The Impact of Fire Sprinklers on Building Fire Safety

a report by
Roland Huggins

Vice President, Engineering and Technical Services, American Fire Sprinkler Association (AFSA)

Roland Huggins is Vice President of Engineering and Technical Services for the American Fire Sprinkler Association (AFSA). He is registered in Fire Protection Engineering and is a member of the National Fire Protection Association (NFPA) and Society of Fire Protection Engineers (SFPE). He is also a member of numerous NFPA technical committees, including NFPA 13 Technical Correlating Committee, NFPA 13 Discharge Criteria, NFPA 25 and NFPA 5000 (Building Code) Technical Correlating Committee. His NFPA activities have also included involvement in the editing of the 1999 and 2002 editions of the *Sprinkler Handbook*. Other national activities involve the NFPA Research Foundation, Underwriters Laboratories, Inc. Standard Technical Panels, National Institute for Certification in Engineering Technologies (NICET) and SFPE. He has conducted many seminars and presentations as well as written numerous sprinkler-related articles. Mr Huggins is a graduate of the University of Maryland.

Improving the level of fire safety within an existing hospital is a costly and disruptive process. Considering that many facilities are attempting to address multiple deficiencies with a limited budget creates the need to prioritise improvements. In order to optimise the fire safety gain per dollar spent, how to go about evaluating the impact of a deficiency and the effectiveness of optional solutions needs to be determined. This article will introduce an evaluation process and discuss the effectiveness of fire sprinklers as a solution to fire safety deficiencies. It will also discuss why there is a difference between the level of safety provided by a quick-response sprinkler and a standard-response sprinkler.

One of the difficulties in evaluating the overall level of fire safety is defining the relative impact of a deficiency or proposed improvement to the building. One method for such evaluations is the Fire Safety Evaluation System (FSES) of National Fire Protection Association (NFPA) standard 101A.[1] It is a measuring system that compares the level of life safety provided by a facility to that provided by full compliance with NFPA 101.[2] It takes into account the fact that different types of occupancies have different risks associated, such as hospitals applying a defend-in-place philosophy. This is accomplished by using separate FSES forms for the different occupancies. Even if one were interested in conforming to a different code, an FSES is still a valuable tool. It provides a means of comparing the effectiveness of proposed improvements by producing a comparative baseline.

The FSES for hospitals breaks the evaluation into four categories: containment safety; extinguishment safety; people movement; and general safety. There are 13 safety parameters (building features) that are assigned a numerical value, either positive or negative, and placed within the different categories. The values placed in each category are added together and compared against a minimum acceptable number. For instance, containment safety looks at eight parameters, one of which is the type of building construction for which values ranging from four to -13 can be assigned. In a new building, the total for the category should equal or exceed 11 for a single-storey building and 18 for locations at or above the fourth storey. In an existing building, it should equal or exceed five and nine, respectively.

In addition to evaluating building features, the general safety category addresses a 'use factor' in that it reflects the ability of the patients and staff to respond to a threat. Use factors include parameters such as patient mobility and age, the number of patients within an area and the ratio of staff to patients. A single parameter with a negative number is undesirable but does not necessarily make an unsafe facility. The FSES looks at the cumulative effect of all applicable parameters in determining the overall level of fire safety.

Most importantly, an FSES readily shows the relative gain in fire safety for proposed improvements. For instance, separating a large open wing by installing corridors with doors to each room provides a 10-point gain. If the corridor walls have a fire rating of 30 minutes, it provides an additional one-point gain.

Another improvement being considered could be the interior finish of the corridors and exits. Upgrading from a Class C to a Class A rating provides an eight-point gain. It is important to note that improving an individual safety parameter typically does not benefit all four safety categories. The above corridor example would only affect containment safety and general safety.

As shown by the FSES, fire sprinklers have an extensive impact on fire safety. Providing sprinklers throughout the building provides a gain of 10 points. Even a partial system protecting just the corridors and habitable spaces provides a gain of eight points. Habitable spaces include patient rooms, nurses' stations and other areas used for human occupancy. It does not include wardrobes, bathrooms, toilets, lifts and similar spaces. This allowance is predicated on the presence of fire-rated construction that can

1. *NFPA 101A, Guide on Alternative Approaches to Life Safety, National Fire Protection Association, 2001.*
2. *NFPA 101, Life Safety Code®, National Fire Protection Association, 2000.*

prevent the spread of fire from non-sprinklered areas. The presence of fire sprinklers also has a beneficial impact on other safety parameters. They allow retaining a higher flame spread rating of interior finishes. A Class C interior finish in corridors and exits is assigned -5 points but with sprinkler protection it is assigned zero points. A second affected parameter is hazardous areas. If the area is enclosed with fire-rated construction, installing sprinklers in that area provides a gain of six points. If the enclosure is not fire-rated, sprinklers provide a five-point gain. A third affected parameter is smoke detection and alarm. For a partial detection system, the gain is increased by one point if a sprinkler system is present that uses quick-response sprinklers instead of standard-response sprinklers.

There are two general categories of sprinkler, based on how quickly they activate. The quick-response sprinkler will activate when the fire is much smaller, about 60% of the fire size required to activate a standard response sprinkler. By activating when the fire is smaller, it causes the detection system to sound an earlier alarm.

The use of quick-response sprinklers will provide some additional benefits that are not identified by the FSES. To explain this statement, a brief explanation of how sprinklers operate is needed. A sprinkler is activated by being exposed to the elevated temperatures produced by a fire, though only the sprinklers that get hot enough will activate, rather than all of the sprinklers in the area. Even within a single room containing two sprinklers, only one may activate. As the fire is smaller when the quick-response sprinkler activates, the design basis for the system can require less water, which reduces the cost of the system. The most important benefit, though, is that quick-response sprinklers increase the potential of saving the people in the room of fire origin. By activating (and discharging water) when the fire is smaller, anyone in the room of fire origin is exposed to much lower temperature levels (approximately 30% of that reached when standard response sprinklers are used) and much less smoke. It should be noted that smoke not only obscures the vision but also contains toxic gases, such as carbon monoxide.

Deciding what improvements to make in order to improve the fire safety in a hospital can be a difficult process. The FSES of NFPA 101A provides a logical, simple-to-use evaluation system that readily shows the relative value of proposed improvements. As shown by such evaluations, fire sprinklers provide a significant individual improvement on all safety categories as well as a positive benefit on multiple safety parameters. There is no other single improvement to a hospital that creates such a large overall gain to the level of fire safety. ■