



## 14.1 General.

Early suppression fast-response (ESFR) sprinklers shall be selected for use and installation as indicated in this chapter and shall be positioned and spaced in accordance with Section 9.5.

## 14.2 Early Suppression Fast-Response Sprinklers.

### 14.2.1 General.

All requirements of Section 9.5 shall apply except as modified in Section 14.2.

### 14.2.2

ESFR sprinklers shall be used only in wet pipe systems unless specifically listed for use in dry systems or preaction systems.

### 14.2.3

ESFR sprinklers shall be installed only in buildings where the roof or ceiling slope does not exceed a pitch of 4 in 12.

### 14.2.4 Draft Curtains.

#### 14.2.4.1

Where ESFR sprinkler systems are installed adjacent to sprinkler systems with standard-response sprinklers, a draft curtain of noncombustible construction and at least 2 ft (600 mm) in depth shall be required to separate the two areas.

#### 14.2.4.2

A clear aisle of at least 4 ft (1.2 m) centered below the draft curtain shall be maintained for separation.

### 14.2.5 Temperature Ratings.

Sprinkler temperature ratings for ESFR sprinklers shall be ordinary or intermediate unless 9.4.2 requires intermediate-temperature ratings.

### 14.2.6 \* Occupancy and Hazard.

ESFR sprinklers designed to meet any applicable ESFR criteria in Chapter 20 or Chapter 23 through Chapter 26 shall be permitted to protect light and ordinary hazard occupancies.

#### 14.2.6.1

When ESFR sprinklers are used for the protection of light or ordinary hazard occupancies, the obstruction to the sprinkler discharge pattern of ESFR sprinklers shall be permitted to meet the obstruction discharge requirements of 10.2.8.2.

## 14.2.7 Protection Areas per Sprinkler (Early Suppression Fast-Response Sprinklers).

### 14.2.7.1 Determination of Protection Area of Coverage.

The protection area of coverage per sprinkler ( $A_s$ ) shall be determined in accordance with 9.5.2.1.

### 14.2.7.2 Maximum Protection Area of Coverage.

#### 14.2.7.2.1 \*

The maximum allowable protection area of coverage for a sprinkler ( $A_s$ ) shall be in accordance with the value indicated in Table 14.2.7.2.1.

### Table 14.2.7.2.1 Protection Areas and Maximum Spacing of ESFR Sprinklers

Construction Type	Ceiling/Roof Heights Up to 30 ft (9.1 m)				Ceiling/Roof Heights Over 30 ft (9.1 m)			
	Protection Area		Spacing		Protection Area		Spacing	
	ft <sup>2</sup>	m <sup>2</sup>	ft	m	ft <sup>2</sup>	m <sup>2</sup>	ft	m
Noncombustible unobstructed	100	9	12	3.7	100	9	10	3.0
Noncombustible obstructed	100	9	12	3.7	100	9	10	3.0
Combustible unobstructed	100	9	12	3.7	100	9	10	3.0
Combustible obstructed	100	9	12	3.7	100	9	10	3.0

**14.2.7.2.2**

Unless the requirements of 14.2.7.2.3 are met, the maximum area of coverage of any sprinkler shall not exceed 100 ft<sup>2</sup> (9.3 m<sup>2</sup>).

**14.2.7.2.3 \***

Where obstructions that prevent sprinkler discharge from reaching the hazard exist, ceiling sprinklers shall be permitted to exceed their maximum allowable spacing to avoid these obstructions as follows:

- (1) The linear spacing of the obstructed sprinkler, in the direction the sprinkler is moved, shall not exceed 1 ft (0.3 m) beyond the maximum allowable linear spacing.
- (2) The linear spacing of the obstructed sprinkler, in the direction the sprinkler is moved, shall not exceed 12 ft (3.7 m).
- (3) The area of coverage of the obstructed sprinkler shall not exceed 110 ft<sup>2</sup> (10 m<sup>2</sup>).
- (4) Where the obstructed sprinkler has been moved in a direction along the branch line, the linear and area spacing of the sprinklers on either side of the obstructed sprinkler along the branch line shall comply with the allowable sprinkler spacing requirements.
- (5) Where the obstructed sprinkler has been moved in a direction between the branch lines, the linear spacing and area of coverage of the sprinklers on either side of the obstructed sprinkler between the branch lines shall comply with the allowable sprinkler spacing requirements.

**14.2.7.3 Minimum Protection Area of Coverage.**

The minimum allowable protection area of coverage for a sprinkler ( $A_s$ ) shall not be less than 64 ft<sup>2</sup> (5.9 m<sup>2</sup>).

**14.2.7.3.1 \***

In buildings with unobstructed construction where sprinklers are located entirely above the bottom plane of an adjacent solid structural member, the requirements of 14.2.7.3 shall not apply to the sprinklers on either side of the solid structural member.

**14.2.8 Sprinkler Spacing (Early Suppression Fast-Response Sprinklers).****14.2.8.1 Maximum Distance Between Sprinklers.**

The maximum distance between sprinklers shall be in accordance with the following:

- (1) Where the storage height is less than or equal to 25 ft (7.6 m) and the ceiling height is less than or equal to 30 ft (9.1 m), the distance between sprinklers shall be limited to not more than 12 ft (3.7 m) between sprinklers as shown in Table 14.2.7.2.1.
- (2) Unless the requirements of 14.2.8.1(3) or 14.2.8.1(4) are met, where the storage height exceeds 25 ft (7.6 m) or the ceiling height exceeds 30 ft (9.1 m), the distance between sprinklers shall be limited to not more than 10 ft (3.0 m) between sprinklers.
- (3) Regardless of the storage or ceiling height arrangement, deviations from the maximum sprinkler spacing shall be permitted to eliminate obstructions created by structural elements (such as trusses, bar joists, and wind bracing) by moving a sprinkler along the branch line a maximum of 1 ft (300 mm) from its allowable spacing, provided coverage for that sprinkler does not exceed 110 ft<sup>2</sup> (10 m<sup>2</sup>) where all of the following conditions are met (*See Figure A.14.2.7.2.3*):
  - (a) The average actual floor area protected by the moved sprinkler and the adjacent sprinklers shall not exceed 100 ft<sup>2</sup> (9 m<sup>2</sup>).
  - (b) Adjacent branch lines shall maintain the same pattern.
  - (c) In no case shall the distance between sprinklers exceed 12 ft (3.7 m).
- (4) Where branch lines are parallel to trusses and bar joists, deviations from the maximum sprinkler spacing shall be permitted to eliminate obstructions created by structural elements (such as trusses, bar joists, and wind bracing) by moving a single branch line a maximum of 1 ft (300 mm) from its allowable spacing, provided coverage for the sprinklers on that branch line and the sprinklers on the branch line it is moving away from does not exceed 110 ft<sup>2</sup> (10 m<sup>2</sup>) per sprinkler where all of the following conditions are met:

- (a) The average actual floor area protected by the sprinklers on the moved branch line and the sprinklers on the adjacent branch lines shall not exceed 100 ft<sup>2</sup> (9 m<sup>2</sup>) per sprinkler.
- (b) In no case shall the distance between sprinklers exceed 12 ft (3.7 m).
- (c) It shall not be permitted to move a branch line where there are moved sprinklers on a branch line that exceed the maximum sprinkler spacing.

#### **14.2.8.2 Maximum Distance from Walls.**

The distance from sprinklers to walls shall not exceed one-half of the allowable distance permitted between sprinklers as indicated in Table 14.2.7.2.1.

#### **14.2.8.3 Minimum Distance from Walls.**

Sprinklers shall be located a minimum of 4 in. (100 mm) from a wall.

#### **14.2.8.4 Minimum Distance Between Sprinklers.**

Sprinklers shall be spaced not less than 8 ft (2.4 m) on center.

##### **14.2.8.4.1 \***

In buildings with unobstructed construction where sprinklers are located entirely above the bottom plane of an adjacent solid structural member, the requirements of 14.2.8.4 shall not apply to the sprinklers on either side of the solid structural member.

##### **14.2.8.4.2**

Sprinklers shall be permitted to be placed less than 8 ft (2.4 m) on center where the following conditions are satisfied:

- (1) Baffles shall comply with the criteria in 14.2.10.2.1.
- (2) Baffles shall be of solid and rigid materials that will stay in place before and during sprinkler operation.
- (3) Baffles shall not be less than 8 in. (200 mm) long and 6 in. (150 mm) high.
- (4) The tops of baffles shall extend between 2 in. (50 mm) and 3 in. (75 mm) above the deflectors of upright sprinklers.
- (5) The bottoms of baffles shall extend downward to a level at least even with the deflectors of pendent sprinklers.

##### **14.2.8.4.3**

Where sprinklers are installed in every channel formed by solid obstructed construction with the deflectors above the bottom of the structural members, the structural members shall be considered baffles in accordance with 14.2.8.4.2.

#### **14.2.9 Deflector Position (Early Suppression Fast-Response Sprinklers).**

##### **14.2.9.1 Distance Below Ceilings.**

###### **14.2.9.1.1 Unobstructed Construction.**

###### **14.2.9.1.1.1**

Where nominal K-14.0 (K-200), K-16.8 (K-240), and K-28.0 (K-400) pendent sprinklers are installed under unobstructed construction, the deflectors shall be positioned a minimum 6 in. (150 mm) and a maximum of 14 in. (350 mm) below the ceiling/roof deck.

###### **14.2.9.1.1.2**

Where nominal K-22.4 (K-320), K-25.2 (K-360), and K-33.6 (K-480) pendent sprinklers are installed under unobstructed construction, the deflectors shall be positioned a minimum 6 in. (150 mm) and a maximum of 18 in. (450 mm) below the ceiling/roof deck.

###### **14.2.9.1.1.3**

Where nominal K-14.0 (K-200) and K-16.8 (K-240) upright sprinklers are installed under unobstructed construction, the deflectors shall be positioned a minimum of 3 in. (75 mm) and a maximum of 12 in. (300 mm) below the ceiling/roof deck.

###### **14.2.9.1.2 Obstructed Construction.**

###### **14.2.9.1.2.1 Obstructed Construction Less than or Equal to 50 Percent Open for Ceilings with Slopes Not Exceeding 1 in 12.**

Where the slope of the ceiling does not exceed 1 in 12, the sprinkler deflector shall be located in accordance with one of the following arrangements:

- (1) Sprinklers shall be installed in each individual channel of obstructed construction with the deflectors located below the ceiling/roof deck in accordance with 14.2.9.1.1.

- (2) Where the maximum depth of the structural members, including concrete tees, is 18 in. (450 mm), sprinkler deflectors shall be permitted to be installed within a horizontal plane not exceeding 6 in. (150 mm) vertically below the bottom of the structural members.
- (3) Where the maximum depth of the structural members, including concrete tees, is greater than 18 in. (450 mm) but does not exceed 24 in. (600 mm), sprinkler deflectors shall be permitted to be installed within a horizontal plane not exceeding 6 in. (150 mm) vertically below the bottom of the structural members only when the channels formed by obstructed construction are provided with blocking to the full depth of the structural member with material equivalent to or less combustible than the structural member's construction so that individual channel volumes do not exceed 400 ft<sup>3</sup> (11.3 m<sup>3</sup>).

#### **14.2.9.1.2.2 Obstructed Construction Less than or Equal to 50 Percent Open for Ceilings with Slopes Not Exceeding 2 in 12.**

Where the slope of the ceiling is greater than 1 in 12, but does not exceed 2 in 12, the sprinkler deflector shall be located in accordance with one of the following arrangements:

- (1) Sprinklers shall be installed in each individual channel of obstructed construction with the deflectors located below the ceiling/roof deck in accordance with 14.2.9.1.1.
- (2) Where the maximum depth of the structural members, including concrete tees, is 12 in. (300 mm), sprinkler deflectors shall be permitted to be installed within a horizontal plane not exceeding 6 in. (150 mm) vertically below the bottom of the structural members.
- (3) Where the maximum depth of the structural members, including concrete tees, is greater than 12 in. (300 mm) but does not exceed 24 in. (600 mm), sprinkler deflectors shall be permitted to be installed within a horizontal plane not exceeding 6 in. (150 mm) vertically below the bottom of the structural members only when the channels formed by obstructed construction are provided with blocking to the full depth of the structural member with material equivalent to or less combustible than the structural member's construction so that individual channel volumes do not exceed 400 ft<sup>3</sup> (11.3 m<sup>3</sup>).

#### **14.2.9.1.2.3 Obstructed Construction Less than or Equal to 50 Percent Open for Ceilings with Slopes Not Exceeding 4 in 12.**

Where the slope of the ceiling is greater than 2 in 12, but does not exceed 4 in 12, the sprinkler deflector shall be located in accordance with one of the following arrangements:

- (1) Sprinklers shall be installed in each individual channel of obstructed construction with the deflectors located below the ceiling/roof deck in accordance with 14.2.9.1.1.
- (2) Where the maximum depth of the structural members, including concrete tees, is 12 in. (300 mm) and the structural members are installed perpendicular to the ceiling slope, sprinkler deflectors shall be permitted to be installed within a horizontal plane not exceeding 6 in. (150 mm) vertically below the bottom of the structural members only when the channels formed by obstructed construction are provided with blocking to the full depth of the structural member with material equivalent to or less combustible than the structural member's construction so that individual channel volumes do not exceed 300 ft<sup>3</sup> (8.5 m<sup>3</sup>).

#### **14.2.9.1.2.4 Obstructed Construction Greater than 50 Percent Open.**

Where the slope of the ceiling is greater than 1 in 12 under obstructed construction that is greater than 50 percent open, sprinklers shall be installed in accordance with the rules for unobstructed construction.

#### **14.2.9.2 Deflector Orientation.**

Deflectors of sprinklers shall be aligned in accordance with 9.5.4.3.

### **14.2.10 \* Obstructions to Sprinkler Discharge (Early Suppression Fast-Response).**

#### **14.2.10.1 General.**

##### **14.2.10.1.1**

In addition to the requirements of 9.5.5, ESFR sprinklers shall be arranged in accordance with 14.2.10 to minimize obstruction to their discharge pattern, or supplemental sprinklers shall be provided to ensure adequate coverage of the hazard.

##### **14.2.10.1.2**

ESFR sprinklers with a special obstruction allowance shall be installed according to their listing.

##### **14.2.10.1.3 \***

Where high-piled storage is not physically separated from an adjacent light or ordinary hazard area, the sprinkler obstruction criteria of 14.2.10 shall apply to all ceiling sprinklers located within 15 ft (4.6 m) horizontally of any high-piled storage.

#### **14.2.10.2 Obstructions to Sprinkler Discharge Pattern Development.**

**14.2.10.2.1**

ESFR sprinklers shall be arranged to comply with Table 14.2.10.2.1(a) or Table 14.2.10.2.1(b) and Figure 14.2.10.2.1 for obstructions at the ceiling, such as beams, ducts, lights, and top chords of trusses and bar joists.

**Table 14.2.10.2.1(a) Positioning of Sprinklers to Avoid Obstructions to Discharge (ESFR Sprinklers)**

<b>Distance from Sprinkler to Side of Obstruction (A) (ft)</b>	<b>Allowable Distance of Deflector Above Bottom of Obstruction (B) (in.)</b>
Less than 1	0
1 or more	1½ or less
1½ or more	3 or less
2 or more	5½ or less
2½ or more	8 or less
3 or more	10 or less
3½ or more	12 or less
4 or more	15 or less
4½ or more	18 or less
5 or more	22 or less
5½ or more	26 or less
6 or more	31 or less

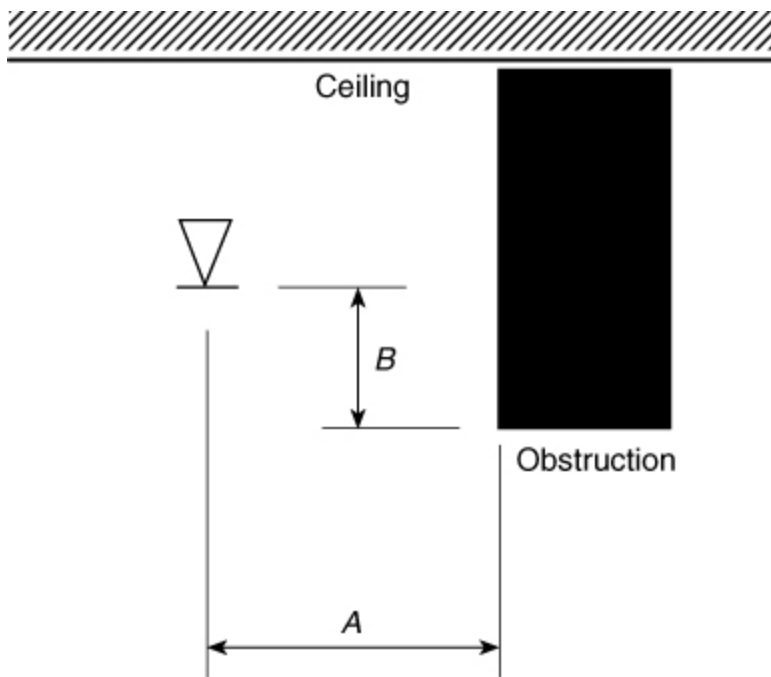
Note: For A and B, refer to Figure 14.2.10.2.1.

**Table 14.2.10.2.1(b) Positioning of Sprinklers to Avoid Obstructions to Discharge (ESFR Sprinklers)**

<b>Distance from Sprinkler to Side of Obstruction (A) (mm)</b>	<b>Allowable Distance of Deflector Above Bottom of Obstruction (B) (mm)</b>
Less than 300	0
300 or more	40 or less
450 or more	75 or less
600 or more	140 or less
750 or more	200 or less
900 or more	250 or less
1100 or more	300 or less
1200 or more	375 or less
1400 or more	450 or less
1500 or more	550 or less
1700 or more	650 or less
1800 or more	775 or less

Note: For A and B, refer to Figure 14.2.10.2.1.

**Figure 14.2.10.2.1 Positioning of Sprinkler to Avoid Obstruction to Discharge (ESFR Sprinklers).**



#### 14.2.10.2.2

The requirements of 14.2.10.2.1 shall not apply where one of the following conditions is satisfied:

- (1) Sprinklers are spaced on opposite sides of an obstruction less than 24 in. (600 mm) wide, provided the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance between sprinklers.
- (2) Supplemental sprinklers have been installed under the obstruction.

#### 14.2.10.2.3 Sprinkler Pipe.

Upright sprinklers shall be permitted to be positioned with respect to the sprinkler pipe that feeds them in accordance with one of the following:

- (1) Attached directly to sprinkler pipe less than or equal to 4 in. (100 mm) nominal in diameter
- (2) Offset horizontally a minimum of 6 in. (150 mm) from the sprinkler pipe
- (3) Supplied by a riser nipple (sprig) to elevate the sprinkler deflector a minimum of 12 in. (300 mm) from the centerline of any sprinkler pipe over 4 in. (100 mm) nominal in diameter

#### 14.2.10.3 Obstructions that Prevent Sprinkler Discharge from Reaching Hazard. (See A.9.5.5.2.)

##### 14.2.10.3.1

Obstructions, continuous or noncontinuous, individual or grouped, that interrupt the water discharge in a horizontal plane below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with 14.2.10.3.

##### 14.2.10.3.2 \*

For pipes, conduits, or groups of pipes and conduit to be considered individual, they shall be separated from the closest adjacent pipe, conduit, cable tray, or similar obstructions by a minimum of three times the width of the adjacent pipe, conduit, cable tray, or similar obstruction.

##### 14.2.10.3.3

Supplemental sprinklers shall be installed under obstructions located entirely below the elevation of ceiling sprinklers where the obstruction(s) interferes with the sprinkler discharge pattern reaching the hazard.

##### 14.2.10.3.4

Supplemental sprinklers shall not be required below obstructions when the obstruction or occupancy is in accordance with one of the following:

- (1) The location of the obstruction relative to the ceiling sprinklers complies with Table 14.2.10.2.1(a) or Table 14.2.10.2.1(b).
- (2) The obstruction is 1½ in. (38 mm) or less in width and is located a minimum of 12 in. (300 mm) below the elevation of the sprinkler deflector.
- (3) The obstruction is 6 in. (150 mm) or less in width and is located a minimum of 6 in. (150 mm) horizontally from the sprinkler.

- (4) The obstruction is 24 in. (600 mm) or less in width and is located a minimum of 12 in. (300 mm) horizontally from the sprinkler.
- (5) The obstruction is 4 in. (100 mm) or less in width, and is located entirely below the sprinkler pipe connected to the ceiling sprinkler, and the ceiling sprinkler is upright.
- (6) The occupancy is protected in accordance with 14.2.6, and obstructions comply with 9.5.5.3.

#### **14.2.10.3.5 Spacing of Supplemental Sprinklers.**

##### **14.2.10.3.5.1 \***

When supplemental sprinklers are required, in addition to the requirements of 9.5.5.3.3 the spacing of supplemental sprinklers under obstructions shall be in accordance with one of the following:

- (1) Where supplemental sprinklers are required below non-flat or non-solid obstructions, the sprinklers shall be located no more than 2 ft (0.6 m) horizontally from the edges of the obstruction and be installed using linear and area spacing that does not exceed 4 ft (1.2 m) and 16 ft<sup>2</sup> (1.5 m<sup>2</sup>), respectively.
- (2) Where supplemental sprinklers are required below flat, solid obstructions not exceeding 2 ft (0.6 m) in width, the maximum allowable linear spacing for the sprinklers shall be 8 ft (2.4 m).
- (3) Where a flat, solid continuous horizontal barrier having the same footprint of the obstruction is installed below an obstruction not exceeding 2 ft (0.6 m) in width, the maximum allowable linear spacing for the sprinklers shall be 8 ft (2.4 m).
- (4) Where supplemental sprinklers are required below flat, solid obstructions greater than 2 ft (0.6 m), but not exceeding 10 ft (3.0 m) in width, the maximum allowable linear spacing for the sprinklers shall be 10 ft (3.0 m).
- (5) Where a flat, solid continuous horizontal barrier having the same footprint of the obstruction is installed below an obstruction greater than 2 ft (0.6 m), but not exceeding 10 ft (3.0 m) in width, the maximum allowable linear spacing for the sprinklers shall be 10 ft (3.0 m).
- (6) Where supplemental sprinklers are required below flat, solid obstructions greater than 10 ft (3.0 m) in width, the supplemental sprinkler spacing shall be in accordance with the sprinkler's spacing requirements for when the sprinkler is installed under unobstructed construction.
- (7) Where a flat, solid continuous horizontal barrier having the same footprint of the obstruction is installed below an obstruction greater than 10 ft (3.0 m) in width, the supplemental sprinkler spacing shall be in accordance with the sprinkler's spacing requirements for when the sprinkler is installed under unobstructed construction.

##### **14.2.10.3.5.2**

When supplemental sprinklers are installed in accordance with 14.2.10.3.5.1, supplemental sprinklers shall not be required to be equipped with water shields.

#### **14.2.10.3.6 Overhead Doors.**

Quick-response spray sprinklers shall be permitted to be utilized under overhead doors.

#### **14.2.10.3.7 Conveyors.**

Sprinklers shall be arranged with respect to conveyors in accordance with one of the following:

- (1) Quick-response standard spray sprinklers shall be permitted to be installed below conveyors without high-piled storage located underneath.
- (2) Ceiling-level sprinklers shall be installed below conveyors with high-piled storage located underneath.
- (3) Additional sprinklers shall not be required below belt or similar type conveyors where the conveyor has a horizontal profile that is a minimum 70 percent open.
- (4) Additional sprinklers shall not be required below belt conveyors up to 4 ft (1.2 m) wide where the area below the conveyor is void of high-piled storage.
- (5) Additional sprinklers shall not be required below roller conveyors where the horizontal opening between rollers equals or exceeds the width of the roller.
- (6) Additional sprinklers shall not be required below roller conveyors where the area below the conveyor is void of high-piled storage.

#### **14.2.11 Clearance to Storage (Early Suppression Fast-Response Sprinklers).**

The clearance between the deflector and the top of storage shall be 36 in. (900 mm) or greater.