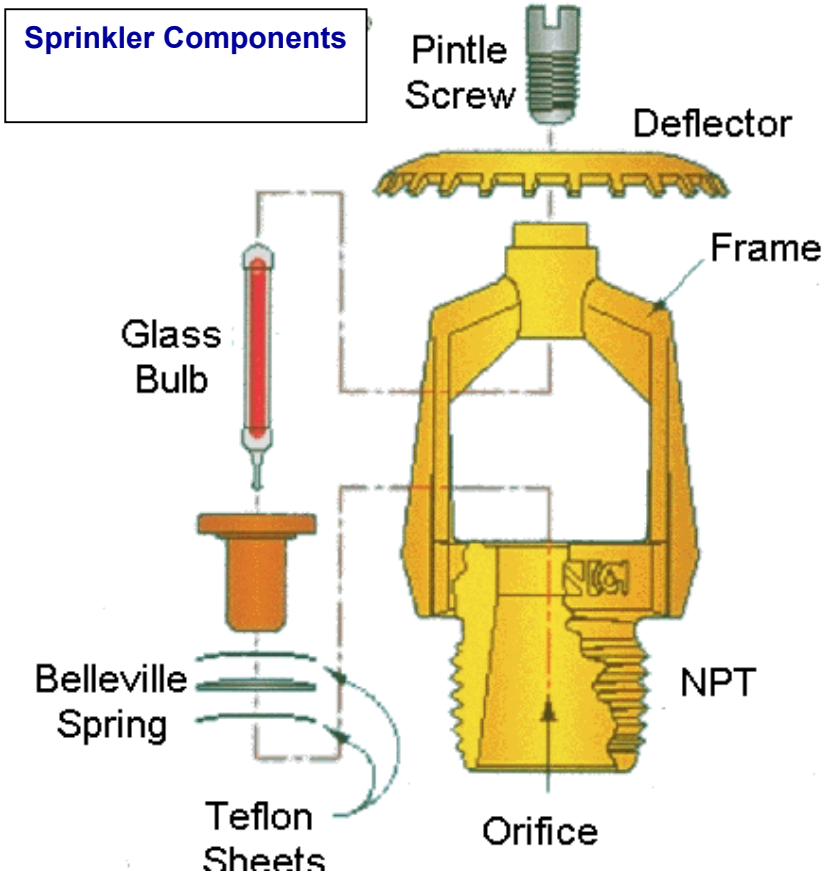
General Design of Firefighting - Sprinkler System
(Description, spacing, flow rate, Pressure Requirements, Applications and Related Standards)

Parts of a Sprinkler

The components of a sprinkler head are: ١. Frame or casting, ٢. Deflector ٣. Fusible element or frangible bulb, ٤. Pip Cap, ٥. Pintle Screw. ٦. Belleville Spring
Some Sprinklers utilize low zinc content brass to provide a more resilient frame or casting. This low zinc content protects the sprinkler from de zincification.
The Bellville Spring seals the water way of the sprinkler. This metal to metal sealing mechanism allows the waterway to clear even when no pressure is on the inlet of the - Sprinkler head



Laboratory Approvals

UL & c-UL (ULC) : NFPA & UL Requirements
FM : FM Requirements
(NFPA : NFPA minimum)
LPC :P LPC Standard
VDS : VDS Standard
NYC & LA : Specific City

approvals

Types of Sprinkler Heads
Control Mode – Standard Response and Quick Response

Standard Coverage
Upright
Pendent
Sidewall

Extended Coverage
Upright
Pendent
Sidewall

Control Mode Special Application
Large Drop Sprinkler
Suppression

ESFR – upright and Pendent
Residential

Control Mode Sprinklers
Control Mode Sprinklers are separated in the following
Categories:
Standard Coverage - Standard Response
Standard Coverage - Quick Response
Extended Coverage – Standard Response
Extended Coverage – Quick Response
Dry Barrel – Standard Response/Quick Response
Storage – Standard/Quick Response

Sprinkler Head Identification

MICROMATIC® Model M Glass Bulb Sprinkler V12 V01 - V11[4]			Model Number (SIN)
STANDARD RESPONSE			
UPRIGHT 			VK100 VK200 VK200 VK001 VK002 VK002 VK145 VK200
	BSP BSP BSP		
PENDENT 			VK102 VK202 VK202 VK003 VK004 VK004 VK202 VK202
	BSP BSP BSP		

The Model or SIN (Sprinkler Identification) Number is a number assigned to a sprinkler head. The number is stamped on the sprinkler deflector as a means of identifying the sprinkler

Sprinkler identifying

SIN Number

SIN Number

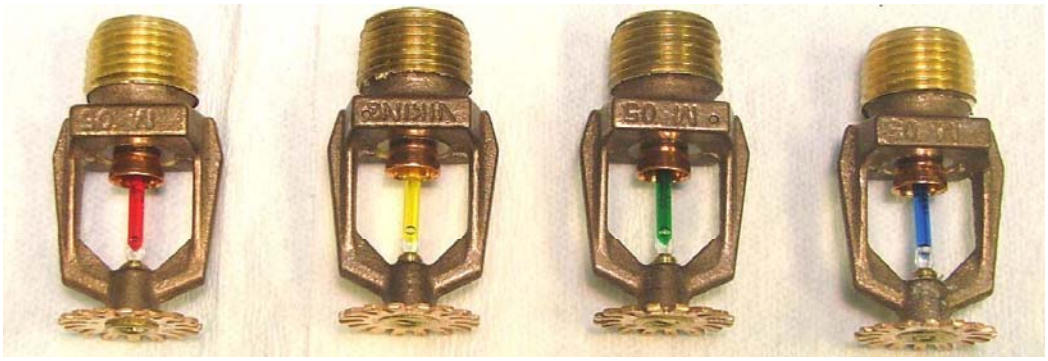
Thermal Response Requirements

TEMPERATURE RATINGS FOR GLASS BULB HEADS

A - Standard Response Elements – ٥ mm bulb

١٥٥°F	١٧٥°F	٢٠٠or٢١٢°F	٢٨٦°F	٣٦٠°F	٥٠٠°F
(٦٨°C)	(٧٩°C)	(٩٣or١٠٠°C)	(١٤١°C)	(١٨٢°C)	(٢٦٠°C)
Ordinary	Intermediate		High	Extra High	Ultra High
Red	Yellow	Green	Blue	Mauve	Black
Max Ceil Temp ١٠٠°F (٣٨°C)	Max Ceiling Temp ١٥٠°F (٦٥°C)		Max Ceiing Temp ٢٢٥°F (١٠٧°C)	Max Ceiing Temp ٣٠٠°F (١٤٩°C)	MaxCeiing Temp ٤٦٥°F (٢٤٠°C)

B - Fast Response Elements – ٣ mm bulb



١٥٥°F	١٧٥°F	٢٠٠or٢١٢°F	٢٨٦°F
(٦٨°C)	(٧٩°C)	(٩٣or١٠٠°C)	(١٤١°C)
Ordinary	**Intermediate**		**High**
Max Ceiling Temp	**Max Ceiling Temp**		**Max Ceiling Temp**
١٠٠°F	١٥٠°F		٢٢٥°F
(٣٨°C)	(٦٥°C)		(١٠٧°C)
Red	Yellow	Green	Blue

K Factors

K factors are known as the coefficient of discharge. the larger the K factor in number, the more water it can discharge at a given pressure. There are (٣) current thread sizes used for sprinkler heads, ½", ¾", and ١" threads.

Do not just match the thread size when replacing a sprinkler head. Identify what orientation, K factor, and temperature prior to replacing a sprinkler.

Orifice Sizes - Effect of Larger K Factors

- Develop larger water droplets that penetrate the fire plume
- Discharges same water density at lower pressures
- Lower starting pressures may save the designer a pipe size in their calculations, which will lower the cost of the system installation.

Calculating (K)

NOMINAL K FACTORS- NFPA١٣ and Factory Mutual
Sprinkler “K Factors are as follows

K	of% ٥.٦	Thread
١.٤	٢٥%	½”
١.٩	٣٣.٣%	½”
٢.٨	٥٠%	½”
٤.٢	٧٥%	½”
Baseline		
٥.٦	١٠٠%	½”
٨.٠	١٤٠%	¾”
١١.٢	٢٠٠%	¾”
١٤.٠	٢٥٠%	¾”
١٦.٨	٣٠٠%	¾”
١٩.٦	٣٥٠%	١”
٢٢.٤	٤٠٠%	١”
٢٥.٢	٤٥٠%	١”
٢٨.٠	٥٠٠%	١”

Sprinkler Sensitivity

-Thermal Response Requirements

SPRINKLER SENSITIVITY

- **STANDARD RESPONSE : – ٣ Min. ٥١ Sec. Room Fire Test**
  -١٠٠ Sec. Plunge Test

- **QUICK RESPONSE : – ٧٥ Sec. Room Fire Test**
  – ١٤ Sec. Plunge Test

- **RESIDENTIAL : – Special Fire Test**
  – ١٤ Sec. Plunge
  – Plunge Oven

Response Time Index - RTI

• RTI - measures the speed of response of the heat sensitive element
• Traditionally Fast Response sprinklers have a thermal element with an RTI of ٥٠ (m/s²) or less. ESFR's must have a thermal element with an RTI of ٣٦ m/s²) or less

• Standard Response Sprinklers have a thermal element with an RTI of ٨٠ (m/s²) or more.
Components:
Strut –١١٠ m/s², Glass Bulb (٥mm) - ١٠٥ m/s², Fusible Link –٢٦ m/s², Glass Bulb (٣mm) - ٣٦ m/s², Glass Bulb (٢.٥mm) - ٢٢ m/s²
Heat Fin - ٢٦ m/s²

MINIMUM SPRINKLER FLOW

Q = Area x Density
Q = K x P
P = (Q/K)٢
K = Q/ P
Were:
Q = Water Flow
K = Coefficient of discharge
P = Pressure

Sprinkler Spacing

-Determining Area/Sprinkler
A. Along branch lines:
١. Determine distance between sprinklers (or to wall/obstruction)
٢. Choose largest - twice distance to wall or distance to next sprinkler.
This dimension will be defined as S.

B. Between branch lines:
١. Determine distance to adjacent branch line (or to wall//obstruction).
٢. Choose largest - twice distance to wall or distance to adjacent line.
This dimension will be defined as L.

Area/Sprinkler = S × L

Extended Coverage or Residential
Must use one of the listed coverage areas

The actual area protected per sprinkler must fit within the listed design coverage area

7.4 (107) K-factor

VK458, Part No. 13230
Tech Data Page Sprinkler 140w

- Larger K-Factor provides lowest starting pressure in NFPA 13 applications (0.1 density)

12 x 12 (3,7x3,7)	20 (75,7)	7.3 (0,50)	20[1] (75,7)	7.3 (0,50)
14 x 14 (4,3x4,3)	20 (75,7)	7.3 (0,50)	20[1] (75,7)	7.3 (0,50)
16 x 16 (4,9x4,9)	20 (75,7)	7.3 (0,50)	20[1] (75,7)	7.3 (0,50)
18 x 18 (5,5x5,5)	22 (83,3)	8.8 (0,61)	23[1] (87,1)	9.7 (0,67)
20 x 20 (6,1x6,1)	24 (90,8)	10.5 (0,72)	24[1] (90,8)	10.5 (0,72)

[1] Flows shown for 155°F/68°C; see data page for flows at 175°F/79°C

5.2 (75) K-factor

VK436, Part No. 12166
Tech Data Page Sprinkler 140j

- Listed with beam ceilings up to 14"

12 x 12[2] (3,7x3,7)	14 (53,0)	7.2 (0,50)	14 (53,0)	7.2 (0,50)
14 x 14[2] (4,3x4,3)	14 (53,0)	7.2 (0,50)	14 (53,0)	7.2 (0,50)
16 x 16[2] (4,9x4,9)	14 (53,0)	7.2 (0,50)	14 (53,0)	7.2 (0,50)
18 x 18[2] (5,5x5,5)	17 (64,4)	10.7 (0,74)	18[1] (68,1)	12.0 (0,83)
20 x 20 (6,1x6,1)	20 (75,7)	14.8 (1,02)	20[1] (75,7)	14.8 (1,02)

[1] Flows shown for 155°F/68°C; 175°F/79°C available at 21 (79,5) / 16.3 (112,4).
[2] Also listed for 4/12 slopes at 17 (64,4) / 10.7 (73,7).

5.5 (79) K-factor

VK432, Part No. 10050
Tech Data Page Sprinkler 141a

- Continually listed by UL since 1997

12 x 12 (3,7x3,7)	16 (60,6)	8.5 (0,58)	21 (79,5)	14.6 (1,01)
14 x 14 (4,3x4,3)	19 (71,9)	11.9 (0,82)	21 (79,5)	14.6 (1,01)
16 x 16 (4,9x4,9)	19 (71,9)	11.9 (0,82)	21 (79,5)	14.6 (1,01)
18 x 18 (5,5x5,5)	21 (79,5)	14.6 (1,01)	22 (83,3)	16.0 (1,10)
20 x 20 (6,1x6,1)	24 (90,8)	19.0 (1,31)	28 (106,0)	25.9 (1,79)

7.4 (107) K-factor

VK458, Part No. 13230
Tech Data Page Sprinkler 140w

- Larger K-Factor provides lowest starting pressure in NFPA 13 applications (0.1 density)

12 x 12 (3,7x3,7)	20 (75,7)	7.3 (0,50)	20[1] (75,7)	7.3 (0,50)
14 x 14 (4,3x4,3)	20 (75,7)	7.3 (0,50)	20[1] (75,7)	7.3 (0,50)
16 x 16 (4,9x4,9)	20 (75,7)	7.3 (0,50)	20[1] (75,7)	7.3 (0,50)
18 x 18 (5,5x5,5)	22 (83,3)	8.8 (0,61)	23[1] (87,1)	9.7 (0,67)
20 x 20 (6,1x6,1)	24 (90,8)	10.5 (0,72)	24[1] (90,8)	10.5 (0,72)

[1] Flows shown for 155°F/68°C; see data page for flows at 175°F/79°C

Example:
١٩ ft x ١٠ ft (٥.٨m X ٣m) room
Use ٢٠ ft X ٢٠ ft (٦.١ X ٦.١)m

Determining design area

١. Determining Size- standard
Use NFPA Chart

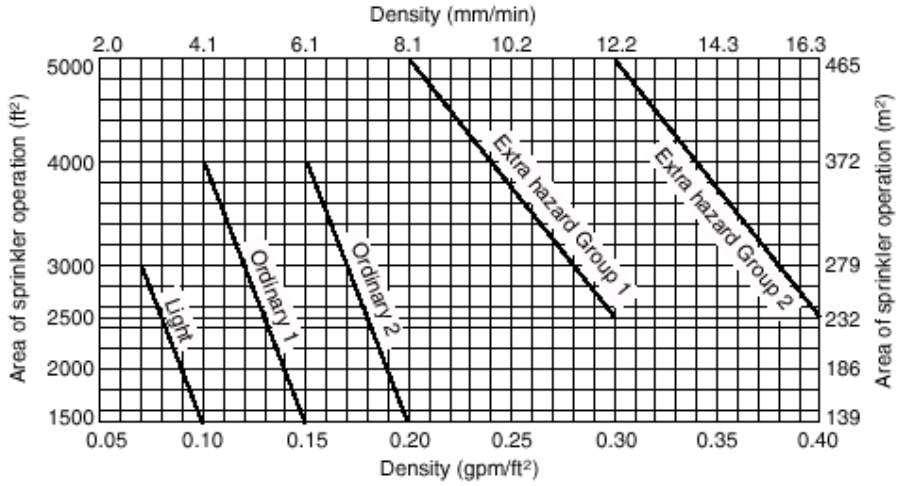


FIGURE 11.2.3.1.5 Density/Area Curves.

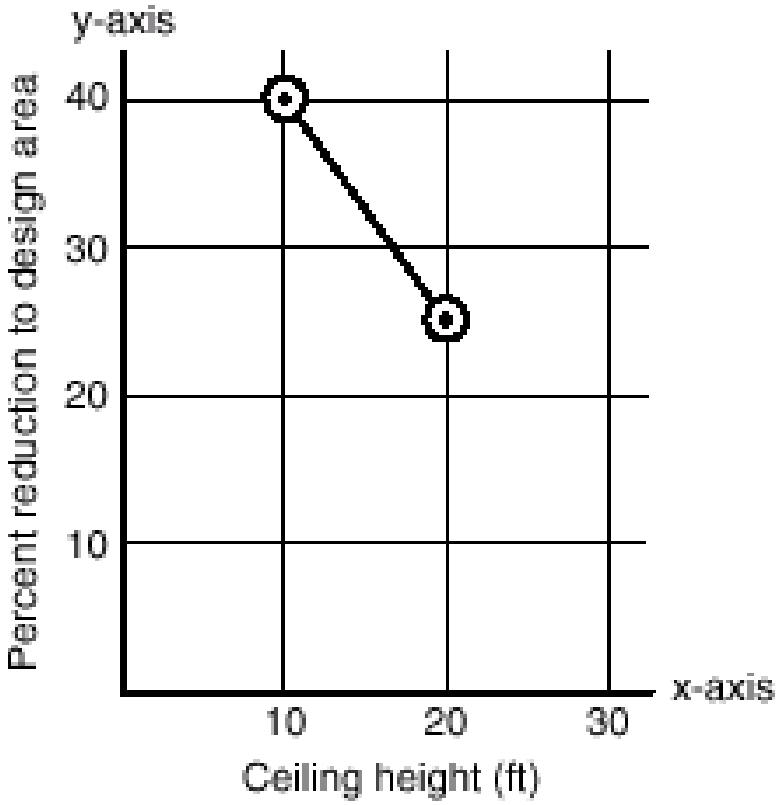
٢. Determining Size - Extended Coverage

Must use Greater of… Coverage of five sprinklers or area required by occupancy

Example ١:
Light Hazard w/ ٢٠x٢٠ Sprinklers ٤٠٠sf x ٥ sprinklers = ٢٠٠٠sf
LH = ١٥٠٠ sf
Use ٢٠٠٠sf

Example ٢:
Light Hazard w/ ١٤x١٤ Sprinklers ١٩٦sf x ٥ sprinklers = ٩٨٠sf
LH = ١٥٠٠ sf
Use ١٥٠٠sf

٣. Determining Size - Quick Response Sprinklers



When using Quick Response…
You can reduce the design area based on ceiling height

(Remember: NFPA ١٣ limits the minimum size to ٩٠٠sf= ٨٤m²)

Design Calculations

Calculating Flow (Q) at sprinkler End Head
Q = Area x Density
Example: .١٥ density with ١٢٠sf coverage per sprinkler
.١٥ x ١٢٠ = ١٨gpm minimum at sprinkler end head

Calculating Pressure (P) at the sprinkler End Head
$P = (Q \div K)^2$
Q = Flow at sprinkler end head
K = K Factor of Sprinkler

Example:
Q = ١٨gpm

K = ٥.٦
So… (١٨ ÷ ٥.٦)² = ١٠.٣psi Minimum

Calculating (K) - Orifice Sizes

Orifice Sizes are Represented by a “K Factor”
The K Factor is derived by the following formula:

$$K = ٢٩.٨٣\ CD^2$$

Basically, the larger the K value the larger the orifice.

Starting Pressure Comparison for Different Orifice Sprinklers

K Factor	Flow Rate	Starting Pressur
٥.٦	٢٦ gpm	٢١.٥٥ psi

٨.٠	٢٦ gpm	١٠.٥٦ psi
١١.٢	٢٦ gpm (٢٩.٦٣ gpm)	٥.١١ psi (min ٧ psi)

K Factor	Flow Rate	Starting Pressur
١٦.٨	٢٦ gpm (٤٤.٤٤ gpm)	٢.٣٩ psi (min ٧ psi)

٠.٢٠ gpm per sq. ft x ١٣٠ sq. ft. = ٢٦ gpm

Standard Coverage Sprinklers Pendent or Upright

Minimum operating pressure is ٧ psi. Flow rate per sprinkler is determined by area x density or minimum pressure multiplied by square root of minimum pressure (which ever is greater)

Pendent

Upright

Standard Spray Sprinkler Spacing (Area of Coverage)
Light Hazard (as defined by NFPA ١٣) : ٢٢٥ sq. ft.
max Ordinary Hazard (as defined by NFPA ١٣) : ١٣٠ sq. ft.
Max Extra Hazard (as defined by NFPA ١٣) : ١٠٠ sq. ft. max
(Note: areas given for hydraulically calculated systems)

Classification of Occupancies

Upright and pendent spray sprinklers shall be permitted in all occupancy hazard classifications and building construction types.

٥.١* Classification of Occupancies.

٥.١.١ Occupancy classifications for this standard shall relate to sprinkler design, installation, and water supply requirements only.
٥.١.٢ Occupancy classifications shall not be intended to be a general classification of occupancy hazards
.

٥.٢* Light Hazard Occupancies.

Light hazard occupancies shall be defined as occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.
EXAMPLES: Churches, Clubs, Hospitals, Museums, Offices, Restaurant Seating Areas

NFPA ١٣ limits maximum area of coverage for Light Hazard to ٢٢٥ sq. ft. per sprinkler

O O O

١٥ft(٤.٥٧m)

O ١٥ft(٤.٥٧m) O O

Density prescribed for Light Hazard is ٠.١٠ gpm per sq. ft.
Minimum flow rate for sprinklers spaced ٢٢٥ sq. ft. is
Determined by area x density
Q = ٠.١٠ gpm per sq. ft. x ٢٢٥ sq. ft. = ٢٢.٥ gpm

٥.٣.١* Ordinary Hazard (Group ١).
Ordinary hazard (Group ١) occupancies shall be defined as occupancies or portions of other occupancies where combustibility is low, quantity of combustibles is moderate,
stockpiles of combustibles do not exceed ٨'-٠", and fires with moderate rates of heat release are expected.
Examples: Restaurant Service Areas, Bakeries, Automobile Parking and Showrooms, Laundries

٥.٣.٢* Ordinary Hazard (Group ٢). Ordinary hazard (Group ٢) occupancies shall be defined as occupancies or portions of other occupancies where the quantity and combustibility of contents are moderate to high, stockpiles do not exceed ١٢', and fires with moderate to high rates of heat release are expected.
Examples: Dry Cleaners, Horse Stables, Machine Shops, Library
Stack Rooms, Mercantile, Confectionary Products, Casino area.

NFPA ١٣ limits maximum area of coverage for Ordinary Hazard to ١٣٠ sq. ft. per sprinkler

O O O

١٣ft(٣.٩٧m)

O ١٠ft(٣.٠٤m) O O

Density prescribed for Ordinary Hazard ١ is ٠.١٥ gpm per sq. ft.

Minimum flow rate for sprinklers spaced ١٣٠ sq. ft. is
Determined by area x density
Q = ٠.١٥ gpm per sq. ft. x ١٣٠ sq. ft. = ١٩.٥ gpm

Density prescribed for Ordinary Hazard ٢ is ٠.٢٠ gpm per sq. ft.

Minimum flow rate for sprinklers spaced ١٣٠ sq. ft. is
Determined by area x density = Q
Q = ٠.٢٠ gpm per sq. ft. x ١٣٠ sq. ft. = ٢٦ gpm

٥.٤.١* Extra Hazard (Group ١).

Extra hazard (Group ١) occupancies shall be defined as:
occupancies or portions of other occupancies where the quantity and combustibility of contents are very high and dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release but with little or no combustible or flammable liquids.
Examples: Combustible Hydraulic Fluid Use Areas, Metal Extruding, Saw Mills, Upholstering with Plastic Foams, Rubber Reclaiming

٥.٤.٢* Extra Hazard (Group ٢).

Extra hazard (Group ٢) occupancies shall be defined as occupancies or portions of other occupancies with moderate to substantial amounts of flammable or combustible liquids or occupancies where shielding of combustibles is extensive.

Examples: Flammable Liquids Spraying, Open Oil Quenching, Plastics Processing, Solvent Cleaning, Varnish and Paint Dipping

NFPA ١٣ limits maximum area of coverage for Extra Hazard to ١٠٠ sq. ft. per sprinkler

O O O

١٠ft(٣.٠٤m)

O ١٠ft(٣.٠٤m) O O

Standard Coverage Sprinklers

Density prescribed for Extra Hazard ١ is ٠.٣٠ gpm per sq. ft.

Minimum flow rate for sprinklers spaced ١٠٠ sq. ft. is Determined by area x density = Q

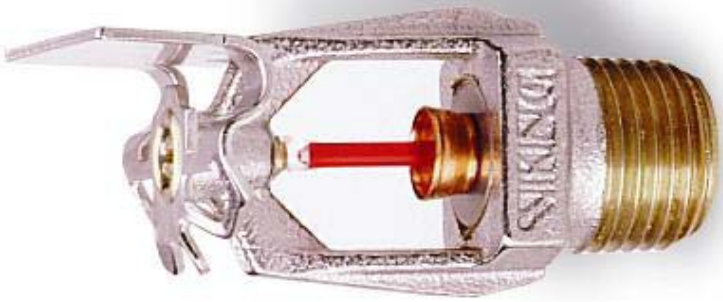
Q = ٠.٣٠ gpm per sq. ft. x ١٠٠ sq. ft. = ٣٠ gpm

Density prescribed for Extra Hazard ٢ is ٠.٤٠ gpm per sq. ft.

Minimum flow rate for sprinklers spaced ١٠٠ sq. ft. is Determined by area x density = Q

Q = ٠.٤٠ gpm per sq. ft. x ١٠٠ sq. ft. = ٤٠ gpm

Standard Coverage Sprinklers Sidewall



Standard Spray Sprinkler Spacing (Area of Coverage) Light Hazard (as defined by NFPA ١٣) : ١٩٦ sq. ft. max (١٨,٢ sq. m)

Ordinary Hazard (as defined by NFPA ١٣) : ١٠٠ sq. ft. max
(Note: Must be listed for Ordinary Hazard) (٩,٢٩ sq. m)

SIDEWALL SPRINKLER DISTRIBUTION

Must meet Average Distribution Requirements over the ١٠٠ ft٢ (٩,٣ m٢) area between two sprinklers spaced ١٠ ft. (٣,٠٥ m) apart for standard ١/٢" (١٥ mm) orifice sprinklers: ٠.٠٥ gpm/ft٢ (٠.٠٣٤ L/s/m٢) or ٠.٠٧gpm/ft٢ (٠.٠٤٨ L/s/m٢) for large orifice sprinklers ١٧/٣٢" (٢٠ mm) : And still provide ٣.٥% against wall in which sprinklers are installed, for both ١/٢" and L/O.

Density prescribed for <u>Light Hazard</u> is ٠.١٠ gpm per sq. ft.

^ ^ ^

Sidewall Sprinklers

١٤ft(٤.٢٧m) Sp/Sp ١٤ft(٤.٢٧m) Sp/Sp

١٤ft (٤.٢٧m) Sp/W

Maximum Distance

Minimum flow rate for sprinklers spaced ١٩٦ sq. ft. is
Determined by area x density = Q
Q = ٠.١٠ gpm per sq. ft. x ١٩٦ sq. ft. = ١٩.٦ gpm

Density prescribed for <u>Ordinary Hazard</u> Group ١ is ٠.١٥ gpm per sq. ft.

^ ^ ^

Sidewall Sprinklers

١٠ft(٣.٠٤m)Sp/Sp ١٠ft(٣.٠٤m)Sp/Sp

١٠ft (٣.٠٤m)Sp/W

Maximum Distance

Minimum flow rate for sprinklers spaced ١٠٠ sq. ft. is
Determined by area x density = Q
Q = ٠.١٥ gpm per sq. ft. x ١٠٠ sq. ft. = ١٥ gpm

Density prescribed for Ordinary Hazard Group ٢ is ٠.٢٠ gpm per sq. ft.

Minimum flow rate for sprinklers spaced ١٠٠ sq. ft. is
Determined by area x density = Q
Q = ٠.٢٠ gpm per sq. ft. x ١٠٠ sq. ft. = ٢٠ gpm

Extended Coverage Sprinklers ECLH Sprinkler Minimum Design

Have maximum coverage areas of ٤٠٠ sq. ft. as mandated by NFPA ١٣.
Spacing is in increments of ٢'-٠" intervals, example: ١٢'x١٢', ١٤'x١٤', ١٦'x١٦', ١٨'x١٨', and ٢٠'x٢٠

ECLH Sprinkler Minimum Design

Model M ECLH-ELO Pendent VK٦٠٨type

Spacing	Area of Coverage	Light Hazard Density	Minimum water flow	* % Fewer Sprinklers
١٦'x١٦'	٢٥٦ ft²	٠.١٠ gpm/sq ft.	١٩.٦ gpm	١٣%
١٨'x١٨'	٣٢٤ ft²	٠.١٠ gpm/sq ft.	٣٢.٤ gpm	٣٠%
٢٠'x٢٠'	٤٠٠ ft	٠.١٠ gpm/sq ft.	٤٠ gpm	٤٤%

***Based on a ٢٢٥ sq. ft. coverage area for standard coverage upright and pendent**

EC(extended coverage) Sidewall vs. Standard

- EC has larger protection areas
- EC has flatter distribution
- Require greater separation from obstructions
- Need to be designed and installed per listing

Extended Coverage Sidewall Spacing

- *Per NFPA ١٣: Unobstructed, flat*

– Max. area of coverage = ٤٠٠ ft٢ (Lt. & Ord.)
– Light Hazard ٢٨’ max. between sprinklers
– Ordinary Hazard ٢٤’ max. between sprinklers