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Technical Article

# Automatic Sprinkler Thermal Sensitivity: Clarifying the Terms Fast Response and Quick Response

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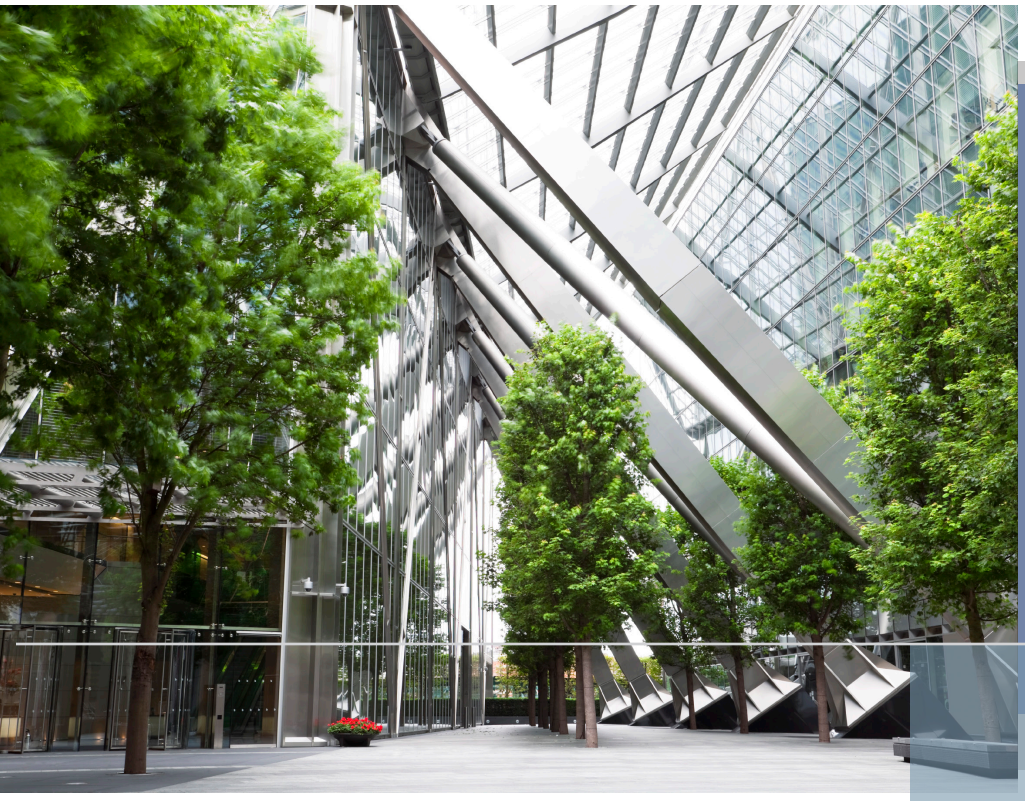

As the evolution of automatic sprinkler technology continues, the fire protection industry is presented with more and more options for specialized sprinklers in all the categories defined in NFPA 13. The terminology, unique installation requirements, and variety of listings and approvals can at times be confusing and in some cases cause errors in proper sprinkler selection. One area in particular that seems to be causing a large amount of confusion within the industry are the terms “fast response” and “quick response”.

Some who are unfamiliar with the differences between these terms mistakenly believe that they are interchangeable and that a sprinkler which utilizes a fast response heat responsive element is by definition a quick response sprinkler. Unfortunately, this is not true and for those who make this correlation an error in sprinkler selection may occur. This paper will describe how heat interacts with automatic sprinklers, how heat is defined, how the thermal sensitivity of sprinklers is determined and the difference between fast and quick response.

**Heat and Sprinkler Activation**

Transfer of heat governs all aspects of fire, from ignition through final extinguishment. Heat is transferred by one or more of three mechanisms: conduction, convection, or radiation.[1] Convective heat transfer, or heated air from a fire rising to the ceiling, is the primary means by which a sprinkler is activated.[2] The heated air rises in a plume to the ceiling. When the plume hits the ceiling it produces a ceiling gas jet. The heat responsive elements of the sprinklers within the jet are then heated by conduction of the heat from the air.[3] When the heat responsive element reaches its operating temperature the sprinkler will activate.

It is necessary to measure this process in order to determine the thermal sensitivity of the sprinkler. Thermal sensitivity is the measure of how fast a heat responsive element operates when installed in a sprinkler. Factory Mutual developed a method to measure thermal sensitivity that is used today, which utilizes the concept of a Response Time Index (RTI). The device used to conduct this measurement is commonly referred to as a “plunge oven” and the test is referred to as an “oven heat test” in Underwriters Laboratories standard UL 199 (figure 1).

Figure 1

Within the plunge oven an air stream is moving through a metal duct at a constant velocity and temperature. The sprinkler, which is at room temperature, is plunged into the air steam. A measurement is made of the time, in seconds, required to raise the temperature of the heat responsive element to approximately 63% of the temperature of the heated air stream. This measurement is called a “tau factor.”[4] Multiplying this factor by the square root of the velocity provides the number which is the RTI of the sprinkler.

RTI= τυ1/2

τ= tau factor
υ= air velocity

NFPA 13 section 3.6.1(a) (1) defines the response time for fast response sprinklers as having a thermal element with an RTI of 50 (meter-seconds)1/2 or less and section 3.6.1 (a) (2) defines standard response as having a thermal element with an RTI of 80 (meter-seconds)1/2 or more. The standard does not have a separate defined RTI for quick response sprinklers. Section 3.6.2.9 defines quick response as a type of spray sprinkler that meets the criteria of 3.6.1(a) (1) making them a type of fast response sprinkler.

**Fast Response vs. Quick Response**

Quick response sprinklers are not the only type of sprinkler that meet the fast response RTI definition. Residential and Early Suppression Fast Response (ESFR) also meet the requirements of the fast response RTI definition. Although all of these sprinklers are considered fast response they are all used in very different applications. Fast response is a broad category term that includes several different types of sprinklers as shown in the chart below (figure 2). In addition, some sprinklers which are only listed or approved as standard response may use a fast response heat responsive element making it critical to review the technical data from the manufacturer to verify the listings and approvals.

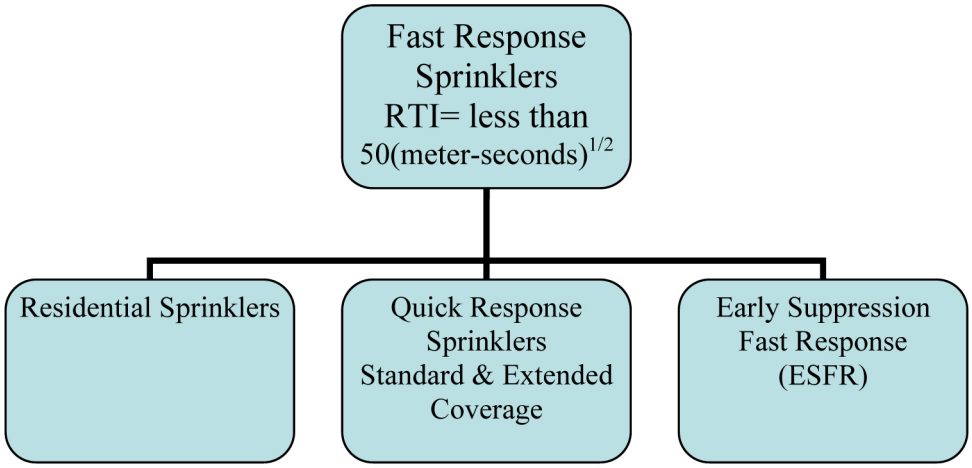


Figure 2

**What is the difference for the sprinkler system design?**

NFPA 13 does not provide any design guidance for a fast response sprinkler. The design guidance is provided for the listed sub categories (quick response, residential and ESFR). Essentially, this means that a sprinkler that uses a fast response heat responsive element but is not UL Listed or FM Approved into one of the sub-categories cannot be installed in the same manner as a sprinkler which is listed or approved into one of the sub-categories. In other words because a sprinkler uses a fast response element it does not mean it is a listed quick response sprinkler and the design area reductions outlined in NFPA 13 cannot be utilized.

**Conclusion**

The area which seems to cause the greatest confusion is NFPA13 section 11.2.3.2.3.1 which allows up to a 40% reduction in the design area when listed quick response sprinklers are used. Unfortunately, because the term fast response is used on some manufacturers technical data sheets an error is made and the design reduction is applied to a sprinkler using a fast response element which is not listed as quick response. Care must be taken by the designing engineer, sprinkler lay-out technician and authority having jurisdiction to ensure the proper listings are in place and the design parameters in NFPA 13 have been achieved.

**References:**

[1] Drysdale, D, D. “Chemistry and Physics of Fire”, Fire Protection Handbook, Nineteenth Edition, National Fire Protection Association, Quincy, MA, 2003, Pg 2-62.

[2] Wass, Harold, S. “Sprinkler Hydraulics and what it’s all about”, 2 Edition, Society of Fire Protection Engineers, Betheda, MD, 2000, Pg 19.

[3] Fleming, Russell, P., “Principles of Automatic Sprinkler Performance” Fire Protection Handbook, Nineteenth Edition, National Fire Protection Association, Quincy, MA, 2003, Pg 10-159.

[4] Wass, Harold, S. “Sprinkler Hydraulics and what it’s all about”, 2 Edition, Society of Fire Protection Engineers, Betheda, MD, 2000, Pg 19.