



Coffee Break Training - Fire Protection Series

Automatic Sprinklers: Sprinkler System Design: Introduction to Hydraulic Calculation (Part 3)

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Learning Objective: The student will be able to explain density in fire sprinkler system design.

As fire behavior studies and sprinkler performance have become more sophisticated, we are learning more about efficient fire sprinkler system design.

One of the economic concerns about pipe schedule systems was that they often tended to be overdesigned: Pipe sizes often were larger than they needed to be, with a corresponding increase in materials and labor costs. The advent of hydraulic design has allowed a more customized approach to match the sprinkler system to the hazard that it protects.

A key principle in understanding hydraulic design is density, usually referenced in the shorthand version, such as 0.10/1,500 or 0.21/2,200 gpm/ft² (4.1/139 or 8.3/204 mm/min/m²). Translated, this shorthand means 0.10 gallons per minute per square foot over 1,500 square feet (4.1/139 millimeters/minute/square meters). The density (gallons or liters per minute) is the amount of water deemed necessary by National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems* or the sprinkler designer for what is needed to control or suppress a fire. (The area value is the area of application that will be explained in subsequent Coffee Break Trainings.)

As the hazard classification of the occupancy or product being stored increases, the required density generally increases as well because more water is needed every minute to control the heat energy released by a fire. For a simple analogy, imagine attacking a car fire with a small handline while needing a larger handline to attack a warehouse fire. The greater fuel load requires more water application.

NFPA 13 provides the minimum density requirements based on hazard classifications of the property that is being protected. The property owner, insurer or sprinkler designer can increase the density design if he or she desires. The density selection should be made by a qualified person with sound engineering judgment. The following table¹ provides some sample densities based on hazard classifications. The table is illustrative only and does not represent all of the available design density options.



Density in sprinkler design refers to the amount of water per square foot (square meter) that the system is intended to deliver each minute. (Photo/Keith Heckler, Rockville Fire Department, Maryland)

Occupancy Hazard Classification	Density/Area American Standard Units gpm/ft ²		Density/Area SI Units mm/min/m ²	
Extra Hazard, Group 2	0.40	2,500	16.3	232
	0.34	4,000	13.8	372
Extra Hazard, Group 1	0.30	2,500	12.2	232
	0.25	3,800	10.2	353
Ordinary Hazard, Group 2	0.20	1,500	8.1	139
	0.18	2,500	7.4	232
Ordinary Hazard, Group 1	0.15	1,500	6.1	139
	0.14	2,000	5.7	186
Light Hazard	0.10	1,500	4.1	139
	0.09	2,000	3.7	186

For more information, consider enrolling in the National Fire Academy (NFA) course “Water-based Fire Protection System Plans Review” (R0137). Information and applications can be obtained at <http://apps.usfa.fema.gov/nfacourses/catalog/details/10542>. The course is available at the NFA in Emmitsburg, Maryland, or through your state fire service training agency.

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