

FIRE SPRINKLER RETROFIT GUIDE

AUTOMATIC SPRINKLERS IN EXISTING BUILDINGS FOURTH EDITION



Partners in Progress



International Association of Fire Chiefs
4795 Meadow Wood Lane, Suite 100w
Chantilly, VA 20151
www.iafc.org



National Fire Sprinkler Association
514 Progress Drive, Suite A
Linthicum Heights, MD 21090
www.nfsa.org

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In 2006, Jim Dalton, then Director of Public Fire Protection for the National Fire Sprinkler Association (NFSA), had the vision to compile a best practices document to help local and state authorities in their efforts to improve fire protection in their cities and towns. Originally entitled *Fire Sprinkler Retrofit – A Step-By-Step Approach for Communities*. Dalton's six decades of contribution to public safety have had a profound impact at the local, state, and national levels and he is considered one of the pivotal leaders of our time in advocating for public safety initiatives.

This fourth edition of that document, now called the Fire Sprinkler Retrofit Guide, is the result of even more collaboration and includes details of current and proposed code requirements, retrofit case studies, and highlights the impact of the 2018 Tax Reform Bill. The NFSA grateful to several people for their invaluable assistance in updating and maintaining this document, they include:

Shane Ray
President

Jeffrey M. Hugo, CBO
Vice President of Codes, Standards, and Public Fire Protection

Terin Hopkins
Public Fire Protection Specialist

Vincent Powers
Inspection, Testing, and Maintenance (ITM) Specialist

Andrew Bevis, CBO, MCP
Codes and Standards Specialist

Derrick Sawyer, EFO
Former Retrofit Specialist
Fire Chief, Upper Darby Township

John R. Waters, EFO, MA, MS
Former Field Service Coordinator

Table of Contents

Introduction.....	1
Chapter 1: What is Retrofit?	3
Chapter 2: Why Are Retrofit Programs Needed?.....	5
Chapter 3: Codes and Standards	10
Chapter 4: Community Risk Assessment & Building Inventory.....	18
Chapter 5: Historical Preservation	23
Chapter 6: Downtown Revitalization: Infrastructure Projects and Fire Protection	30
Chapter 7: Alternatives – Engineered Life Safety Systems	34
Chapter 8: Retrofits – The Economics	39
Chapter 9: Conclusions	46
Appendix:	
Appendix A: Sample Adopting Ordinance.....	50
Appendix B: Inventory Form	51
Appendix C: Case Studies.....	52
Appendix D: References.....	56
Appendix E: Resources	58

INTRODUCTION

It is unfortunate, but true; we are exceedingly reactive to fire safety in the United States. We change our regulations only when shocked into doing so; we always seem to ask, "How could this have happened" after major life loss fires. It has been observed that "...fires involving major loss of life have resulted in important changes in building and fire codes and in standard protection and prevention practices."¹ But, if we learn our lessons by studying the past; can we not be proactive to assure that history does not repeat itself? The fact of the matter remains "Automatic fire sprinkler use has the ability to solve much of America's fire problem in every class of occupancy."²

The federal government expressed their acknowledgement of the value of fire sprinklers in nursing homes, passing rules stating all nursing homes must be fully sprinklered to participate in Medicare or Medicaid.³

The hospitality industry also found the value of sprinklers after several disastrous fires in the 1970s and 1980s, including:

Fatalities:

1972	Pioneer International, Tyrone, PA	12
1976	Hotel Pathfinder, Portland, OR	11
1978	Coates House, Kansas City, MO	20
1980	MGM Grand, Las Vegas, NV	85
1980	Stouffer's Inn, West Chester, NY	26
1982	Westchase Hilton, Houston, TX	12
1986	Dupont Plaza, Puerto Rico	98

As a result of these fires, and the damage to their reputations, every major hotel chain has required the retrofit of sprinklers in all their hotels. In addition, these fires were the impetus behind the federal Hotel/Motel Fire Safety Act of 1990. It requires that federal employees, when traveling, stay in lodging that is protected by fire sprinklers.⁴

In January of 2000, 3 students were killed and more than 57 injured in a fire in a dormitory on the campus of Seton Hall University, raising awareness of dormitory fires and resulting in dormitory retrofit legislation in the State of New Jersey, the first such legislation in the United States.

That fire was studied by the National Institute for Science and Technology and an experimental recreation was conducted.



A fire in a dormitory on the campus of Seton Hall University injured 57 and 3 students were killed.



The Seton Hall Fire Recreation

<https://www.youtube.com/watch?v=tGeEMGLfwo0>

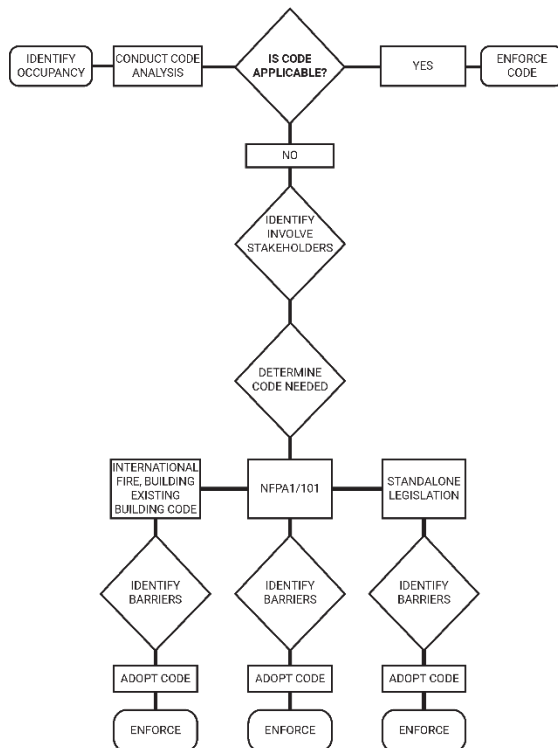
Off campus fires have also taken their toll, with 5 students killed in 1994 at Bloomsburg University. Unfortunately, lessons were not learned, as an additional 3 students were killed at another fire at Bloomsburg in March of 2000. The warnings have been there and ignored as, in July of 2018, 5 students were killed in off campus housing at Texas State University. According to the Center for Campus Fire Safety, there have been 92 fatal fires associated with college housing since 2000.⁵ As such, there has been continued, voluntary efforts to retrofit student housing on college and university campuses. These fires have been the catalyst for similar municipal level retrofit requirements, with the public asking of their elected officials, "Why weren't these buildings protected with sprinklers?" In addition, recent catastrophic fires in high-rises have resulted in some municipal efforts to require retrofits in such structures, most recently in Honolulu, HI, Pittsburgh, PA and Wilkes Barre, PA (December 2018).

"Between 2007 and 2009 the U.S. witnessed a series of banking failures that led to a prolonged recession. The financial crisis was the worst since the Great Depression and caused a significant increase in the federal budget deficit."⁶ This could be one of the reasons that, in the years

between the original publication (2006) and this current revision, there have been fewer fire sprinkler retrofit programs, especially at the municipal and state level; however, other entities have understood the value of fire sprinklers and have made strides in requiring these lifesaving systems. The United States has recovered from that financial crisis and, perhaps, the time has come again to examine the need for retrofit legislation.

FIRE SPRINKLER RETROFIT DECISION FLOWCHART

The original Retrofit Guide provided a Fire Sprinkler Retrofit Decision Flowchart, to help establish whether current State and Local laws, and/or Ordinances had been adopted that included fire sprinkler retrofit provisions.



The Decision Flow Chart was supported by a Code Matrix developed to identify the various codes, building and/or fire, new and existing, National Fire Protection Association (NFPA) or International Code Council (ICC). The respective code sections that address retrofit provisions of the various occupancy classifications is provided in the codes and sprinklers section of this guide, however, this flowchart is still useful today as a tool to help develop programs advocating fire sprinkler retrofit programs. Mandatory requirements for the retrofitting of automatic sprinklers in existing buildings can be found in the National Fire Protection Association's NFPA 1 Fire Code, NFPA 101, Life Safety Code, in the International Code Council's Building Code (IBC) & Fire Code (IFC) and Existing

Building Code (IEBC). A complete reference to these codes can be found in Chapter 3 entitled Codes and Standards.

The 2021 edition of the International Fire Code took a major step where high-rises are concerned. Previously, the retrofit regulations concerning high-rise buildings, regardless of occupancy, were in the appendix, specifically Appendix M. Through the consensus process, and in response to several recent fatal fires in high-rise buildings, the membership of the International Code Council has moved the retrofit requirements into the main body of the International Fire Code; they realized that automatic fire sprinklers are the only reasonable solution to high-rise fires. The separate adoption of an appendix section is no longer required. Specifically, it states that high-rise buildings shall be equipped with automatic fire sprinklers when any of the following conditions apply:

- The high-rise building has an occupied floor located more than 120' above the lowest level of fire department access.
- The high-rise building has occupied floors more than 75' and not more than 120' above the lowest level of fire department access AND the building does not have at least two 2-hour interior exit stairways.
- The high-rise building has occupied floors more than 75' and not more than 120' above the lowest level of fire department access AND the building does not have a fire alarm system that includes smoke detectors in mechanical equipment, electrical, transformer, telephone equipment and similar rooms; corridors, elevator lobbies, and at doors penetrating interior exit stairway enclosures.⁷

Optimistically, this update of the Fire Sprinkler Retrofit Guide will encourage others to be a voice and move forward with the vision held by the original authors more than a decade ago, moving toward a safer future through the adoption of retroactive requirement for the installation of fire sprinkler systems. ■

Chapter 1 –

WHAT IS RETROFIT?

The Merriam-Webster Collegiate Dictionary defines “retrofit” as “to install (new or modified parts or equipment) in something previously manufactured or constructed.”⁸ As you will see as you go through this guide, fires have changed and changes in the building code result from experience... i.e., a tragic fire occurs and then the building code is modified to prevent a reoccurrence of the circumstances that contributed to the tragedy.

Unfortunately, building codes are only applicable for new construction, yet there are thousands of buildings out there, that, if newly built, would require fire sprinklers, but, since they already existed when the changes in the building code were adopted, they remain without sprinklers, this is commonly referred to as “grandfathering.”

As we study these tragic fires: how the fire started, how it grew, that which fire department found when upon arrival, and how to prevent them in the future; we find that, perhaps in certain instances, we need to pass laws that would require the retroactive requirement for sprinklers regardless of when the building was built. That is what “retrofit” is all about, identifying high risk occupancies and buildings that were built before sprinklers were required and passing legislation to require that sprinklers be installed within some reasonable timeframe, either through adoption of model codes that require retrofit or adopting standalone ordinances for the requirements.

PROPERTY PROTECTION VERSUS LIFE SAFETY PROTECTION

Typically, when discussing fire sprinkler protection, the issue is raised as to whether a fire sprinkler system is a property protection or life safety system. The purpose of NFPA 13 – Standard for the Installation of Fire Sprinklers “...shall be to provide a reasonable degree of protection for life and property from fire through standardization of design, installation, and testing requirements for sprinkler systems, including private fire service mains, based on sound engineering principles, test data, and field experience.”⁹

NFPA 13R – Standard for the Installation of Fire Sprinklers in Low-Rise Occupancies and NFPA 13D– Standard for the Installation of Fire Sprinklers in One- and Two-Family Dwellings and Manufactured Homes their purpose is a little different; it is “...to prevent flashover (total involvement) in the room of fire origin, where sprinklered, and to improve the chance for occupants to escape or be evacuated.”¹⁰ As such, NFPA 13R and NFPA 13D must be considered a life safety system. A benefit of the system is that it's designed “to prevent flashover (total involvement) in the room of fire origin,” however, the system will also reduce the property damage resulting from a fire.

As organized as a fire department may be in responding to a fire emergency, or any emergency for that matter, it must be said that they can only respond to the alarm once it has been called in and subsequently dispatched. Until arrival at the scene of an emergency, there is little they can accomplish to control and extinguish a fire.

Both the firefighter and the automatic fire sprinkler work a schedule that is 24-hours, 7-days a week, 365-days a year.

The difference is that a fire sprinkler is located directly over the area of fire origin and can operate as soon as the temperature in that area reaches the activation temperature, which in the case of a residential fire sprinkler is 135°-170°F.

Similarly, an automatic fire alarm system works the same schedule but can only detect and alert the fire department or occupants in the event of a fire. While the need for detection and notification is essential, through the use and installation of smoke alarms, for a balanced fire protection design, it must also be recognized that fire detection does not proactively control the growth of a fire. ■

Chapter 2 –

WHY ARE RETROFIT PROGRAMS NEEDED?

Fires have changed; it's as simple as that. The key to saving lives and reducing property damage, once the fire has started, is the prevention of a phenomena called “flashover” – when the fire becomes deadly. Flashover is not a survivable event. According to Dr. James Milke, Department Chair of Fire Protection Engineering at the University of Maryland, “flashover is considered the point of transition from a ‘small fire,’ involving a small number of objects in the room, to a ‘large fire,’ involving all objects in the room.”¹¹ NFPA 921 defines flashover as “A transitional phase in the development of a compartment fire in which surfaces exposed to thermal radiation reach its ignition temperature more or less simultaneously and fire spreads rapidly throughout the space resulting in full room involvement or total involvement of the compartment or enclosed area.”¹²

Most are aware that people who succumb to fire are felled by “smoke inhalation.” The primary constituent of smoke is carbon monoxide and Gordon Hartzell observed “...a rapid increase in carbon monoxide yield occurs almost simultaneously with flashover.”¹³ If we can prevent flashover, we can save lives. The key is time... we need to get water on the fire before flashover. Fire sprinklers buy time – time buys life.

So, what of the time to flashover? As mentioned, fires have changed and the time to the achievement of flashover in a compartment fire has changed drastically. Prior to the requirement for sprinklers in many of our buildings and occupancies, the fire department had time to receive the information, be dispatched and arrive in a timely manner to interdict in the march towards flashover. Unfortunately, this is no longer true. If a picture is worth a thousand words, a video must be worth millions. The following video succinctly depicts the difference in fire growth between then and now.



Comparison of Room Furnishings Video

<https://www.youtube.com/watch?v=aDNPhq5ggoE>

As you can see, flashover in a typical living room is occurring in under 4 minutes; this is due to changes in the material of modern furnishings. As for the office environment, the National Institute of Science and Technology (NIST) conducted tests of a fire in single workstation.



NIST Flashover Video

<https://www.youtube.com/watch?v=VUXdRcEO1DY>

Flashover was achieved in about 5 minutes for the same reason, the composition of the furnishings.

In a video in which we urge caution in watching, that of The Station nightclub fire, first indications of ignition occur at the 0:18 mark in the video; flashover appears to occur by the 1:38 mark. One hundred people died in this fire. Again, caution is urged due to depictions and language in this video.



The Station Nightclub Fire Video

https://www.youtube.com/watch?v=9e_19dUezCQ

FIRE DEPARTMENT RESPONSE TO FIRES

Large metropolitan fire departments have the best of modern firefighting equipment, they are exceedingly well trained and, since their stations are staffed 24/7/365, have lower response times than their volunteer counterparts. Suburban or rural area fire departments are also exceedingly well trained but can have longer response times.

The National Fire Protection Association publishes numerous standards, but for the purpose of this guide, we will look at those standards that pertain to modern fire department response.

When a call is placed to “911,” it is expected that call will be answered within 15 seconds, 90% of the time (7.4.1).¹⁴ Further, dispatch of the fire department is expected within 60 seconds of the telecommunicator answering “911, what’s your emergency?” again 90% of the time (7.4.3).¹⁵ Once the fire department is dispatched, the crew has 80 seconds to respond to the emergency and turn out of the station (4.1.2.1 (2)) and the first arriving engine is expected to be “on scene” within 4 minutes of leaving the station (4.1.2.1(3)).¹⁶

Suburban and rural area departments have a slightly different response standard, depending on the density (number of people per square mile) of the area served. In addition to the best practices regarding the answering of the “911” call and dispatching the fire department, are as follows:¹⁷

NFPA 1720 Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments provides the following benchmarks:

TABLE 4.3.2 STAFFING AND RESPONSE TIME

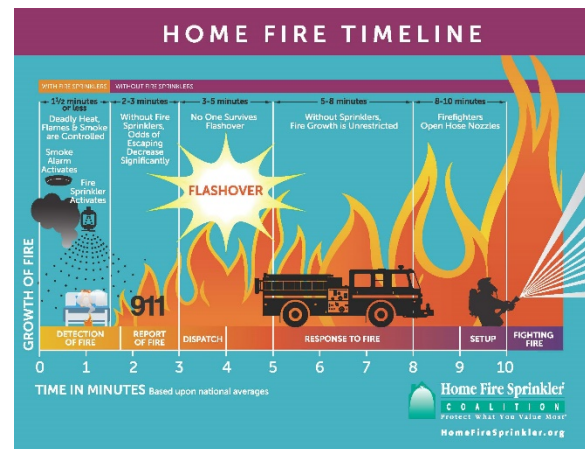
DEMAND ZONE a	DEMOGRAPHICS	MINIMUM STAFF TO RESPOND b	RESPONSE TIME (MINUTES) c	MEETS OBJECTIVE (%)
URBAN AREA	>1,000 PEOPLE/SQ MILE	15	9	90
SUBURBAN AREA	500-1,000 PEOPLE/SQ MILE	10	10	80
RURAL AREA	<500 PEOPLE/SQ MILE	6	14	80
REMOTE AREA	TRAVEL DISTANCE ≥ 8 MILES	4	DIRECTLY DEPENDENT ON TRAVEL DISTANCE	90
SPECIAL RISKS	DETERMINED BY AHJ	DETERMINED BY AHJ, BASED ON RISK	DETERMINED BY AHJ	90

a. A jurisdiction can have more than one demand zone.

b. Minimum staffing includes members responding from the AHJs department and automatic aid

c. Response time begins upon completion of the dispatch notification and ends at the time interval shown in the table.

To recap, you can expect the first engine to arrive, in a career department, in about 6 ½ minutes after the caller dials “911.” In a volunteer department, with the most stringent recommendation, you’re looking at a little under 9 ½ minutes from fire department notification, not ignition. The chart below, in addition to showing the various NFPA standards’ benchmarks, includes pre burn time (the time between ignition and the time the “911” center is notified), set up time (the time between the arrival of the fire apparatus and water hits the fire).



Home Fire Timeline¹⁸

With flashover occurring in 3 to 5 minutes from ignition, depending on the fire department to prevent flashover in today’s environment is simply unrealistic. Fire sprinklers are the only viable system that can prevent flashover.

TENABILITY / SURVIVABILITY

It's not just time to flashover that is of concern; it is well known that smoke is the killer, specifically, its components. In January 2010, the fire research division of the National Institute of Standards and Technology (NIST) conducted experiments regarding room tenability and the impact of the presence of sprinklers.¹⁹ Human untenability criteria was listed as:

- Temperature >120°C
- Oxygen level <13%
- Carbon Dioxide level >8%
- Carbon Monoxide level >1%

The tests were conducted by NIST, in cooperation with the University of Arkansas and the Fayetteville, Arkansas Fire Department, in a 4-story building of fire resistive construction built in the 1950s. The tables below show the results; in all experiments with sprinklers, tenability criteria were maintained.



Photograph of the outside of the northwest wing of the dormitory building, looking southwest (University of Arkansas, Fayetteville, AR)

TABLE 4.4.1 Sprinkler and Smoke Alarm Activation Times (in seconds) and Temperatures at Those Devices at the Time of Activation

EXPERIMENT	DOOR POSITION	ACTIVE SPRINKLER SYSTEM	ROOM SMOKE ALARM ACTIVATION TIME/TEMP	WEST CORRIDOR SMOKE ALARM ACTIVATION TIME/TEMP	CENTER CORRIDOR SMOKE ALARM ACTIVATION TIME/TEMP	EAST CORRIDOR SMOKE ALARM ACTIVATION TIME/TEMP	ROOM SPRINKLER ACTIVATION TIME/TEMP	CORRIDOR SPRINKLER ACTIVATION TIME/TEMP
		(s)/(°C)	(s)/(°C)	(s)/(°C)	(s)/(°C)	(s)/(°C)	(s)/(°C)	(s)/(°C)
1	CLOSED	NO	24/52	160/27	216/27	316/27	120/118	NA
2	CLOSED	YES	12/32	NA	NA	NA	105/119	NA
3	OPEN	YES	22/46	68/27	36/28	62/29	112/112	NA
4	OPEN	NO	14/45	60/31	32/29	62/32	76/136	128/99
5	OPEN	NO	26/31	62/30	80/31	98/31	110/82	224/125

TABLE 4.4.2 Time (in seconds) to Reach Given Untenability Criteria (dark gray) or Most Significant Tenability Risk Encountered for the Dorm Room Corridor

EXPERIMENT	DOOR POSITION	ACTIVE SPRINKLER SYSTEM	DORM ROOM				CORRIDOR			
			TEMP.	OXYGEN	CARBON DIOXIDE	CARBON MONOXIDE	TEMP	OXYGEN	CARBON DIOXIDE	CARBON MONOXIDE
			>120°C	<10%	>8%	>1%	>120°C	<10%	>8%	>1%
1	CLOSED	NO	156 s	14%	6%	0%	26°C	21%	0%	0%
2	CLOSED	YES	84°C	20%	1%	0%	27°C	21%	0%	0%
3	OPEN	YES	68°C	20%	1%	0%	27°C	21%	0%	0%
4	OPEN	NO	128 s	310 s	318 s	340 s	110°C	426 s	398 s	318 s
5	OPEN	NO	182 s	328 s	292 s	346 s	110°C	454 s	426s	292 s

The results were unequivocal, only with sprinklers were all tenability criteria kept within the parameters of human survivability, both within the room of origin and its adjoining corridor. The fastest times in reaching untenability was (both with the corridor door in the open position):

- In the room of origin: 128 seconds (2.1 minutes) • In the corridor: 292 seconds (4.8 minutes)

UNITED STATES EXPERIENCE WITH FIRES AND FIRE SPRINKLERS

Based on national fire incident reporting, the National Fire Protection Association (NFPA) has estimated that there were 1,318,500 fires in the United States during 2018.²⁰ This means that a fire department responded to a fire somewhere in the United States on an average of every 24 seconds. These fires were reported to have resulted in total of 3,655 civilian fire deaths, 15,200 civilian injuries, and \$25.6 billion dollars in property damage. Of these fires, slightly less than half a million were structure fires. It is widely acknowledged that fire sprinkler systems have helped reduce these losses over the past few decades and could reduce them even further.

In addition to statistics regarding fires, the NFPA has compiled statistics on the performance of automatic fire sprinkler systems and concluded that they are “highly reliable and effective elements of total system designs for fire protection in buildings” that “save lives and property, producing large reductions in the number of deaths per thousand fires, in average direct property damage per fire, and especially in the likelihood of a fire with large loss of life or large property loss.”²¹

While modern building codes require the installation of automatic sprinklers in almost all new construction of size, there have been many buildings constructed over the years without sprinkler protection. The NFPA sprinkler performance report stated that, based on fire department data for the years 2007 to 2011, sprinkler systems were present in only 10 percent of reported structure fires.

Due to their potential in reducing fire loss, many communities have enacted fire sprinkler retrofit requirements, especially for the occupancies that, based on experience, present the greatest risks to civilians. In many cases, the communities have addressed multiple occupancies at the same time by adopting a code that contains occupancy-based requirements for sprinkler retrofit. This Retrofit Guide envisions a dual approach that essentially overlays the code-based consensus provisions for sprinkler retrofit through the requirements of the International Fire Code, International Building Code or through the adoption of a special ordinance. In this manner there can be a clear understanding of the need and plan for implementation that simultaneously applies to all dangerous existing occupancies in need of fire sprinkler retrofit.

Fire dynamics, the study of fire behavior in the built environment, has shown that the time to reach flashover has shortened to a critical point; a point that demands a fresh look at how and when water is applied to the burning material. Old buildings or new, traditional design or

modern, the age of the building is immaterial; it's the contents that take us to flashover and the time we must get water on the fire prior to flashover is so short that successful fire department intervention is unlikely.

Our fire problems have been identified and, through the consensus method, model codes have been modified to address the changing fire environment. ■

Chapter 3 – CODES AND STANDARDS

The basic provisions for fire sprinklers in existing occupied buildings have been in place for decades, although they are continually examined and modified in the light of new fire data and experience. It is no surprise, through the fire history of the United States, existing occupancies that are in most need of fire sprinkler protection are those in which multiple life loss fires continue to take place in the absence of fire sprinklers.

Sprinklers are a very reliable and effective part of fire protection. Their impact is seen most strongly in the reduction of civilian fire deaths per 1,000 reported fires when sprinklers are present compared to fires without automatic extinguishing systems. Notable reductions are also seen in injury rates, and in most occupancies, average loss per fire. Increasing the usage of sprinklers will the reduce loss of life and property from fire.²²

AMERICA BURNING – 1973

In 1973, the National Commission on Fire Prevention and Control released a landmark study entitled *America Burning*. In it, the writers made an astonishing statement regarding codes in this country that holds true even today, specifically:

Historically, major changes in the model codes have been made when a particular fire problem achieves a certain magnitude (as is happening in response to high-rise fires) or when a dramatic fire or two focuses public attention on a problem (as happened in the wake of the Cocoanut Grove nightclub fire in Boston in 1942). Further, the model codes should specify automatic fire extinguishing systems and early warning detectors for high-rise buildings and low-rise buildings in which many people congregate.²³

WINGSPREAD VI – 2016

Remarkably, over 40 years after *America Burning*, in another fire safety study entitled *Wingspread VI* Statements of National Significance to the United States Fire and Emergency Services,²⁴ it was stated unequivocally “Automatic fire sprinkler use has the ability to solve much of America’s fire problem in every class of occupancy.” The writers went on to observe “The application of automatic fire sprinkler technology poses a greater political challenge than a technology challenge.”

The authors of *Wingspread VI* also noted “To be competitive and sustainable in a changing environment, agencies must become change agents rather than reactionaries.”²⁵ Yet, we remain a reactionary society; once a disaster occurs, we want to sue someone, hold someone responsible, and change laws to mitigate the probability of a similar event happening again.

Seldom do we attempt to compare the cost of the fire, including damages and settlements to the cost of retrofitting the building that experienced the fire. It would be clear that the installation of sprinklers is a prudent investment. An investment that would prevent lives lost and the inevitable lawsuits their families bring, property restoration cost, the cost to demolish and rebuild the structure that experienced the fire, business interruption and the interruption to the other tenants in the building. There is no doubt that a fire in any given building is a low

probability event, but it comes with high consequences when it occurs. Such consequences can be significantly mitigated with the installation of an automatic fire sprinkler system.

MODEL CODES

The fire sprinkler requirements for existing buildings are contained in several national and international model codes, such as the National Fire Protection Association’s (NFPA), NFPA 1 Fire Code, NFPA 101 Life Safety Code® and the International Code Council’s (ICC), International Building Code (IBC), International Fire Code (IFC), and the International Existing Building Code (IEBC). These model codes are minimum construction standards, developed under an open consensus process recognized by the American National Standards Institute (ANSI).

The fire sprinkler requirements in these national model codes are applied to address a wide range of occupancies, as well as heights, areas, and hazards. Model codes are developed by multiple technical committees, each of which includes subject matter experts. These experts, including user groups, code officials, fire chiefs, engineers, architects, manufacturers, insurance authorities and members of the public, who have carefully studied the occupancy characteristics, fire characteristics, and history over a long period of time, to recognize when the benefits of fire sprinkler systems are absolutely needed.

The basic provisions for fire sprinklers in existing occupied buildings have been in place for decades, although they are continually examined and modified in the light of new fire data and experience. For example, the requirements for fire sprinklers in existing nightclub occupancies were strengthened in the aftermath of the 2003 Station Nightclub fire in West Warwick, Rhode Island, that killed 100 individuals and left 230 with severe injuries.

When sprinkler retrofit provisions are in a national model code, they are considered the “national standard of care;” their adoption can be considered an “express plan” for fire sprinkler retrofit without having to go through the lengthy process of a standalone retrofit ordinance. In other words, there is widespread agreement that certain occupancies identified by use, size and configuration are inherently unsafe without the benefit of automatic fire sprinkler systems. Virtually all events wherein there have been the multiple fatalities or casualties due to fires, that have taken place over the past century, have been in buildings without automatic sprinkler systems.

NFPA 1 – FIRE CODE – EXISTING OCCUPANCY REQUIREMENTS

The NFPA Fire Code prescribes minimum requirements necessary to establish a reasonable level of fire and life safety protection from the hazards created by fire, explosion, and dangerous conditions.

EXISTING ASSEMBLY

OCCUPANCIES: 2021 NFPA 1, Section 13.3.2.7

- The occupant load exceeds 100 in the following assembly occupancies:
 - Dance halls
 - Discotheques
 - Nightclubs
 - Assembly occupancies with festival seating.
- The exhibition or display area exceeds 15,000 sq. ft. in any assembly occupancy used or capable of being used for exhibition or display purposes, except that sprinklers are not required over seating or floor areas within stadium or arenas.

EXISTING HIGH-RISE BUILDINGS:

2021 NFPA 1, Section 13.3.2.25.2

- Entire building to be protected with an automatic sprinkler system within 12 years of adoption.

NOTE: This requirement was originally adopted as Section 7.1.3.2.2 of the 1997 edition of NFPA 1 and has been part of the code since that time. Subsequent editions of NFPA 1 were published in 2003, 2006, 2009, 2012, 2015. As such, communities that adopted the 1997 edition of NFPA 1 should have had all their high-rises protected with automatic sprinklers since 2009. The 12-year compliance clock applies to communities that adopted any of the subsequent editions of the code. The clock does not reset upon adoption of a newer edition of NFPA 1; i.e.,

<i>Adoption Year</i>	<i>Compliance Year</i>
2009	2021
2012	2024
2015	2027
2018	2030
2021	2033

NFPA 101 – LIFE SAFETY CODE – EXISTING OCCUPANCY REQUIREMENTS

The NFPA 101 Life Safety Code addresses a wide range of building exit and other fire protection issues, but the intent of this Fire Sprinkler Retrofit Guide is to encourage only the adoption of fire sprinkler retrofit provisions as a special overlay, recognizing that fire sprinklers can make up for numerous other fire protection deficiencies and ensure mitigation of loss due to fire.

EXISTING ASSEMBLY OCCUPANCIES

2021 NFPA 101, Section 13.3.5.1, 13.5.2, 13.4.5

Automatic sprinkler systems are required to be retrofitted where:

- The occupant load exceeds 100 in the following assembly occupancies:
 - Dance halls
 - Discotheques
 - Nightclubs
 - Assembly occupancies with festival seating.
- The exhibition or display area exceeds 15,000 sq. ft. in any assembly occupancy used or capable of being used for exhibition or display purposes, except for under stage areas less than 4 ft. in height used exclusively for chair or table storage and lined on the inside with gypsum wallboard or the approved equivalent.
- Stages, including storerooms, workshops, permanent dressing rooms and all accessory spaces contiguous to the stages, except for stages 1,000 sq. ft. in area or less where curtains scenery and other combustible hangings are not retractable vertically, and where combustible hangings are limited to borders, legs, a single main curtain, and a single backdrop, and except for under stage areas less than 4 ft. in height used exclusively for chair or table storage and lined on the inside with gypsum wallboard or the approved equivalent.
- Assembly occupancies are in existing high-rise buildings.

EXISTING EDUCATIONAL OCCUPANCIES:

2021 NFPA 101, Section 15.3.5 and 15.4.3

Automatic sprinkler systems are required to be retrofitted in:

- All high-rise buildings.
- Every portion of a floor in which student occupancy exists below the level of exit discharge, except where windows for rescue and ventilation are provided and approved by the authority having jurisdiction.
- Buildings with unprotected openings between floors.
- Every portion of a floor below the level of exit discharge in which student occupancy does not exist, except where such floors are separated from the rest of the building by a minimum of one hour fire resistant construction.

EXISTING DAY CARE OCCUPANCIES:**2021 NFPA 101, Section 17.3.5 and 17.4.3**

Automatic sprinkler systems are required to be retrofitted in:

- High-rise buildings with daycare above 75 feet.
- Buildings with unprotected vertical openings.

EXISTING HEALTH CARE OCCUPANCIES:**2021 NFPA 101, Section 19.3.5**

Automatic sprinkler systems are required to be retrofitted in:

- All nursing homes.
- All high-rise buildings containing health care occupancies.
- Hospitals or limited care facilities with construction type limitations.

EXISTING AMBULATORY HEALTH CARE OCCUPANCIES:**2021 NFPA 101, Section 21.4.3.1**

Automatic sprinkler systems are required to be retrofitted in:

- All high-rise buildings

EXISTING DETENTION AND CORRECTIONAL OCCUPANCIES:**2021 NFPA 101, Section 23.3.5 and 23.4.4**

Automatic sprinkler systems are required to be retrofitted in:

- All high-rise buildings.
- All detention and correctional facilities with construction type limitations.

EXISTING HOTELS AND DORMITORIES:**2021 NFPA 101, Section 29.3.5**

Automatic sprinkler systems are required to be retrofitted all high-rise buildings, except where each guest room or suite has exterior exit access.

EXISTING APARTMENT BUILDINGS:**2021 NFPA 101, Section 31.3.5.9**

Automatic sprinkler systems are required to be retrofitted in:

- All high-rise buildings, except where:
 - Every dwelling unit has exterior exit access.
 - Previously approved engineered life safety systems are developed and installed to provide an equivalent level of safety to automatic sprinkler systems.

EXISTING RESIDENTIAL BOARD AND CARE OCCUPANCIES:**2021 NFPA 101, SECTION 33.2.3.5, 33.3.3.5**

Automatic sprinkler systems are required to be retrofitted in:

- All small facilities with impractical evacuation capabilities.

- All large facilities that are high-rise or with impractical evacuation capabilities.

EXISTING MERCANTILE OCCUPANCIES:**2021 NFPA 101, Section 37.3.5**

Automatic sprinkler systems are required to be retrofitted in all the following except one story buildings:

- Throughout with a story over 15,000 sq. ft. in gross area.
- Throughout exceeding 30,000 sq. ft. in gross area
- All stories below the level of exit discharge where such stories have an area exceeding 2,500 sq. ft. used for sale, storage, or handling of combustible merchandise
- Throughout mixed occupancies where any of the above conditions apply to the mercantile portion

EXISTING BUSINESS OCCUPANCIES:**2021 NFPA 101, SECTION 39.4.2**

Automatic sprinkler systems are required to be retrofitted in:

- All high-rise buildings, except where:
 - An engineered life safety system is developed and installed to provide an equivalent level of safety to automatic sprinkler systems.

EXISTING HISTORIC BUILDINGS:**2021 NFPA 101, Section 43.10.4.11**

Automatic sprinkler systems are required to be retrofitted when historic buildings cannot meet the construction requirements from the existing building chapters but constitute a fire safety hazard.

EXISTING HIGH-RISE BUILDINGS:**2021 NFPA 101**

Automatic sprinkler systems are required to be retrofitted (or in some cases, an engineered life safety system) in the following existing high-rise occupancies or buildings:

- 13.4.5: Assembly
- 15.4.3: Education
- 17.4.3: Daycare
- 19.4.3.1: Healthcare
- 21.4.2: Ambulatory health care
- 23.3.5.1: Detention and correctional
- 29.4.1.1: Hotels and dormitories
- 31.3.5.12: Apartment
- 33.3.3.5.3: Residential board and care
- 39.4.2.1: Business

ICC – INTERNATIONAL FIRE CODE – EXISTING OCCUPANCY REQUIREMENTS

The International Fire Code (IFC) requires the maintenance of existing building fire protection systems and contains fire sprinkler and standpipe retrofit regulations in Chapter 11. The 2021 edition takes the high-rise provisions out of the appendix and places them in the main body of the code. Unlike the International Existing Building Code (IEBC), where an activity such as new work is being done, the IFC requirements in Chapter 11 are triggered for all buildings when the IFC is adopted locally. There is some correlation between the IFC and IEBC, meaning, work done through one code will comply with the other code. This provides some continuity between the fire department and the building department.

EXISTING A-2 OCCUPANCIES:

2021 IFC, Section 1103.5.1

Automatic sprinkler systems are required to be retrofitted in A-2 fire areas with an occupant load 300 or more where alcohol is consumed.

EXISTING I-2 OCCUPANCIES:

2021 IFC, Section 1103.5.2

Automatic sprinkler systems are required to be retrofitted in I-2 fire areas, throughout the floors containing the I-2 fire area and on all intervening floors to the level of exit discharge. I-2 occupancies are classified as:

- Foster care facilities
- Detoxification facilities
- Hospitals
- Nursing homes
- Psychiatric hospitals

EXISTING I-2 CONDITION 2 OCCUPANCIES:

2021 IFC, Section 1103.5.3

Automatic sprinkler systems are required to be retrofitted throughout I-2 Condition 2 buildings. I-2 occupancies Condition 2 include all the I-2 facilities but provide:

- Surgery
- Emergency care
- Obstetrics
- Inpatient stabilization

ALL HIGH-RISE BUILDINGS:

2021 IFC, Section 1103.5.4

Automatic sprinkler systems to be retrofitted throughout all high-rise buildings with:

- An occupied floor located more than 120' above the lowest level of fire department access. High-rise buildings (2021 IFC) with occupied floors more than 75' but not more than 120' above the lowest level of fire department are

exempt from retrofitting throughout an automatic sprinkler system in the following conditions:

- The building has at least two 2-hour interior exit stairways, or
- A fire alarm system that includes smoke detectors in mechanical equipment, electrical, transformer, telephone equipment and similar rooms; corridors, elevator lobbies, and at doors penetrating interior exit stairway enclosures.

CELLULOSE NITRATE and PYROXYLIN PLASTIC BUILDINGS:

2021 IFC, Section 1103.5.5

Automatic sprinkler systems are required to be retrofitted throughout all buildings with cellulose nitrate film and pyroxylin plastics manufacturing, storage, or handling.

STANDPIPE RETROFIT:

2021 IFC, Section 1103.6

- Buildings with occupied floors more than 50 feet above (or below) the nearest level of fire department access are required to retrofit with standpipes.
- Buildings with existing helistops or heliports that are over 30 feet above the lowest level of fire department access shall be retrofitted with standpipes.

ICC – INTERNATIONAL EXISTING BUILDING CODE

The International Existing Building Code (IEBC) applies to existing buildings only when work is being performed. The IEBC provides alternative approaches to remodeling, repair, additions, alterations, renovations, or change of occupancy of existing buildings. This code is often the choice of architects and building departments for maintaining basic levels for fire prevention, structural and life safety features while controlling design decisions and costs of projects. Fire sprinklers provide the largest benefit in the IEBC to keep existing building stock from being obsolete in the community. An automatic sprinkler system or standpipe system is installed based on the level and scope of work to the building.

When work is being performed on an existing building, such work is classified as either:

REPAIRS

Defined as the reconstruction or renewal of any part of an existing building for the purpose of its maintenance or to correct damage.²⁶

- Fire protection shall be done in a manner that maintains the level of fire protection already provided.

ALTERATION LEVEL 1

Includes the removal and replacement or the covering of existing materials, elements, equipment, or fixtures using new materials, elements, equipment, or fixtures that serve the same purpose.

- Fire protection shall be done in a manner that maintains the level of fire protection already provided.

ALTERATION LEVEL 2

Includes the reconfiguration of space, the addition of or elimination of any door or window, the reconfiguration or extension of any system, or the installation of any additional equipment.

- In high-rise buildings, work areas that have exits or corridors shared by more than one tenant or that have exits or corridors serving an occupant load greater than 30 shall be provided with automatic sprinkler protection in the entire work area where the work area is located on a floor that has a sufficient water supply system from an existing standpipe or sprinkler riser serving that floor.
- In buildings with occupancies of use groups A, B, E, F-1, H, I, M, R-1, R-2, R-4, S-1, and S-2, work areas shared by more than one tenant or that have exits or corridors serving an occupant load greater than 30 shall be provided with automatic sprinkler protection where all of the following conditions exist:
 - The work area is required to be provided with automatic sprinkler protection (unless a new fire pump is installed)

in accordance with regulations for new construction under the International Building Code, and

- The work area exceeds 50% of the floor area.
- Windowless stories are required to be provided with automatic sprinkler protection in accordance with regulations for new construction under the IBC unless such installation would force the need for a fire pump to meet the demand of the system.

ALTERATION LEVEL 3

Any construction or renovation to an existing structure, other than a repair or addition, where the work area exceeds 50% of the building area.

- In addition to the requirements for a Level 2 alteration, an approved fire extinguishing system is required in rubbish and linen chutes in accordance with the regulations for new construction under the IBC.
- Alteration work areas that manufacture, display, or sell upholstered furniture and mattress are required to be protected with automatic fire sprinklers in
 - Group F-1 and S-1 if the area used to manufacture these items exceeds 2,500 sq. ft.
 - Group M, if the area used for display or sales of these items exceeds 5,000 sq. Ft.

CHANGE OF OCCUPANCY

Includes any change of occupancy classification, any change from one group to another group within an occupancy classification or any change in use within a group for a specific occupancy classification.

- Automatic sprinklers are required in accordance with the regulations for new construction under the IBC.

ADDITIONS

Any extension or increase in floor area, number of stories, or height of a building or structure.

- Automatic sprinklers are required in accordance with the regulations for new construction under the International Building Code.²⁷

The IEBC provides three main options for the user in dealing with rehabilitation of existing buildings. The options are better described as paths of compliance for the architect. Once a path is chosen, the IEBC narrows down the rules for compliance.

In addition, the IEBC has retrofit rules for standpipe system regardless of the level of alteration being conducted. Essentially, a standpipe must be installed if a "work area:" is shared by more than 1 tenant and that work area:

- is > 50' above the lowest level of fire department access, or
- is > 50' below the highest level of fire department access.

IBC – INTERNATIONAL BUILDING CODE

The International Building Code (IBC) is primarily for new construction and requires fire sprinklers in several occupancies and generally where the highest floor of the building exceeds 55 feet from the lowest level of fire department access. While it is not too often the IBC will be used for retrofitting existing buildings, there are several places where other codes, such as the International Existing Building Code (IEBC) and International Fire Code (IFC) refer to the IBC.

Installation Standards

When buildings are retrofitted with automatic sprinklers, such installations still need to meet certain standards; they include:



NFPA 13 – Standard for the Installation of Sprinkler Systems

- Can be used as the design standard for all installations
- Design and installation requirements
- Design area for residential areas of four operating sprinklers
- Water Supply – must be capable of providing the required flow and pressure for a minimum of 30 minutes in residential occupancies, and up to two hours for some types of occupancies.



NFPA 13R – Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies

- For residential occupancies up to and including four stories in height
- Buildings not to exceed 60' in height above grade plane.
- Design and installation requirements (hydraulics per NFPA 13)
- Design area maximum of four (4) operating sprinklers
- Water Supply – preferably domestic supply for minimum 30 minutes



NFPA 13D – Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes

- For one- and two-family dwellings and manufactured homes
- Design and installation requirements
- Design area maximum of two operating sprinklers
- Water Supply – preferably domestic supply for minimum 10 minutes



NFPA 14 – *Standard for the Installation of Standpipe and Hose System*

- For standpipe systems used by the fire department and trained personnel
- Design and installation requirements
- Types of Systems
- Water Supply

STANDARDS

An automatic fire sprinkler system designed and installed in accordance with NFPA 13 “Standard for the Installation of Sprinkler Systems” “...is to provide a reasonable degree of protection for life and property as a result of fire.”²⁸

It is worthy of noting that a fire sprinkler, designed and installed in accordance with the NFPA residential sprinkler standards, NFPA 13R or NFPA 13D, is expected to “prevent flashover, or total involvement, in the room of fire origin, where sprinklered, and to improve the chance for occupants to escape or be evacuated.” (Section 1.2.2 of NFPA 13R and Section 1.2.2 of NFPA 13D)

Where enhanced property protection is also desired, NFPA 13 can be specified to provide such protection: “Greater protection to both life and property could be achieved by protecting all areas in accordance with NFPA 13, which permits the use of residential sprinklers in residential areas.” (Section A.1.2 of NFPA 13R, 2016 edition.)

The above sections are referenced only to clarify any drawbacks that may result from the misunderstanding of those who would require a sprinkler system installed in accordance with NFPA 13R or 13D based on that system being used for not only life safety, but also for property protection. While many fires have been controlled and extinguished as a result of the activation of fire sprinklers in residential occupancies protected by NFPA 13R and 13D systems, they have not been designed for that purpose.

A residential fire sprinkler system is designed as a fast response sprinkler making the time of temperature activation much less than that of a conventional sprinkler. Additionally, the discharge characteristics are required to administer water within 28 inches of the ceiling at the perimeter of their coverage areas, addressing the likely placement of furnishings along walls. This combination of high wall wetting pattern and fast thermal response helps the residential sprinkler system control or suppress typical residential fires with water flows much lower than standard sprinklers. ■

Chapter 4 – COMMUNITY RISK ASSESSMENT & BUILDING INVENTORY

The first step in the process is understanding where retrofits are, and will be, required.

STARTING A COMMUNITY RISK ASSESSMENT

The first step in starting a community risk assessment is to understand what codes and standards are adopted in the jurisdiction being considered. After the determining what codes and standards are adopted in the jurisdiction, it will be vital to understand where the retrofits will be required. This topic was covered thoroughly in Chapter 3. However, the basics will be covered again.

The International Fire Code has seen widespread adoptions, at either the state or local level.

Past editions of the International Fire Code required several retrofits, including:

- Pyroxylin plastics
 - In existing buildings where cellulose nitrate, nitrate film or pyroxylin plastics are manufactured, stored, or handled in quantities exceeding 100 pounds, shall be protected with automatic fire sprinklers
 - Vaults located within buildings for the storage of raw pyroxylin shall be protected with an automatic sprinkler system capable of discharging 1.66 gallons per square foot over the area of the vault.²⁹
- Standpipes
 - Existing multiple story buildings with occupied floors more than 50' above the lowest level of fire department

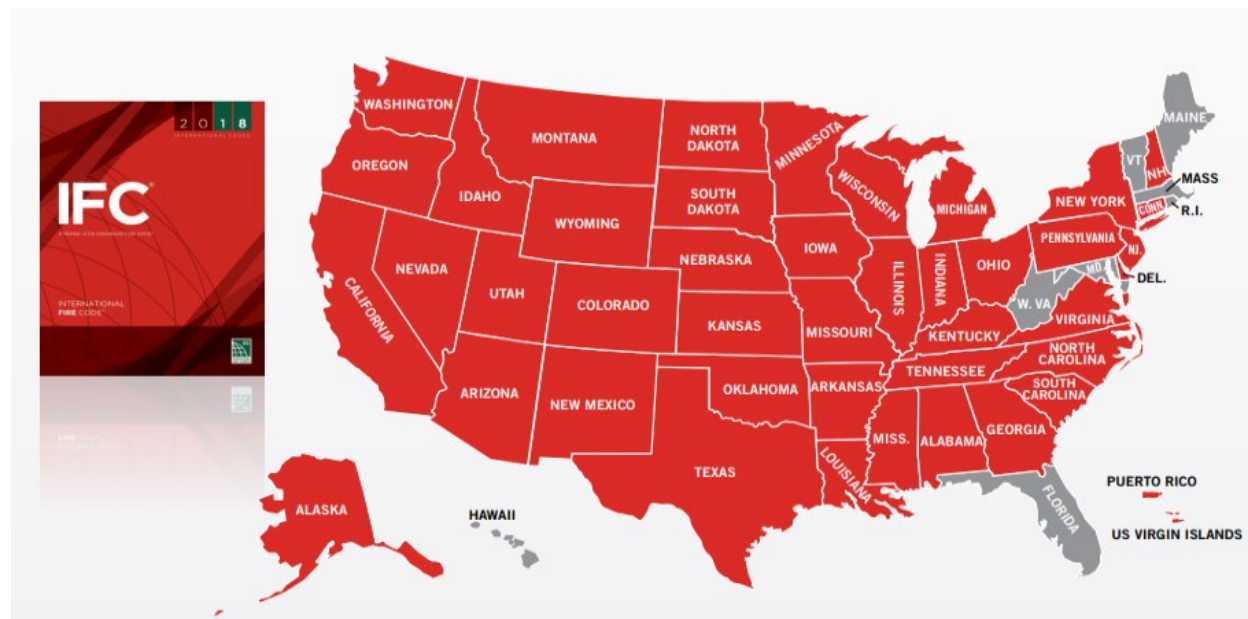
access, or more than 50" below the highest level of fire department access shall be equipped with standpipes.³⁰

- Existing buildings with a rooftop helistop or heliport located more than 30' above the lowest level of fire department access to the roof level on which the helistop or heliport is located shall be equipped with standpipes.³¹

In the 2021 edition of the International Fire Code, several occupancies were affected by retrofit requirements:

- In existing I-2 occupancies automatic sprinklers shall be installed throughout the floor where the I-2 occupancy is located, and in all floors between the I-2 occupancy and the level of exit discharge.³²
- Existing buildings of I-2 Condition 2 occupancies shall be equipped throughout with an automatic sprinkler system with a timetable for compliance to be determined by the adopting ordinance.³³
- Existing A-2 occupancies with an occupant load of 300 or more must be retrofitted with automatic if alcoholic beverages are served.³⁴

The 2021 edition of the International Fire Code will take a major step where high-rises are concerned. Previously, the retrofit regulations regarding high-rise buildings, regardless of occupancy, were in the appendix, specifically Appendix M. Through the consensus process, and in response to several recent fatal fires in high-rise buildings, the membership of the International Code Council has moved the retrofit requirements into the main body of the



IFC ADOPTION MAP

The IFC is in use or adopted in 42 states, the District of Columbia, Guam, Puerto Rico and the U.S. Virgin Islands.

International Fire Code; they realized that automatic fire sprinklers are the only reasonable solution to high-rise fires. The separate adoption of an appendix section is no longer required. Specifically, it states that high-rise buildings shall be equipped with automatic fire sprinklers when any of the following conditions apply:

- The high-rise building has an occupied floor located more than 120' above the lowest level of fire department access
- The high-rise building has occupied floors more than 75' and not more than 120' above the lowest level of fire department access AND the building does not have at least two 2-hour interior exit stairways
- The high-rise building has occupied floors more than 75' and not more than 120' above the lowest level of fire department access AND the building does not have a fire alarm system that includes smoke detectors mechanical equipment, electrical, transformer, telephone equipment and similar rooms; corridors, elevator lobbies, and at doors penetrating interior exit stairway enclosures.³⁵

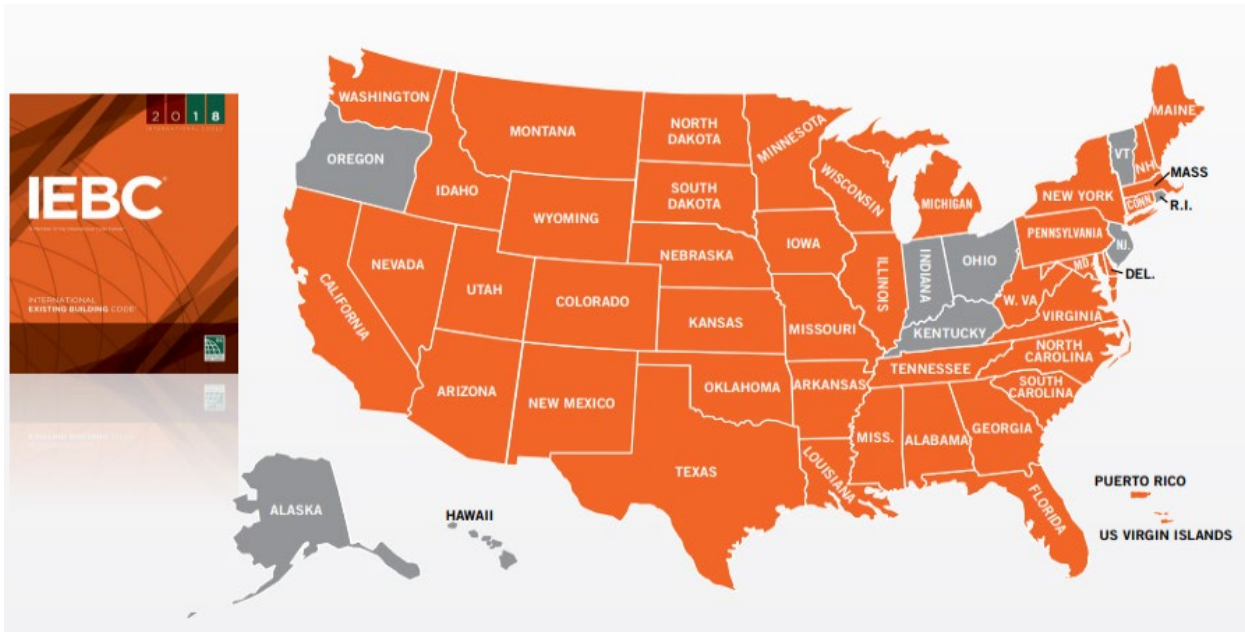
This new section also includes a timeframe for compliance and requires something new of the authority having jurisdiction. Simply put, at least for this section, no longer is the requirement to advertise the proposed adopting ordinance in a newspaper of general circulation considered adequate notice to building owners. For retrofitting high-rise buildings, after adoption of the 2021 International Fire Code:

- The authority having jurisdiction must notify, in writing, (preferably, a registered letter, for documentation of receipt) building owners that new regulations have been adopted and outlining the requirements
- Within 365 days of the receipt of that notification letter, the building owner must provide their plan, in writing to the authority having jurisdiction, to bring the building into compliance
- This plan must detail how the building owner intends to bring the building into compliance with a schedule that does not exceed 12 years. The authority having jurisdiction must then ensure compliance with that plan and issue notices of violations if the plan is not strictly followed

The International Existing Building Code has also seen widespread adoption throughout the United States.

Using the NFPA 101 Life Safety Code as well as NFPA 1 Fire Code, the process is similar.

Understanding all these retrofit requirements is necessary to create a thorough and accurate retrofit inventory.



IEBC ADOPTION MAP

The IEBC is in use or adopted in 42 states, the District of Columbia, Guam, Puerto Rico and the U.S. Virgin Islands.

INVENTORY INFORMATION

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Chapter 5 – HISTORIC PRESERVATION

“At its most basic, preservation is about protecting places that matter to each of us. We want our children to know these places. We want them to stand as beacons for us and for those who come after us... to tell our stories, and the stories of our communities and our lives.”

– *Stephanie K. Meeks*

President and CEO of the National Trust for Historic Preservation

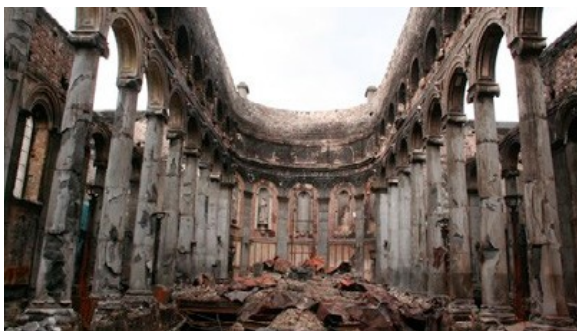
Unfortunately, historically significant buildings are not immune to fire and the loss of these buildings can have far reaching effects beyond those that an insurance claim may cover.

July 2004 – Bellefonte, PA – Bellefonte Academy, a historical private school which educated “more governors, senators and judges than any other school in Pennsylvania” was destroyed by fire.⁴³ In February of 2006, two years later in the same town of Bellefonte, the historic Bush House Hotel built in 1868, was also destroyed by fire. The small size town suggests that the fires and loss of two significant historical properties put a considerable impact on the local economy.⁴⁴

December 2009 – Longford, Ireland – Saint Mel’s Cathedral was lost to fire, leaving just the shell of the building standing. The fire appears to have begun in the chimney, spreading into the area of the altar and, ultimately, burning the church “from end to end.”⁴⁵



One of the artifacts lost to the fire, was St. Mel’s Crosier, a staff carried by a bishop as a symbol of his pastoral office; it was over 1,000 years old, obviously irreplaceable. It took 5 years to rebuild.



September 2013 – Georgetown, SC – The town suffered a fire “that leveled the center of the town’s historic waterfront district... one century old building after another

was consumed until an entire city block, mainstay businesses, restaurants and apartments lay in ruin.”⁴⁶



Four years later, there was still a gaping hole in the middle of Georgetown’s historic district. Seven buildings and over 130 jobs were lost, and the cause is officially listed as “undetermined.”

July 2017 – Wagoner, OK – A massive fire burned down several historic buildings in the downtown area that were built in the 1800s. This fire prompted the Mayor of Wagoner to encourage residents to “limit water usage” because of the amount of water utilized to contain the fire.⁴⁷

October 2017 - Spring Valley, MN – A fire engulfed a historic building and residents from neighboring apartment buildings were evacuated. This building was dated back to 1870 and listed in the National Register of Historic Places database, however the after the fire the building was considered a “total loss.”⁴⁸

January 2018 – Stratford, CT – The Shakespeare Theater was a total loss. The Theater, which hosted such greats as Fred Gwynne, James Earl Jones, Kim Hunter, Hal Holbrooke and Ed Asner, burned to the ground after the fire department was called to the building at about 1:00 am.

According to Fox 61 News, the structure was still burning at 6:00 am and had suffered at least a partial collapse.⁴⁹



April 2019 – Paris, France – Started in the year 1163 and completed in 1345, the Cathedral Notre Dame de Paris is an iconic structure known throughout the world. The laying of the corner stone was completed in 1163 and was witnessed by King Louis VII and Pope Alexander III.⁵⁰ The Cathedral Notre Dame de Paris has witnessed history as few other structures have, through revolutions and wars; and yet it stood, until now.



Scaffolding from renovations to the Cathedral caught fire, burning much of the wooden structure. According to Frederic Letoffe, the head of several companies that restore historic monuments, feels that full restoration of the Cathedral could take up to 15 years. It is reported that the Cathedral, as a tourist site, is visited by up to 12 million people per year. Fire spares nothing; only through the efforts of the Brigade des sepeurs pompiers de Paris, France's army-based fire department, were many of the historical and religious artifacts saved. Fire cares nothing about the "historical fabric" of the building or its contents; there must be found some happy medium to assure that such cultural icons are not lost forever; our children deserve no less.

August 2017 – Washington, DC – Compare the Notre Dame fire to a fire event that was experienced at the Smithsonian Institution Building, also known as "The Castle," in Washington, DC in August of 2017.



Completed in 1855, it was retrofitted with sprinklers to protect the building, those who work and visit there and, of course, any and all historical artifacts stored there. The fire occurred on the 3rd floor, in a staff area, was electrical in nature and, according to Smithsonian Spokesperson Linda St. Thomas, "...the sprinkler put it out."⁵¹ The building was reopened the following day. The unsprinklered Notre Dame restoration will take years and millions of dollars. The sprinklered Smithsonian Castle was closed for less than 24 hours and damage was minimal. A perfect comparison and a compelling example of the difference sprinklers make.

PROTECTING HISTORIC STRUCTURES FROM FIRE

These are a few recent examples of historical building fires that changed the lives, character, and history of many communities.

Annapolis, MD

Many communities with historical buildings utilize those buildings to enhance their economy. For example, the City of Annapolis, MD is a National Historic Landmark District (NHL), which means it is officially recognized by the United States government for its outstanding degree of historical significance. National Historic Landmarks such as the Maryland State House, St. Anne's Church, and William Paca House are a part of the historic district.⁵² As a result, many tourists visit Annapolis to view the historic structures and learn about their rich history.

On December 12, 2015, a fire occurred at the Historic Annapolis Yacht Club that caused \$9,000,000 worth of damage. In addition to the loss of the building itself, numerous artifacts that were displayed in the yacht club were lost.



The Yacht Club fire prompted the city to consider adopting a retrofit ordinance for their historic district to ensure that the city would not experience a similar catastrophic loss. To facilitate the process a taskforce was put together consisting of various community stakeholders consisting of alderman, business owners, emergency management, fire department, and the Bureau of Inspections and Permits, to name a few. The decision was made to rebuild with a sprinkler system in place.

Bellefonte, PA

The Bockerhoff Hotel is a historical building in Bellefonte, PA. Later named the Bockerhoff House, this building was rehabilitated and retrofitted with a fire sprinkler system. Subsequently, the building was utilized as a multiuse facility, housing residential individuals. Furthermore, the Bockerhoff House was added to the National Register of Historic Places on April 11, 1977 and is quaintly located in the Bellefonte historical district.



Bockerhoff House, Bellefonte PA

Petaluma, CA

In 2002, a devastating fire in Petaluma, CA severely damaged five businesses in their downtown / historic district. Realizing the risk fire posed to this historical area, City Council passed a "Fire Sprinkler Retrofit Ordinance for Existing Buildings in the Historic Downtown Business District."⁵³ In its executive summary, the justification for the ordinance states:

The architecture and building configurations contribute to the charm and ambience of the downtown area. Since 1960, the Historic Downtown has suffered 16 fires... The potential exists to have a fire that destroys several of our vintage buildings and forever changes the face of the downtown area. The installation of fire sprinklers in these buildings would significantly reduce the risk of fire and preserve the City's structural heritage for years to come.

To that end, the City identified the historic district boundaries and required the retrofit of sprinklers:

- At any change of use
- When the building or occupancy is increased by 25%
- In below grade areas by December 31, 2014
- Throughout the entire building by December 31, 2024

Certain sections of the Historic District did not have the infrastructure to support fire sprinklers. Working with the Fire Department, their Water Department planned to replace the water mains in this area and install connections for sprinklers as part of that project. It should be noted that in the sections that did have the supporting infrastructure, the Water Department installed these connections as part of the upgrade. In the sections that needed the upgrade the requirement for final installation of sprinklers became effective:

- 10 years after the upgrade for below grade area
- 20 years after the upgrade for the entire building

Lewisville, TX

In Texas, the City of Lewisville was so concerned with the possibility of fires in their historic district, they decided to fund the retrofit of sprinklers in 27 buildings, totally over 80,000 square feet. They went to bid in July of 2019 as the first step in this process.

Philadelphia, PA

Christ Church in Philadelphia's Old City section took heed of the words of a former member, Benjamin Franklin, who stated "A penny of prevention is worth a pound of cure."



They retrofitted not only the interior of the church but installed a deluge system to protect the steeple.



When built in 1754, the steeple was the tallest structure in the city. The system was tested recently to demonstrate the commitment the

congregation has in protecting this iconic symbol in the place where the United States was born.

The building houses historic artifacts going back to 1695. The Church hosted members of the Continental Congress during the American Revolution and such notables as George Washington and John Adams attended services there. Its loss would be devastating to the City of Philadelphia, thus justifying the investment in the retrofit of fire sprinklers.

NFPA 914 – CODE FOR THE PROTECTION OF HISTORIC STRUCTURES

This code introduces the concept of goals and risk tolerance. It states, "Goals and objectives shall be adopted that reflect the tolerance for risk that is acceptable to those responsible for the historic structure and historic district."⁵⁴

Essentially, it asks "those responsible" to consider the possible fire scenarios that could occur within the structure or district and to determine the possible consequences of such fires, including: "the development of fire, the spread of combustion products throughout the building or portion of the building, the reactions of people to fire, the impact of a fire on the historic significance, and the effects of combustion."⁵⁵

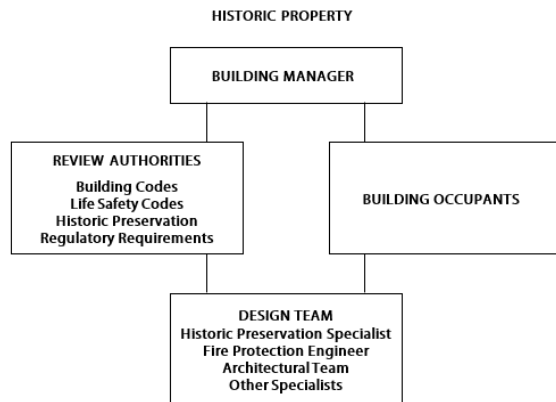
"Those responsible," then, would determine what degree of loss is tolerable and how to mitigate those effects that are intolerable.

Apparently, fire sprinklers were considered for the Cathedral Notre Dame de Paris; in an article in the New York Times, it was reported that there was a "conservative approach" to preserving the historic wooden structure in its "unadulterated form."⁵⁶ From a risk management approach, "those responsible" for the Cathedral decided to forego modern fire protection features, banked on fire prevention and detection; obviously that did not work as expected.⁵⁷

Given that historic structures have stood the test of time, it's part of their historic fabric, the chances of historic structures experiencing a fire in any given year are exceedingly small. But a small chance is not "no" chance. It could take centuries before fire strikes, but the consequences are more than catastrophic; the consequences are cataclysmic. The loss a historical structure and the artifacts within cannot be replaced; the rebuild is simply a facsimile; the artifacts are gone forever if a fire occurs. Such structures and their contents are lost to the dream of preserving the historical fabric, after all, in many cases sprinklers weren't even invented when the building was built. Therein lies the irony, to protect the historical authenticity of the structure, one condemns the structure to destruction when a fire strikes. Can, or should, one take that chance? Those in charge of fire protection at the Cathedral Notre Dame de Paris took that chance and now, look at the results.

THE DECISION-MAKING PROCESS

Once the decision has been made to retrofit a historic building, steps should be taken to increase the probability of success. A guide titled *Fire Safety Retrofitting in Historic Buildings* which was jointly issued by the Advisory Council on Historic Preservation and the General Services Administration provides steps that could be taken to assess how a historic building currently performs in the event of a fire, define what deficiencies need to be corrected to ensure building and content preservation, and to determine how best to correct these deficiencies in a manner that both ensures fire safety and preservation of historical features.



Project Team Organizational Chart for Fire Safety Retrofitting ⁵⁸

SPRINKLER SYSTEM DESIGN AND INSTALLATION

Designing a fire protection system for a historical building can be complex and often require innovative approaches that protect and preserve the building simultaneously. Multiple stakeholders should be involved to ensure that protection and preservation goals are accomplished. Listed below are a few of the stakeholders that you may want to consider:

- Building Owner or Manager to define important building features and aesthetic details and identify specific occupancies and functions of the building. This person should provide information regarding any expected alterations or changes in use so that future modifications to these systems can be minimized.
- System Designer to produce the design and installation details and identify technical solutions that comply with code requirements for the existing or intended use while preserving the building's significant features. In some instances, a fire protection engineer with experience in

historic buildings may be necessary or appropriate.

- Code Official who is responsible for code and standard requirements and will approve the design including nonstandard solutions to unique aspects of the project.
- Fire Official to provide information on the fire department's emergency capabilities and offer guidance to the design team to ensure that the fire protection systems are compatible with the emergency response procedures and abilities. In some instances, the code official and fire official will be the same person.
- Insurance Representative to identify potential insurance savings with the additional fire protection. If the location does not have a code or fire official the insurer may fulfill that role.
- Historic Preservationist who can help ensure that the design is compliant with historic preservation standards. In communities such as Bellefonte where exterior changes to buildings located in a regulated historic district require review, the preservationist can help guide the design through any necessary review processes. This person may also be able to help the owner identify preservation grants and tax credits that reduce the financial outlay. They may be affiliated with a preservation architect an architectural historian, or the state historic preservation office.
- Others: In addition to the individuals listed above, the fire protection design team may also include assistance from the local administrator (mayor, city manager), public works director, and chamber of commerce to ease the construction effort or help to promote a fire safe facility.⁵⁹

Conventional fire sprinkler systems include pipes which transport water throughout the building and sprinklers that disperse the water in the event of a fire. When designing a sprinkler system, decisions must be made concerning the type of pipe and sprinklers that will be used. However, perhaps the most important factor to consider when designing an automatic fire sprinkler system is how the system will be installed. With respect to the actual placement of sprinkler components, there are three general approaches: exposed, camouflaged, and concealed.

- **Exposed.** This type of sprinkler system is designed and installed in existing buildings with sprinkler pipes and sprinklers exposed. No

attempt is made to hide or camouflage them. Because the labor required to cut, patch, and refinish existing walls and ceilings is a large part of the expense of installing a sprinkler system in a historical building, this will be the least expensive option in most cases. Because of the cost savings, this approach is commonly used in basements, attics, and secondary spaces where appearance concerns are minimal. It is rarely recommended for the most aesthetically sensitive spaces. However, in some instances it may be used when the physical harm of cutting and channeling a building's historic surfaces outweighs the visual impact.

- **Camouflaged.** The camouflaged approach also leaves sprinkler piping exposed to avoid cutting and patching of historic materials, but places sprinklers and other fire system components in the least visible portion of a room. Pipes can also be painted to match the background colors of the wall or ceiling.
- **Concealed.** The third approach is to conceal the sprinkler components as much as possible. This minimizes the sprinkler system's visual impact in the space and is favored where aesthetics is a concern. It is however the most expensive approach since it requires the largest amount of cutting and repair of historic surfaces and may require additional sprinklers to provide proper coverage since the sprinklers cannot always be placed where they are the most effective. Utilizing the concealed approach is frequently limited by budgetary constraints and therefore is often only applicable for the most sensitive spaces.⁶⁰

NATIONAL PARK SERVICE RECOMMENDATIONS

One cannot “unburn” a historical structure; it’s gone forever, as is its story. That which might replace it can be, at best, a replica. Historic preservation is a challenge, a balancing act; how does one preserve the historic character of the building, and its contents, while assuring that it will stand for generations by protecting itself from the ravages of fire? Jack Watts, author of *Fire Safety in Historical Buildings* seems to have answered that question. In writing his guideline for the National Trust for Historical Preservation, he states:

“To own or to live or work in a historic building engenders a sense of pride as well as responsibility as a custodian of our cultural heritage. Damage by fire can be one of the speediest and most ruthless threats to this heritage (p. 1).”⁴¹

“Automatic suppression systems can significantly help prevent loss of a historical building to fire – and can also save lives.”⁴²

INVESTING IN FIXED FIRE PROTECTION

Identification of cost for retrofitting historical or heritage buildings varies widely. These variances will be based upon the aesthetic sensitivity of the building and architectural design of the building, as well as the use of a restoration carpenter to facilitate the artistic blueprint of the building.⁶¹

In summary, fire is one of the most serious threats to a historical building, with consequences that can include harm to occupants and firefighters, damage to the structure and its content loss of building use, and impact on the tax base. Automatic fire sprinkler systems can further reduce a fire's impact by identifying a fire while it is small and initiating fire control before the fire department can respond. Selecting a fire protection system is dependent upon a variety of factors including the life safety, building significance, content value, aesthetics, historic features, and cost. As mentioned above, there is an inherent responsibility to ensure that historic structures are maintained and protected so that they can be seen and appreciated for many generations. ■

Chapter 6 – DOWNTOWN REVITALIZATION: INFRASTRUCTURE PROJECTS AND FIRE PROTECTION

When any downtown area experiences a significant fire that causes the destruction of a building or buildings, it is usually many years before there is recovery if there is any recovery of the building or re-use of the space.

Prior to COVID-19, during COVID-19, and coming out of the worldwide pandemic, the city of Greeneville, Tennessee, home of the 17th President of the United States, Andrew Johnson, planned for a downtown revitalization project that would improve the quality of life in the community and preserve portions of its historical downtown.

A meeting was held on May 6th, 2021, at the Greeneville Light and Power Building. This result of the public was overwhelmingly positive. With full support of the revitalization efforts and reserved concern of the public works project about to take place, the appointed officials, business owners, city employees, chamber of commerce staff and members, as well as the “outsiders” from the National Fire Sprinkler Association (NFSA), all shared civilly without opposition on the matter of water supply, fire protection, and the fact that all buildings were better with fire sprinklers because of the flexibility it allowed in the use of the building and the fact that it maintained the economy and the environment in the community.

Thanks to the progressive leadership of the local fire chief, the support of the city manager, the cooperation of the public works director, an experienced city planner, and a building official that was a fire and life safety advocate, everyone in the community came together and agreed on a plan to ensure the buildings in the area where the new water, sewer, and all public utilities would be added as well as new street scape would have access to water taps for fire sprinklers. The city was announcing the release of bids for the water and sewer line project on West Depot Street and the business owners were informed that the best use of their buildings would be enhanced if they ensured they had fire sprinklers. They were also informed that the benefit was now because of the Tax Cuts and Jobs Act of 2017, which allowed a small business owner to depreciate the value of the fire protection systems, including the fire alarm, fully in the first year, which prior to that law would have been 39 years.

Naturally, when a community makes such an investment in a small section of the city, but one that has big potential for lifestyle and economic benefits, it doesn't want to spend years planning and executing to have to go back in over the next several years as the plan begins to work and buildings begin to become living units above retail, new offices, mercantile shops, etc. and have to dig up the sidewalks and streets to include fire protection that is required by the building and fire codes to protect the occupants and firefighters from danger, but also to preserve the building, the street scape of the city, and the economic viability of the community.

Many communities place a moratorium on cutting sidewalks and streets after such projects, but then always

end up making exceptions because the investment begins to attract investing in the community and for it all to pay off, you need fire protection to meet the codes.

Back in Andrew Johnson's time, there was a huge fear of the entire community burning to the ground. Thanks to great fire departments, better fire apparatus and equipment, and adequate volumes of water in our communities, most do not fear conflagration like they did through the turn of the 20th century. While it may not seem like a treat today, it is a threat to burn down a block of an old downtown city and it is certainly reality and happens several times per year where the vital portion of a downtown city burns beyond restoration.

When any downtown area experiences a significant fire that causes the destruction of a building or buildings, it is usually many years before there is recovery if there is any recovery of the building or reuse of the space. The term quality of life is often used a “cliché,” but it is very real, and fire has a significant impact on lives, businesses, jobs, tax bases, and the overall health, safety, and general welfare of a community. All the way back to Benjamin Franklin, who said that “an ounce of prevention is worth a pound of cure” and reused by Winston Churchill in his “Iron Curtain Speech,” where he said, “prevention is better than a cure.”

Make sure when planning a revitalization, preservation, or especially if building a new section of any community, to include fire sprinklers as part of the overall project. Being compliant with the latest building and fire codes will pay dividends for the community many, many years beyond any elected or appointed officials' life, and it will give the owners of the buildings a piece of mind because of the preservation of the property, the limited risk to citizens and firefighters, and the economic impact of their livelihood and the communities.

The term water mains, water taps, lead ins, control valves, occupancy types, fire flow, backflow devices, light hazard, ordinary group 2, residential, mercantile, assembly, impact fees, utility assessments, and on and on and on will become familiar as any project begins to move forward.

All of these terms can become confusing, it's important to understand the confusions of the building owners or the citizens. This often happens in public hearings or meetings involving major infrastructure projects. It usually results in confusing terms, misunderstandings, and good intentions that are misaligned with the real intent of the project.

The National Fire Sprinkler Association (NFSA) can assist with planning for revitalization projects. We cooperate with Main Street America, the US Chamber of Commerce, the Building Owners and Managers Association, the International Association of Firefighters, and the

International Association of Fire Chiefs to bring vital expertise and information to the community.

Based on experience and analysis of the most economical with the least impact, it is the position of NFSA to promote the following:

- A single tap from the water main that serves two buildings
- Incentives should be provided instead of punitive fees for the enhanced fire protection
- Fire sprinkler contractors should be involved in the projects from the beginning and fire protection engineers should be consulted as water flow is determined
- Local and state laws must be considered prior to beginning the project. We support licensed fire sprinklers contractors doing the underground water main work from the public utility valve into the building.

The following items should be gathered prior to the start of any revitalization or preservation of downtown.

- Water flow and pressures
- Size the buildings and number of stories
- Use or intended use of the building (if local zoning codes prohibit certain uses, that should be known as well) Especially intended or future mixed use of buildings.
- Intended utility layout from those in authority for allowing the configuration
- Knowing the fire department required fire flow for affected areas is important for discussing how sprinklers will reduce fire department requirements after building are sprinklered.
- Get the ISO Individual Property (IP) fire flow information for discussing individual building options in the affected area.
- Limited fire department access issues and operational limitations that can be corrected by installing fire sprinklers.

HISTORY OF GREENEVILLE, TENNESSEE.

Greeneville, Tennessee's second oldest town, was founded in 1783 and served as the capital of the Lost State of Franklin, 1785-1788. The area's first European settlers were Scots Irish who came from other areas of the southeastern United States. The city and county were named for Revolutionary War hero General Nathanael Greene of Rhode Island. Frontiersman Davy Crockett was born in Greene County, near present day Limestone in 1786. He died in Texas in 1836 defending the Alamo during the war for Texas' independence from Mexico.

Greeneville is the home and burial place of Andrew Johnson, the 17th President of the United States. His home and tailor shop, as well as a visitor center, and a national cemetery where he is buried, are open to the public and

maintained as a National Historic Site by the U.S. Park Service.

During the Civil War, Greeneville changed hands numerous times. Although the state as a whole had voted to secede, East Tennessee was an island of predominately Unionist sentiment in the South. In September 1864, Confederate General John Hunt Morgan, an overnight guest of Dr. and Mrs. Alexander Williams of Greeneville was killed here during a surprise attack by Federal troops. Hotel Brumley, now known as The General Morgan Inn, was first called the Grand Central, and was considered to be the finest hotel "from Chattanooga to Roanoke."

On the lawn of the Greene County Courthouse are two monuments that commemorate the Civil War. One is dedicated to local troops who served in the Grand Army of the Republic (Union), and another memorializes General Morgan, known as the "Thunderbolt of the Confederacy." Greeneville is thought to be the only town in the United States that pays tribute to both the Union and the Confederacy in its courthouse square.

The Greeneville Cumberland Presbyterian Church was constructed on land purchased from Andrew Johnson. During the Civil War it was used as both a hospital and a stable. On September 4, 1864, it was shelled by cannon fire. Today, an unexploded cannon ball still exists in the front in the front of the building to the right of the door.

In 2018, town officials, with the cooperation of a development and urban design firm, began efforts towards the redevelopment of the central business district of Greeneville. The project was projected to operate in several phases, these proposed projects included: a farmer's market pavilion, a greenway along Richland Creek, an alley park, improved access for pedestrians and cyclists, parking garages, and the conversion of Depot Street into a street fair area. They still have the "Ye Olde Towne Gate" that was erected to welcome visitors and close the town off at night.

On April 7th, 2021, the Greeneville Fire Chief approached the NFSA at the Tennessee Fire Chiefs Association meeting and asked for NFSA's assistance on their project. NFSA staff was involved in several calls to discuss how the NFSA could assist. NFSA staff had prior knowledge and experience in working with the City of Greeneville on several projects throughout the years. The first option provided was from an education standpoint to the stakeholders through a Fire Team USA proposal. The NFSA later met with the city manager and Fire Chief to discuss timing and other options. Time was the biggest constraint and because the water department was already planning the underground work with preliminary plans already established, the city manager invited the NFSA

come to their stakeholders meeting and answer questions related to fire sprinklers benefits.

The people of Greeneville are very proud of their history. Greeneville is still considered a Tennessee town rather than a city. Their downtown historic district was first officially established by the city in 1974. The Planning Commission developed a 2017-2035 plan in 2016 that established a Downtown Revitalization Committee. This committee is very active, even today.

Their mission is: *“Downtown Greeneville shall be the most vibrant area of our community – friendly and welcoming to everyone irrespective of personal identities and backgrounds. It will be a place where both residents and visitors find it pleasant to be present at all times. It will be a place for living, doing business, engaging in tourism, and providing and obtaining public and private services. Our Downtown will also be a social space for personal relaxation, outdoor dining and recreation, personal fulfillment, and interpersonal interactions. Our Downtown shall be a mixed land use area: a place of residence, education, employment, shopping, preserved history, entertainment, walking, site seeing, cultural and recreational facilities and events, government and private services, public open spaces, religious enrichment, and low impact manufacturing activities.” ■*

Chapter 7 – ALTERNATIVES – ENGINEERED LIFE SAFETY SYSTEMS

Whenever discussions are held regarding the retrofit of sprinkler systems in buildings, the question of “alternatives” is always asked. As noted in the economics section, the retrofit of sprinklers into existing buildings can be costly, so there is always the question of cheaper alternatives, something that is equivalent to sprinklers, but less expensive.

Such systems go by any number of names, such as Engineered Life Safety Systems (ELSS), or Fire & Life Safety Systems (FLSS), etc. NFPA 101, requires automatic fire sprinklers in all existing high-rise buildings. However, there is an exception for an Engineered Life Safety System for ambulatory healthcare, apartments, and business use occupancy. Such systems must be designed by a registered fire and life safety professional engineer and approved by the authority having jurisdiction. Such systems shall include any, or all, of the following:

1. Partial automatic sprinkler protection
2. Smoke detection systems
3. Smoke control systems
4. Compartmentation
5. Other approved systems.⁶²

All codes have a section addressing alternatives or equivalences; they recognize that the code cannot describe all designs and methods and provide for a means for approval for those systems not mentioned in the prescriptive requirements. The International Building Code has a section addressing alternative materials, design and methods of construction and equipment. In that section it states:

*An alternative materials, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of the code, and that the material, method or work offered is, for the purpose intended, no less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability, and safety.*⁶³

How does one determine such equivalency and effectiveness? To do that, we must determine the level of service to be provided by the original design and then test the alternative to see if the proposed design meets that level of service. We can then ask, what is the purpose of the building code? In the International Building Code, that question is answered:

The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, public health, and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light, and ventilation, energy conservation and safety to life and property from fire and other hazards attributed to the built environment and to provide a reasonable level of safety to firefighters and emergency responders during emergency operations.⁶⁴

The Fire Code has a similar section detailing its reason for existence:

*The purpose of this code is to establish the minimum requirements consistent with nationally recognized good practice for providing a reasonable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions in new and existing buildings, structures, and premises, and to provide a reasonable level of safety to firefighters and emergency responders during emergency operations.*⁶⁵

By their nature, fatal fires appear to demonstrate that the building, or systems within the building, failed to provide that reasonable level of life safety. Therefore, to determine an equivalent level of life safety from a fire, we need to ascertain at which point a structure fire becomes deadly.

There can be little doubt; the point at which a fire in a structure becomes deadly is flashover. Bukowski and Peacock, conducting research for the Building and Fire Research Laboratory of the National Institute of Standards, reported:

*The occurrence of flashover within a room is of considerable interest to the fire protection specialist since it is perhaps the ultimate signal of untenable conditions within the room of origin as well as a sign of greatly increased risk to other rooms within the building (p. 82).*⁶⁶

At the point where they speak of “increased risk to other rooms within the building,” it can certainly be inferred that the occupants of those rooms also face this increased risk. As such, flashover is the point where a fire in a structure becomes deadly.

Dr. James Milke, Chairman of the Fire Protection Engineering Program at the University of Maryland stated:

*The onset of flashover is of interest to all individuals concerned with building fire safety. This interest is motivated by the fact that, typically, flashover is considered as the point of transition from a “small fire” involving a small number of objects in the room to a “large fire” involving all objects in the room. Once a fully developed room fire exists, life safety for occupants within that room is no longer of concern because the room is obviously untenable after flashover (p. 8-2).*⁶⁷

One can extrapolate that, to provide for a “life safety system,” engineered or otherwise, the building, or systems within buildings, must prevent flashover within the compartment of origin. That said, how does one measure flashover; what are its triggering conditions? Richard

Custer has provided a more scientific definition of the phenomenon of flashover. He described the triggering conditions for the flashover to be:

1. The temperature of the upper gas layer in the compartment or enclosure is approximately 600°C and,
2. The radiant flux on unignited materials in the compartment or enclosure at approximately 20kW/m² (p. 1-89).⁶⁸

Passive vs. Active Fire Protection

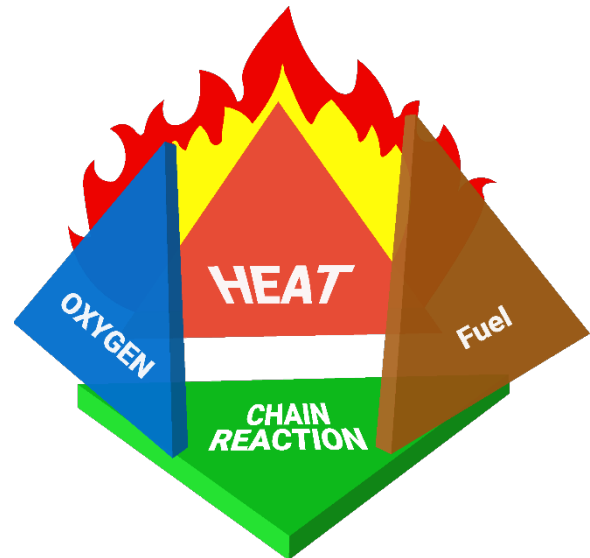
There are any number of ways to classify fire protection systems. For this section, we will examine two... passive and active. Passive systems take no positive steps in interrupting the combustion process, either by cooling or by chemical disruption. They consist of detection notification systems, such as smoke detectors, heat detectors, carbon monoxide detectors and flame detectors, etc. They also consist of construction features, such as fire walls, fire partitions, fire doors, fire dampers and “fire proofing,” i.e., insulation on steel to prevent deformation from excessive heat. It is interesting to note that, up until the 1970s, there was a classification of building construction known as “fireproof,” which were, essentially, concrete buildings.



Fires that occur in such buildings could burn for hours, even days! The building itself is fireproof, but the contents are not. It was reported that, in 1951, the Ryan and Christie Furniture Warehouse in Bryn Mawr, PA burned for over a week. Following the fire, the façade that was the rear wall was removed, a small bulldozer placed on each floor and the tons of ash from the fire were simply pushed outside the building and cleaned up from the ground. The interior

was cleaned, the rear façade wall was rebuilt, and the company was back in business.

Active systems, on the other hand, interrupt the combustion process by taking away one of the sides of the fire tetrahedron, either by removing the oxygen, such as a carbon dioxide system, taking away the fuel, such as a foam system, interrupting the chemical chain reaction, such as a halon system, or the most common method, by cooling with water.



By far, the most effective and cost-efficient method is by cooling; applying enough water to cool the fuel package below their ignition temperatures; take away the heat and the fire goes out. Manual firefighting efforts, such as fire department operations, or automatic fire protection systems, such as fire sprinkler systems, are all about cooling.

Evaluating Equivalence

If lives are to be saved, we must develop a system that will cool the fuel package in buildings before enough energy is generated to result in flashover. Any evaluation of an engineered life safety system must be judged on that system's ability to stop flashover. To put it succinctly, an Engineered Life Safety System must prove that it can, in the compartment of origin:

- Prevent ceiling temperatures from reaching 600°C or,
- Mitigate the effects of a radiant flux of 20kW/m² reaching fuel packages other than the material originally involved.

As we revisit the concept of an “engineered life safety system,” which acceptable alternatives will prevent flashover?

1. Partial automatic sprinkler protection
 - a. Only if that partial sprinkler system is installed in the compartment of origin, near the fuel package, without obstructions.
2. Smoke detection systems
 - a. Such systems do not interrupt the combustion process and, therefore, will not prevent flash over. Their purpose is notification only.
3. Smoke control systems
 - a. Depending on the design, such systems might exacerbate the situation by allowing fresh air to the fire.
 - b. One of the most effective methods of smoke control is to limit the size of the fire. "Limiting the fire size can be accomplished by controlling the type, quantity and arrangement of fuel. In addition, the fire size can be controlled through an automatic suppression system."⁶⁹ In the December 2014 issue of Consulting – Specifying Engineer Magazine, William Koffel, PE, wrote "Effective smoke control starts with providing automatic sprinkler protection. Properly designed, installed, and maintained automatic sprinkler system will assist in accomplishing any smoke control, by limiting fire growth and therefore the quantity of smoke produced."⁷⁰ There is no better smoke control systems than sprinklers.
4. Compartmentation
 - a. Fire rated assemblies may delay the spread of fire, both horizontally or vertically, but they do not interrupt the combustion process; they do not prevent flashover within the compartment of origin and those trapped within that compartment will not survive.
5. Other approved systems
 - a. There are other approved systems, such as misting systems, common on cruise ships, but they are exceeding expensive.

"Dorothy Mae" Sprinkler Systems

One such "alternative" is the "Dorothy Mae" sprinkler system; such a design was the result of a fire at the Dorothy Mae Apartments at 821 West Sunset Boulevard in Los Angeles, CA in September of 1982. This fire resulted in the loss of 24 lives.

The Dorothy Mae system is, essentially, a partial sprinkler system. The system consists of sprinklers installed in the corridors of a residential apartment or condos, and a single

sprinkler head, through the corridor wall into the apartment or condo, installed just above the corridor door.



The orange line represents a cross main down installed in the corridor and sidewall sprinklers are spaced along the main. The spray pattern of the single sprinkler over the doorway to the apartment cannot reach all the occupied spaces of the unit. Such a system will not prevent flashover in these rooms and, if you don't prevent flashover, you don't save lives.

Risk based decision making demands that we evaluate the risk and determine that risk which we are willing to tolerate, the "acceptable level of risk." Note that the "acceptable level of risk," in the fire safety arena, is also the "acceptable level of loss."

In this context, what would the fire safety performance objectives for a Dorothy Mae System? The performance objective is for a Dorothy Mae system is elusive, but it appears as if the acceptable level of loss is most of the apartment of origin, and those within it. The single sprinkler over the door to the corridor within each apartment or condo is not going to stop flashover from occurring in the kitchen (the most common location of fires in the US), or in the bedrooms (the 2nd most common location of fatal fires in the US).

How long is the time to burnout in an apartment, or the time it takes for the fire to start to decay? If the objective is to simply stop the fire at the door to the corridor, we already have a fire door to do that; we simply must assure the door will hold until burnout. We simply need to put into their Computer-Aided-Dispatch notes that the fire department should not open the door until there are no more flames evident from the outside; they should focus on either evacuation or shelter in place for the other residents of the building.

There appears to be a misconception that there is any equivalent to a fully operating sprinkler system. If our intent is to save lives, all the lives within the building... including those in the apartment/condo of origin, sprinklers are really the only answer. All the passive fire protection in the world will not stop the march to flashover.

Unless the ELSS has provisions to state that a system, or systems, within the building shall be designed to prevent ceiling temperatures from reaching 600°C or mitigate the effects of a radiant flux of 20kW/m², the occupants of any given building will believe that the installation of an ELSS, accepted as an alternative, and whose real purpose to prevent the installation of sprinklers, will provide equivalent protection and give the occupants of the building a false sense of safety. The question often asked: "Isn't any protection better than none?" Yes, it is, but the occupants need to be fully aware of the limitations of "any protection."

In 1977, the International Association of Fire Chiefs appointed an Automatic Fire Detection Committee to study various claims of smoke detector manufacturers. Chief Thomas C. Hayden, Lower Merion Fire (PA) Department and Chief James Dalton, Montgomery County Fire (MD) Department ran the committee. They were testing smoke detectors and examining a proposal to require smoke detectors on every level of the home. At the time, there was push back about requiring smoke detectors in every room, except the kitchen; they addressed the concept of "any protection is better than none," by stating:

Any degree of protection is better than none – This is tantamount to saying that one, 1935, 500 gpm, Class "B" pumper, used to protect our downtown, high value district is better than no pump at all.

Thus, the Committee feels that the Fire Chief should advocate that each citizen purchases the best protection within his means. If a man can afford a system, let him be protected by a system – but if he can't afford it – let him buy less protection, but don't let him provide minimum protection and feel that he is fully protected.⁷¹

A system, such as the Dorothy Mae, could be acceptable if it was the first step in a phased installation:

- System designed and calculated as a full NFPA 13-complaint system
- Installation of sprinklers in common areas including all the corridors
- Corridor piping teed off to provide a pipe into each apartment or condo, sized for complete protection
- One head over the corridor doorway during this phase
- Extension of full coverage, as per NFPA 13 within each apartment or condo upon change of occupant or sale of the condominium.

Any alternative to a fully compliant NFPA 13, 13R or 13D system, depending on the application, should be looked upon with a degree of skepticism if it is being considered as an equivalent to a full automatic fire sprinkler system. ■

Chapter 8 – THE ECONOMICS

Fire sprinklers cost money: there is no denying that fact. In addition, the retrofit of sprinklers is not cheap. But that is only if one considers the installation of fire sprinklers an outright cost, as opposed to an investment.

TOTAL ECONOMIC IMPACT OF FIRES

In Hawaii, there is a residential high-rise called the Marco Polo; it is a condominium of 36 stories with 568 dwelling units; built in 1971 and was not, at the time, required to be protected with fire sprinklers. The building experienced a fire in 2013 causing \$1.1 million in damages with no injuries. After that fire, the Marco Polo's building association received an estimate of \$4.5 million to retrofit the entire building, about \$8,000 per dwelling unit. They decided against installing fire sprinklers; after all, what was the chance of having another fire?⁷²

They found out; on July 14th, 2017, at 2:17 in the afternoon, the Honolulu Fire Department was dispatched to the Marco Polo for a fire on the 26th floor. By the time it was over, 4 people were dead (including 1 who was found 6 floors above the floor of origin), 13 others were injured, 200 dwelling units were damaged or destroyed and it is estimated that there was over \$100 million in direct damages.⁷³

According to a lawsuit filed on behalf of the estates of the deceased, this was the third fire in the building. It was reported that a fire occurred in the building on the 23rd of November 2010, a second on the 15th January 2013 and the third, the fire of the 14th of July 2017; all were accidental in nature.⁷⁴ So, in addition to the \$100 million in direct fire damage, there will be additional payouts of significant sums of money due for litigation; all due to the refusal to retrofit sprinklers in 2013, even after two fires that should have made it obvious – the fact that fires in high-rise buildings have the potential to be disastrous and, after two fires, it should have been made clear that sprinklers were needed.

This refusal stems from the fact that such a retrofit program is seen as pure “cost.” It should not be seen as a cost, but as an investment. If the building owners had invested the \$4.5 million to retrofit sprinklers in 2013; the 2017 fire would have been an insignificant event, a fire sprinkler save, and nothing more.



THE BLACK SWAN EVENT

A “black swan” event is one that is a surprise to everyone; has large scale consequences and is often followed by the comment “I could have told you that was going to happen.” From a risk management standpoint, such events are termed “low probability – high consequence” incidents. The chances of them happening are small, but the outcome, in terms of life loss and property damage, can be catastrophic. It’s a gamble, you’re betting the fire won’t happen, but if it does, you lose, and you lose big.

In 1972, the Fidelity Mutual Life Building was completed in the City of Philadelphia; it stood adjacent to City Hall. It was a 38-story office building. At the time, the City of Philadelphia was enforcing its 1949 building code and the building was not required to be protected by sprinklers.

Subsequently, in 1984, the City began to require sprinklers in all new high-rise office buildings.⁷⁵ Through a succession of owners, the building was in the process of being retrofitted with sprinklers and by 1991, 4 floors had been provided with sprinklers, it was done as a part of the renovation of those 4 floors.

On the 23rd of February 1991, workers, who had been refinishing woodwork on one of the unprotected floors, left a pile of linseed oil-soaked rags on the 22nd floor; they ignited and set off the smoke detection system within the building; unfortunately, this did not trigger a phone call to the “911” center. The investigation revealed that the smoke detector activated at approximately 8:23 pm; the fire department was notified at 8:27 pm by a passerby who saw smoke coming from the building; a short, 4-minute delay. The fire went to 12 alarms, involving 8 floors of a modern high-rise building; 3 firefighters died in the effort, Captain David Holcombe (age 52), Firefighter Phyllis McAllister (age 43) and Firefighter James Chappell (age 29). In addition, 24 other firefighters were injured.

Fire operations included 51 engines, 11 ladders, 11 battalion chiefs, and numerous support units. Operations lasted for 19 hours; 8 stories of the building were destroyed. The fire climbed from the 22nd floor, despite the presence of passive fire protection features such as rated walls and floor/ ceiling assemblies, until it reached the 30th floor, one of the floors that had been retrofitted with automatic sprinklers. Ten fire sprinklers operated on the 30th floor, stopping the fire from ascending further up the partially sprinklered high rise.⁷⁶



Damage estimates were in the hundreds of millions of dollars. The building stood as a vacant eyesore in the City of Philadelphia for 8 years and the owners, it is reported, settled with their insurance company for \$300 million. The owners spent

\$500,000 per month on security, utilities, inspections, and engineering to determine the viability of repair; it was ultimately demolished by the end of 1999 at a cost of \$23,000,000.⁷⁷ As a result of the fire, the City of Philadelphia passed a law requiring the retrofit of sprinklers in all non-residential buildings over 75' in height, giving building owners 5 years to comply.

THE MYTH OF “LIGHT HAZARD”

Office buildings are considered “light hazard,” yet they can still have disastrous fires. Another catastrophic office building fire occurred in Los Angeles in 1988; the fire at the First Interstate Building destroyed 5 floors of a modern office building and resulted in retrofit requirements for high-rises in that city.

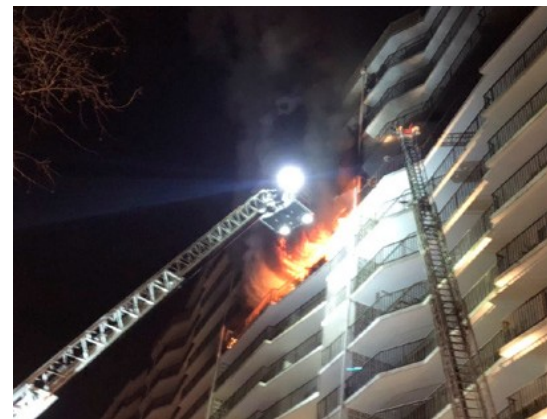


The fire caused approximately \$50 million dollars in damages in 1988, equal to about \$110 million in 2019.

A fire at the Grenfell Tower, a residential high-rise in London, occurred in June of 2017; the building was 24-stories tall and had 129 apartments. The fire resulted in 72 fatalities and over 70 injuries. The building was insured for about \$25 million.⁷⁸



More recently, April of 2019, the Waterford Condominium Building, a 12-story, 150-unit apartment building suffered a fire on the 9th floor.



As of this writing, the only injury was a civilian from within the apartment of origin, who discovered the fire, pulled the alarm, and called 911. Despite passive fire protection features, the fire was not contained to the unit of origin and destroyed two units on the 9th floor. As seen in the photos, the fire itself was just within reach of fire department aerial devices.

GENERAL COST ESTIMATES

So, how does one calculate costs for a low probability, high consequence fire in a building and compare it with the investment of installing sprinklers in existing buildings? Certainly, years after a fire event, when all the bills to repair or replace are paid and all the lawsuits are settled, the cost of a given fire can be determined with some degree of accuracy. Such numbers can be staggering.

Attempting to provide a cost estimate for retrofitting sprinklers is a challenging chore, but it can be said with certainty, that it is but a small fraction of the cost of the fire in terms of dollars and lives affected.

It is exceedingly difficult to give a general cost estimate for the retrofit of fire sprinkler systems in an existing building. Truly, every building is different; however, some of the variables in determining cost include:

- Height
- Type of Construction
- Configuration
- Available water supply
- Type of pipe
- Is a fire pump needed?
- Are soffits needed?

Cost estimates from several high-rise retrofits in the Philadelphia, PA area provide some general information regarding retrofits:

As can be seen, the cost per square foot ranges from \$2.44 to \$10.22 depending on whether the water supply infrastructure needs to be upgraded; similarly, the cost per dwelling unit ranges from \$1,944 to \$13,832.⁷⁹

Salt Lake City, UT passed a retrofit ordinance giving high-rise buildings 12 years to install sprinklers throughout. One of the buildings affected is the Aztec Condominiums, a 10-story building constructed in 1965. Following the passage of the ordinance, their homeowner's association has been proactive in pursuing this goal. They provided cost estimates for each unit as follows:

- \$5,980 for a one-bedroom unit
- \$8,075 for a two-bedroom unit
- \$10,170 for a three-bedroom unit and
- \$18,254 for a penthouse or suite unit

In addition, installation started in the common areas and will not begin to be installed in individual units until 2021, thus giving each unit owner

5 years to budget for these funds.⁸⁰

These expenditures, however, might be offset by insurance reductions, it has been reported that one insurance company is offering reductions of up to 15%.

The installation of sprinklers can also result in the savings from the cost of maintaining various passive fire protection systems, such as 1-hour corridor walls no longer being needed in many occupancies; Table 1020.1 of the 2018 International Building Code provides for that reduction.⁸¹

The long-term benefits of investing in fire sprinklers will, eventually, be realized and, due to changes in the federal tax law, now is the time to invest in this lifesaving system.

	YEAR	TOTAL SQ FT	NO. OF UNITS	FIRE PUMP (ELEC/DSL)	NEW OR EXISTING FIRE SERVICE	SPRINKLER COST	INFRA-STRUCTURE	TOTAL COST	COST/ FOOT	COST/ UNIT	OCCUPIED
6-STORY HIGH-RISE	2016	58,440	78	EXISTING ELECTRIC	EXISTING	\$246,000		\$246,000	\$4.21	\$3,154	YES
9-STORY HIGH-RISE	2014	123,000	180	EXISTING DIESEL	EXISTING	\$350,000		\$350,000	\$2.85	\$1,944	YES
11-STORY HIGH-RISE	2013	229,900	323	EXISTING DIESEL	EXISTING	\$500,000		\$500,000	\$2.44	\$1,734	YES
3-STORY LOW-RISE	2008	52,800	39	EXISTING	EXISTING	\$472,800	\$66,667	\$539,467	\$10.22	\$13,832	NO
3-STORY LOW-RISE	2008	53,640	39	EXISTING	EXISTING	\$475,800	\$66,667	\$542,467	\$10.11	\$13,909	NO
3-STORY LOW-RISE	2008	54,000	39	EXISTING	EXISTING	\$474,695	\$66,667	\$541,362	\$10.03	\$13,881	NO
12-STORY HIGH-RISE	2000	125,400	250	EXISTING	EXISTING	\$893,888		\$893,888	\$7.13	\$3,576	YES

TAX INCENTIVE FOR RETROFITTING FIRE SPRINKLERS

Section 179 of the United States Tax Code allows businesses to deduct the full purchase price of qualifying equipment and/or software purchased or financed during the tax year. That means that if you buy (or lease) a piece of qualifying equipment, you can deduct the full price from your gross income as an expense. This had the effect of lowering your income for tax purposes.

Section 179 does come with limits. The total amount that may be written off is capped at \$1 million and limits the total amount of equipment purchased in a given year to \$2.5 million. In addition, the deduction begins to phase out on a dollar for dollar after more than \$2.5 million is spent by a given business. Under this phase out the entire deduction goes away once \$3.5 million in purchases is reached. This phase out is used to make sure that only small and medium sized businesses may use the deduction.

Congress in 2017 made a major enhancement to section 179 and included fire sprinklers and suppression as an eligible deduction.

The Tax Cut and Jobs Act of 2017 (P.L. 115-97) increased fire safety in two important ways:

- For small businesses – fire sprinklers became an eligible expenditure for section 179 expensing in non-residential structures. This will allow critical occupancies such as night club venues to install fire sprinklers. This is exactly what this benefit was intended for, to prevent another Station Nightclub Fire where 100 people lost their life, which occurred in Rhode Island in 2003. However, residential structures were not included.
- For larger businesses – Qualified Improvement Properties (QIP) were intended to be included as being eligible for bonus depreciation. QIP

includes fire sprinklers and any other non-structural improvement to the inside of a commercial building. Under the Tax Cut and Jobs Act, QIP would be eligible for immediate expensing for the first 5 years, tapering down to zero over the next 5 years. This provision, however, needs a technical correction from Congress due to a drafting error in the Conference Report. This technical correction has not yet been enacted.

OTHER INCENTIVES

- The City of Enid, OK provides grants up to \$25,000 for the installation of sprinklers in their downtown historic district.
- Grapevine, TX provided low interest, 20-year loans.
- Skagway, AK also provided grant related funds – up to \$100,000.
- Lockport, IL provided grants for up to 50% of the total cost, not to exceed \$15,000.
- When Annapolis, MD needed to “rebrick” the streets in their historic downtown, the Public Works Department, in conjunction with their water purveyor, installed taps for fire sprinklers in front of each building to lessen the cost of retrofits when the time came to install.

PROPOSAL

Currently there is no economic incentive for high-rise property owners to protect their residents and retrofit their properties with fire sprinklers. The fire service is asking for two things:

1. Residential high rise – Under current law, fire sprinklers would be depreciated over 27.5 years – long past the time that many building owners and real estate investment trusts, who are increasing activity in this sector, plan to own the building. The fire service would like to accelerate this depreciation to 15 years.
2. Commercial high rise – Assuming the pending QIP technical correction is enacted by Congress, fire sprinklers will receive accelerated depreciation through 2027. After that date, fire sprinklers would revert to 15 years permanently. The fire service strongly supports enacting the QIP technical correction.

In addition to tax incentives, there are state and municipal communities who so value the importance of retrofitting sprinklers in existing buildings that they have established, or are in the process of establishing, low interest loan programs. Such programs, funded by local government, can greatly increase the life safety of their constituents.

For instance, Hawaii House Bill 1822 (2018) states: The tragic fire that occurred on July 14, 2017, at the Marco Polo high-rise in Honolulu, resulting in four deaths and the damage or destruction of

approximately two hundred units in the building, brought to light the consequences that can occur when a residential high-rise building lacks an automatic fire sprinkler system. The loss of life, as well as property damage estimates exceeding \$100,000,000, has fueled the debate on the need to require the retrofitting of older residential buildings with automatic fire sprinkler systems.

While automatic fire sprinkler systems have a proven record of significantly reducing loss of life, injury, and property damage caused by fires, these systems have only been required to be installed in apartment and condominium buildings in Honolulu since 1975. Residential high-rise buildings constructed prior to 1975, including the Marco Polo, are exempt from this requirement.

Although the retrofitting of all high-rise hotels in Honolulu constructed prior to 1975 with automatic fire sprinkler systems was required in 1983 and extended to commercial high-rise buildings eight years later in 2001, attempts over the years to mandate similar requirements for residential high-rise buildings built prior to 1975 have failed. Currently, over three hundred high-rise buildings on Oahu do not have automatic fire sprinkler systems.

One of the biggest obstacles to the installation of automatic fire sprinkler systems in older residential high-rise buildings is the cost of installing these systems. In 2005, a city community taskforce trying to find ways to make the installation of automatic fire sprinklers more palatable for apartment and condominium owners determined that the cost for installing such systems ranged from

\$4,305 per unit to over \$13,473 per unit depending on varying factors. More recent estimates of costs associated with retrofitting these older buildings with automatic fire sprinkler systems have suggested that the per unit cost estimates of 2005 have doubled. Offsetting the costs of installing these systems in older buildings is a key component of any attempts to mandate their installation.

While the legislature finds that retrofitting older residential buildings with automatic fire sprinkler systems is in the best interest of fire safety, the legislature also understands the impacts the costs of installing such a system will have on individual apartment and condominium owners, particularly those on fixed incomes. The provision of low interest loans to assist homeowners will help to alleviate some of these concerns.⁸²

The purpose of this Act is to create an automatic fire sprinkler revolving fund to provide low interest loans for installation costs associated with the installation of automatic fire sprinkler systems in apartments and condominiums, built before 1975, including common areas.

California has gone even further; they fully realize that the retrofit of an automatic sprinkler system can significantly increase the value of a building, thus significantly increasing its tax bill. Their legislature has introduced legislation that would change the State Constitution that remove the fire sprinkler costs from the “newly constructed” provisions of the state tax code.⁸³

TAX CREDITS

In the State of New York, they are exploring a 25% tax credit for residential properties in which there is installed a residential sprinkler system. This could certainly be quite the incentive to have prospective buyers install such systems.⁸⁴

SPECIAL ASSESSMENTS

Minnesota allows a local jurisdiction to make improvements to any properties and assess the costs to the property owners via a special tax assessment. Essentially, the local jurisdiction pays for

the improvements, then recoups the costs from the property owner by assessing their taxes over a period of 30 years. Fire protection systems (sprinklers) are included in the definition of allowed improvements. This applies to public and private buildings and has been used successfully many times in Saint Paul.

A partnership with the local water utility can pay dividends regarding the installation of fire sprinklers. Both the City of Petaluma, CA and Annapolis, MD's water utilities installed “taps” for sprinklers as water mains are replaced in their historic districts. This significantly reduces the cost of retrofits when the adjacent property owners decide to install sprinklers.

INSURANCE PREMIUM DISCOUNTS

The owners of the Saligman House, a senior living facility in Philadelphia, began a retrofit project for their 5 high-rise residential buildings. After completion of the first building, their insurance company offered them a 15% discount across their whole portfolio.

Insurance premium reductions in many commercial properties can help to recoup the investment within a decade. ■

Chapter 9 – CONCLUSIONS

It can only be concluded that fires have changed and our philosophy of fighting them must change also.

1. Certain building/occupancies pose a grave threat in the event of a fire.

- They include high-rise buildings, regardless of occupancy and some assembly occupancies

2. The point at which a fire becomes deadly is flashover occurs.

- The triggering conditions for flashover are well known.
- Many experiments have depicted the time from first flame to flashover
 - The times from first flames to flashover have changed dramatically in the last few decades.
 - These changes have been so dramatic that fire department response is, in many cases, no longer sufficient to prevent flashover.

3. The key to saving lives is to prevent flashover.

4. The model code organizations recognize the value of sprinklers in saving lives.

- NFPA 1 – Fire Prevention Code, has required the retrofit of automatic sprinklers in some occupancies for over 2 decades.
- The International Fire Code has recommended the retrofit of sprinklers in high-rise buildings also for decades. However, in the upcoming 2021 edition, it will become a requirement.

5. The process is a long-term project, including:

- Adoption of a retrofit requirement
 - Either by standalone ordinance, or by adopting a model code that requires it
- Create an inventory of the buildings within your jurisdiction that require retrofits.
- Notify the owners of the building of the requirement
 - Meet with the owners and explain the need
- Historic structures and contents cannot be “unburned.”
- “Acceptable level of risk” should be equated with “acceptable level of loss.”
- Partial sprinkler systems should only be permitted if part of an overall plan to phase in complete sprinkler protection.

The cost of a sprinkler system should be considered an “investment” as opposed to pure expenditure.

- The buildings that have suffered fires without sprinkler protection have incurred losses far greater than the initial investment in sprinkler protection.
- There are several financial incentives to offset the investment in sprinklers:
 - Tax incentives
 - Tax credits
 - Special Assessments
 - Insurance premium reductions

Many conferences regarding fire safety in the United States, from Truman’s Conference on Fire Prevention (1947), to America Burning (1973) to Wingspread VI (2016), all consider automatic fire sprinkler protection as the most cost-effective system in preventing flashover.

APPENDIX

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APPENDIX A – SAMPLE ADOPTING ORDINANCE

ORDINANCE (insert number)
A(N) (ORDINANCE / STATUTE / REGULATION)
ADOPTING THE 2021 EDITION OF THE
INTERNATIONAL FIRE CODE, REGULATING AND
GOVERNING THE SAFEGUARDING OF LIFE AND
PROPERTY FROM FIRE AND EXPLOSION HAZARDS
ARISING FROM THE STORAGE, HANDLING AND USE
OF HAZARDOUS SUBSTANCES, MATERIALS AND
DEVICES, AND FROM CONDITIONS HAZARDOUS TO
LIFE OR PROPERTY IN THE OCCUPANCY OF
BUILDINGS AND PREMISE IN THE (NAME OF
JURISDICTION); PROVIDING FOR ISSUANCE OF
PERMITS AND COLLECTION OF FEES THEREFORE,
REPEALING (ORDINANCE
/ STATUTE / REGULATION) NO. _____ OF THE
(NAME OF JURISDICTION) AND ALL OTHER
ORDINANCE OR PARTS OF LAWS IN CONFLICT
HEREWITH.

The (governing body) of the (name of jurisdiction)
does ordain as follows:

SECTION 1. ADOPTION OF FIRE PREVENTION CODE

That certain document, three (3) copies of which are on file
in the (name of jurisdiction), being marked and
designated as The International Fire Code, 2015 edition,
including Appendix Chapters (fill in appendix chapters
being adopted), as published by the International Code
Council, is hereby adopted by (name of jurisdiction); for the
control of buildings, structures, and premises
as herein provided; and each and all of the regulations,
provisions, penalties, conditions and terms of said ICC
International Fire Code, are hereby referred to, adopted
and made a part hereof as if fully set out in this Ordinance,
with the additions, insertions, deletions and changes
prescribed in Section 3 of this Ordinance.

SECTION 2. THAT THE FOLLOWING SECTIONS ARE HEREBY REVISED:

Section 101.1: Insert name of jurisdiction
Section 109.4: Insert offence, dollar amount and # of
days
Section 111.4: Insert dollar amount in two locations
Section 1103.5.3: Insert date by which sprinklers must
be installed

SECTION 3. ESTABLISHMENT OF LIMITS

Section 5704.2.9.6.1 Insert geographic limits in which
storage of Class I and Class II liquids in above ground
tanks outside of buildings is prohibited.

Section 5706.2.4.4 Insert geographic limits in which
storage of Class I and Class II liquids in
above ground tanks outside of
buildings is prohibited.

Section 5806.2 Insert geographic limits in which
the storage of flammable cryogenic
liquids in stationary containers is
prohibited

Section 6104.2 Insert geographic limits in which the
storage of liquified petroleum gas is
restricted for the protection of heavily
populated or congested areas

SECTION 4. SEVERABILITY

The provisions of this Ordinance are severable, and if any
section, sentence, clause, part of provision hereof shall be
held illegal, invalid or unconstitutional by any court of
competent jurisdiction, such decisions of the court shall not
affect or impair the remaining sections, sentences, clauses
part or provisions of this Ordinance. It is hereby declared to
be the intent of the Board that this Ordinance would have
been adopted if such illegal, invalid, or unconstitutional
section, sentence, clause part or provision had not been
included herein.

SECTION 5. SAVING CLAUSE

That nothing in this Ordinance or in the Fire Prevention
Code hereby adopted shall be construed to affect any
lawsuit or proceeding impending in any court, or any rights
acquired, or liability incurred, or any cause or causes of
action acquired or existing, under any act or ordinance
hereby repealed as cited in Section 2 of this Ordinance: nor
shall any just of legal right or remedy of any character be
lost, impaired, or affected by this Ordinance.

SECTION 6. PUBLICATION

The (jurisdiction's keeper of records) is hereby ordered and
directed to cause this legislation to be published in
accordance with that jurisdiction's regulations and policies
for adopting ordinances, statutes, and regulations.

SECTION 7. DATE OF EFFECT

That the Township Manager shall certify to the adoption of
this Ordinance and cause the same to be published as
required by law; and this Ordinance shall take full force and
be in effect immediately after this date of final passage and
approval.

ENACTED AND ORDAINED by the (governing body of the
jurisdiction) on (date).

RETROFIT INVENTORY FORM

[illegible][illegible]

APPENDIX C – CASE STUDIES

CASE STUDY – SALIGMAN HOUSE PHILADELPHIA, PA

Robert Saligman House

BACKGROUND

The Robert Saligman House is a 202/Section 8 HUD subsidized/affordable housing community located in Philadelphia, PA. Managed by Federation Housing this building is 10 stories, with 180-units which include efficiencies and one-bedroom apartments. The building had sprinkler protection in the common areas but none in the apartments.

During 2014, the building owner decided to renovate Saligman House because of the age of the buildings and inherited risk associated with an older adult population which occupied the apartments. Renovations included painting, replacing carpets and windows, etc. The owner realized that renovating the building presented an opportune time to retrofit each apartment with fire sprinklers to enhance the safety of the residents and reduce their liability as property owners.

In order to move forward with the retrofit, the owner needed approval from a 42-member Board which consisted of other apartment and building owners throughout the city. After explaining how important it was for himself and other property owners to protect their assets (buildings and people) the Board approved the retrofit project. Additionally, the owner received a 20 percent discount from his insurance carrier.

TN Ward Company is an award winning general contracting company that has successfully completed a wide range of projects. TN Ward was hired as the general contractor (GC) to complete renovations throughout the Saligman House and worked closely with Oliver Fire Protection & Security to coordinate the sprinkler installation activities. A key to the successful renovation and retrofit was the ability for both companies to coordinate activities, get timely approval of designs, and stay on schedule.

Timeliness and coordination of work schedules and activities was important because the occupants were relocated while their apartments were being renovated and

sprinklers were being installed. Furthermore, at the conclusion of each workday each apartment had to be returned to its original condition.

With a commitment towards creating a customer experience that makes life safety challenges easy to manage, Oliver Fire Protection & Security has been in business for more than 60 years and employs 250 highly skilled employees. A survey of the property revealed that



the building had existing sprinklers only in the corridors. Oliver Fire Protection & Security's proposal to retrofit Saligman House included installing sprinklers on the main floor–1st thru 9th floors and the Elevator Penthouse. Following approval Oliver Fire Protection & Security was hired to complete the retrofit project which was accomplished in 11 months.

CODES

During this retrofit project, the city of Philadelphia was utilizing the 2013 edition of the Philadelphia Fire Code. The 2013 edition of "The Philadelphia Fire Code," is based off the 2009 edition of the International Fire Code published by the International Code Council. The pricing for this project was based on NFPA 13: Standard for the Installation of Sprinkler Systems.

CHALLENGES

There were two challenges faced during the retrofit of the building. The first challenge was to figure out what to do with the residents during the retrofit because the building was fully occupied. It was important to retrofit the building with the least amount of impact to the residents. Second, was the discovery of asbestos throughout half of the building.

RESULTS

To address the displacement of the residents during retrofit, each occupant was relocated to the community room located within the building. Residents were only displaced during work hours (8:00 am to 4:00 pm) and was able to return to their apartment at the end of each workday. No more than five apartments were retrofitted at a time which minimized the number of residents that were displaced each day.

The number of apartments (five) chosen to work on each day was because work was already being done on those apartments by the general contractor. However, if no other maintenance work was being done in the apartments, retrofit work would have been done in only two apartments per day.

After discovering asbestos in the popcorn finish on the ceiling, the decision was made to hang the pipe via the concrete block walls in lieu of the ceiling. Hanging pipe via the concrete block walls helped minimize the financial impact of the retrofit project.

COST

The cost to retrofit the Saligman House was \$515,840. The breakdown of cost are as follows:

Year	2014
Total Square Feet (SF)	123,000
SF per Floor	13,667
SF per Head	145
Number of Units	180
Number of Units per Floor	20
Number of Sprinklers	848
Pipe Type	CPVC
Standpipes	Yes - Existing
Fire Pump (Electric/Diesel)	Existing Diesel
Partial/Entire	Entire building
New or Existing Fire Service	Existing
GC/Owner	GC
Soffit Type	DecoShield
Sprinkler Cost	\$350,000
Soffit Cost	\$165,000
Combined Cost	\$515,840
Cost/SF (including soffits)	\$4.19
Cost/Unit	\$2,866
Occupied	Yes

CASE STUDY – 735 SW ST. CLAIR APARTMENTS PORTLAND, OREGON

St. Clair Apartments

BACKGROUND

St. Clair Apartments is an existing 23-story apartment (R-2) building with a rooftop mechanical penthouse and outdoor amenity space. It is a type I-B construction. The building was partially protected with an automatic fire sprinkler system. There is a two-level attached parking garage which is protected with a 6" dry pipe system. Levels 1 and 2 contain building storage, mechanical, lobby, and amenity areas protected with a 4" wet sprinkler system. No dwelling units or attached corridors are currently protected with automatic sprinklers.

The sprinkler systems are provided with a fire department connection located on the front of the building. There is an existing 6" manual dry standpipe located on the exterior of the building adjacent to the unconditioned south stair tower equipped with 2-1/2" hose valves at every level and four 2-1/2" hose valves at the roof level. The fire department connection for the manual dry standpipe consists of six 2-1/2" inlet connections. There are existing Class II fire hose cabinets at every level supplied by a 4" riser capable of supplying the Class II design per NFPA 14.

This project was a voluntary life safety upgrade of the existing occupied 23-story apartment building. The original windows and a number of existing building mechanical systems were at the end of their useful life which created the opportunity to retrofit fire protection as part of the overall building "upgrade."

The scope of the project was to install a new wet combination standpipe/sprinkler riser in the interior exit stair and supply each floor with a life safety sprinkler system. Main piping was installed down corridors supplying corridor sprinklers and stubbing a single sprinkler into each apartment unit above the unit doorway. Pipe and outlets were sized to accommodate future expansion into the apartment units as the opportunity becomes available.

Viking Automatic Sprinkler Company was responsible for the sprinkler upgrade project. Viking provides fire sprinkler and special hazard services in commercial, industrial, and residential markets. Viking features design build fire protection capability for all sizes and scopes of projects, a 24-hour service department, an inspection and maintenance program, and full fabrication shops in its Portland and Seattle locations.

The design process started by analyzing the existing building systems and conceiving an economical way to approach the intent of NFPA 14 for standpipes and NFPA 13 for sprinkler systems.



Fully protecting the occupied units was not feasible, so Viking proposed a "life safety" system which protected the exit corridors and placed a sprinkler in each unit above the door. One advantage of the project was that the available water supply was capable of operating the fire sprinkler systems without the use of a fire pump. The new wet standpipe was proposed as a manual wet system.

After Viking developed the proposed design, they met with the Portland Fire & Rescue's Fire Marshal's office to discuss the project. Because the proposal was voluntary and increased active fire protection features in the building, the fire marshals were very willing to cooperate and offered suggestions to improve the appeal case. Suggestions by the Portland Fire Marshal included sizing the systems to allow future expansion and providing ample signage so responding fire personnel would understand the unconventional design.

With the approval of the Fire Marshal, a Fire Code Appeal was prepared which included a design narrative and supporting sketches. The Portland Fire Marshal supported the case with the Appeals Board and the appeal was accepted.

CODES

The design of this project was based on a 2014 Oregon Fire Code appeal (OFC).

CHALLENGES

The short floor to floor height of typical tower floors created a space and coordination challenge to install piping concealed above ceilings. Installing sprinklers above unit doorways required detailed coordination with tenants.

RESULTS

The final product is a clean and functional life safety system. Piping is concealed above the ceilings in corridors, and semi-recessed sidewall sprinklers were utilized above unit doorways to create a clean finished look.

COST

The cost to retrofit the St. Clair Apartments was \$292,560. The breakdown of cost are as follows:

Year	2016
Number of Units	225
Number of Sprinklers	447
Pipe Type	Steel
Standpipes	Existing dry, new wet
Fire Pump (Electric/Diesel)	No
Partial/Entire	"Life Safety" (sprinkler above each unit door). Full protection in common areas.
New or Existing Fire Service	Existing 6"
GC/Owner	Owner
Soffit Type	ACT
Sprinkler Cost	\$292,560
Cost/Unit	\$1,300
Cost/Floor	\$12,720
Occupied	Yes

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APPENDIX E – RESOURCES



<https://www.usfa.fema.gov/blog/fire-sprinklers.html>



www.nfpa.org
www.nfpa.org/Codes-and-Standards



<https://www.nfpa.org/-/media/Files/Membership/member-sections/Metro-Chiefs/Wingspread-VI-final-ereportfull.ashx>

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International Association of Fire Chiefs

4795 Meadow Wood Lane, Suite 100w
Chantilly, VA 20151
(703) 273-0911
www.iafc.org

About IAFC

The International Association of Fire Chiefs represents the leadership of over 1.2 million firefighters and emergency responders. IAFC members are the world's leading experts in firefighting, emergency medical services, terrorism response, hazardous materials spills, natural disasters, search and rescue, and public safety legislation. Since 1873, the IAFC has provided a forum for its members to exchange ideas and uncover the latest products and services available to first responders.

IAFC Mission Statement

To provide leadership to career and volunteer chiefs, chief fire officers, company officers and managers of emergency service organizations throughout the international community through vision, information, education, services, and representation to enhance their professionalism and capabilities.



About NFSA

Established in 1905, the National Fire Sprinkler Association (NFSA) is the voice of the fire sprinkler industry. NFSA leads the drive to get lifesaving and property protecting fire sprinklers into all buildings; provides support and resources for its members – fire sprinkler contractors, manufacturers, and suppliers; and educates authorities having jurisdiction on fire protection issues. Headquartered in Linthicum Heights, Maryland, NFSA has regional operations offices throughout the country.

NFSA Mission Statement

To protect lives and property from fire through the widespread acceptance of the fire sprinkler concept.



**514 Progress Drive, Suite A
Linthicum Heights, MD 21090 • nfsa.org**