SUCCESSFUL RESIDENTIAL SPRINKLER ACTIVATION
Greenburgh, NY
November 1, 1985
&
Dover, New Hampshire
December 28, 1985

FIRE INVESTIGATIONS
NATIONAL FIRE PROTECTION ASSOCIATION

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Summary Investigation Report

Successful Residential Sprinkler Activations
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Prepared By

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ABSTRACT

In the past decade, the concept of residential sprinkler protection, through research, has become a viable technology that is believed to have the potential for making an impact on national fire losses in residences. Some communities have passed legislation requiring residential sprinkler protection in new construction and others promote the voluntary use of residential sprinklers. Recently in two of these communities, fires have occurred in protected properties. The analysis of these fires affirms the life saving and property protection capability of a residential sprinkler system.

On November 1, 1985 at approximately 9:30 a.m., a fire occurred in an unoccupied single-family dwelling in Greenburgh, New York. The accidental fire began on a kitchen counter and spread to combustible cabinets. The home was protected with a residential-type sprinkler system which activated and extinguished the fire. A neighbor heard the exterior sprinkler alarm bell operating and notified the homeowner. When the owner returned home, he found that sprinklers had operated and extinguished the fire with a minimum amount of property damage.

On December 28, 1985 at approximately 3:00 p.m., a fire occurred in a condominium in Dover, New Hampshire. At the time of the fire, an adult and a young child were in the building. Like the dwelling in Greenburgh, this home was protected with a residential-type sprinkler system. The accidental fire started in the basement which contained a large amount of combustible materials. The combination of sound from the sprinkler activation and the externally mounted alarm horn alerted occupants of the fire. The sprinkler system not only alerted the occupants but completely extinguished the fire as well. Once again property damage was reported to be minimal.
Both the Greenburgh and Dover incidents involved fire scenarios that commonly occur in residential occupancies. In many instances, these fires have caused casualties and severe property damage in unprotected dwellings. The potential for significant losses existed in both incidents; however, the activation of the sprinkler systems prevented such an occurrence.
INTRODUCTION

The National Fire Protection Association (NFPA) with the assistance of the Building Officials and Code Administrators (BOCA) investigated the Greenburgh, NY fire in order to document and analyze this successful residential sprinkler operation. The NFPA was assisted in the data collection and analysis by a BOCA representative under an agreement between NFPA and the three model building code organizations to investigate significant structural fires throughout the United States. In addition to BOCA, the other cooperating building groups are the International Conference of Building Code Officials (ICBO) and the Southern Building Code Congress International (SBCCI). The three model building code groups are supporting NFPA by lending technical staff support for on-site field work and a building code analysis.

The NFPA became aware of the fire in Greenburgh within days of its occurrence and under the agreement, NFPA notified BOCA of the incident. Michael S. Isner, Fire Protection Specialist, NFPA Fire Investigations and Applied Research Division, and Bruce Larcomb of Building Officials and Code Administrators International (BOCA) visited Greenburgh, New York for an on-site documentation of facts. Shortly following the visit to Greenburgh, New York, another fire that involved a residential sprinkler system occurred in Dover, New Hampshire. Michael S. Isner also visited this community in order to document the facts regarding this incident.

The information contained in this report has been based on the best data available following the fires and additional data obtained in subsequent followup. The purpose for the NFPA documentation of fire incidents is to identify, analyze, and record factors that have particular educational and technical interest. It is not the NFPA's intention that this report pass judgment on, or fix liability for, casualty or property losses in these incidents.

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The cooperation and assistance of Mr. Robert Brunner, Building Commissioner, Town of Greenburgh, NY, Mr. Neil Slack, Fire Marshal, Town of Greenburgh, NY, and Assistant Chief David Stevens, Dover Fire and Rescue Service are acknowledged and appreciated. In addition, the author thanks Mr. Bruce Larcomb, P.E., Regional Staff Engineer, Building Officials and Code Administrators International for his on-site assistance and his input during analysis of the incident.
BACKGROUND

NFPA statistics indicate that in 1984 nearly 5,240 civilians were killed by fire in the United States. The statistics also indicate that approximately 80 percent of those deaths occurred in residential fires -- dwellings, apartments, mobile homes, hotels, and motels.\(^1\) Moreover, the estimates of the civilian fire deaths reveal that 3,290 of these casualties occurred in one- and two- family dwellings.

Early in the effort to reduction of life loss in residential occupancies, the need for early warning devices in homes and other residential environments was recognized. Since their introduction in the 1970's, smoke detectors have been installed into approximately 75 percent of American homes. Current studies suggest that "a person who has a home fire and does not have a detector is twice as likely to die in that fire as another person who suffers the same fire but is protected by detectors."\(^2\)

A more recent technological advancement in residential fire protection is the development and introduction of low-cost residential sprinklers systems for use in one- and two- family dwellings and mobile homes. In the early 1980's, several communities (Cobb County, Georgia; Greenburgh, New York and others) became aware of research being conducted in the area of residential sprinkler protection. Recognizing that such systems could reduce the potential for life and property losses, the communities began to investigate the feasibility of introducing sprinkler protection in local residences. Eventually they became some of the first communities in the nation to promote


voluntary or require mandatory sprinkler installations for residences. Following this precedent, and working closely with Cobb County, Georgia, Dover Fire Department Officials have also begun to promote a voluntary residential sprinkler installation program in their community.

In September 1983, the first successful residential sprinkler activation that has been reported to the NFPA occurred in Cobb County, Georgia. A woman preparing popcorn inadvertently applied too much heat to grease, which flashed into flame. The sprinkler activated and extinguished the fire. Since then three other residential systems have activated and extinguished fires in Cobb County. The most notable incident occurred on May 2, 1985 when an early morning fire in a young girl's bedroom activated the room's sprinkler which prevented the child's death. In addition, the activation controlled the fire before it could compromise the safety of adults who were sleeping in other rooms of the apartment.

Since the incidents in Cobb County, Georgia, two fires have occurred and resulted in successful residential sprinkler activations. One was in Greenburgh, New York and the other was in Dover, New Hampshire.

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Successful Residential Sprinkler Operation

Dobbs Ferry Road
Town of Greenburgh, NY
November 1, 1985

The Building

The home was a split-entry, ranch-style house, (see Photo 1) that was prefabricated and site-assembled on a poured-in-place concrete foundation. The lower level of the building contained a one-car garage and an unfinished storage/basement area. The upper level contained three bedrooms, a bathroom, kitchen, dining room, and livingroom (see Figure 1). Walls and ceilings were painted gypsum board on wood studs/joists and all floors were covered with wall to wall carpet, except in the kitchen and bathrooms. The kitchen and bathroom floors were covered with linoleum-type material. The home furnishings and contents were typical for a family of two adults and two young children.

Fire Protection

The house was provided with a sprinkler system because the Town of Greenburgh passed a law in 1982 that required new buildings, including one- and two- family dwellings, to be sprinklered. According to the law, all areas in residences (except enclosed closets 50 square feet or less in area, bathrooms, and unheated areas) shall be sprinklered. In addition, the sprinkler system design must comply with the 1980 edition of NFPA 13D, Installation of Sprinkler System in One- and Two- Family Dwellings and Mobile Homes.

The sprinkler system involved in this incident was connected to the domestic water supply line which was a 1-inch pipe. The riser contained the components typically included as part of a NFPA 13D sprinkler system riser.
(see Figure 2). All piping in the system was copper with soldered connections. All the sprinklers were quick response sidewall-type, listed for residential use (K Factor 4.2), and had a rated activation temperature of 165°F. The manufacturer specifications indicated that the sprinklers could be used to effectively protect an area 16 feet wide and 14 feet long at a required sprinkler flow of 24 gpm (single sprinkler operation). The specifications also indicated that effective protection could be attained with a flow rate of 17 gpm each sprinkler during a two sprinkler operation. Finally, it was stated that these flows would be possible only if the system provided 33 psi or 16 psi at the most remote head during one or two sprinkler operations, respectively. Town records indicated that a 8-inch street main with 125 psi street pressure supplied this house.

An electric bell was externally mounted near the building's front entrance door and was connected to a sprinkler system water flow switch (see Photo 2). In addition to the electronic bell, the home contained an AC-powered smoke detector. This was mounted in the upper level hallway outside the bedrooms (see Figure 1).

Fire Incident

On the morning of the fire, all occupants had left the building for various reasons. Prior to his leaving at approximately 8:20 a.m., one of the occupants moved two bags of apples, which had been temporarily stored on the kitchen floor, onto the kitchen counter. This placed the bags adjacent to a toaster, blender, coffee maker, and other combustible materials kept on the counter top.

At about 10:00 a.m., a neighbor heard the externally mounted electronic bell operating and attempted to call the owners of the building. Once notified of this problem, one of the homeowners left work and arrived home slightly before 11:00 a.m. to find the alarm bell still operating.
Upon entering the building, the home owner observed two sprinklers and a smoke detector operating but no obvious signs of fire. Thus he went immediately to the basement and shut off the system. He returned to the upper level and found that there had been a fire in the kitchen, but it had been completely extinguished by the sprinkler system. He then called the fire department.

The fire department received the telephone call at 11:00 a.m. Upon their arrival, fire fighters confirmed that the fire had in fact been completely extinguished. Therefore, they were left with the task of removing water from the first floor and basement. They estimated that up to two inches of water had collected in some areas of the basement. Most of this water was pushed out of the basement via the garage. The remaining water was cleaned up with suction equipment and mops. In addition, the fire fighters serviced the sprinkler system and returned it to its operational condition.

**Damage**

Since the building was vacant at the time of fire, no occupants were affected by the fire. The fire did, however, severly char the cabinets directly above the point of fire origin and damaged the toaster, blender, coffee maker plus other materials adjacent to the point of fire origin. (See Photos 3 & 4). In addition to the severe charring, less severe damage occurred on the cabinets up to five feet from the point of fire origin and on the ceiling above the point of fire origin. (See Photo 5).

An insurance estimator assessed the structural damage due to fire and smoke at $2000. He also estimated that water caused about $2500 worth of damage to the structure. The refrigerator, several small appliances, some cabinets, and one rug had to be replaced. The cost of these and other minor content repairs was estimated to be $2500. Therefore, the total loss was
estimated at $7000. The judgment of the insurance representative was that without sprinkler protection, the fire damage could have conceivably reached the limit of the policy which was $85,000.

**Analysis**

The Greenburgh Fire Marshal determined the fire cause to be accidental. He felt the man "turned on" the toaster when he put a bag of apples on the counter. The bag then held the lever-type switch in the "on" position. Eventually, the heat being generated ignited combustible materials that were adjacent to the toaster and its electric supply cord. With the fire originating against a wall and the combustible cabinets directly above, the fire began in an area with geometric characteristics that enhanced its growth. As the fire increased in size, flames and heat spread along the bottom side of the kitchen cabinets. The resulting damage suggests the growing fire was well-established; it could have involved the entire kitchen and potentially the entire structure.

The developing fire produced sufficient heat and smoke to activate two sprinklers and a smoke detector. (See Figure 1 for the location of these devices). It appears that Sprinkler #1 was primary in the extinguishment of the fire. Since the fire was spreading along the bottom of the cabinets, the spray would not have been able to directly contact some of the flames. In addition, the refrigerator appears to have blocked and prevented even more of the sprinkler discharge water from contacting the fire directly. Despite these obstructions, the water from the sprinkler completely extinguished the fire. The position of Sprinkler #2 with respect to the point of origin (see Figure 1), indicates that water from this sprinkler could not have directly contacted the fire. Therefore, it appears this sprinkler had little or no affect during the fire extinguishment even though heat from the fire caused it to fuse.
Since the neighbor reported that she heard the sprinkler alarm bell at 10:00 a.m. and the home owner did not discover the operating sprinklers until just before 11:00 a.m., it appears that the sprinkler discharge lasted for about an hour. Rugs in the dining room, living room, and bedrooms absorbed a large amount of water. Some water managed to pass under the exterior wall plate and drain directly to the outside of the building. Voids and cracks in the floor provided a means for water to drain into the basement. However, most of the water entered the basement through the interior stairway. Once notified, the fire department was able to remove the nearly two inches of water that collected in parts of the basement.

The externally mounted alarm bell appears to have helped reduce the amount of water damage in this incident. The bell alerted a person outside that there was a problem, and that person in turn notified the building owner. Without the intervention on the part of a neighbor, the undetected water discharge may have continued for an undeterminable time and increased the potential for serious water damage.

The Greenburgh Building Commissioner stated that the home owner was extremely upset because he was required to install a sprinkler system in his home during the construction of his house. Besides being concerned about the installation cost, the owner could not understand the value of the system and was extremely apprehensive about the potential for accidental sprinkler discharge. When applying for his building permit, the man referred to the sprinkler system as an "unnecessary evil." After experiencing an actual fire in his home that had the potential for severe damage, if not total destruction of his home, the homeowner has a new appreciation for residential sprinkler systems and told this investigator that he "now believes 110% in them."
Successful Residential Sprinkler Operation

Bellamy Woods
Dover, New Hampshire
December 28, 1985

The Building

The home involved in this incident was the end unit in a wood-frame building containing five townhouse condominiums. The exterior wall assembly consisted of wood siding, plywood sheathing, insulation, wood studs, and painted gypsum board for an interior finish. Interior partitions were gypsum board on wood studs. The wall assemblies between the condominium units were also gypsum board on wood studs, however, they were designed to provide a 1 1/2-hour fire separation between units. These walls were continuous from the foundation through the attic space.

With foundation dimensions of 20 feet by 28 feet, two floors and a finished basement, each townhouse provided approximately 1700 sq. ft. of usable floor space. The basement had a large general purpose room with a wood stove (see Figure 3). The room was used for both storage and living space. In addition to this room, the basement contained a small 20-foot by 10-foot unfinished utility room and it too was used for storage (See Figure 3). A doorless opening provided communication between the utility room and general purpose room. A blanket-like material was suspended in this opening. Access to the basement was provided by an open interior stair and bulkhead that lead to grade on the backside of the building.

The fuel load for the first and second floors was considered moderate for a dwelling. The primary combustible materials were typical furnishings and other household goods. Since both rooms in the basement were used for storage, they appeared to have a higher concentration of combustible materials.
than other rooms in the unit. Photo 6 shows the area of fire origin and some of the materials that were kept in the utility room. Even more materials, including a 20 lb. propane gas bottle, were present in other parts of the room.

**Fire Protection**

At the time of this incident, residential sprinkler systems installations were made on a voluntary basis or when the fire department indicated that it could not provide adequate fire protection. In this case, the condominium complex that included the Bellamy Woods units was constructed in an area that received water through a system of old 6-inch mains. The fire department determined that the available water would not be adequate for fire fighting operations. As a result, the developer was provided with two alternatives before he was granted permission to build. He could provide either a standby reservoir with a fire pump or sprinklers in all the living units. The developer chose the latter.

With the rated walls between units, each townhouse was considered an independent dwelling. Therefore, the developer was allowed to install systems that conformed with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two- Family Dwellings*. A 1-inch nominal supply line connected the domestic water system to the water main in the street. This main had estimated 100 psi static pressure. The sprinkler system was connected to the domestic water supply on the system side of the 1-inch water meter. The sprinkler system control valve had been installed prior to the fitting separating domestic water piping from sprinkler piping. This plumbing arrangement was intended to reduce the potential for a sprinkler system being shut-off over extended time periods.

Steel piping was used in sprinkler riser which also had a nominal diameter of 1-inch. Following the riser assembly, the piping for the sprinkler system
was converted to "listed" Chlorinated Polyvinyl Chloride (CPVC) piping with glued connections. Feed mains had 1-inch nominal diameters and the branch lines had 3/4-inch nominal diameters.

The system contained pendant sprinklers. All were quick-response type listed for residential application and rated to activate at 160°F. The manufacturer's literature indicated the sprinkler had a K Factor of 3.85 and a 3/8-inch nominal orifice. The literature also indicated that the sprinklers could provide the required protection at a flow of 18 gallons per minute (gpm). To produce this flow the manufacturer indicated that the system would have to provide 21.9 pounds per square inch (psi) of the sprinkler.

The sprinkler system had a flow switch that activated an electric horn mounted outside and on the back side of the building. In addition to this alarm, AC-powered smoke detectors with interlocked alarms were provided on all levels.

**Fire Incident**

A woman and her 2-year-old son were in the townhouse on the afternoon of the fire. At some time prior to the fire, ashes had been removed from the wood stove and put into a cardboard box kept in the utility room. The box was on the floor approximately eight feet below and 6 feet horizontally away from a sprinkler.

The woman and her son were on the first floor when they heard an "explosion-like" noise in the basement and then the exterior sprinkler alarm horn. She ran to the basement and realized there was a fire in her utility room. She also noted that the sprinkler was operating. Returning immediately to the kitchen, she attempted to call the fire department. However, in her haste and excitement, the woman was unable to complete her call so she grabbed
her son and left the townhouse. It is estimated that about ten minutes passed before the woman found a neighbor at home and attempted to call the fire department for the second time.

The Dover Fire Department received the call at 1:53 p.m. and responded with one engine plus a ladder truck. Upon arrival, fire fighters noted that the sprinkler system had completely extinguished the fire. They were left with the task of removing water from the building and servicing the sprinkler system to return it to an operational condition.

Casualties and Damage

Both occupants of the unit were able to escape safely. Only one sprinkler operated and it quickly extinguished the fire. Even though the sprinkler discharge appears to have lasted for approximately 20 minutes, fire fighters were able to clean up the accumulated water with suction equipment and mops. The home owner indicated that the burned materials had no real value so damage due to fire was considered to be negligible (see Photo 7). Water damage was estimated at $200 and affected only materials in or near the utility room.

Analysis

The Dover Fire Department determined that the fire was accidental and the result of the improper storage (in a cardboard box) of ashes from the wood stove. The cardboard box ignited first, and fire spread to combustible materials adjacent to the box. The fire grew to a size sufficient to activate the sprinkler, and was then quickly extinguished.

Fire officials feel that the "explosion-like" noise heard by the woman was the sound of the sprinkler activating and the water flowing. They also feel that the basement smoke detector (which was operational and about 10 feet from the doorless opening to the utility room) did not operate because the blanket-like material apparently acted as a smoke barrier keeping smoke in the utility room.
It appears that property damage from this fire would have increased in the absence of sprinkler protection. Assuming the smoke detector would have sensed smoke about the time that the sprinkler operated, it appears that it would have warned the occupants and allowed them to safely escape. Considering the availability of combustible materials, including the 20 lb. gas bottle, the fire probably would have continued to grow. Unlike the sprinklers, the smoke detector would not have prevented this growth. Complementing the increased fire size with the delay in fire department notification and the same fire department response time, fire officials believe the fire would have seriously damaged or even destroyed the townhouse.

Apparently, the occupant of the townhouse vaguely understood the purpose and operation of the sprinkler system in her home. After the fire and recognizing the potential for a serious loss, the woman credited the sprinkler system as having prevented the destruction of her family's personal possessions and home.

Five days before this fire, a serious fire occurred in a Dover unsprinklered apartment building. The fire gutted two apartments and damaged ten others. Aware of the devastation in the apartment fire, the developer of the condominiums at Bellamy Woods recognized the value of residential sprinkler protection. After comparing the damage from the apartment fire against the fire damage in the Bellamy Woods townhouse, the developer was convinced that residential sprinklers are valuable protection systems. He has become an advocate of residential sprinkler protection and he intends to include these systems in future construction whenever possible.

Discussion

The Technical Committee on Automatic Sprinklers intends that a residential sprinkler system improve the chance for occupants to escape or be evacuated.
As a result, residential sprinkler systems installed in accordance with NFPA 13D⁴ are required to have water flow alarms that will provide occupants with early warning. The committee also recognizes that smoke detectors can provide early warning. As a result, they allow a sprinkler water flow alarm to be eliminated in dwellings or mobile homes having smoke detectors in accordance with NFPA 74, Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment.

The dwellings in both Greenburgh and Dover exceeded the code requirements because each contained both operational sprinkler water flow alarms and smoke detectors. It is interesting to note that the occupants in neither case became aware of the fire by smoke detector activation. The occupants of the Dover townhouse became aware of the fire by the noise of sprinkler activation and the water flow alarm. The water flow alarm, however, was the only indication of trouble in the Greenburgh incident. Had the neighbor not heard the exterior mounted water flow alarm, the discharging sprinkler would have operated for a longer period of time and increased the potential for water damage. These accounts suggest that the potential for casualties or property loss may be reduced by including both water flow alarms and smoke detectors in residential fire protection systems.

The living units involved in both the Greenburgh, New York and Dover, New Hampshire incidents were one-family dwellings and both contained sprinkler systems that conformed to NFPA 13D criteria. Each incident involved fire scenarios that are common to the residential fire problem. In the Dover incident, the sprinkler system alerted occupants and extinguished the fire

while it was still small and before the occupants were seriously threatened. Although, the Greenburgh home was vacant at the time of the fire, the sprinkler clearly limited the amount of property damage. It is reasonable to conclude that, had this home been occupied, the level of protection contained in the home would have provided early warning and protection to its occupants. Like the successful residential sprinkler activation in Cobb County, Georgia, and Washington, D.C., these successes confirm that residential sprinkler systems can protect occupants and prevent serious property damage in typical fire scenarios.


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Sprinkler Riser Detail

FIGURE 2: Typical sprinkler riser used in Greenburgh, New York.
FIGURE 3: Basement Plan, Dover, New Hampshire
PHOTO 3: (Greenburgh, NY) Point of fire origin. Credit: Fairview Fire Dept.

PHOTO 4: (Greenburgh, NY) Point of fire origin; note severe damage to cabinets. Credit: Fairview Fire Department
PHOTO 5: Area of fire origin; note extended area of charring. Credit: Fairview Fire Department

PHOTO 6: Area of fire origin; note sprinkler to right of light. Credit: Dover Fire & Rescue Service (Dover, NH)
PHOTO 7: Direct fire damage in Dover, NH fire. Credit: Dover Fire & Rescue Service