AN ASSESSMENT OF THE PERFORMANCE OF AUTOMATIC SPRINKLER SYSTEMS

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According to recent reports,¹ the reliability of automatic sprinkler systems varies between 80 percent and 99 percent. This variation has confused efforts to determine the performance level that can be reasonably expected from such systems.

To assess sprinkler system reliability, statistical data on system performance in building fires were reviewed. The data were taken from the following sources:


Other possible sources were identified, but were not analyzed because of doubts as to their reliability, and size of the statistical base.² ³ ⁴

SATISFACTORY PERFORMANCE

The answer to the question “What constitutes satisfactory performance by an automatic sprinkler system?” is largely subjective. One approach is to consider that satisfactory performance is achieved if the system extinguishes the fire or controls the fire in the specific area for which the system was designed. For example, if the design of a sprinkler system allows for the simultaneous operation of all sprinklers in a certain room, or over a specific area in a larger space, satisfactory performance would mean that the system controlled or extinguished the fire within that room or that area.

The Fire Journal Performance Tables define “control” as the prevention of excessive fire spread in accordance with the nature of the occupancy. In certain occupancies, fewer than five sprinklers should establish control while in other occupancies more than 100 may be needed. If, by reason of poor design or human failure, a sprinkler system does not establish control, its performance must be labeled unsatisfactory.

The Australian definition of satisfactory performance is “performance where, after the fire has been extinguished, the building has suffered only minor damage, and the loss of contents through fire, water and smoke is a relatively small portion (say of the order of not more than 20 percent) of the total value involved.”

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Satisfactory sprinkler performance is even more difficult to define in terms of life safety. The *Fire Journal* observes that the only reported fatalities in fully sprinklered structures were the result of:

- Explosions or flash fires,
- Ignition of bedding or clothing of a person incapable of escaping,
- Closure of system water supply valves, or
- Hazards too severe for effective sprinkler performance.

Australian experience indicates that no one has died there in a sprinklered residential building, and only one person has died in an institutional building. The one victim was an elderly woman who dropped a cigarette that ignited the rubber chair cushion on which she was sitting. Four fatalities, including three in explosions and one in a flash fire, were reported in industrial and commercial occupancies.

Although the New York City statistics do not define satisfactory performance, it appears that satisfactory performance is as assigned by the Fire Patrol of the New York Board of Fire Underwriters.

**Sprinkler Systems and Structural Fire Protection**

The system's capability to protect the supporting structure of a building must be considered when assessing the system's performance because a structural failure could result in a sprinkler system failure. If the sprinkler system is to be an alternative to other fire-resistant measures, it is essential that it be designed to provide the required protection.

The type of building construction did not directly affect the performance of automatic sprinklers in the Australian experience, except in the fourteen cases in which automatic sprinkler performance was judged to be unsatisfactory. The reason stated is that, in most cases, only the contents of the buildings were involved in fire. There were very few cases in which the building structure was involved. No damage to, or distortion of, steel roof members was reported in those cases where sprinkler performance was considered satisfactory.

The value of automatic sprinklers in maintaining structural integrity is indicated in fire tests by Factory Mutual Research Corp. (FMRC) on unprotected steel library book stacks. (Unprotected structural steel begins to fail at approximately 1,000°F.) The temperature of the steel in stacks protected by sprinklers did not exceed 500°F. In stacks not so protected, the temperature of the steel was approximately 1,500°F.

In a study to assess the capability of automatic sprinklers to contain fires in exhibition halls following the 1967 McCormick Place Fire in Chicago, temperatures of unprotected steel members above the test fire area were recorded to determine possible structural damage. Where sprinklers were permitted to operate normally, the temperatures of unprotected steel, and at the ceiling, were in the 500°F range, while temperatures at the fire source were in the 1,700°F range. Where sprinkler discharge was purposely delayed, temperatures of the unprotected steel ranged from 1,350°F to 1,550°F prior to sprinkler discharge. Following sprinkler discharge, the temperature of the unprotected steel was reduced to less than 500°F.

These studies show that activated automatic sprinkler systems can protect structural members by keeping temperatures below the point at which structural damage will occur.

**Review of Statistics**

The NFPA statistics are based on fire reports voluntarily submitted to the Association from 1897 to 1969. The statistics probably exclude the many