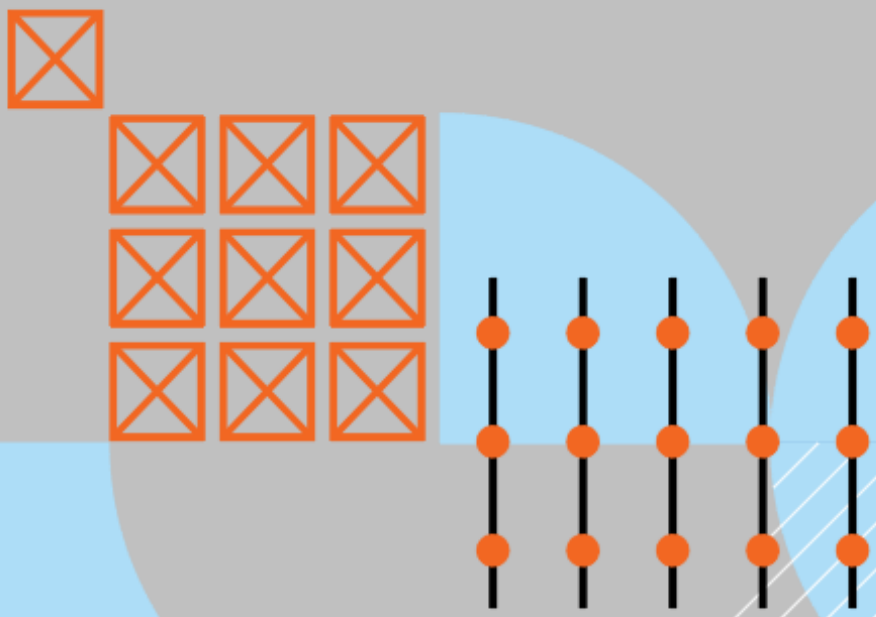
Technical Document

Selecting Design Point from Density/Area Curves

Written by: Rahil Kiaghadi, CSITMS



NSV
NSVsoft.net

Selecting Design Point from Density/Area Curves

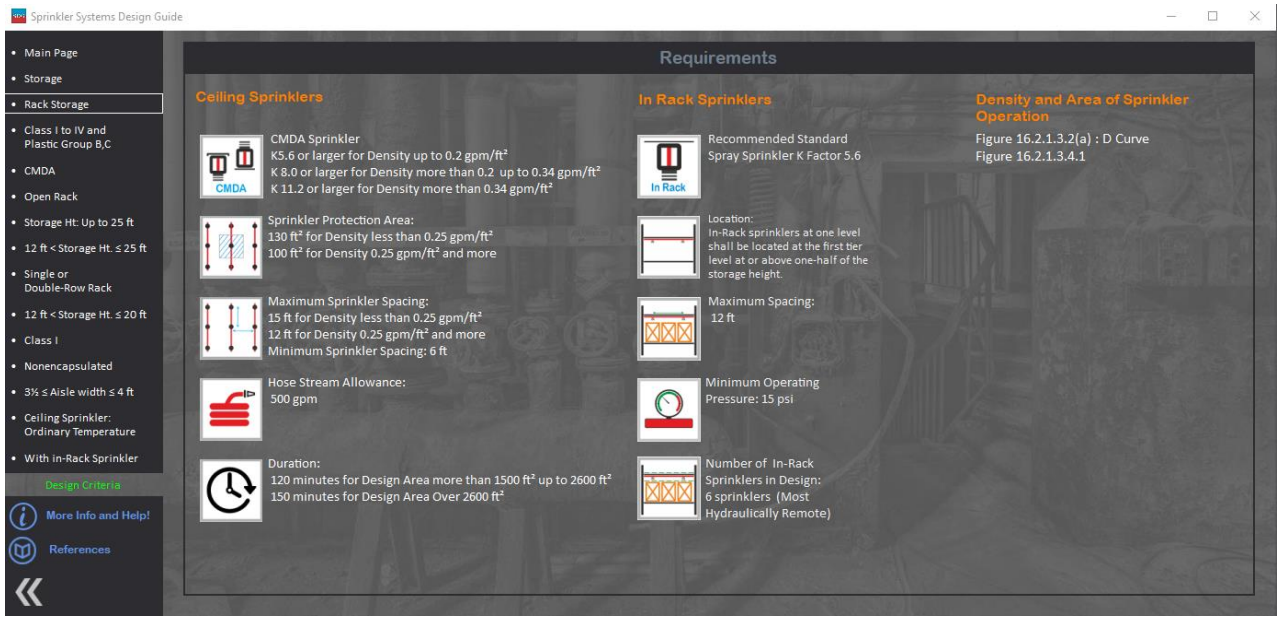
In NFPA 13 (2016), for Standard Spray, Extended Coverage, and CMDA sprinklers, Density/Area curves are used to design fire sprinkler systems. For the following conditions, NFPA 13 provides design curves:

- Light, Ordinary, and Extra Hazard occupancies where the hydraulic calculations method is used
- Miscellaneous and low-piled storage
- Palletized, Solid-Piled, Bin Box, Shelf, or Back to Back Shelf storage of Class I to IV
- Rack Storage of Class I to IV (with storage height Up to 25 ft)

This text aims to examine the advantages of each point of the curve.

As shown in the below figure that is extracted from the “Design criteria” window of "Sprinkler Design software”, NFPA 13 requires Curve "D" of Figure 16.2.1.3.2(a) for the following conditions:

- **Rack Type:** Double Row, Open Rack
- **Commodity:** Nonencapsulated Class I
- **Storage height:** 12 to 20 ft
- **Aisle width:** 4 ft
- **Ceiling Sprinklers:** CMDA, Ordinary temperature
- **In Rack sprinklers Option:** Selected



The designer can select any point from the curve; for example, we consider two points:

Point of the curve	Density (gpm/ft²)	Design area (ft²)
Lowest	0.255	2,000
Highest	0.232	3,000

The advantages of selecting the lowest Point:

1) ***Reduction of the system's water demand:*** If we ignore the minor and major friction loss in rough estimation, the flow rate will be 510 gpm (=2,000 ft² x 0.255 gpm/ft²), when the lowest point is selected. On the other hand, for the highest point, the flow rate will be 696 gpm (= 3,000 ft² x 0.232 gpm/ft²). A lower flow rate means a smaller pump capacity and water tank. So, the lowest point on the curve generally corresponds to the lowest required flow rate for a given project.

2) ***Reduction of fire damage:*** By selecting the lowest point, the fire will be controlled in a smaller area, so less heat and smoke will be produced.

3) ***Lower main sizes:*** Where the system`s flow decreases, the size of the main pipes (Cross, feed, and Riser) will be lower based on the Hazen-Williams or Darcy-Weisbach equation.

4) ***Less number of sprinklers in the design area:*** The design area will be smaller for the lowest point of the curve. Suppose that the area coverage of sprinklers in the project is 100 ft². For the lowest point, where the design area is 2000 ft², the number of sprinklers in the design area is 20 (=2000 ft²/ 100 ft²), and for the highest point is 30 sprinklers (=3000 ft² ÷ 100 ft²).

The advantages of selecting the highest Point:

1) ***Greater coverage area of sprinklers:*** Where the lowest point is selected, the density will be more than 0.25 gpm/ft², and per Table 8.6.2.2.1(d), the maximum area coverage of sprinklers will be 100 ft². But at the highest point, the density is less than 0.25 gpm/ft², and the coverage of each sprinkler will be 130 ft². The greater area coverage of sprinklers means that we need fewer sprinklers for the project.

2) ***Flow reduction for each sprinkler:*** Imagine the coverage area of sprinklers in the project is 100 ft². Where the lowest point is selected, the flowrate will be 25.5 gpm (= 100 ft x 0.255 gpm/ft²), but for the highest point, the flow is equal to 23.2 gpm. Also, less flow means less required pressure, based on the Q=K$\sqrt{P}$ equation.

3) **Lower branch line sizes:** Where sprinklers discharge less flow, the friction loss will be reduced, so we can use the smaller sizes for the branch lines.

4) ***Using smaller K factor:*** In some curves in NFPA 13, selecting upper points will help us to use smaller K Factor, based on paragraphs 12.6.1, 12.6.2 & 12.6.3.

Designers should consider all the variables to design cost-effective, high-performance systems. Where the water supply has sufficient pressure, we usually apply the lowest point of the curve in sprinkler system design to control fire in a smaller area and minimize fire damage.

In the 2022 edition of NFPA 13, the technical committee provided Table 19.2.3.1.1 based on the lowest points of design curves in LH/OH/EH occupancies. So, designers should use those values in hydraulic calculations of new sprinkler systems.

NSV
NSVsoft.net