Welcome

Technical Services Team
APAC-ME

2016-2017

tyco
Fire Protection Products

Trainer Introduction

Student Introductions



Sprinkler Systems

Sprinklers



Topics

- Introduction
- History
- Principle of Sprinklers
- Sprinkler Types
- Characteristics
- Special Sprinklers
- Inspection Test & Maintenance
- Questions

Section 1.0

Introduction

True or False



Key Terms

- VdS - Verband der Schadenversicherer
- LPCB – Loss Prevention Certification Board
- EN – European Standard
- NFPA – National Fire Protection Association
- FM – Factory Mutual
- UL – Underwriters Laboratories Inc.
- CE - Conformité Européenne (European conformity)
- AHJ – Authority Having Jurisdiction

Why Sprinkler Systems?

Sprinklers take care of fire protection and as such a decrease in property losses.

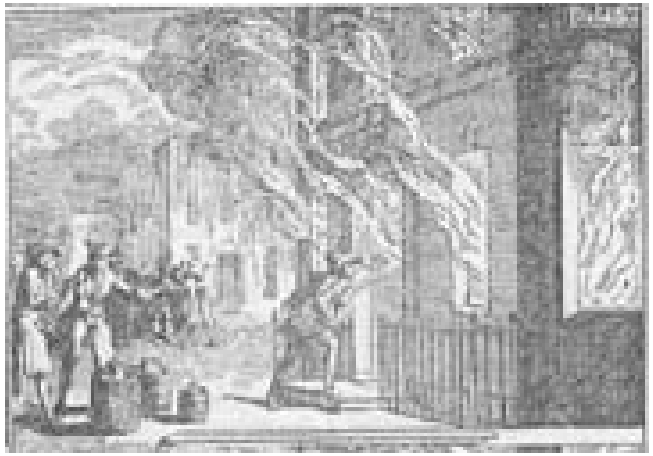


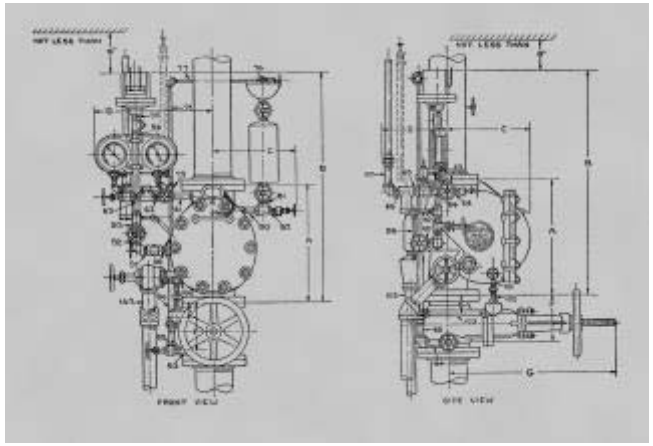
Section 2.0

History

England – 1723-1864

- Water based fire protection systems have been traced back to the early 1700's
- Many were manually operated deluge style systems, with water distributed through perforated pipes
- The reliability of early automatic valves had been questioned, and some valves were prone to leaking
- Most of the systems were of the deluge type

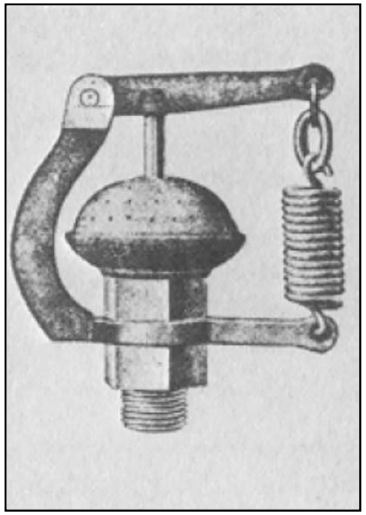




United States – Henry Parmelee

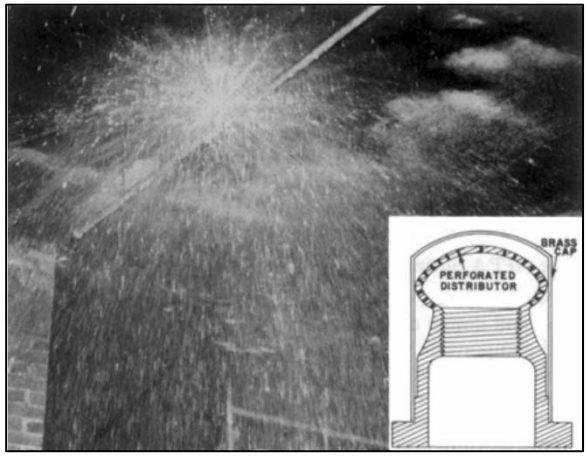


Used technology similar to what was being used in England



1874

- Henry Parmelee of New Haven, CT, patented the 1st practical automatic sprinkler
- First coined the term “sprinkler”



1875

- Developed a new style sprinkler with a brass cap soldered over a nozzle
- Simplistic in design and improved reliability

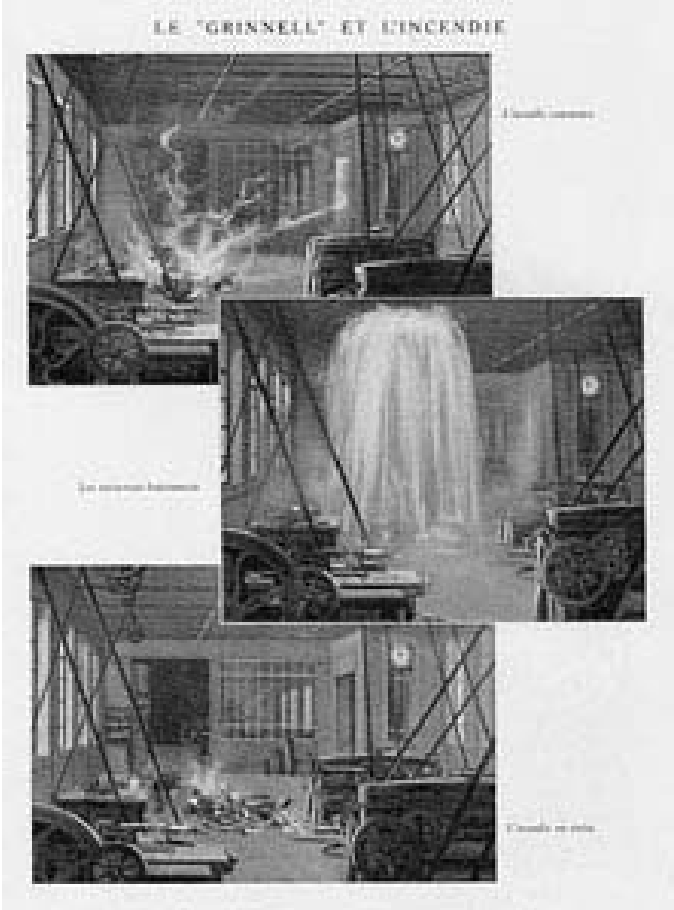
England – George Parmelee

1881

- Brother of Henry Parmelee Traveled Manchester, England to promote sprinkler use
- Began extensive testing to substantiate the value of sprinklers in fire protection

1884

- For the first time insurance companies in England offered reductions on premiums of 20% over and above the standard 2.5% - 15% for automatic sprinkler protection vs. non-automatic/manual fire protection



United States – Frederick Grinnell



Profile

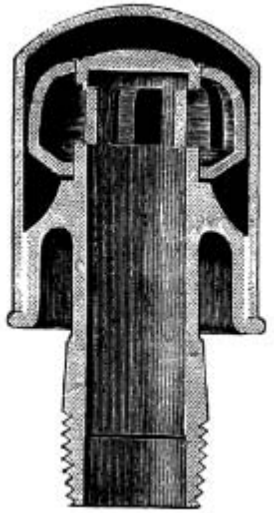
- Mechanical Engineer
- Owned Providence Steam and Gas Pipe Company
- Designed and installed sprinkler systems using the Parmelee Sprinkler

1878

- Frederick Grinnell of Providence, RI started to make the Parmelee sprinkler on a royalty basis

1879

- Patented the 1st dry pipe valve.





United States – Frederick Grinnell



1881

- Grinnell patented the first “sensitive sprinkler”
- Separated the heat sensing element from coming in contact with the water for greater sensitivity
- Introduced the ½ orifice
- Employed the saw toothed deflector
- Promoted as the “the fireman that never sleeps”





1882

- Introduced the “modern” sprinkler.

Section 3.0

Principle of Sprinklers

How does an Automatic Sprinkler Fight a Fire?

Three things must be present at the same time in order to produce fire:

- Enough oxygen to sustain combustion
- Enough heat to raise the material to its ignition temperature
- Some sort of fuel or combustible material



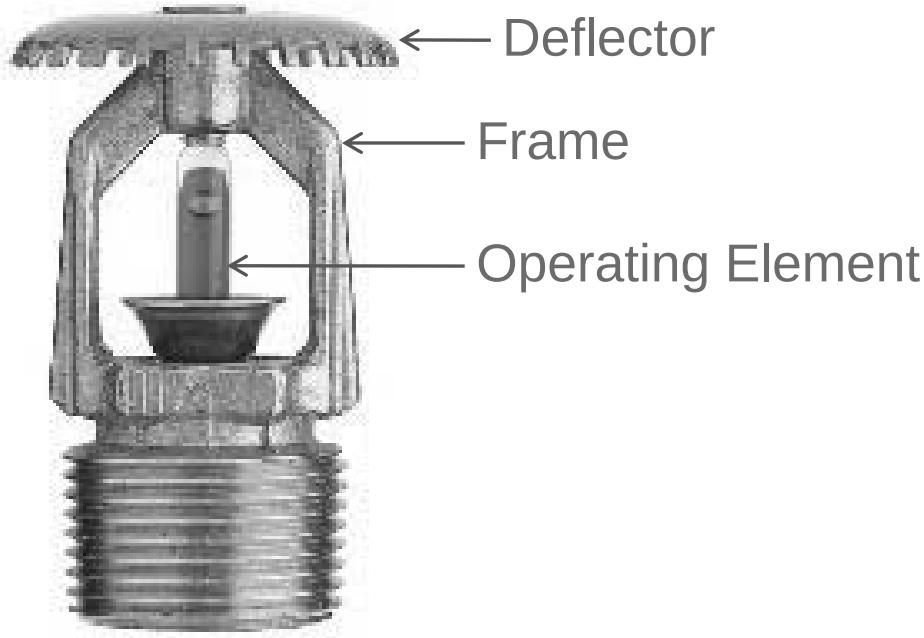
Automatic Sprinkler Components

Installation Orientation

Deflector

Operating Element

Frame & Orifice

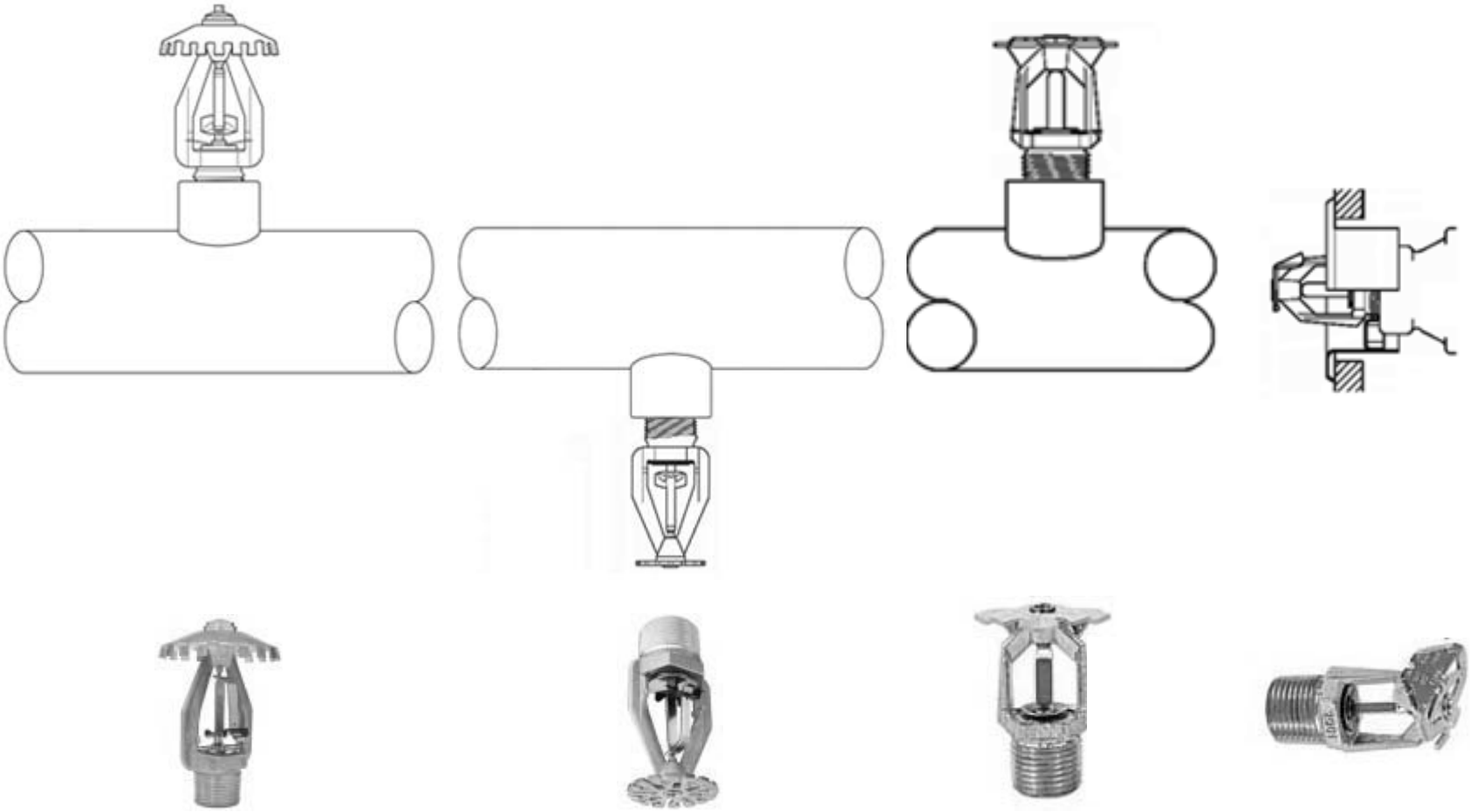


Orientation (Upright)



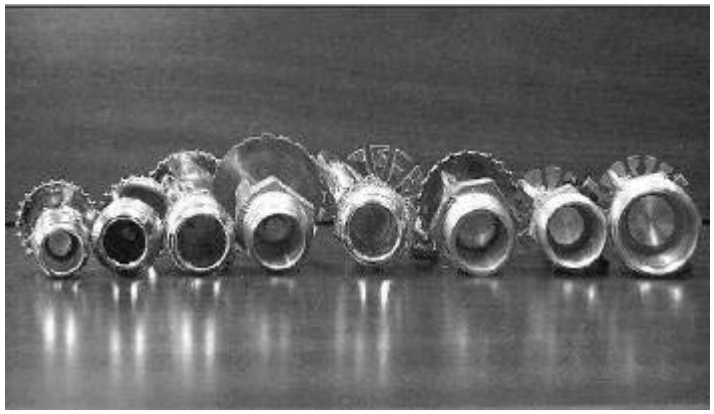
Orifice

Installation Orientation



Orifice & Thread Size

Nominal K-factor	K-factor Range	Nominal Orifice Size (mm)	% of K-80 Discharge	Thread Size
20	19–22	6.4	25	1/2" NPT
27	26–29	8	33.3	1/2" NPT
40	38–42	9.5	50	1/2" NPT
57				3/8" ISO
60	59–64	11	75	1/2" NPT
80	76–84	12.7	100	1/2" NPT
115	107–118	13.5	140	3/4" NPT or 1/2" NPT
160	159–166	15.9	200	3/4" NPT or 1/2" NPT
200	195–209	19	250	3/4" NPT
240	231–254	—	300	3/4" NPT
280	272–301	—	350	1 ISO
320	311–343	—	400	1 ISO
360	349–387	—	450	1 ISO



$$Q = K (\sqrt{P})$$

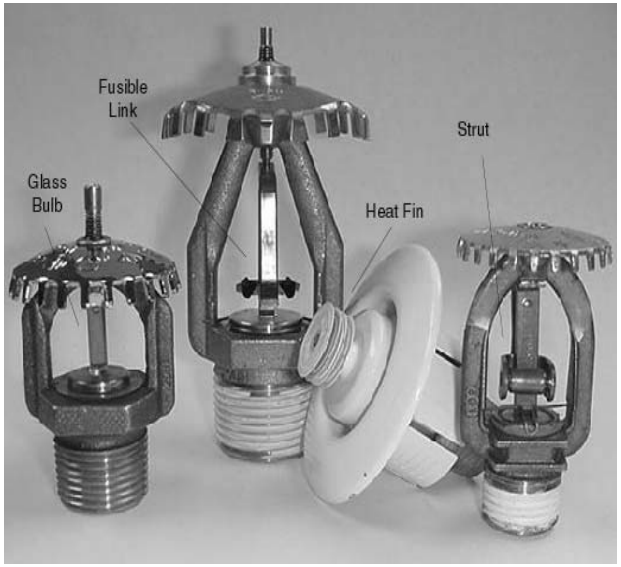
Q = Flow (lpm)
K = K-factor (lpm/bar ½)
P = Pressure (bar)

Operating element

Thermal sensitivity - A measure of the rapidity with which the thermal element operates as installed in a specific sprinkler or sprinkler assembly.

One measure of thermal sensitivity is the response time index (RTI) as measured under standardized test conditions.

- Fast Response > heat sensitive element with an RTI of 50 $(m\text{-}s)^{1/2}$ or less.
- Special Response > heat sensitive element with an RTI between 50 $(m\text{-}s)^{1/2}$ and 80 $(m\text{-}s)^{1/2}$
- Standard Response > heat sensitive element with an RTI of 80 $(m\text{-}s)^{1/2}$ or more.



Center Strut – 125 m-s½

Glass Bulb (5mm) - 105 m-s½

Glass Bulb (3mm) - 36 m-s½

Fusible Link – 26 m-s½

Heat Fin - 26 m-s½

Thermal Sensitivity



RTI of Center Strut
125 m-s½



RTI of Fusible Link
26 m-s½



RTI of the heat fin
26 m-s½



RTI of 3mm Glass
Bulb – 35 m-s½



RTI of 5mm Glass
Bulb – 105 m-s½

The Plunge Tunnel

$$t_o = \frac{-\mathrm{RTI} * \ln\left[1 - \left[\frac{(T_m - T_u)}{T_g - T_u}\right]\right]}{\sqrt{u}}$$



Where:

RTI: Response Time Index $[(m \cdot s)^{1/2}; (ft \cdot s)^{1/2}]$

t_o: Operating time of the sprinkler [s]

u: Nominal gas velocity in the test section of the wind tunnel [2.54 m/s; 8.33 ft/s]

T_m: Marked temperature rating of the sprinkler [°C; °F]

T_g : Nominal gas temperature in test section in Table 19.2 [°C; °F]

T_u : Nominal ambient air temperature [24°C; 75°F]

Sprinkler temperature rating		Oven temperature	
°F	(°C)	°F ±2°F	(°C ±1°C)
135 – 170	(57 – 77)	275	(135)
175 – 225	(79 – 107)	386	(197)
250 – 300	(121 – 149)	555	(290)
325 – 375	(163 – 191)	765	(407)
400 – 475	(204 – 246)	765	(407)
500 – 575	(260 – 302)	765	(407)

Sensitivity – Room Heat Test

To ensure sensitivity, Quick Response sprinklers must also pass actual burn test to achieve UL Listing

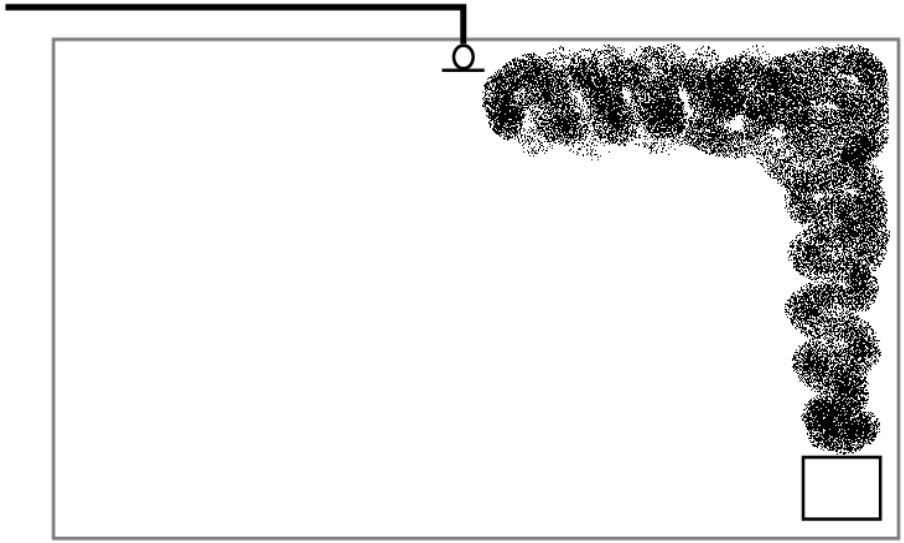
- Ceiling Height: 2.44 m (8’)
- Heat source at opposite corner of room

QR Sprinklers must operate within:

- 75 seconds (LH)
- 55 seconds (OH)

SR Sprinklers must operate within:

- 3 min 51 seconds
- 2 min 30 seconds (ECOH)



Sensitivity – EC11 & EC14 according UL

Area	Style	Light Hazard					Ordinary Hazard				
		135°F (57°C)	155°F (68°C)	175°F (79°C)	200°F (93°C)	286°F (141°C)	135°F (57°C)	155°F (68°C)	175°F (79°C)	200°F (93°C)	286°F (141°C)
14 x 14	Upright or Pendent	-	-	-	-	-	QR	QR	QR	QR	SR
	Style 30 Recessed	-	-	-	-	-	QR	QR	QR	QR	N/A
	Style 40 Recessed	-	-	-	-	-	QR	QR	QR	QR	N/A
16 x 16	Upright or Pendent	QR*	QR*	QR*	QR*	QR*	SR	SR	SR	SR	SR
	Style 30 Recessed	QR*	QR*	QR*	QR*	QR*	SR	SR	SR	SR	N/A
	Style 40 Recessed	N/A	N/A	N/A	N/A	N/A	SR	SR	SR	SR	N/A
18 x 18	Upright or Pendent	QR*	QR*	QR*	QR*	QR*	SR	SR	SR	SR	SR
	Style 30 Recessed	QR*	QR*	QR*	QR*	QR*	SR	SR	SR	SR	N/A
	Style 40 Recessed	N/A	N/A	N/A	N/A	N/A	SR	SR	SR	SR	N/A
20 x 20	Upright or Pendent	QR*	QR*	QR*	SR*	SR*	SR	SR	SR	SR	SR
	Style 30 Recessed	QR*	QR*	QR*	SR*	SR*	SR	SR	SR	SR	N/A
	Style 40 Recessed	N/A	N/A	N/A	N/A	N/A	SR	SR	SR	SR	N/A

QR: Quick Response
SR: Standard Response
N/A: Not Applicable
* Does not apply to Upright K=14.0

TABLE B
SENSITIVITY RATING FOR UL AND C-UL LISTING OF SERIES EC-11 OR EC-14 SPRINKLERS
(Refer to Table D for Permitted K-Factor/Area Combinations)

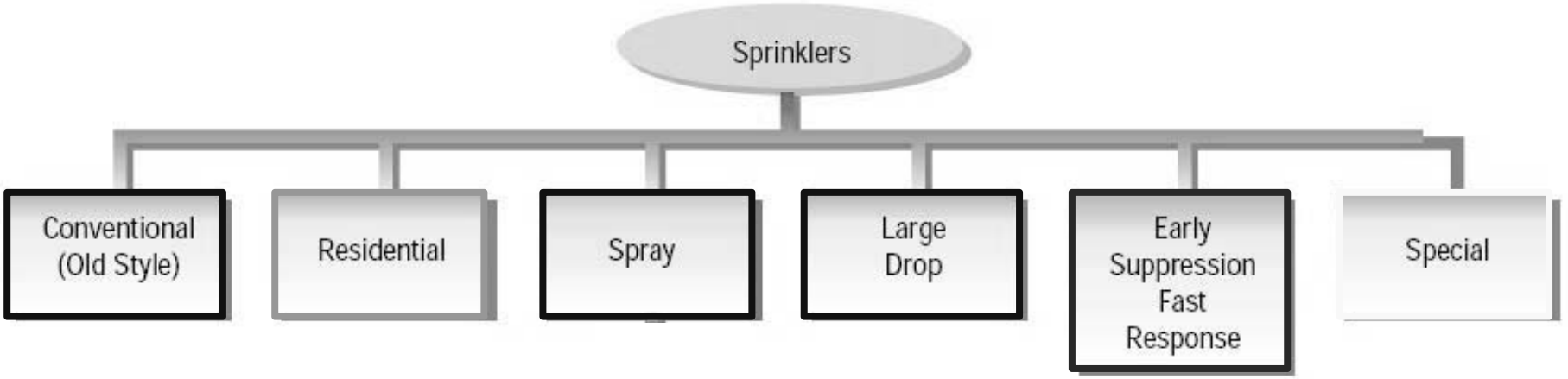




Section 4.0

Sprinkler Types

Sprinkler Types General



Control mode sprinklers

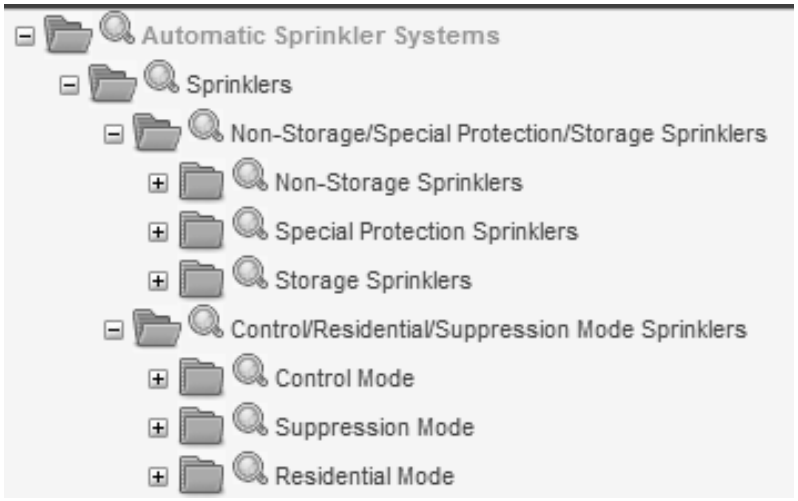
Suppression sprinklers

Special sprinklers

Life safety sprinklers

According FM Global

- **Storage Sprinklers**: Used for storage and other high challenge type occupancy hazards
- **Non-Storage Sprinklers**: Used for occupancy hazards with moderate to low challenge fire hazards
- **Special Protection Sprinklers**: Used for special hazards such as the protection of the inside of ducts, cooling towers, corrosive environments, etc.

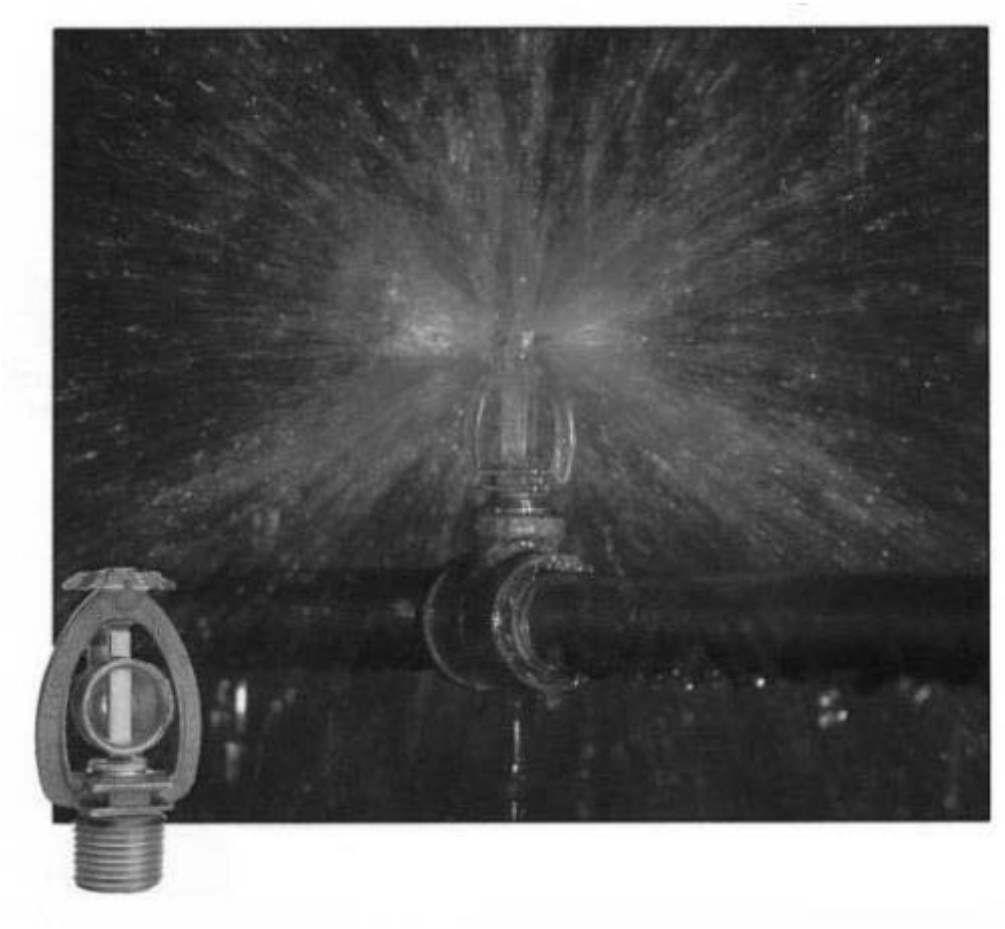


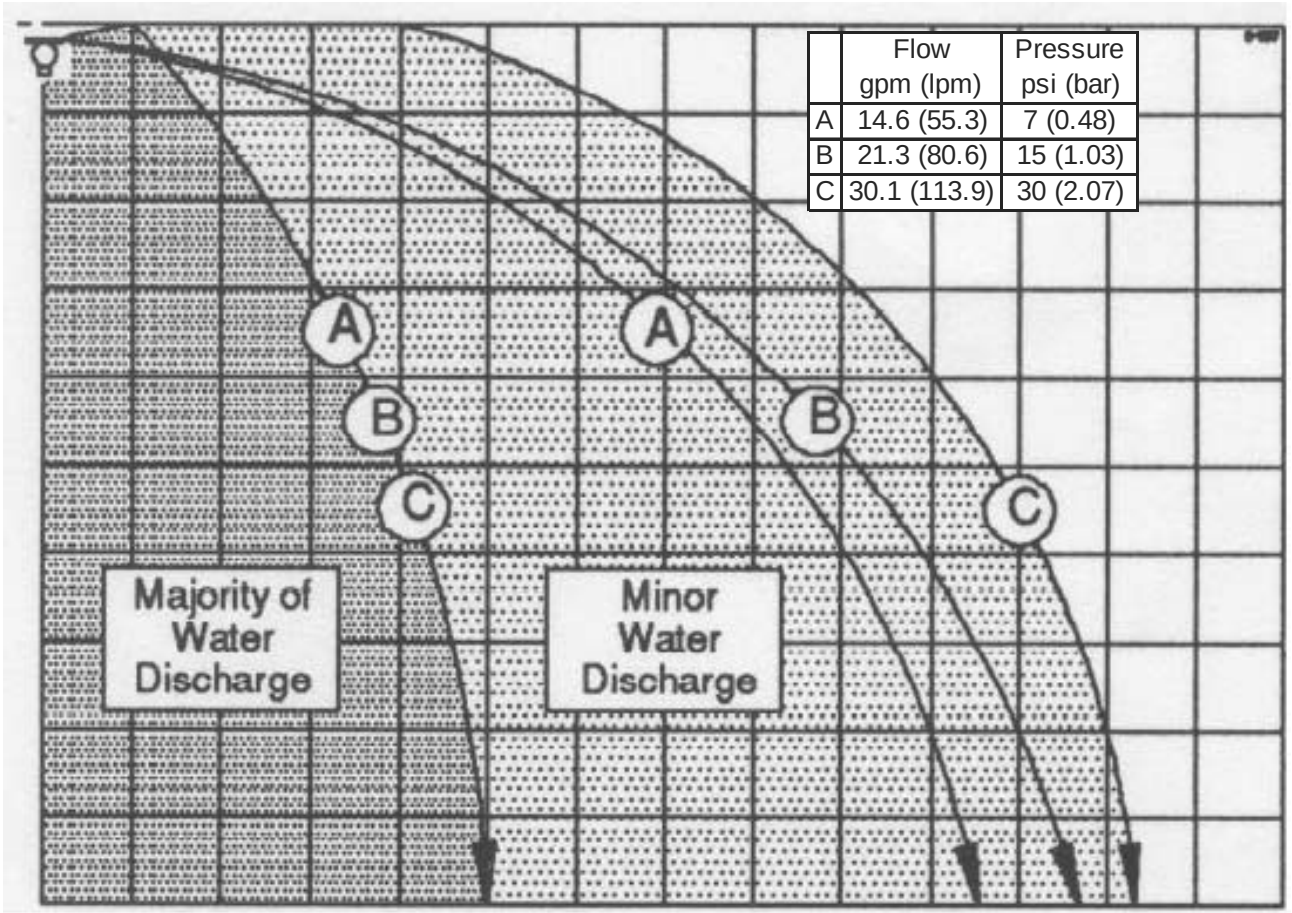
Conventional (Old-Style) Sprinklers (CUP)

A sprinkler intended for installation in the upright or pendent position

Directs from 40 - 60% of the total water initially discharged in the downward direction.

When installed in the upright position, this discharge covers a 10’ (3m) diameter circle, 10’ (3m) below the sprinkler, when the sprinkler is discharging water at the rate of 15 gpm (57 lpm)





	Flow gpm (lpm)	Pressure psi (bar)
A	14.6 (55.3)	7 (0.48)
B	21.3 (80.6)	15 (1.03)
C	30.1 (113.9)	30 (2.07)

10’ (3m)

8’ (2.4m)

6’ (1.8m)

4’ (1.2m)

2’ (0.6m)

0

4’ (1.2m)

8’ (2.4m)

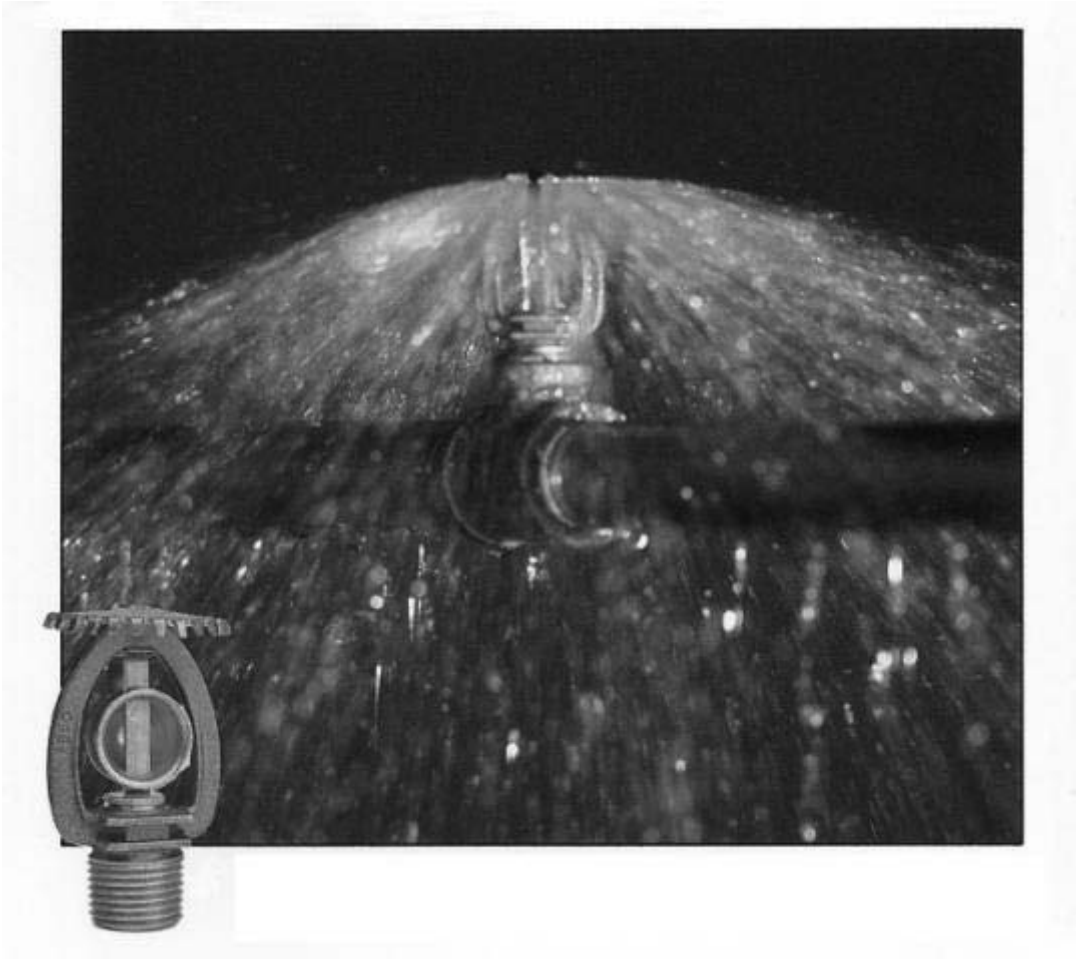
12’ (3.7m)

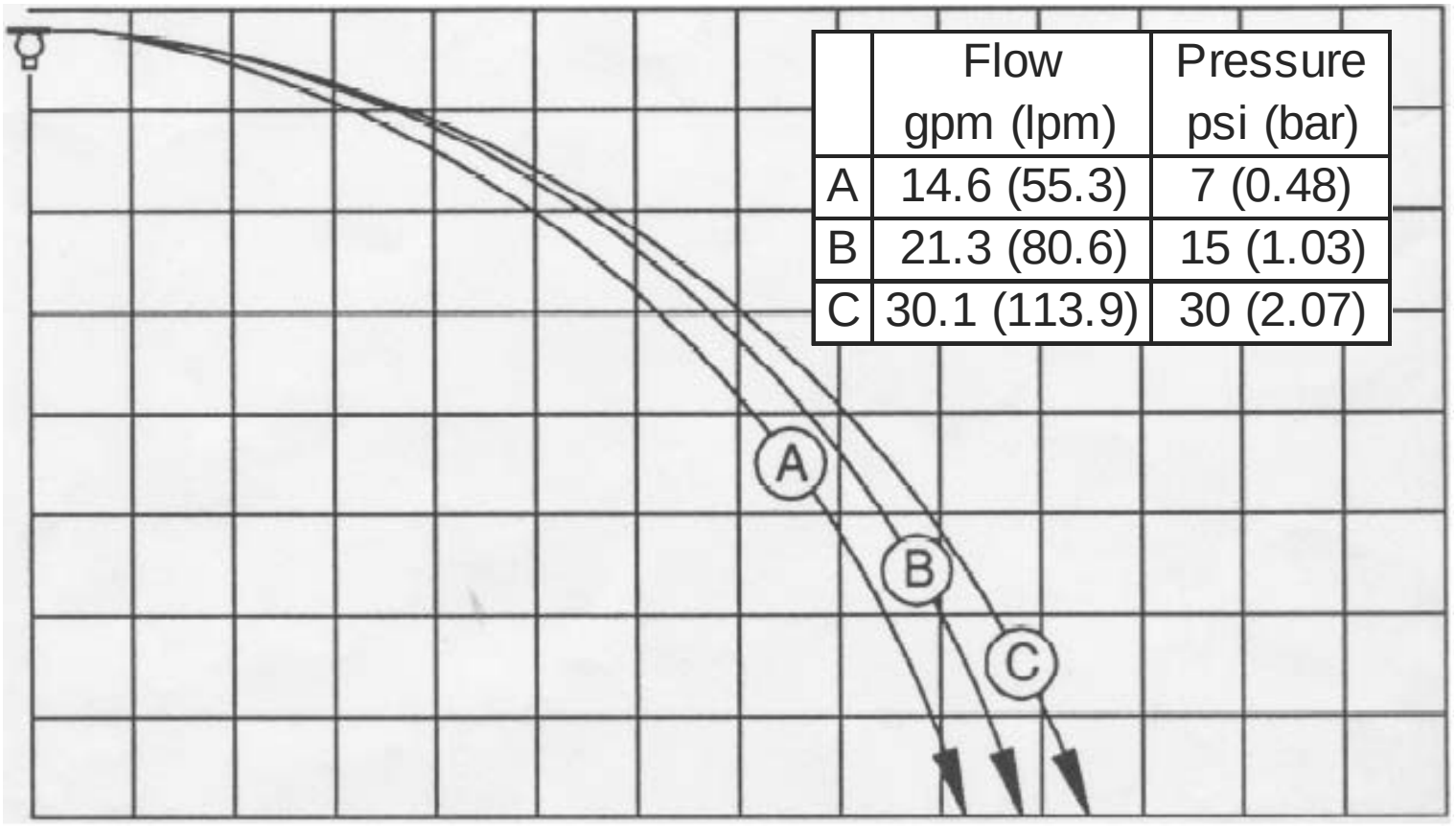
Standard Spray Sprinklers

A sprinkler intended for installation in either the upright or pendent position respectively.

Designed to distribute water downward in an umbrella-shaped pattern.

The discharge from a K-factor 80 spray sprinkler covers a 4.88m diameter circle 1.22m below the sprinkler, when discharging at 57 lpm





	Flow gpm (lpm)	Pressure psi (bar)
A	14.6 (55.3)	7 (0.48)
B	21.3 (80.6)	15 (1.03)
C	30.1 (113.9)	30 (2.07)

8’ (2.4m)

6’ (1.8m)

4’ (1.2m)

2’ (0.6m)

0

5’ (1.5m)

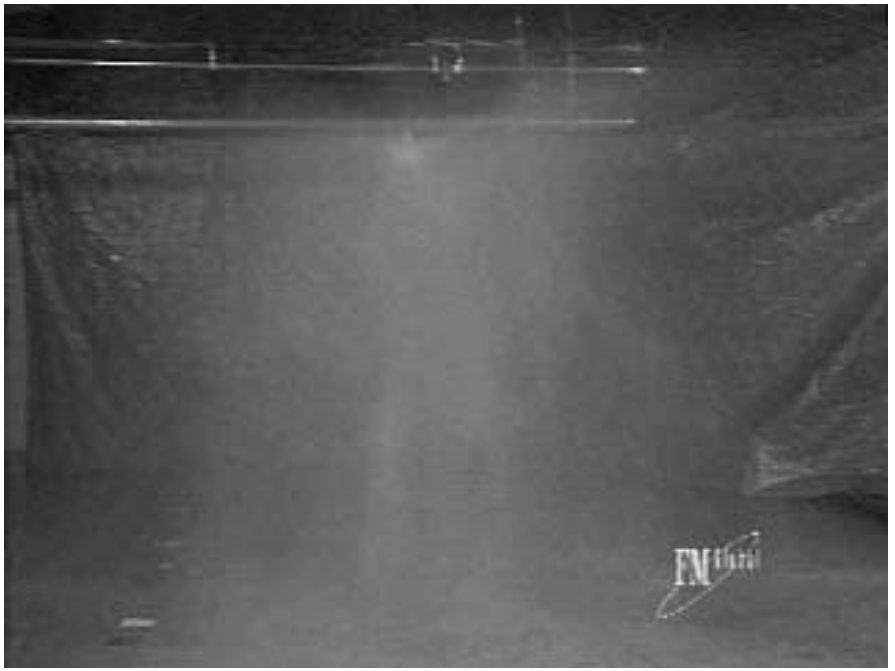
10” (3m)

15’ (4.6m)

Spray vs. Conventional Sprinkler



Spray Sprinkler



Conventional Sprinkler

Standard Spray Sidewall Sprinklers

A sprinkler with a deflector designed to discharge most of the water away from the nearby wall in a pattern resembling one-quarter of a sphere, with a small portion of the discharge directed at the wall behind the sprinkler.

Horizontal Sidewall sprinklers are sidewall sprinklers mounted on a horizontal wall.

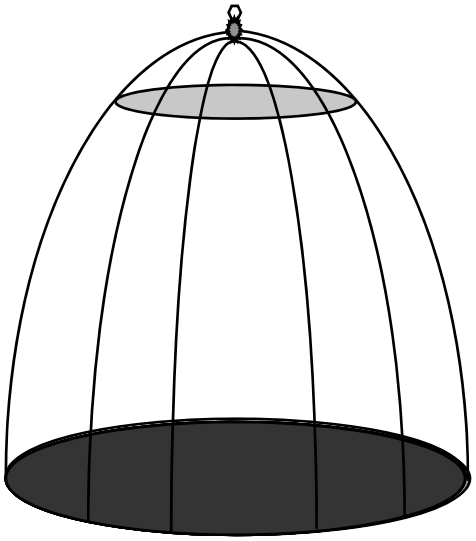
Vertical Sidewall Sprinklers sidewall sprinkler are mounted on the top or bottom of a piping system.



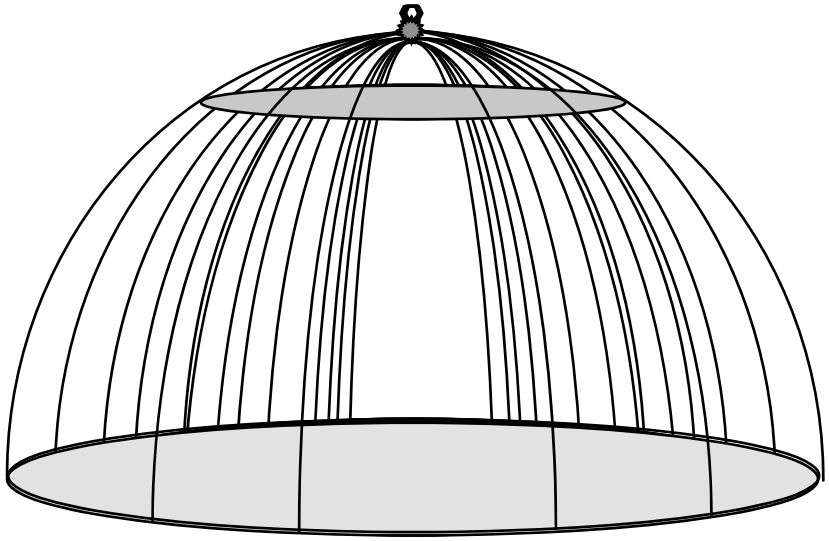


Extended Coverage Sprinkler

The higher the pressure, the higher the density over a certain area.



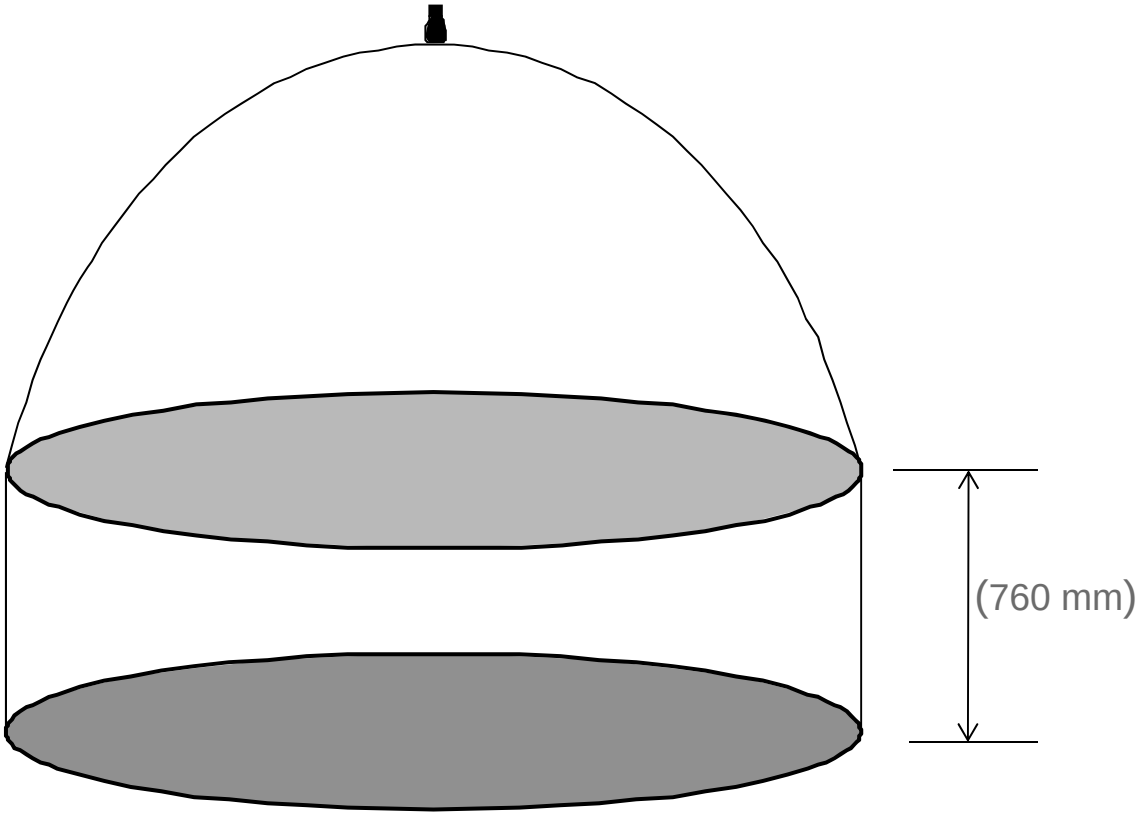
Standard Coverage



Extended Coverage

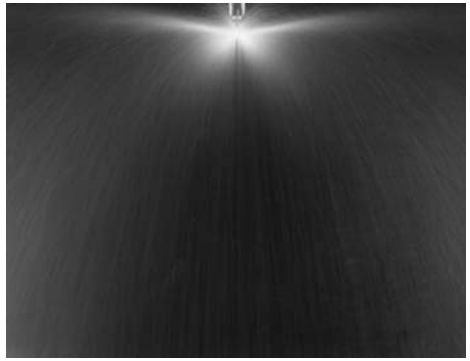
EC Upright & Pendent Sprinklers

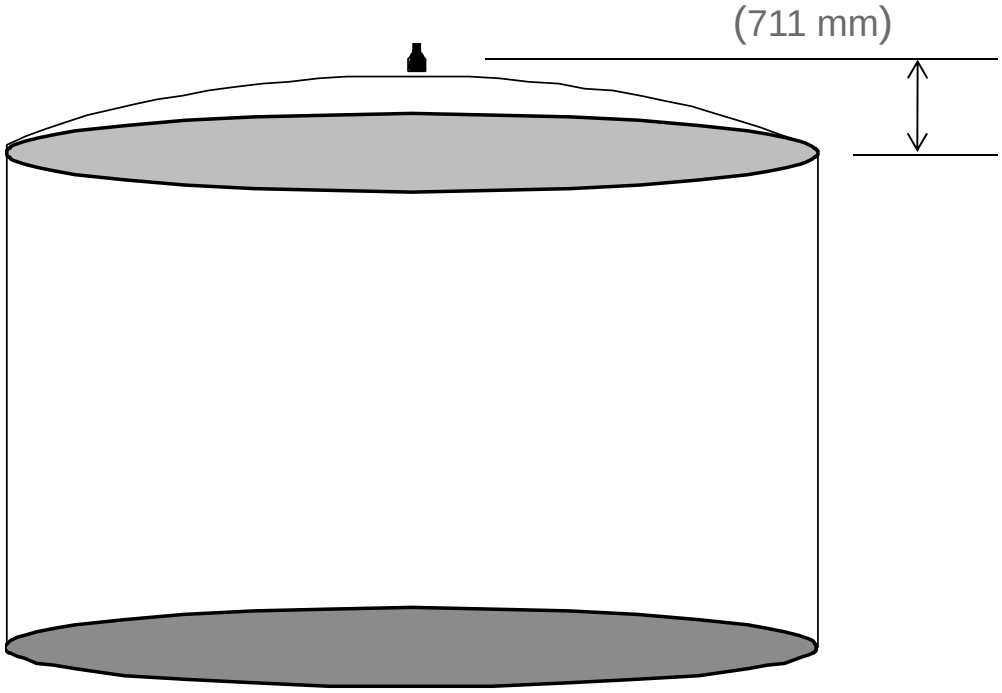
- Extended Coverage sprinklers must wet the wall 760 mm above the floor.
- Obstructions near the sprinkler are more of a concern



Residential Sprinklers

- The primary focus for residential sprinklers is life-safety.
- Give the occupants 10 minutes to evacuate the occupancy.
- High wall wetting is critical to sprinkler success.





Section 5.0

Characteristics

Center Strut Sprinkler

Operation (Pellet in a Horizontal Tube) -

- A copper tube sealed by two stainless steel balls holds a fusible alloy.
- When the rated temperature is reached, the alloy melts, the balls are forced toward each other releasing the tension mechanism, allowing the sprinkler to operate.
- Examples – TY-L, PH-2 & PH-5



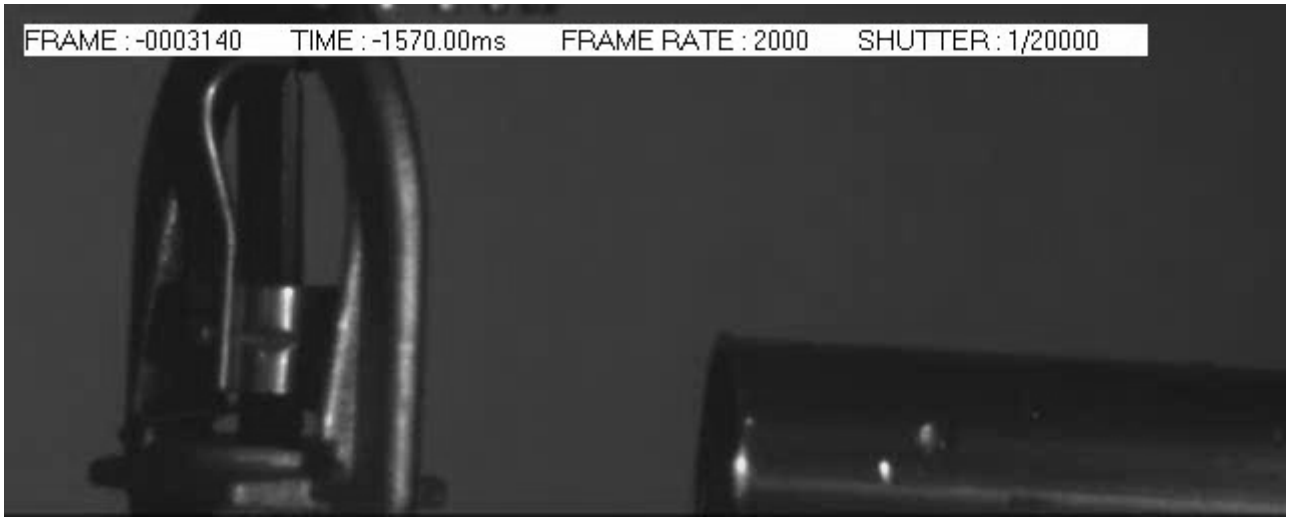
Operation (Vertical Tube) -

- A fusible alloy is sealed into a bronze actuating rod (center strut) by a stainless steel ball.
- When the alloy melts at its rated temperature, the ball is forced upward into the center strut, releasing the two ejectors and operating the sprinkler.
- Examples – ELO-231



RTI of Center Strut – 125 m-s½

Center Strut Upright Sprinkler



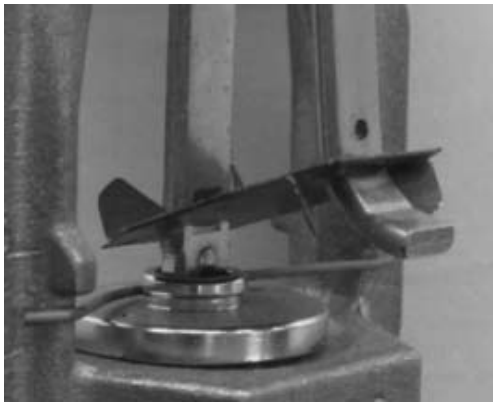
Fusible Link Sprinklers

Operation

- The fusible link (heat collector) assembly is comprised of two halves that are joined together by a thin layer of solder.
- When the rated temperature is reached, the solder melts and the two link halves separate, allowing the sprinkler to operate.

Examples – TY-FRL, ESFR-25, ESFR-17, ESFR-1, EC-25, ELOC, LFII Concealed, BB1, BB2, BB3, SD1, SD2 & SD3

RTI of Fusible Link – 26 m-s½





Fusible Link Pendent Sprinkler



Heat Fin Sprinklers

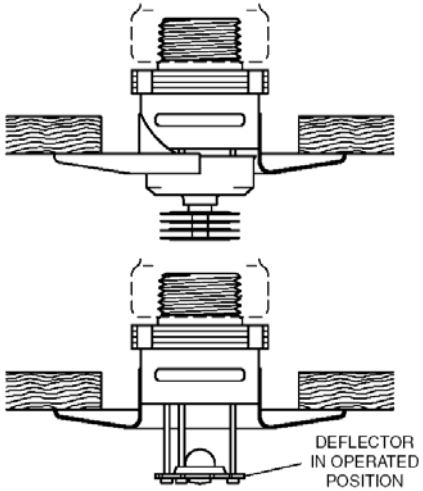
Operation

- The sprinkler assembly contains a small fusible solder element.
- When exposed to sufficient heat from a fire, the solder melts and enables the internal components of the sprinkler to fall away.
- At this point the sprinkler activates with the deflector dropping into its operated position allowing the sprinkler to operate.

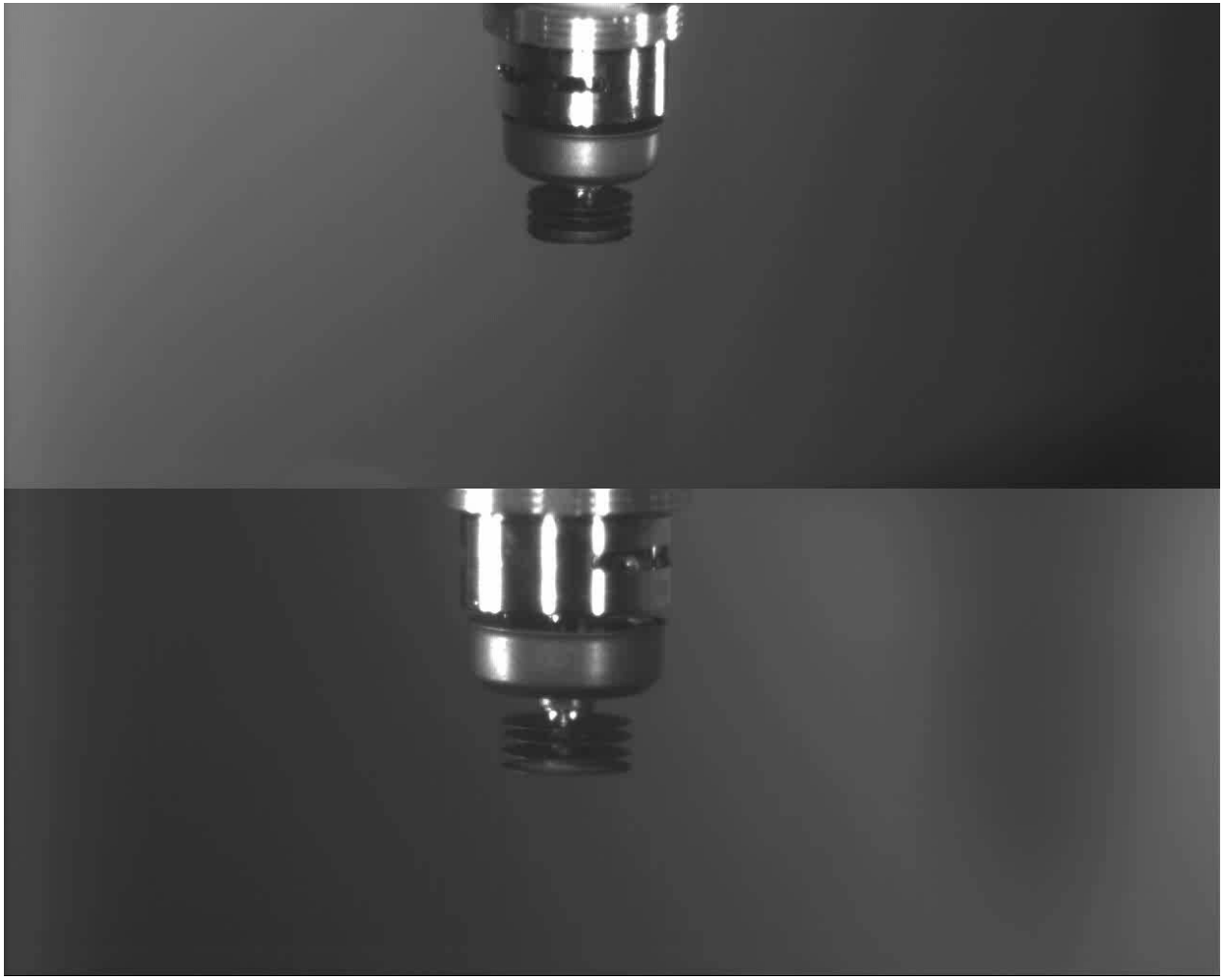
Examples – LFII Flush, TY-QRF Flush

RTI of Fusible Link – 26 m-s½





Heat Fin Pendent Sprinklers



Glass Bulb Sprinklers

Operation

- The glass Bulb contains a fluid which expands when exposed to heat.
- When the rated temperature is reached, the fluid expands sufficiently to shatter the glass Bulb, allowing the sprinkler to activate and water to flow.

5mm Bulb (Glycerin Antifreeze)

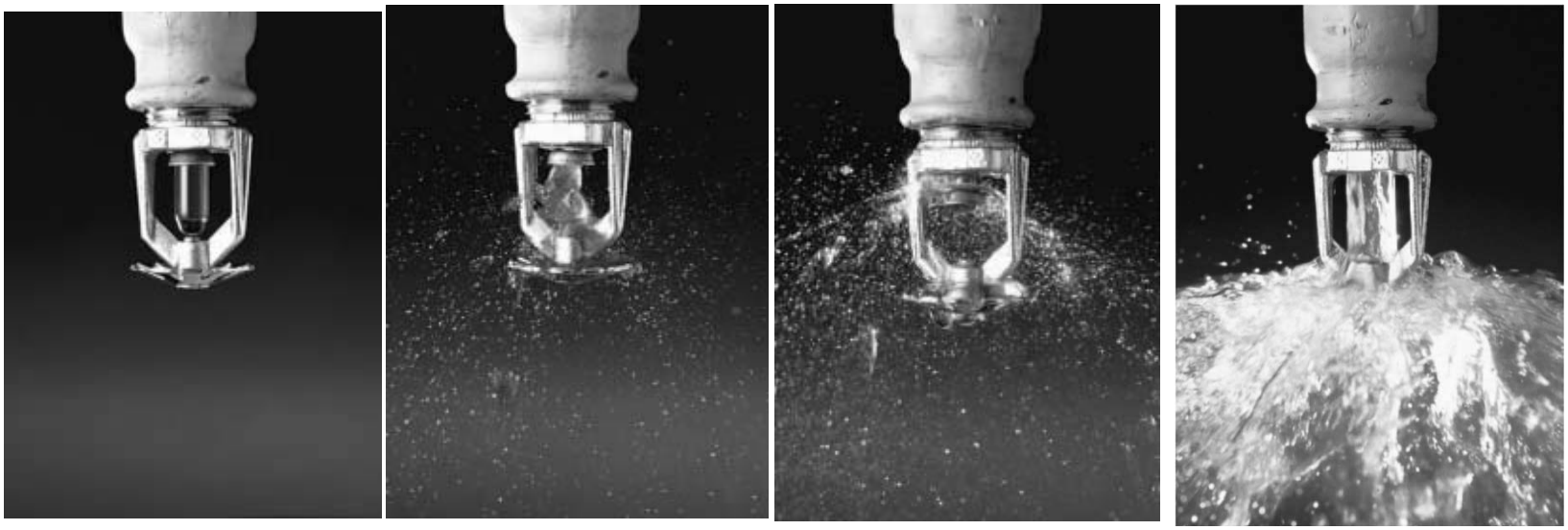
- Examples – TY-B, RFII, Ultra K17, K17-231, ELO-231B, LD, DS-1 & DS-2
- RTI of 5mm Glass Bulb – 105 m-s½

3mm Bulb (Tetrachloroethylene)

- Examples – TY-FRB, RFII, EC-14, EC-11, EC-8, ELO-231FRB, LFII Pend. & HSW., DS-1 & DS-2, BB1 17/32, BB2 17/32, BB3 17/32, HIP, WS, CC1 & TFP Max
- RTI of 3mm Glass Bulb – 35 m-s½



Glass Bulb Activation



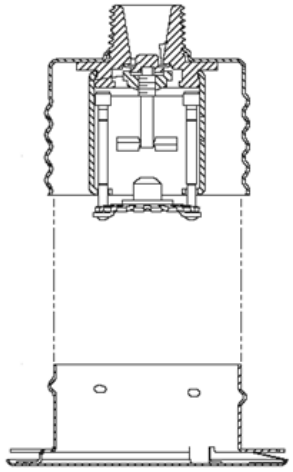
Concealed Sprinklers

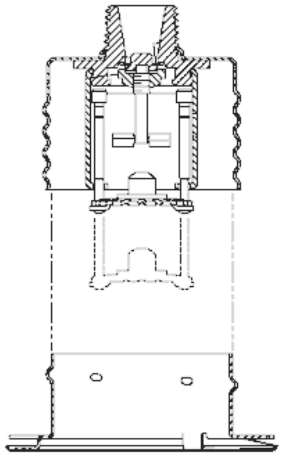
Operation

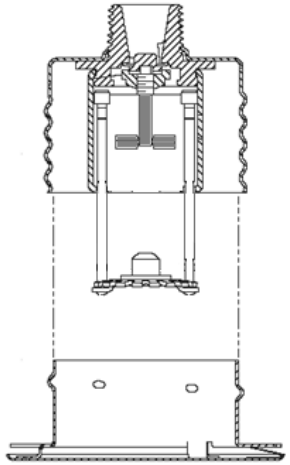
- A cover Plate, which is normally soldered to the Retainer at three points, falls away to expose the Sprinkler Assembly.
- The sprinkler deflector may be fixed or supported by the Guide Pins that allow the deflector to drop down to its operational position.
- When the rated temperature of the sprinkler is reached, the sprinkler activates allowing water to flow.

Examples – RFII, CHEC & LFII









Concealed Pendent Sprinkler



Temperature Rating NFPA13

Maximum Ceiling Temperature		Temperature Rating		Temperature Classification	Color Code	Glass Bulb Colors
°F	°C	°F	°C			
100	38	135–170	57–77	Ordinary	Uncolored or black	Orange or red
150	66	175–225	79–107	Intermediate	White	Yellow or green
225	107	250–300	121–149	High	Blue	Blue
300	149	325–375	163–191	Extra high	Red	Purple
375	191	400–475	204–246	Very extra high	Green	Black
475	246	500–575	260–302	Ultra high	Orange	Black
625	329	650	343	Ultra high	Orange	Black





There are many factors that can affect the activation time of an automatic sprinklers

- Ceiling height
- Sprinkler spacing
- Ambient room temperature
- Distance below ceiling
- Obstructions
- Fire Loading
- Sprinkler Operating Element

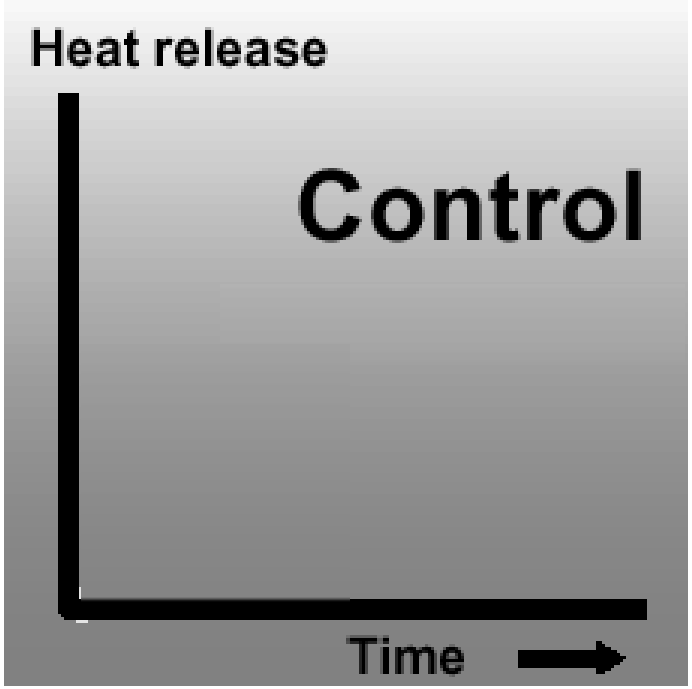


Control Mode Sprinklers

Limiting the size of a fire by distribution of water so as to control the heat release rate and pre-wet adjacent combustibles, while controlling ceiling gas temperatures to avoid structural damage.

Sprinkler Types:

- Control Mode Density Area (CMDA)
- Control Mode Extended Coverage (CMEC)
- Control Mode Specific Application (CMSA)



Control Mode Density/Area Standard Coverage (CMDA)

Sprinkler Type:

- 2.7 (40) K Up & Pend
- 4.2 (60) K Up & Pend
- 5.6 (80) K Up, Pend, HSW & VSW
- 8.0 (115) K Up & Pend
- 11.2 (160) K Up & Pend
- 14.0 (200) K Pend
- 16.8 (240) K Up & Pend



Control Mode Density/Area Extended Coverage (CMDA)

Sprinkler Type:

- 5.6 (80) K Pend & HSW
- 8.0 (115) K Pend & HSW
- 11.2 (160) K Up, Pend & HSW
- 14.0 (200) K Up & Pend
- 16.8 (240) K Pend
- 25.2 (360) K Up & Pend



Design:

- Calculate all the sprinklers within a given geometric area at a specific density

Control Mode Specific Application (CMSA)

Specific Application Control Mode Sprinkler For Storage Use. A type of spray sprinkler listed at a minimum operating pressure or density with a specific number of operating sprinklers for a given protection scheme.

Large Drop Sprinkler. A type of specific application control mode sprinkler that is capable of producing characteristic large water droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards.

Design:

- Calculate a specific # of sprinklers at a specific pressure

Model LD



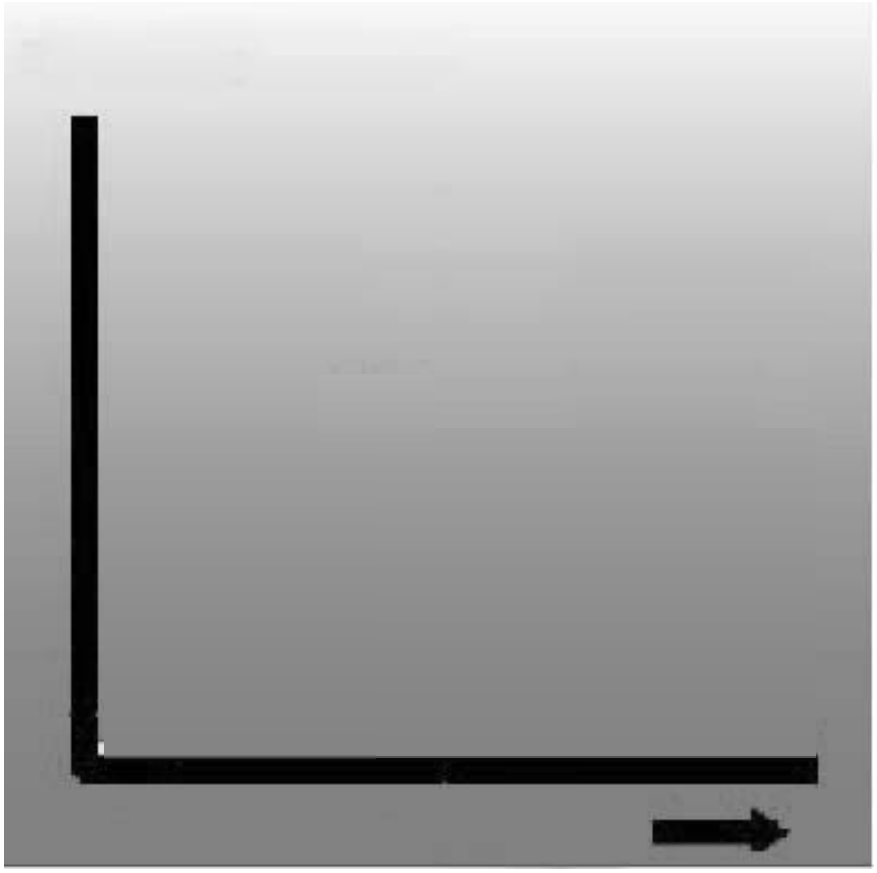


Ultra K-17

Suppression Mode Sprinklers

- Vertical fire spread is reversed
- Sprinklers operate quickly, while heat release is small & reduce heat radiation
- High density water delivered direct to the base area of fire
- Fewer sprinklers operate, less water damage
- Design parameters much more critical

- Sprinkler Types:
  - Early Suppression Fast Response (ESFR)



Suppression Mode Sprinklers

Sprinkler Type:
- 14.0 (200) K Up & Pend
- 16.8 (240) K Up & Pend
- 22.4 (326) K Pend
- 25.2 (360) K Pend

ESFR-17



Max Area of Coverage:
- 100 sq.ft. (9.3 m2)

Max Distance Between Sprinklers:
- 12’ (3.7m) – 30’ (9.1m) Building
- 10’ (3.01m) – >30’ (9.1m) Building

ESFR-25

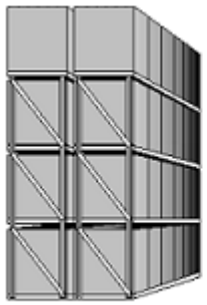


Design:
- Calculate a specific # of sprinklers at a specific pressure

Why ESFR?

11.2 (160) & 14 (200) K Spray Sprinklers

27’ (8.2m) Building
20’ (6.1m) Storage
~
.6 gpm/ft^2
(24.5 mm/min)



16.8 (240) K Spray Sprinkler

30’ (9.1m) Building
20’ (6.1m) Storage
~
.8 gpm/ft^2
(32.6 mm/min)



14 (200) & 16.8 (240) K ESFR’s

40’ (12,2 m) Build.

35’ (10,7 m) Stor.

ESFR-1

75 psi (5,17 bar)

ESFR-17

52 psi (3,59 bar)



25.2 (360) K ESFR’s

48’ (14,6 m) Build.

43’ (13,1 m) Storage

45 psi (3,1 bar)



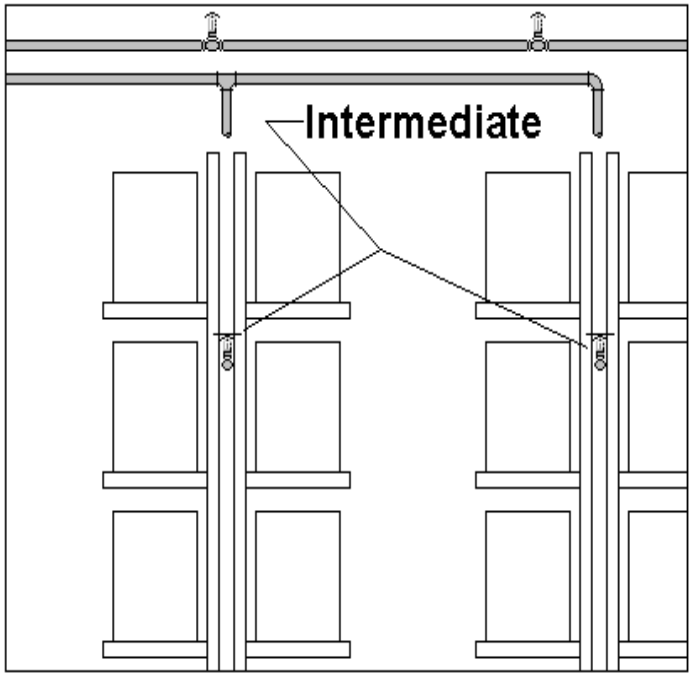
Elimination of in-rack sprinklers		
Building Height	**Storage Height**	**Sprinklers**
7.7 m	6.1 m	Std. Spray (K160 & K240), EC (K360), CMSA (K200 & K240), ESFR (K200, K240 & K360)
8.2 m	6.1 m	Std. Spray (K160 & K240), EC (K360), CMSA (K200 & K240), ESFR (K200, K240 & K360)
9.1 m	6.1 m	Std. Spray (K240), EC (K360), CMSA (K200 & K240), ESFR (K200, K240 & K360)
9.1 m	7.7 m	Std. Spray (K240), CMSA (K240), ESFR (K200, K240 & K360)
9.8 m	7.7 m	ESFR (K200, K240 & K360)
10.7 m	9.1 m	ESFR (K200, K240 & K360)
12.2 m	10.7 m	ESFR (K200, K240 & K360)
13.7 m	12.2 m	ESFR (K360)
14.6 m	13.1 m	ESFR (K360) (Specific Application Listing)

Intermediate Level / Rack Storage Sprinklers

A sprinkler equipped with integral shields to protect its operating elements from the discharge of sprinklers installed at higher elevations.





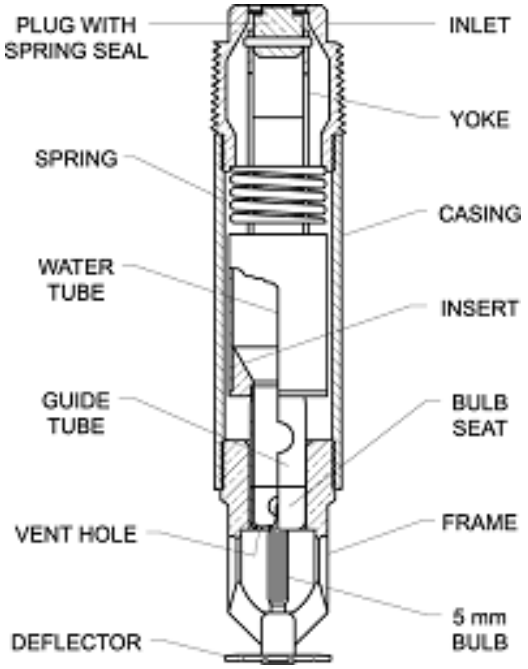


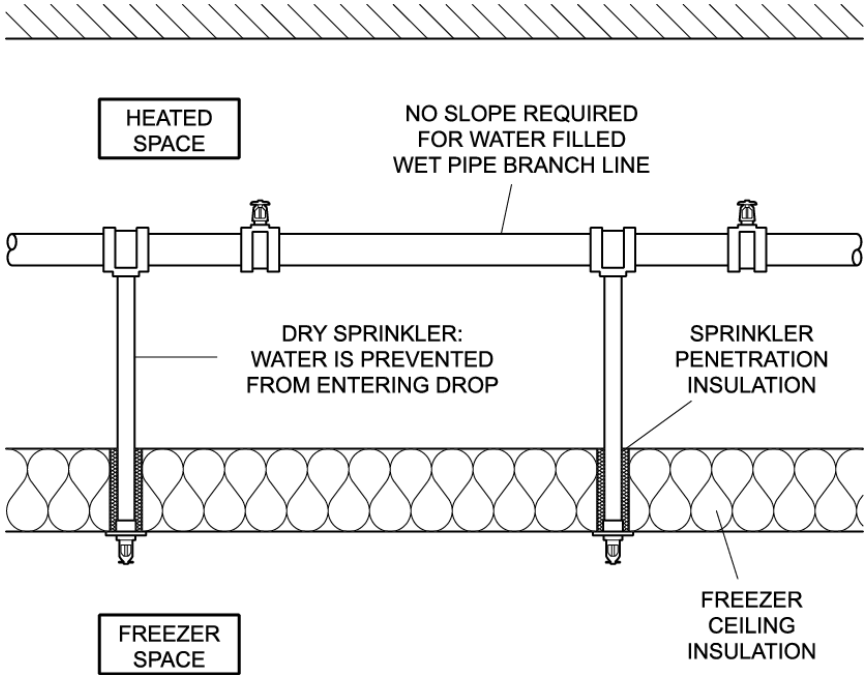
Section 6.0

Special Sprinklers

Dry Type Sprinklers

A sprinkler secured in an extension nipple that has a seal at the inlet end to prevent water from entering the nipple until the sprinkler operates.

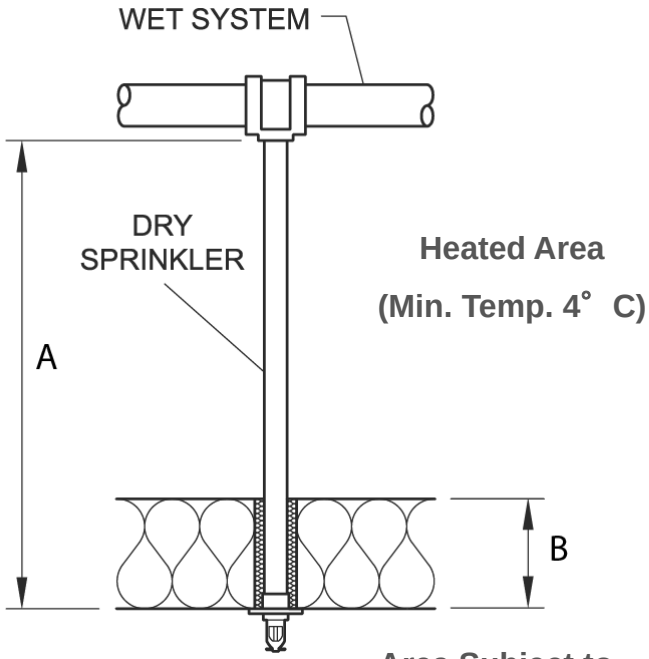




Wet Pipe Systems (Typically Freezers)

Calculating Minimum Order Length

Concern: The travel of cold conduction from the freeze area to the water seal. Formula creates length within the warm area in order to disperse freezing temperatures. ***Applying insulation to the sprinkler barrel will compound the issue.***



A=B+14(-7 -° C)

A = Order Length - Face of Fitting to Finished Ceiling (Inches)

B = Depth of Insulation (Inches)

Example:

Freezer Temp: -29° C & Insulation: 305mm

A=B+14(-7 -° C)

A=305+14[-7-(-29)]

A=305+14(-7+29), A=305+14(22)

A=305+308, A=613mm

Dry Type Sprinklers

Sprinkler Type:

- 5.6 (80) K Up, Pend & HSW
- 11.2 (160) K Pend & HSW
- 16.8 (240) K Pend (ESFR)







DSB-2

Dry Sprinkler Boot *(For Use With TFP Dry Type Sprinklers)*

- Helps to close the air gap created by the clearance hole through a wall or ceiling through which the dry type sprinkler has penetrated
- Intended for use with clearance holes through freezer ceiling structures
- Helps to stop the air exchange between the inside and outside of the freezer (or any other type of similar construction) to help prevent transfer of moist air into the freezer space
- Provides the added feature of eliminating the occurrence of cracking of some commonly used sealants, where the cracking of these sealants subsequently allows the passage of moist air

INCLUDES	1 Boot, 2 Strap Ties, and 1/3 oz. of Adhesive *(quantity of adhesive is sufficient for installing 1 Boot)*
TECH DATA	TFP591





Attic Sprinklers

tyco / Fire & Building Products

PEAK™ PERFORMANCE
ATTIC PROTECTION SPRINKLER SYSTEM

Models BB, SD, HIP, and AP
"Specific Application Sprinklers for Protecting Attics"

TFP610









Attic Sprinklers

TFP610

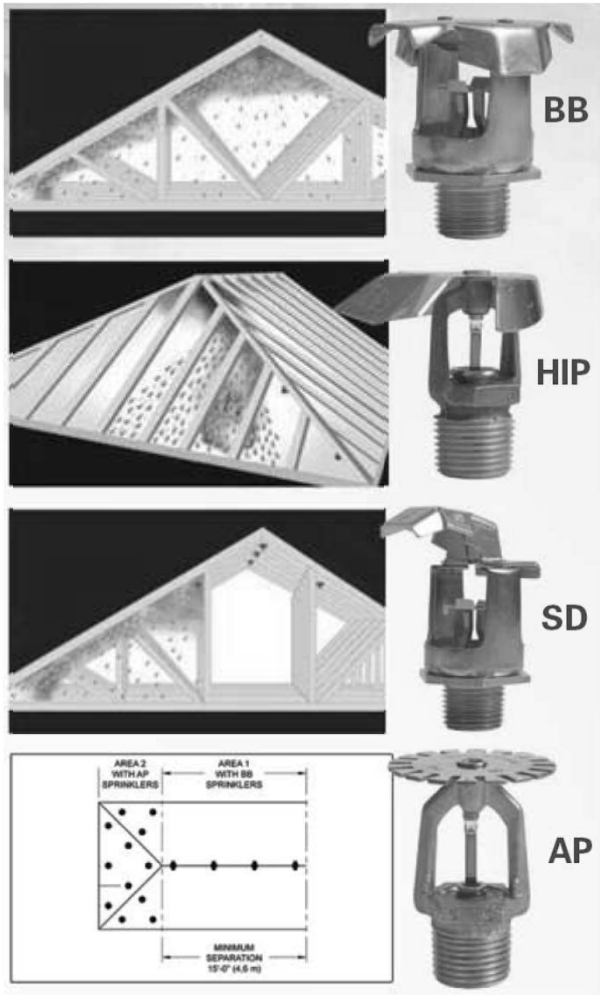
UL & C-UL listed

Pipe thread connection:

- ½” NPT for K=60 and 80
- ¾” NPT for K=115

Temperature Ratings:

- 93ºC for HIP, AP, BB (K=60, 115)
- 100ºC for SD, BB (K= 80)



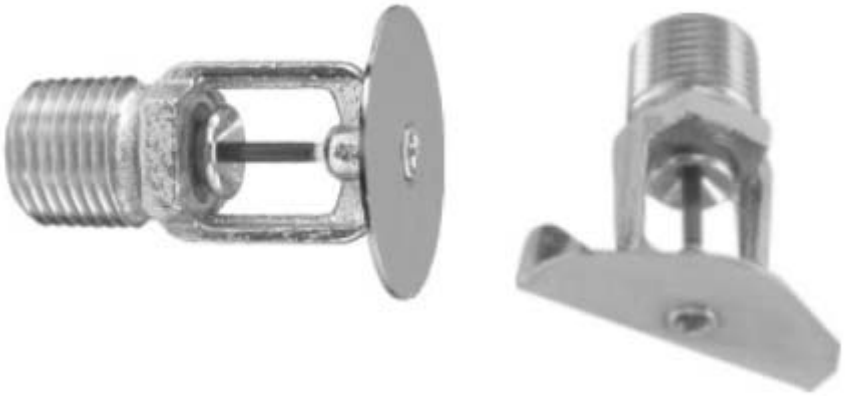
Specific Application Window Sprinkler, WS

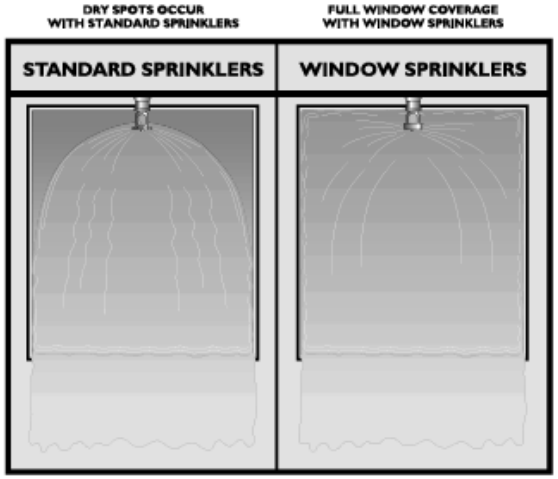
These sprinklers are the first sprinklers ever to be specifically Listed to provide protection for heat strengthened or tempered glass windows using automatic sprinklers.

These sprinklers are also recognized by ICC-ES, & ULC as providing a two-hour equivalency for a fire separation assembly.



GLAZING





Combustible Concealed Space Sprinklers (Specific Application)

Designed to provide protection of specific light hazard combustible, as well as non-combustible, concealed spaces requiring sprinkler protection.

The Model CC Sprinklers can in some cases allow for the use of BlazeMaster CPVC in wood truss construction & steel piping for the protection of solid wood joist construction.





Flat Spray Sprinkler

- Meets EN12845 Automatic Sprinkler Systems - Design, Installation and Maintenance
- In accordance with ‘CEA 4001 Sprinkler System Planning and Installation’
- Minimum clearance below the sprinkler can be reduced to 300 mm instead of 500 mm.
- Distance between sprinkler deflector and the top of storage ca. be reduced to 100 mm instead of 150 mm.



Institutional Sprinklers

Institutional Sprinklers are designed for use in areas such as correctional, detention & mental health care facilities

The unique features of these sprinklers provide a tamper resistant sprinkler design that helps eliminate the opportunity for individuals to injure themselves or others with the sprinkler components

These sprinklers are designed so that a suspended load applied to the linkage mechanism will release the sprinkler





Institutional Sprinklers

The Tyco® RAVEN™ Institutional Pendent and Horizontal Sidewall Sprinklers are quick response spray sprinklers designed for use in areas such as correctional, detention, and mental health care facilities, as well as other commercial buildings.

Both the pendent and horizontal sidewall styles are available for standard or extended coverage applications.



High Pressure Sprinklers

High Pressure Sprinklers – A type of sprinkler with a maximum rated service pressure greater than 175 psi (12,1 bar) used in applications that otherwise would require the use of a pressure control valve to reduce the static pressure to less than 175 psi (12,1 bar).

One of the most common uses for High Pressure Sprinklers is in the protection of high rise buildings.

Limited to use in light & ordinary hazard occupancies.



TY-B & TY-FRB
Upright, Pendent, Rec. Pendent
& Horizontal Sidewall (250 psi – 17 bar)



TY-FRB ECLH
Horizontal Sidewall
(250 psi – 17 bar)



RF II
Standard Coverage
Concealed Pendent
(250 psi – 17 bar)

Residential Sprinklers

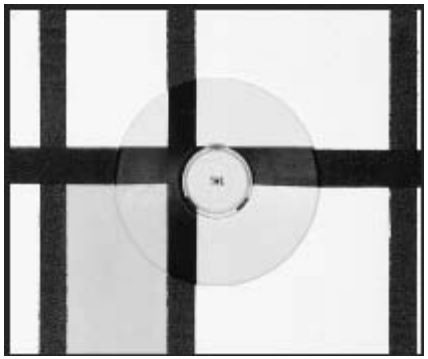
A type of fast-response sprinkler that has been specifically investigated for its ability to enhance survivability in the room of fire origin and is listed for use in the protection of dwelling units.

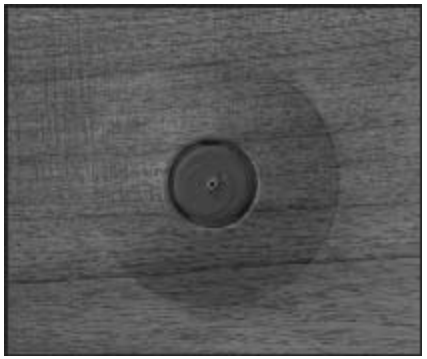




RAVEN Studio Sprinklers

TYCO RAVEN Studio Sprinklers, Pendent and Horizontal Sidewall (HSW) Quick Response, Standard Coverage for Light and Ordinary Hazard applications and Extended Coverage for Light Hazard applications only, are intended for use in areas as designed per NFPA 13.







Finishes

Sprinkler: White, Grey, or Custom Color

Escutcheon: White, Grey, Chrome, Primed*, Custom Color, or Electropolish

* Ready to paint-in-place

The Illusion™

Casino Sprinkler TY5521, TFP184

Extra Large Orifice, Concealed Pendent

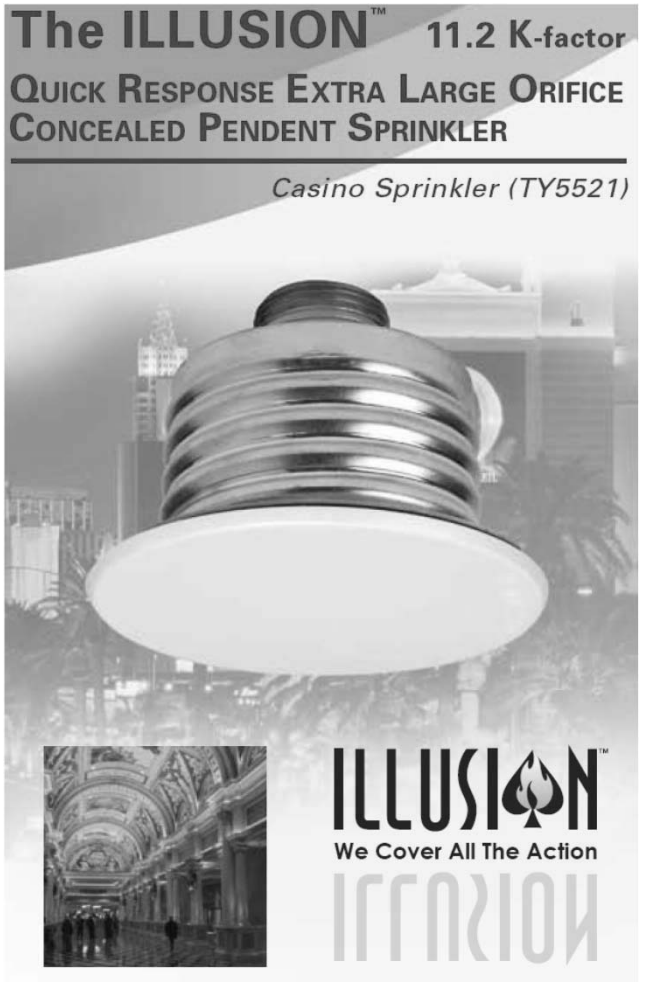
Sprinkler, Quick Response Standard Coverage

UL and C-UL Listed

NOT for storage protection

K-factor 160, ¾” NPT

Temp. ratings: 71º C & 100º C



Datasheets



www.tyco-fire.com

Section 7.0

Questions



Thank You

tyco
Fire Protection Products