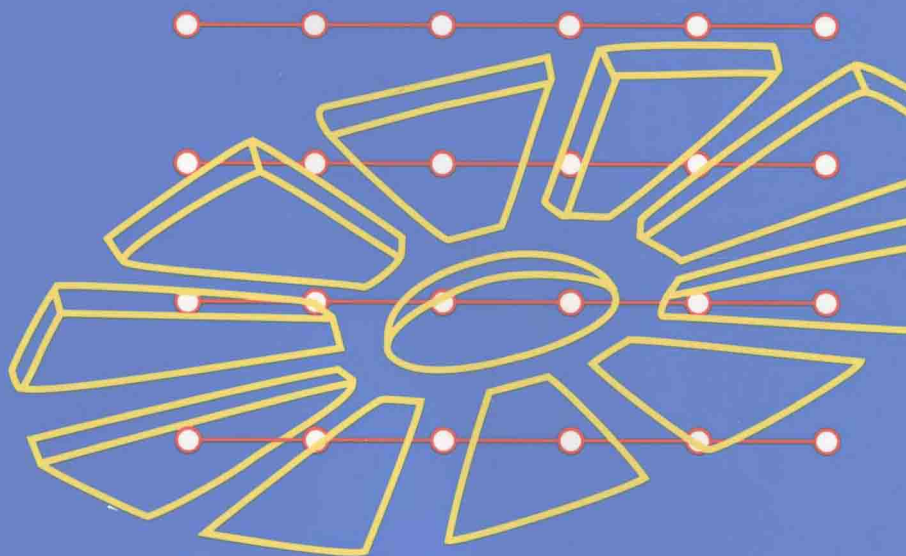


AUTOMATIC

# SPRINKLER SYSTEMS

HANDBOOK



SIXTH EDITION

Robert E. Solomon,  
P.E., Editor



National Fire Protection  
Association

# Automatic Sprinkler Systems Handbook

## **Sixth Edition**

WITH THE COMPLETE TEXT OF

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 Edition

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 1994 Edition

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*, 1994 Edition

## **Edited by**

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National Fire Protection Association  
Quincy, Massachusetts

This sixth edition of the *Automatic Sprinkler Systems Handbook* is the authority on sprinkler installation, design, and use. Based on the 1994 edition of NFPA 13, *Standard for the Installation of Sprinkler Systems*, and its companion documents, the residential sprinkler standards 13D and 13R, this handbook helps to explain requirements found in the standards. It also gives helpful guidance in applying provisions of the various standards, with an emphasis on changes to the requirements from the previous editions. The handbook contains the complete text of each standard, along with explanatory commentary, which is integrated between requirements. The commentary consists of the following useful components: intent and interpretations; historical perspective on provisions; application of requirements; illustrations, tables, and photographs; and supplemental material providing history of the sprinkler standards, technical information, and additional resources.

All NFPA codes and standards are processed in accordance with NFPA's *Regulations Governing Committee Projects*. The commentary in this handbook is the opinion of the author(s), recognized experts in the field of sprinkler systems. It is not, however, processed in accordance with the *NFPA Regulations Governing Committee Projects*, and, therefore, shall not be considered to be, nor relied upon as, a Formal Interpretation of the meaning or intent of any specific provision or provisions of NFPA 13, 13D, or 13R. The language contained in the standards, rather than the commentary, represents the official position of the NFPA.

The standards that this handbook is based on are developed by the NFPA Technical Committee on Automatic Sprinklers, which consists of a broad range of representatives from many sprinkler-related fields, including designers, engineers, sprinkler product manufacturers, code enforcers, building owners, and insurers. All of the commentary material has been researched, written, and reviewed by experts in the field of fire safety.

This handbook is a must for engineers, building and fire officials, safety personnel, architects, manufacturers, installers, and all others whose responsibilities include fire and life safety.

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# Foreword

NFPA 13, *Standard for the Installation of Sprinkler Systems*, is the oldest standard published by the National Fire Protection Association and, in some ways, predates the Association itself. The first edition of the sprinkler standard was published in 1896, the year in which the National Fire Protection Association was organized.

The Technical Committee responsible for development of the standard has, over the years, been made up of a group of highly qualified individuals representing a large number of interests. These include representatives of the fire service, insurance industry, research and testing laboratories, manufacturers and installers of automatic sprinkler systems, users of automatic sprinkler systems, including industrial, commercial, and governmental personnel, as well as independent consultants.

During the 1960s, the National Fire Protection Association's Board of Directors charged the Sprinkler Committee with development of a standard that would encourage innovative technology and maintain economical system costs. This was intended to make the automatic sprinkler system available on a wider basis and to further help reduce our nation's fire losses. Major changes following this charge have included the introduction of hydraulic design methodology, new joining methods, new types of pipe or tubing, and new types of sprinklers. As a result, the cost of automatic sprinkler installations has escalated at a considerably lesser rate than the various other mechanical systems in buildings. Alternate materials, and new methods and devices, have been — and continue to be — encouraged. Innovative technology continues, supported by major research projects of the National Fire Protection Research Foundation. This charge, although over three decades old, continues to be a prime consideration of the committee.

The life safety record of the automatic sprinkler system over its long history has been outstanding in occupancies that have been properly protected. In May of 1973, the committee, recognizing the need to reduce the annual life loss from fire in residential occupancies, established a subcommittee to deal with residential and light hazard occupancies. This subcommittee was responsible for the development of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, which was first adopted in May 1975 and which has been revised as technology improved and as a result of extensive fire tests. Activities in the residential sprinkler field resulted in the development of a new residential sprinkler whose prime goal is life safety. This new fire protection tool now makes it possible to protect the person in the room of the origin of the fire. In 1989, NFPA 13R was developed to expand detailed residential sprinkler technology to residential occupancies up to and including four stories high. Residential sprinklers may, of course, also be appropriately applied under NFPA 13.

Present technology as reflected in the residential, early suppression fast-response, and new quick-response early suppression efforts depends on applying water in adequate quantities and of proper quality early in the fire. Thus far, this limits this technology to wet systems. A major challenge is the development of a dry pipe system or method to allow expansion of the technology to areas where wet systems cannot be used.

The sprinkler standard is not written as a legal document, nor does it cover all situations that might be encountered. It must be used with engineering judgment as well as common sense. Assistance in the application of the standard can be found in the Formal Interpretations that have been issued by the committee. Additional information is also available through reviewing substantiation associated with the Report on Proposals and the Report on Comments developed under the Regulations Governing Committee Projects, which govern the standards-making system of the Association.

This handbook is intended to assist in the application of NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*; and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*.

Contributors to the handbook include members of the Technical Committee and who have been responsible for the development of the individual documents who deserve our sincere thanks not only for their work on the handbook, but also for their tireless efforts in committee work.

Hopefully, this handbook will help toward achieving easier and more accurate application of the standards and will contribute to the continuation of the enviable record of life safety and property protection provided by automatic sprinkler systems.

*Chester W. Schirmer*  
*Chairman*  
*Technical Committee on*  
*Automatic Sprinklers*

# Preface

The first automatic fire extinguishing system on record was patented in England in 1723 and consisted of a cask of water, a chamber of gunpowder, and a system of fuses. The first form of sprinkler system used in the United States, however, was the perforated pipe system, which was first installed about 1852.

The first automatic sprinkler was invented in 1864, but it wasn't until 1878 that Henry Parmelee invented a sprinkler that was used extensively in practice. Some 200,000 Parmelee sprinklers were installed throughout New England by the Providence Steam and Gas Pipe Company (later the Grinnell Company) between 1878 and 1882.

The first set of rules for the installation of automatic sprinklers was developed by John Wermald of the Mutual Fire Insurance Corporation of Manchester, England in 1885, based on an 1884 Factory Mutual Fire Insurance Company's study of the performance of sprinklers conducted by C. J. H. Woodbury of the Boston Manufacturers Mutual Fire Insurance Company and F. E. Cabot of the Boston Board of Fire Underwriters. In 1887, similar rules were prepared in the United States by the Factory Improvement Committee of the New England Insurance Exchange.

By 1895, the commercial growth and development of sprinkler systems was so rapid that a number of different installation rules had been adopted by various insurance organizations. Within a few hundred miles of Boston, nine radically different standards for the size of piping and sprinkler spacing were being used. To solve this problem, the following group of men met in Boston early in 1895:

Everett U. Crosby, Underwriters Bureau of New England  
Uberto C. Crosby, New England Insurance Exchange  
W. H. Stratton, Factory Insurance Association

John R. Freeman, Factory Mutual Fire Insurance Companies  
Frederick Grinnell, Providence Steam and Gas Pipe Company  
F. Elliott Cabot, Boston Board of Fire Underwriters

Subsequently, a small group of inspection bureau men met in New York in December of 1895 to draw up a set of uniform sprinkler rules. At a second meeting in March of 1896, these rules were completed, and, at the same time, a committee was appointed to set up an association for the proper recognition of sprinklers. On November 6, 1896 this association, the National Fire Protection Association, came into being.

Thus, the first and only standard for the National Fire Protection Association in 1896 was the *Standard for the Installation of Sprinkler Systems*.

In 1900, the National Board of Fire Underwriters joined the NFPA and voted to adopt and assume the expense of publishing the NFPA standards. Thus, from 1901 to 1964, the NFPA *Standard for the Installation of Sprinkler Systems* was published by the National Board of Fire Underwriters, first as rules and requirements, later as regulations, and still later as a standard of the National Board of Fire Underwriters as recommended by the National Fire Protection Association.

When first printed in 1896, the sprinkler standard concerned itself principally with sprinkler pipe sizes, sprinkler spacing, and water supplies. Since 1900, the sprinkler standard has been subjected to considerable amplification and refinement. The 1991 edition of NFPA 13 was completely reorganized to follow a logical systems design approach for easier understanding and use. This sixth edition of the handbook is based on the 1994 edition, which is the 55th edition of NFPA 13.

In 1938, the Committee on Automatic Sprinklers began work on a *Recommended Practice for the Care and Maintenance of Sprinkler Systems* (NFPA 13A) because an improperly maintained sprinkler system may be worthless. The first edition was adopted in 1939. The last edition of NFPA 13A was the 1987 edition. The requirements for care and maintenance of sprinkler systems are now contained in NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

Recognizing the need to reduce the annual loss of life from fire in residential occupancies, the Committee on Automatic Sprinklers in 1973 began preparing a *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes* (NFPA 13D), which was first adopted by NFPA in 1975.

In 1980, the standard was revised to require the installation of fast-response residential sprinklers which had just been developed to improve the life safety



of residential sprinkler protection. The latest revision of NFPA 13D is the 1994 edition.

Throughout the 1980s, the Committee on Automatic Sprinklers debated the need for a separate standard to cover sprinkler systems in residential occupancies other than one- and two-family dwellings and manufactured homes, primarily for life safety purposes. In 1988 the first edition of NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*, was adopted to cover such occupancies as hotels, motels, dormitories, apartments, lodging and rooming houses, and certain board and care facilities. The latest revision of NFPA 13R is the 1994 edition.

It is hoped that this handbook will assist fire protection practitioners in obtaining a better understanding of, and appreciation for, the requirements contained in the 1994 editions of NFPA 13, NFPA 13D, and NFPA 13R.

It should be pointed out, however, that the commentary on the text contained in this handbook is the opinion of the editor and the technical consultants. The commentary does not necessarily reflect the official position of NFPA nor the Committee on Automatic Sprinklers.

*Arthur E. Cote, P.E.*  
*Vice President and*  
*Chief Engineer*  
*NFPA*

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# PART 1

# Standard and Commentary for NFPA 13, *Installation of Sprinkler Systems*

## 1994 Edition

The text and illustrations that make up the commentary on the various sections of NFPA 13 are printed in black. The text of the standard itself is printed in rust.

The Formal Interpretations included in this handbook were issued as a result of questions raised on specific editions of the standard. They apply to all previous and subsequent editions in which the text remains substantially unchanged. Formal Interpretations are not part of the standard and, therefore, are printed in a shaded rust box.

Paragraphs that begin with the letter "A" are extracted from Appendix A of the standard. Appendix A material is not mandatory. It is designed to help users apply the provisions of the standard. In this handbook, material from Appendix A is integrated with the text, so that it follows the paragraph it explains. An asterisk (\*) following a paragraph number indicates that explanatory material from Appendix A will follow.





# 1

## General Information

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### 1-1 Scope

This standard provides the minimum requirements for the design and installation of automatic fire sprinkler systems and exposure protection sprinkler systems, including the character and adequacy of water supplies and the selection of sprinklers, piping, valves, and all materials and accessories, but not including the installation of private fire service mains and water supplies.

NOTE: Consult other NFPA standards for additional requirements relating to water supplies.

Storage in excess of 12 ft (3.7 m) in height or storage in excess of 5 ft (1.5 m) in height of high hazard materials such as Level II and III aerosols, idle pallets, rubber tires, rolled paper stored on end, plastics, and flammable liquids are outside the scope of this standard. (For guidance and limitations regarding areas, quantities, or methods of storage for high hazard materials, see NFPA 30, 30B, 40, 58, 81, 231, 231C, 231D, 231F, and 409.)

It is very important to understand that this is an installation standard for sprinkler systems having automatic and open sprinklers and using water as the extinguishing medium. It is possible to achieve different levels of performance, for example, by providing supervisory signaling systems or additional protection devices and systems. This standard establishes minimum requirements for sprinkler systems that are not dependent upon these features.