric AC Generators*

Data Sheet 5-14, *Telecommunications*

Data Sheet 5-23, *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 7-93N, *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*

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.

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 that could cause significant damage to the building.

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 ft²; in metric units, m² (1 ft² = 0.093 m²).

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/ft²; in metric units, in mm/min (1 gpm/ft² = 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: A product that has been tested to and meets the requirements of an FM Approval Standard and has been listed in the Approval Guide.

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.

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).

Nonstorage Automatic Sprinkler: A sprinkler that has been categorized by FM Global as acceptable for protecting nonstorage occupancies and/or any other low to moderate heat-release rate fire 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 storage arrangement.

Occupancy-Specific Data Sheet: An FM Global property loss prevention data sheet that addresses a specific occupancy hazard. Individual data sheets belong to a numbered "series" representing the following subjects:

Series Number	Data Sheet Subject
1	Construction
2	Sprinklers
3	Water supply
4	Extinguishing equipment
5	Electrical
6	Boilers and industrial heating equipment
7	Hazards
8	Storage
9	Miscellaneous
10	Human factor
11	Systems instrumentation and control
12	Pressure vessels
13	Mechanical
15	Welding
17	Boiler and machinery miscellaneous

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

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

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 (K160) 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 Global 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:

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/ft² (4 mm/min) over an area of 1500 ft² (140 m²) 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 ft² (230 m²) (dry system: 3500 ft²) 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