



NRC Publications Archive Archives des publications du CNRC

The reliability of automatic sprinkler systems Richardson, J. K.

For the publisher's version, please access the DOI link below./ Pour consulter la version de l'éditeur, utilisez le lien DOI ci-dessous.

Publisher's version / Version de l'éditeur:

<https://doi.org/10.4224/20330497>

Canadian Building Digest, 1985-07-01

NRC Publications Record / Notice d'Archives des publications de CNRC:

<https://nrc-publications.canada.ca/eng/view/object/?id=65edcdb6-8319-4efd-aff9-8083c4dc6218>

<https://publications-cnrc.canada.ca/fra/voir/objet/?id=65edcdb6-8319-4efd-aff9-8083c4dc6218>

Access and use of this website and the material on it are subject to the Terms and Conditions set forth at

<https://nrc-publications.canada.ca/eng/copyright>

READ THESE TERMS AND CONDITIONS CAREFULLY BEFORE USING THIS WEBSITE.

L'accès à ce site Web et l'utilisation de son contenu sont assujettis aux conditions présentées dans le site

<https://publications-cnrc.canada.ca/fra/droits>

LISEZ CES CONDITIONS ATTENTIVEMENT AVANT D'UTILISER CE SITE WEB.

Questions? Contact the NRC Publications Archive team at

PublicationsArchive-ArchivesPublications@nrc-cnrc.gc.ca. If you wish to email the authors directly, please see the first page of the publication for their contact information.

Vous avez des questions? Nous pouvons vous aider. Pour communiquer directement avec un auteur, consultez la première page de la revue dans laquelle son article a été publié afin de trouver ses coordonnées. Si vous n'arrivez pas à les repérer, communiquez avec nous à PublicationsArchive-ArchivesPublications@nrc-cnrc.gc.ca.



Canadian Building Digest

Division of Building Research, National Research Council Canada

CBD-238

The Reliability of Automatic Sprinkler Systems

Please note

This publication is a part of a discontinued series and is archived here as an historical reference. Readers should consult design and regulatory experts for guidance on the applicability of the information to current construction practice.

Originally published July 1985.

J.K. Richardson

Abstract

Automatic sprinkler systems have played a key role in fire protection engineering for over a century. Based on a review of statistical data, this Digest shows the reliability of such systems in place to be in excess of 96%. Means are suggested to improve this reliability to 99% through proper design, inspection and maintenance of systems.

Introduction

Historically, automatic sprinkler systems have played a key role in the protection of property and lives from fire. These systems have been promoted by the insurance industry and accepted, or under certain circumstances, even required by building regulations. While these systems have a well-established record for controlling fires, there are a number of provisions available to improve their effectiveness. This Digest discusses the reliability of sprinkler systems and how it can be improved by certain practices and equipment.

Sources of Information

Although various studies are available on the performance of sprinklers in fires, there are only three principal sources of statistical data. The National Fire Protection Association (NFPA) has published data on over 80,000 fire incidents involving sprinkler systems from 1897 to 1969.¹ The Australian Fire Protection Association has published data on virtually all fires involving sprinkler systems in Australia and New Zealand for the period 1886 to 1968 (over 5,700 incidents).² Statistics are also available from the City of New York based on a similar number of fires.³

An examination of these statistics provides an insight into the reliability of sprinkler systems and the various causes that can lead to their failure.

Satisfactory Performance

Reliability of sprinkler systems is commonly understood to be the percentage of times that they have provided satisfactory performance in controlling fires. The NFPA defines satisfactory performance as the prevention of excessive fire spread in light of the nature of the occupancy being protected. According to the Australian study, satisfactory performance is considered to be achieved if the building and contents suffer only minor damage from fire, water and smoke. (Minor damage is assumed when the damage does not exceed 20% of the total value of the building plus contents.) In the New York City study, satisfactory performance is determined for

each fire by the New York Board of Fire Underwriters. Statistics from these sources, therefore, are based on reliability in protecting property rather than reliability in preventing life loss.

The terms reliability and satisfactory performance are largely subjective. In terms of life safety, satisfactory performance is presumably achieved if there is no loss of life beyond the person directly involved in fire initiation. The lack of instances where fatalities have occurred in sprinklered buildings indicates that, in this regard, sprinkler systems have a high level of reliability. According to a Swedish study⁴ of fire reports and questionnaires from 17 countries, it is estimated that there is about one death per decade in a 100-year period from an estimated 200,000 to 250,000 fires in sprinkler-protected premises.

Statistics

The three principal sources of statistics on sprinkler performance indicate that sprinklers provide satisfactory performance in 96 to 99% of fire occurrences. While these figures show a remarkably high success rate, the reported causes of failure indicate that the performance of sprinkler systems can be improved if measures are taken to avoid what are considered to be preventable failures. According to NFPA statistics, sprinkler systems did not provide satisfactory performance in almost 4% of the fire incidents. This rate of failure is approximately the same as that reported in the New York study. The Australian-New Zealand statistics, however reveal a higher reliability rate. Only 0.25% of these systems were considered to have given unsatisfactory performances.

Causes of Failure

While some of these failures may be unavoidable, the majority could have been prevented through good design and maintenance practices. Lack of water as a result of closed valves, for example, is preventable with appropriate electrical supervisory equipment for the water supply.

Failures can also occur as a result of incomplete sprinkler protection. In many buildings, only certain areas may be sprinklered. When a fire originates in or spreads to an unsprinklered area, the fire cannot be suppressed. This type of failure is also preventable with appropriate sprinkler protection.

Sprinkler systems are designed to deliver sufficient water flow to the system based on the level of fire hazard for that occupancy. An inadequate supply of water to meet the design conditions can seriously reduce the effectiveness of the system to the point where failure can occur. Freezing of the system is another preventable cause of unsatisfactory performance.

Where an extensive dry pipe system is used, an excessive delay may occur before the system is able to deliver water to the fire. High temperature sprinklers used incorrectly in certain locations may also be a cause of slow responses to a fire and can lead to unsatisfactory performance. Large pieces of equipment such as ductwork, or furnishings such as large worktables, can prevent water from reaching a fire below them, allowing it to gain substantial headway before being affected by the sprinklers. Lack of fire stopping can allow fire to spread uncontrolled within concealed spaces, out of range of the sprinklers. Defective equipment, antiquated systems, substandard sprinkler design, and inadequate maintenance are all preventable causes of unsatisfactory performance.

There are cases, however, where reasonable prudence in the design and maintenance of the system could not have prevented failure. Cases of arson, for example, where the water supply is sabotaged, cannot be prevented through design and maintenance procedures. Interruption of the water supply as a result of an explosion or through earthquake damage may also be unavoidable. Fires from sources external to the building can cause structural collapse before the sprinkler system can operate. The unpredictable nature of these hazards makes them very difficult to avoid without incurring unreasonable costs. Human error such as prematurely shutting off the water supply during firefighting, or not restoring the system to full operation following a fire may also be considered almost unavoidable, although there are some operational precautions that can be taken.

Improving Sprinkler System Reliability

Canadian building regulations currently require that sprinkler systems be designed and installed in conformance with standards published by the National Fire Protection Association. Systems designed to such standards should not fail as a result of inadequate water supply since this is specified as part of the sprinkler system design. The modernization of antiquated equipment or systems in conformance with these standards will also improve reliability. Adherence to the standards also ensures that response time for dry systems and the sprinkler reaction time are kept within reasonable limits.

The standards also deal with the problem of sprinkler obstruction from equipment or furnishings, as well as other special considerations that are necessary because of fire hazards for particular occupancies.

Building codes that reference these standards also prescribe compartmentation, fire stopping and other fire safety provisions that assist in reducing the incidence of failure in new installations.

Conformance to minimum building code provisions, however will not guarantee the successful operation of sprinkler systems under all circumstances. Designers and operators of buildings can do much to improve reliability if they go beyond these minimum requirements. For example, building regulations may require sprinkler protection only over a known fire hazard, such as a room containing a paint spray booth. To increase reliability, the designer may choose to extend sprinkler protection to all areas of the building to prevent failures due to partial protection.

Similarly, steps can be taken to prevent closed valves, the greatest single cause of sprinkler system failures. Electrical supervision of valves to indicate when they are closed can prevent many failures due to accidentally-shut valves. Electrical supervision of water flow and water supplies can indicate when a sprinkler is operating or when there is a problem with a water supply source, such as decreased water level in a storage tank or a significant drop in water pressure. The reliability of these systems can be further improved by having these signals transmitted automatically to a central monitoring station remote from the building or to a constantly attended "proprietary control centre" in the building. Alarm signals due to the actuation of the sprinkler system can also be transmitted (where permitted) directly to the fire department for more rapid response. It is of interest to note that this practice is required by law in Australia and New Zealand and may be partly responsible for the higher rate of sprinkler reliability reported there.

Designers can incorporate certain techniques to facilitate maintenance of sprinkler systems. providing a separate room for valves (not one cluttered with materials), installing valves that are used for the testing or control of water supplies in a convenient location (not at ceiling level), selecting the optimum size of pumps or compressors and minimizing the number of low points in the distribution system will facilitate maintenance and thus improve reliability. Maintenance programs should also include provisions for taking corrective action in the event that a valve is closed for any reason including the servicing, inspection and testing of the equipment. The possibility of premature water shutoff can be reduced through better training of personnel and by creating a greater awareness by the fire department of the specific details of operation of the sprinkler systems in the building.

Conclusions

Although statistics show that sprinklers have a high reliability rate, this can be further improved by the use of available techniques and effective on-going inspection, maintenance and testing. Reliability can theoretically exceed 99%, which is probably as high or higher than many other measures used in achieving fire safety.

References

1. National Fire Protection Association, "Automatic Sprinkler Performance Tables, 1970 Edition", Fire Journal, Vol. 64, No. 4 (July 1970).
2. H. W. Marryatt, Fire-Automatic Sprinkler Performance in Australia and New Zealand, 1886-1968, Australian Fire Protection Association, Melbourne, Australia, 1971.
3. Robert W. Powers, "Sprinkler Experience in High Rise Buildings (1969-1979)", SFPE Technology Report 79-1", Society of Fire Protection Engineers, Boston, MA, 1979.
4. A. Haggland, "Deaths from Fires in Sprinkler-Protected Buildings", Fire Technology, Vol. 19, No. 5, National Fire Protection Association (August 1983).