THE INSTITUTE FOR BUSINESS & HOME SAFETY

Residential Fire Sprinklers

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INTRODUCTION

Widespread support by fire safety officials for residential fire sprinklers first emerged in response to the 1973 report America Burning, published by the National Commission on Fire Prevention and Control. At that time, approximately 8,000 people were dying in fires annually in the United States. Of those deaths, eight out of 10 resulted from house fires. More than 30 years later, the number of lives lost in fires has decreased by about 50 percent. Yet, more than 3,000 deaths still occur each year in residential fires.

In response to the 1973 report, an advisory group was formed to develop a standard for residential sprinkler systems. Two years later, the National Fire Protection Association (NFPA) adopted NFPA 13D: Standard for the Installation of Sprinkler Systems in One- and Two- Family Dwellings and Mobile Homes. The most recent edition of this standard, updated in 2007, reflects ongoing testing and product development efforts intended to provide "improved protection against injury, life loss, and property damage."

As part of its ongoing Everyone Goes Home program, the National Fallen Firefighters Foundation adopted a resolution in 2008 stating that "fire sprinklers represent a proven, reliable, efficient, and effective method of protecting life and property in both commercial and residential occupancies" and supporting "the concept that the widespread use of residential sprinklers will improve fire occurrence outcomes for civilians and decrease firefighter injuries and deaths due to firefighting."

In 2007, 414,000 residential fires resulted in 2,895 deaths and 14,000 injuries, and caused $7.5 billion in property damage, according to the U.S. Fire Administration (USFA). When asserting its support for the requirement that automatic fire sprinklers be installed in all new residential construction, USFA cited its studies indicating the potential to save thousands of lives, prevent many injuries, and eliminate hundreds of millions of dollars in property losses. The USFA estimates that 90 percent of house fires are contained by the operation of a single sprinkler.

After the development of the standard for sprinkler installations, NFPA technical committees began to introduce and debate proposals for the inclusion of mandatory provisions in their various model codes. The requirements for one- and two-family dwellings were included in the 2006 editions of the Life Safety Code, Fire Code and Buidling Code. In September 2008, after many years of consideration and debate, the International Code Council (ICC), which promulgates the most widely adopted suite of model building codes in the United States, also approved code change proposals for the 2009 International Residential Code (IRC) to require fire sprinklers in new one- and two-family dwellings and townhomes.

The ICC is a non-profit association that develops model building codes, including the International Building Code, the International Fire Code, and the IRC, among others. The IRC governs construction of one- and two-family dwellings and townhouses not exceeding three stories in height. Although the ICC develops model codes using a consensus-based process, states and local jurisdictions are not required to adopt these model codes. Most states or local jurisdictions do adopt the model codes, however, because it helps standardize building and fire safety regulations over large geographic areas.

The Institute for Business & Home Safety (IBHS) has long included fire sprinkler systems as a recommended part of its code-plus ***Fortified...for safer living®*** program. In November 2007, the IBHS Building Code Committee, which is comprised of representatives from a number of IBHS member insurance companies, unanimously endorsed the idea of pushing for the inclusion of fire sprinkler requirements in the residential building codes.

While the life safety benefits of sprinklers are undisputed, concerns continue to be raised about cost, maintenance, and potential losses to property caused by failures or inadvertent activation of sprinklers. However, it is primarily the cost increase that has motivated some groups, mostly home builders, to actively oppose implementation of the new ICC requirements.

Importantly, residential sprinklers will not be mandatory in any jurisdiction unless and until the new ICC provisions are affirmatively adopted by that jurisdiction – and the adoption process varies in length and type by jurisdiction. Local governments, however, can require sprinklers through ordinances. For example, in 1992, Prince George's County in Maryland enacted an ordinance mandating the installation of automatic fire sprinkler systems in new one- and two-family structures.

A study of the impact of the Prince George's ordinance was released in October 2009, by the Home Fire Sprinkler Coalition. The study found from 1992 to 2007, there were 13,494 fires involving single-family homes and town houses in the county, which resulted in 101 fire-related deaths and 328 injuries in cases where fire sprinklers were not installed. However, no fire deaths and only six injuries occurred in fires involving these same types of residences where fire sprinklers were in place.

As it relates to property protection, the average fire-related property loss in a residence without sprinklers was reported to be $9,983, compared to $4,883 when a fire sprinkler was present.

The study also examined the trends in fire sprinkler installation costs during the same 15-year period. These cost have decreased to less than $2 per square foot for installation in a single-family home, according to interviews with several sprinkler contractors in the county.

MODERN SPRINKLER SYSTEMS

There have been significant technological advancements in the development of fire sprinkler systems since the 1970s. Today's automatic, residential fire sprinklers are designed to react to a fire much faster than standard commercial systems. Key features of today's sprinklers include the following:

- Each fire sprinkler has a temperature-sensitive element that causes it (rather than the entire system) to activate when temperatures reach 135 degrees to 165 degrees Fahrenheit.
- Sprinklers only operate in response to the heat of fire; they do not respond to smoke or vapors.
- Because sprinklers operate individually, only the sprinkler(s) over the fire will activate. While they are primarily intended to control the fire long enough to allow occupants to escape, they often help reduce the extent of damage and property loss.
- When a fire starts, the heat from the fire activates the sprinkler closest to the fire, limiting fire growth. In some instances sprinklers will actually put out the fire before fire fighters arrives. By limiting or stopping fire growth, further property damage, including that caused by streams of high-pressure water from fire department hoses, also is prevented.

RESEARCH FINDINGS

Reliability and effectiveness of sprinkler systems were recently studied in the report, U.S. Experience with Sprinklers and Other Automatic Fire Extinguishing Equipment, (NFPA -January 2009). Some core findings are outlined below.

- Sprinklers operated effectively in 91 percent of all reported structure fires when the sprinkler system was present in the area where the fire was burning, and when the fire was large enough to activate the sprinkler system.
- The primary reason sprinklers were ineffective was insufficient water supply to the area affected by the fire.
- The most common reason for sprinkler system failure was that the system had been shut off prior to fire ignition.
- The average amount of direct property damage from fire was reduced by 63 percent in residential properties when fire sprinklers were present. [NOTE: only one percent of the properties studied had fire sprinkler systems present.]

A report by the National Institute for Standards and Technology (NIST) examined the impact of automatic sprinkler systems on lives lost and property damage as the result of house fires. NIST researchers compared fires in homes with residential sprinkler systems to fires in homes equipped only with smoke alarms. Over the 2002 to 2005 study period, houses equipped with smoke alarms and a fire sprinkler system experienced 100 percent fewer civilian fatalities, 57 percent fewer civilian injuries and 32 percent less direct property losses and indirect costs resulting from fire than houses equipped only with smoke alarms.

In 1986, the city of Scottsdale, Arizona, enacted a code requirement for installation of sprinkler systems in all new single-family houses. The city now has more than 45,000 single-family homes equipped with fire sprinklers. Ten years later, in 1997, a study was conducted by the City of Scottsdale and its Rural/Metro Fire Department in cooperation with the Home Fire Sprinkler Coalition. A brief update also was issued in 2001. Below are some of the findings of the 1997 Scottsdale study (examining 44 house fires that occurred between 1985 and 1996):

- the average fire loss in a house with a sprinkler system was $1,544, compared to $11,624 for houses without automatic fire sprinklers; and,
- one or two activated sprinkler heads controlled or extinguished the blaze in 92 percent of fires.

The Scottsdale study also examined 38 fires to determine water usage. This study found that:

- the average sprinkler used 357 gallons of water per incident to extinguish a fire;
- manual fire suppression operations under similar conditions would have equaled an average of 4,884 gallons of water per incident to extinguish these same 38 fires; and,
- smaller amounts of water distributed earlier in the fire incident by automatic sprinklers had a positive effect on the extent of fire and water damage experienced in the buildings studied.

EVALUATING FIRE RISKS

Engineered Wood Products Research Review

The environmental sustainability movement is leading to more homes being built, retrofitted and furnished with "green" products, including engineered wood products. Lightweight residential structures began to appear widely about 25 years ago, according to The Engineered Wood Products Association (formerly the American Plywood Association), and have become increasingly popular. The Association describes these products as very efficient and green because they often can be manufactured from smaller logs and in shapes and designs that are tailored to their application.

This trend could prove significant as it relates to residential fires and the presence of fire sprinklers because of the findings of three separate studies by Underwriters Laboratories (UL), the

National Research Council of Canada Institute for Research in Construction (NRC-IRC) and NIST. Each of these studies found engineered wood products failed at a faster rate when exposed to fire as compared to traditional wood products, which gives occupants and rescue personnel less time to evacuate a burning structure. If a fire can be more quickly extinguished before rising to the severity levels demonstrated in the studies, these risks can be minimized.

The UL study, Structural Stability of Engineered Lumber in Fire Conditions, was released in December 2008. It was developed in response to a Federal Emergency Management Agency Fire Prevention and Safety Grant and at the request of the Chicago Fire Department. The study compared contemporary construction to traditional construction assemblies for floors and roofs. Specifically, the use of wooden I-joists and truss systems as replacements for traditional 2 x 10-inch floor joists and 2 x 6-inch roof joists, with a primary goal of assessing the stability of traditional materials and engineered wood building components and assemblies in a fire environment.

The study involved nine tests where the components were subjected to fire using the time-temperature curve of the American Society for Testing and Materials (ASTM) E119 test. Among the findings was the performance of a traditionally constructed floor system, without a drywall ceiling to protect its underside, which failed after 18 minutes, as compared to a system using engineered wooden I-beams, which failed after about 6 minutes. By comparison, in one test it took 79 minutes for a ¾-inch plaster ceiling to collapse and fail.

In an effort to learn more about the potential fire dangers involved with new products and building materials, primarily those being used in single-family home construction, the Canadian Commission on Building and Fire Codes (CCBFC) and the Canadian Commission on Construction Materials Evaluation (CCCME) requested the NRC-IRC to perform its own study. One of the focuses of the 2008 NRC-IRC study, Fire Performance of Houses. Phase I. Study of Unprotected Floor Assemblies in Basement Fire Scenarios, was the structural failure of test assemblies, using specific fire test scenarios in a full-scale test facility. A range of engineered floor systems, including wood I-joist, steel C-joist, metal plate and metal web wood truss assemblies, as well as solid wood joist assemblies, were tested. A single layer of oriented strand board (OSB) was used for the subfloor of all assemblies. The tests, which were designed to simulate severe fire conditions, showed a structural failure rate that was 35 percent to 60 percent faster for the wood I-joist, steel C-joist, metal plate and metal web wood truss assemblies as compared to the solid wood joist assembly.

While the UL and NRC-IRC studies focused on building materials, the focus of the NIST study, Performance of Home Smoke Alarms Analysis of the Response of Several Available Technologies in Residential Fire Settings, was interior fires caused by ignited furniture and other sources. The 2004 study was revised and released in 2008. The study found the average time for flaming furniture fires had decreased by 17 percent, and smoldering furniture fire times had decreased by 47 percent, as compared to a similar study conducted by the organization in 1975. NIST researchers concluded that a major factor in the increase in fire growth rate is due to differences in modern furniture materials and construction compared to furniture manufactured four decades ago. The report further concluded that the changing materials used in furniture manufacturing require more research to determine if modifications in smoke alarms are required to accommodate the changing threat and allow occupants more time to escape a fire.

FIRE SPRINKLER-RELATED CHALLENGES

The cost of sprinkler installation is often cited as an initial barrier to the use of residential fire sprinklers. In addition to initial installation, it also is important to consider maintenance issues for sprinkler systems, as well as vulnerability posed by colder climates, availability of adequate water supplies in rural areas, and potential for property damage from accidental activation, perhaps because of a knocked off head.

COSTS

Costs directly associated with fire sprinkler installation are outlined in the National Association of Home Builders' (NAHB) report, Fire Sprinklers and Homeowner Insurance, as well as in the Home Fire Sprinkler Cost Assessment published by the Fire Protection Research Foundation (FPRF). The Scottsdale study referenced above also addressed this issue.

- The NAHB study, which was conducted solely by NAHB for its members, shows median costs for sprinkler installation at $2.45 to $2.94 per square foot, depending on what overhead and profit was included.

- The FPRF report that was conducted two years later with a broad-based review panel including NAHB, insurers and other entities, shows home sprinkler costs ranged from $0.38 to $3.66 per square foot, depending on the type of system and geographic location, with an average cost of $1.61 per square foot.

- In Scottsdale, a reduction in installation costs was noted from $1.14 per square foot to $0.59 per square foot over the 10-year study period.

SYSTEM TYPES AND MAINTENANCE

Two common types of home sprinkler systems are acceptable under the NFPA sprinkler installation standard and the NFPA and ICC model codes, but it should be noted that the amount of maintenance depends on which system is used.

Multi-purpose residential fire sprinkler systems are potable water systems that completely eliminate the need for the cross connection control required for stand-alone fire sprinkler systems (refer to the next paragraph). Since the sprinklers in this type of system are part of the potable water system, their components have to meet code requirements for potable water systems in addition to those for sprinklers. Multipurpose systems, which combine plumbing and sprinklers into one piping network with a continuous flow of circulating water, are relatively low maintenance. They do require visual checks for leaks, and a water flow test about once a year. The Home Fire Sprinkler Coalition offers instructions for conducting a water flow test and

indicates that the test can be performed by the homeowner or sprinkler contractor.

Stand-alone sprinkler systems use a dedicated sprinkler piping supply, so that water flows only when a sprinkler is activated. Stand-alone sprinkler systems hold stagnant water in place through use of check valves. While they may require some type of annual maintenance by a professional if they incorporate a testable backflow device, routine maintenance can be done by the homeowner.

As with any water piping system, whether it is the weather or a simple equipment failure, the potential exists for leaks to occur with automatic residential sprinkler systems.

SYSTEM TYPES AND MAINTENANCE

As with traditional domestic water systems, homes in colder climates are at risk of freezing pipes – including those in sprinkler systems – when the temperature drops. This vulnerability is recognized by installation guidelines offered in the IRC and NFPA 13D standard. In general, 13D provides specific guidance to protect piping in unheated attics with prescriptive insulation details (A.8.3.1). A professional sprinkler contractor would do all they could to avoid unheated attics or running pipes in exterior walls just like a professional plumbing contractor would. Placing piping for plumbing or fire sprinklers in unheated attics is a bad practice and should be discouraged, even if the space is insulated.

FREEZING WEATHER

USFA reports the failure rate for commercial sprinkler heads is one in 16 million and that domestic plumbing ruptures and leaks occur 1,000 times more frequently than sprinkler system ruptures and leaks. No comparable data is available for residential sprinklers.

WATER DAMAGE

In rural areas, concerns exist about the availability of adequate water supplies and the reliance on well water or pump systems to service residential sprinkler systems. The following are among the ways to deal with such concerns:

- Adding a water storage tank (generally 300 gallons) either elevated or pumped; and

- NFPA 13D offers design options including a “non-listed” pump as a water supply component that greatly reduces the cost of the stored water supply system for fire sprinkler systems in houses that use a well or stored water in place of a public water supply.

CONCLUSION

The use of residential sprinklers will not be mandatory in any jurisdiction unless and until the new ICC provisions are affirmatively adopted by individual jurisdictions. This is the beginning of the adoption process, and there will no doubt be continued discussion and debate about the efficacy of residential fire sprinklers. IBHS will continue to monitor the deliberations surrounding this issue and keep members informed.

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