The Code Corner

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Fire Sprinkler Systems

By Ronald L. Geren, AIA, CSI, CCS, CCCA, SCIP

This year marks the 200th anniversary of the automatic fire sprinkler system. In 1806, an Englishman by the name of John Carey, developed the first automatic fire sprinkler system by connecting a series of perforated pipes to an elevated water tank. The water, under pressure due to the tank elevation, was held in place by closed valves. Combustible cords connected to weights held the valves closed. When a fire would burn through the cords, the weights would drop, opening the valves, thereby allowing water to enter the perforated pipes and extinguishing the fire. Crude, but it was only the beginning.

Although the first sprinkler head was invented in 1864 by Major Stewart Harrison of London, the first practical modern sprinkler head was developed ten years later by Henry Parmelee of New Haven, Connecticut. Upset with the extremely high insurance rates of the time, Henry Parmelee developed his sprinkler head to protect his piano factory rather than pay for insurance coverage. Later, he teamed up with Frederick Grinnell, who owned a steam and gas plumbing company at the time, to install the sprinkler systems in other factories at their request. Over 130 years later, the automatic fire sprinkler system remains the leader in fire protection systems.

The success of automatic fire sprinkler systems created another problem: consistency in installation. To resolve this problem, a group of men, the majority of which represented insurance companies, gathered in Boston in early 1895 to discuss this very issue. Later that year, they met again in New York, and the beginnings of a new sprinkler standard, and an association to maintain this standard, started to develop. By March of 1896, they developed a set of sprinkler installation rules and set in motion the development of an organization to administer them.

In November 1896, the National Fire Protection Association (NFPA) was organized, and the sprinkler installation rules eventually became known as NFPA 13, *Installation of Sprinkler Systems*. Although NFPA 13 has become THE standard for sprinkler systems, many people don't really understand when fire sprinkler systems must be installed.

NFPA 13, or amended versions of it, has been referenced in the building codes for many years, as well as its sister document, NFPA 13R *Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*. It wasn't until the publication of the 2000 *International Building Code* (IBC) that the third fire sprinkler standard, NFPA 13D *Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes*, was referenced in a building code. Although the standards establish *how* the sprinkler system is to be installed, it doesn't dictate the conditions *when* a sprinkler system is required to be installed—that's left to the building code, or, in some case, local ordinance, which will be discussed later.

In the IBC, there are two ways that fire sprinklers may be required in a building: through either a direct requirement and or an indirect requirement. A direct requirement is one that the designer has little to no control over such as one based on an occupancy group. On the other hand, an indirect requirement is one that the designer does have control over, such as allowable building area and occupancy separations.

In the IBC, sprinkler system requirements are found in Chapter 9, and, it is in Section 903 that you'll find most of the direct requirements for automatic sprinkler systems. For example, in Section 903.2.5, it states that fire sprinklers "shall be provided throughout buildings with a Group I fire area." Another example of a direct requirement—and one commonly misunderstood—is the requirement for a sprinkler system in all buildings with a Group R fire area. Some have mistakenly applied this requirement to all residential buildings; even detached one- and two-family dwellings and multiple single-family dwellings not more than three stories in height. The *IBC Commentary* clearly states that the *International Residential Code* (IRC), which is applicable to those building types, is considered a separate code, and that the requirements of the IBC do not apply. Conversely, if a building of any of those types does not meet the requirements for application of the IRC, then the IBC will apply and a sprinkler system will be required.

Additionally, there are other areas in the IBC where direct requirements for sprinkler systems are set. In Chapter 4, covered mall buildings must have a sprinkler system installed throughout, as well as high-rise buildings and in atriums. In Chapter 26, freezers, coolers, and the parts of the building where they're located, must also be protected with sprinkler systems.

As for indirect requirements, the most common is the installation of a fire sprinkler system to obtain an area increase, a height increase, or both. The reason this is considered an indirect requirement is that alternative design approaches, other than the installation of a fire sprinkler system, can be incorporated to achieve additional floor area or building height. For example, a higher construction type may be used, providing separated occupancies, incorporating fire walls to separate large buildings into two or more smaller buildings, or a combination of any of those methods.

Other indirect requirements can be found when incidental use areas are included in a building design. Incidental use areas are spaces that could be classified within a separate occupancy group from the main occupancy, but are incidental to the main occupancy and, therefore, can be classified under the main occupancy. These areas, which are listed in Table 302.1.1, have options that either requires a fire barrier separation, the installation of a sprinkler system in the incidental use area, or both.

There are numerous other instances in the IBC where the installation of a sprinkler system—considered an active fire protection system—is permitted to reduce passive fire protection such as fire-resistive construction and finish classification; or increase other aspects of the code such as maximum allowable hazardous material storage, unprotected opening area, and maximum travel distance for egress. These are what the building code community calls "sprinkler trade-offs" and have been included in building codes for 50 years.

When the IBC was being developed, there was a mild uproar about the number of sprinkler trade-offs that the code included, and it still continues to this day. The uproar comes from many directions: firestop contractors and material suppliers, concrete manufacturing organizations, fire marshal associations, door hardware manufacturers, wall and ceiling contractors, and several other groups and individuals. Most of these opponents are looking for an approach to fire safety that uses a balance of active and passive fire protection measures, rather than relying heavily on sprinkler systems, which some argue has a history of unreliability. This might appear to be a concern based on the number of recent recalls on popular sprinkler heads, but a report by the NFPA released in August 2005, states that "sprinklers failed to operate in 7% of structure fires" between the period of 1999 through 2002[1]; to turn that around, sprinklers were 93% effective—a reasonable performance. Although it isn't the intent of this article to get into the sprinkler trade-off debate, it could be expected that, over time, a balance between passive and active fire

protection will work its way into the building code to some degree; probably not to the satisfaction of those listed above, but presumably enough to temper the debate somewhat.

Any article on sprinkler systems in building codes wouldn't be complete without a discussion on the word "throughout." The IBC uses this word in conjunction with many sprinkler requirements, such as that for area and height increases. In Section 506.3, it states "Where a building is protected throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1 [NFPA 13], the area limitation in Table 503 is permitted to be increased…" When the code uses that "throughout," it literally means it. However, like most aspects of a building code, there are exceptions.

Since the building code requires systems to be installed in accordance with NFPA 13 (or one of the other two codes, if permitted), then if the standard allows omission of sprinklers from a certain area, it is still considered sprinklered "throughout." Additionally, the IBC as inserted some exceptions of its own. In Section 903.3.1.1, the section that applies NFPA 13, the IBC permits excluding sprinklers in the following areas:

- In areas where the use of water creates another fire or life safety hazard.
- In areas where it is considered undesirable to have sprinklers due to the nature of the areas' contents, when approved by the building official.
- In generator and transformer rooms when separated by 2-hour fire-resistive assemblies.
- In areas of noncombustible construction with entirely noncombustible contents.

Lastly, the IBC permits the installation of alternative automatic fire-extinguishing systems in place of the sprinkler systems required in Section 903. These systems include wet-chemical, dry-chemical, clean-agent, foam, carbon dioxide, and halon extinguishing systems. It is important to note that the installation of these systems, when used as an alternative to sprinkler systems, must be approved by the building official. However, they can not be a substitute for sprinkler systems installed for the purposes of exceptions or reductions allowed by other requirements of the code (i.e. substitution for one-hour construction in Type IIA, IIIA and VA buildings).

According to the NFPA report, "the chances of dying in a fire are reduced by one-half to three-fourths, and the average property loss per fire is cut by one-half to two-thirds, compared to fires where sprinklers are not present." [1] Because of this potential, some jurisdictions have made fire sprinklers mandatory. The City of Phoenix, through its Bret Tarver Sprinkler Ordinance[2], now requires fire sprinkler systems installed in buildings of all occupancy groups, except for R-3 occupancies less than 5,000 square feet. But, Phoenix wasn't the first: in 1986, the City of Scottsdale required sprinkler systems in ALL construction—including one- and two-family homes. It's in one- and two-family homes where fires have cost the most in number of lost lives; and, it's also where the fewest sprinkler systems are installed.

For those who use building codes, they know that the codes only provide the minimum standards for building construction. There is nothing in the code that prevents an owner from exceeding the code requirements. This includes installing sprinkler systems when not required or implementing compartmentation (separation of spaces with fire barriers) even when a sprinkler system is installed. A prudent owner, knowledgeable in the fire risks associated with their building type, knows that they save could save more money than the initial costs of installing fire protection, not to mention lives, if a fire event should occur in their building with the added fire protection.

[1] *U.S. Experience with Sprinklers and Other Fire Extinguishing Equipment*, "Executive Summary," National Fire Protection Association, August 2005, page i.

[2] Named for Bret Tarver, a Phoenix fire fighter who lost his life during a supermarket fire March 14, 2001. The supermarket had no fire sprinkler system.

To comment on this article, suggest other topics, or submit a question regarding codes, contact the author at ron@specsandcodes.com.

About the Author: Ronald L. Geren, AIA, CSI, CCS, CCCA, SCIP, is an ICC Certified Building Plans Examiner, and is the principal of RLGA Technical Services located in Scottsdale, Arizona, which provides specifications and code consulting services to architects, engineers, owners, and product manufacturers. A 1984 graduate of the University of Arizona, Ron has over 23 years of experience with military, public, and private agencies.