New York State

Residential Sprinkler Committee Report

Report to the

State Fire Prevention and Building Code Council
Regarding Residential Sprinklers In One and Two Family Dwellings and Townhouses

June 16, 2009

State Fire Prevention and Building Code Council
Residential Sprinkler Committee
Department of State
Division of Code Enforcement & Administration
Office of Fire Prevention & Control

New York State Residential Sprinkler Committee Report

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List of Acronyms and abbreviations:

AES	Automatic extinguishment systems
Code Council	New York State Fire Prevention and Building Code Council
Code Division	New York State Department of State, Division of Code Enforcement and Administration
Commission	National Commission on Fire Prevention and Control (Chapter 1)
CPVC	Chlorinated polyvinyl chloride
DOS	New York State Department of State
FEMA	Federal Emergency Management Agency
gpm	Gallons per minute
IAFC	International Association of Fire Chiefs
ICC	International Code Council
IRC	International Residential Code
MRLS	More restrictive local standards
NAHB	National Association of Home Builders
NFPA	National Fire Protection Agency
NFSA	National Fire Sprinkler Association
NHC	National Housing Conference
NYC	New York City
NYCRR	New York Codes, Rules and Regulations
NYFIRS	NYS Fire Incidence Reporting System
NYS	New York State
NYSBA	New York State Builders Association
OFPC	New York State Department of State, Office of Fire Prevention and Control
P. E.	Professional engineer
PRV	Pressure reducing valve
psi	Pounds per square inch
R. A.	Registered architect
UL	Underwriter Laboratories, Inc.
Uniform Codes	New York State Uniform Fire Prevention and Building Code and State Energy Conservation Construction Code
USFA	Unites States Fire Administration

Introduction

On December 12, 2007, the New York State Fire Prevention and Building Code Council (Code Council) requested that the New York State Department of State (DOS), Office of Fire Prevention and Control (OFPC) and the Division of Codes Enforcement and Administration (Codes Division) establish a special committee on residential sprinklers. The Code Council passed a motion that the purpose of this committee is to gather facts, information and data as it relates to the installation of residential sprinkler systems in one and two family homes and to report their findings to the Code Council. The committee is comprised of: the NYS Codes Coalition to Protect and Preserve Our Communities - Steven McDaniel and Wayne Cichon (alternate); fire service representative - Julius Ballanco, P.E.; New York State Builders Association - John Hofelich and Philip LaRocque (alternate); National Association of Home Builders - Richard Schunk and Steven Orlowski (alternate); fire sprinkler industry representative - Dominick Kasmauskas, C. F. P. S.; insurance industry representative - Thomas A. White; plumbing industry representative - David Kaufmann; fire protection engineer - Timothy DeRuyscher, P. E.; and Department of State Facilitators - Raymond Andrews, R. A., Codes Division, John Mueller, OFPC, and Miriam McGiver, P. E., Codes Division staff.

The committee was charged with addressing the following specific aspects of residential fire sprinkler systems in one and two family residences.

I. Historical data regarding fires in one and two-family residences
II. Statistical information of impact on safety of both residents and firefighters
III. Fire suppression system options and other technical issues
IV. Cost of suppression systems (capital and ongoing)
V. Potential impact on housing market
VI. Potential impact on residential insurance premiums
VII. Survey of jurisdictions in New York State mandating fire suppression in one and two-family residences and other case studies
VIII. Additional impact such as system maintenance (leakage), etc.

The committee added to “Additional impacts” a section that considers construction inspection and staffing of contractors and installers.

The committee prepared a detailed analysis of each issue identified above. To support each position reports, data and documents are referenced and listed as resource documents.

Since this report began in September 2008, the International Code Council (ICC) membership voted to add mandatory residential sprinklers to the 2009 International Residential Code. The current NYS code update under consideration at this time contains limited requirements for residential fire suppression sprinklers. New York State (NYS) codes are updated on a three year cycle. The NYS codes update following this one is likely to be based on a modification of the 2009 IRC.

Executive summary

The Residential Sprinkler Committee reviewed an extensive amount of literature, research and data regarding residential sprinklers. This document reports their findings to the NYS Fire Prevention and Building Code Council. The committee compiled this report by reviewing available existing documents and selecting the most relevant to include as excerpts or summaries of existing data.

The committee discussed but did not include several aspects determined to be beyond the scope of this report, including possible future possibilities such as potential changes to national standards, insurance policies, feasible incentives and trade-offs such as tax breaks.

There has been an ongoing national process to develop fire sprinklers that enhance life safety and are affordable. Automatic fire sprinklers were developed in the late 1800's to protect commercial property. However, the goal of residential sprinklers 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" (NFPA 13D, resource 49) thereby allowing occupants time to escape. In 1975, the National Fire Protection Association (NFPA) developed the standard "NFPA 13D, Standard for the Installation of Sprinkler Systems in One and Two-Family Dwellings and Manufactured Homes" in response to repeated calls for residential sprinklers that enhance life safety. The 2009 edition of the International Residential Code (Section P2904) provides for a simplified "cookbook design" for residential sprinkler systems. Both of these documents provide for a variety of construction materials and design configurations.

Residential sprinklers have been developed due to both civilian and fire service casualties, that is, reported deaths and injuries. The New York State Department of State (DOS), Office of Fire Prevention & Control (OFPC) reports that for 2002 thru 2007, an annual average of 10,322 fires and 47 associated civilian fatalities occur in one and two-family homes, representing 41 percent of all reported structure fires and 67 percent of civilian fatalities in all structure fires. Neither structure fires nor civilian deaths show a consistent trend in NYS from 2000 to 2006.

Fire service casualties have decreased significantly in past decades; however, over the past five years numbers in NYS have leveled off. When all fire service fatalities in 2002 thru 2007 associated with the one and two family dwelling fires are considered, including heart attacks, traffic accidents and other casualties that did not occur while conducting interior firefighting operations, NYS data shows an annual range in fatalities 0 to 5, with no consistent trend. During the same time period in NYS, the number of residential structure fires annually shows a slight trend upward. From 2005 thru 2007, fire service casualties involving interior fire-fighting operations in one and two-family dwellings in NYS, excluding New York City, included between 107 and 155 injuries per year and zero deaths.

In NYS from 2000 thru 2006 (Resource #41), 88 percent of fatalities and 86.2 percent of fatal fires occurred in homes built before the NYS building codes mandated smoke alarms in new homes (1984). For this time period, between 82 and 90 percent of homes in NYS were built before 1984.

Effectiveness of fire sprinklers is discussed in several resource documents, some listed below. The documents differ in how effectiveness is quantified, and in determined levels of effectiveness. In general, residential sprinklers combined with smoke detectors enhance life safety. Effectiveness as reported by these resource documents is summarized below:

- Ahrens, Marty (Sept. 2007). **Home Structure Fires.** Quincy, MA: National Fire Protection Association. (Resource #1A) did not report the reduction in death rate for one and two-family

homes due to insufficient data. The report states that in apartments the death rate is 57 percent lower per 1,000 reported non-confined apartment fires when sprinkler systems were present compared to such fires without automatic extinguishing systems. Non-confined means the fire was not confined to the room of origin.

- Butry, D. T.; Brown, M. H.; Fuller, S. K. (Oct 2007). ***Benefit-Cost Analysis of Residential Fire Sprinklers.*** U. S. Dept. of Commerce; National Institute of Standards and Technology (Resource #5) reports no civilian fatalities in one and two-family homes with wet sprinkler systems.

- Bukowski, Richard W., et al. (February 2008). ***Performance of Home Smoke Alarms: Analysis of the Response of Several Available Technologies in Residential Fire Settings.*** Washington, DC: US Dept of Commerce, Fire Research Division, Building and Fire Research Laboratory. Technical note 1455-1. (Resource #6) looked at sprinkler response time, and reports that "for flaming fires, response time ranged from 126 seconds to 246 seconds. For smoldering fires, response occurred shortly after the transition to flaming."

- Hall, John R., Jr. (June, 2007 and 2009). ***U. S. Experience with Sprinklers and other Automatic Fire Extinguishing Equipment.*** Quincy, MA: National Fire Protection Association. (Resource #20 and #20A). Resource #20A claims that residential fire sprinklers operate "effectively in 91 percent of all reported fires where sprinklers were present in the fire area and fire was large enough to activate them." Effectiveness is defined as the sprinklers' ability to contain and control the fire until the responding fire department arrives to fully extinguish the fire (page 75). This excludes areas where sprinklers are not installed and fires that were not large enough to activate the sprinklers.

  In Resource #20, Hall notes that the 2007 American Housing Survey (*American Housing Survey 2007*, U. S. Department of Commerce and U. S. Department of Housing and Urban Development, September 2008, Table 1C-4, 2-4, and 2-25) included a question about sprinkler usage in homes. The survey indicated 3.9 percent of occupied year round housing units had sprinklers. Usage in occupied housing units by type of housing shows usage in dwellings lag behind usage in multi-unit buildings:

  - 1.5 percent of single family detached dwellings
  - 1.9 percent of single-family dwellings, detached or attached
  - 10.6 percent of all housing units in multi-unit buildings
  - 2.9 percent of housing units in buildings with two to four units

- United States Fire Administration (2008). ***Residential Fire Sprinklers.*** Emmitsburg; FEMA. (Resource #60) states that when sprinklers alone are installed, the chances of dying are reduced 69 percent; while the chances are reduced by 82 percent if both sprinklers and smoke detectors are installed and 63 percent when smoke detectors alone are installed.

- United States Fire Administration (October 2008). ***Residential Structure and Building Fires.*** (Resource #61): "[A]utomatic extinguishment systems (AESs)…are reported to be present in only 3 percent of residential buildings fires nationally and 2 percent of fatal residential building fires…As a note, if a fire is extinguished by a sprinkler or other AES, it may never be reported to the fire service, and the statistics below may underrepresent the presence of AES."

The resources reviewed also presented a wide range in cost for sprinklers. In general, lower cost estimates are based on a simple, affordable home with municipal water, without special design issues such as cathedral ceilings. Design issues that increase cost include private water supply, cathedral ceilings,

seasonal use, water meters and backflow preventers. Cost estimates for sprinkler systems vary depending on assumptions made and specific conditions considered. Our resources illustrated a broad range of estimated costs and conditions, including consideration of associated expenses such as water service, backflow prevention, booster pumps, storage tanks, maintenance and inspection. A study done for the Fire Protection Research Council of costs to the homebuilder for sprinkler systems installed in 30 houses found a range of total system costs from $2,386 to $16,060, and in dollars per sprinklered square foot from $0.38 to $3.66. Other estimates reviewed ranged from under a dollar per square foot to $11.20 per square foot.

The sprinkler committee developed sample estimates that had a high total cost than the range found elsewhere. For stand alone systems, total costs ranged from $6,210 to $23,065 and cost per conditioned square foot ranged from $3.30 to 8.56. For the multipurpose system, total costs ranged from $6.856 to $9695 and $3.18 to $4.56 per square foot. Costs were higher for systems on private wells. The higher cost may be due to small sample size, higher regional costs in the northeast and specific issues with the sample homes.

A survey of communities in NYS with mandated residential sprinklers in one and two-family homes did not identify a housing market impact from sprinkler mandates. The communities were mostly characterized as those with high-end homes and aggressive housing markets. An evaluation by the National Association of Home Builders (NAHB) determined that in twelve NYS metro areas, based on the ability to obtain a mortgage, the number of households priced out of the market for a median priced new home by a $1,000 increase in selling price averaged 0.17 percent with a median of 0.19 percent (Table 5.3.2).

For manufactured homes, adding sprinklers will increase the sale price by a larger percentage of current costs than for stick-built or modular homes, approximately 16 to 19 percent. This sector of the market is most likely to be unable to afford a new home. Fire fatality rates per thousand for manufactured homes are similar to other dwellings, although the fatality per fire is higher in manufactured homes than other dwellings. In the U. S. from 2001 to 2007, manufactured home starts ranged from 13 percent to 7 percent of all single family housing starts (source: www.census.gov/const/mhs/sitebuiltvsmh.pdf). The percentage of modular homes for the same period in the northeast U. S. ranged from 9 to 11 percent according to http://www.census.gov/const/www/charindex_excel.html

There has been a slight decrease in affordability of “modestly priced homes” in the U. S. from 1984 to 2004. Over the 1996 to 2006 period, a growing share of household income was devoted to housing.

Most insurance companies have provisions for discounting residential insurance premiums due to a variety of preventive conditions, including fire sprinklers. The total discount available for all preventive conditions is generally assigned an upper limit. A new home may already have premiums discounted to the upper limit so that fire sprinklers would not add additional discounts. Both premium deduction and the potential community-wide decrease in premiums are likely to be less than ten percent.

Today there are standards for effective sprinklers at a lower cost than commercial installations. Costs and benefits for sprinkler systems vary depending on design, methods used and assumptions made. Since so few one and two-family homes have sprinkler systems, information regarding residential systems is based on a few municipalities and apartment systems.

It is important that the systems are designed, installed and inspected properly to minimize operational problems, with a special concern for protecting piping in unconditioned spaces from freezing. The committee discussed the possible need to insure proper inspections, as required by 19 NYCRR Part 1203, for automatic fire sprinkler systems. Following installation, NFPA 13D requires that the owner replace damaged sprinklers and recommends monthly inspections. Antifreeze systems have additional

requirements and recommendations. NFPA does not require additional maintenance for NFPA 13D systems.

1. Historical data regarding fires in one and two-family residences

***Section Summary**: The automatic fire sprinkler was first developed in the late 1800's as a means of providing property protection. In 1973, the life safety aspects of sprinklers were identified by the National Commission on Fire Prevention and Control in their report entitled, "America Burning" which recommended development "of the necessary technology for improved automatic extinguishing systems that would find ready acceptance by Americans in all kinds of dwelling units." This recommendation was reiterated in 2000, in America Burning Re-commissioned. In 1975, the National Fire Protection Association responded to the America Burning report with "NFPA 13D, Standard for the Installation of Sprinkler Systems in One- and Two- Family Dwellings and Manufactured Homes," which set standards for a low cost residential sprinkler system to prevent flashover in the room of fire origin. In 2007, the International Code Council (ICC) developed a simplified "cookbook design" consistent with NFPA 13D to be contained entirely in the 2009 Edition of the International Residential Code (IRC), Section P2904. In September 2008, the ICC membership voted to add mandatory residential sprinklers to the 2009 IRC. The current NYS code update under consideration at this time does not include language requiring residential fire suppression sprinklers except per R313.3, "Buildings having a height of three stories above a basement shall be equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13D". The NYS codes update following this one is likely to be based on a modification of the 2009 ICC Codes.*

1.1. History of residential sprinklers

The automatic fire sprinkler was first developed in the late 1800's as a means of providing property protection. One of the driving forces for installing sprinklers was lower fire insurance rates for many factory and industrial buildings. The savings in insurance premiums more than paid for the cost of the sprinkler installation. It was not until the 1970's that model building codes published by Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (SBCCI) considered sprinklers a life safety system. Prior to this time, very few residential buildings were required to be protected with an automatic fire sprinkler system by model building codes. "America Burning" (1973), Resource #38, recommended in Chapter 11 – Codes and Standards that: "[M]odel codes should specify automatic fire extinguishing systems and early warning detectors for high-rise buildings and for low-rise buildings in which many people congregate."

1.2. Historical national studies

The life safety aspects of sprinklers were identified by the National Commission on Fire Prevention and Control (the commission) in their report to the president of the United States entitled, "America Burning," included in the resource documents as Resource #38, (May 1973, updated 1989). This report became a foundation for residential sprinkler research and development. On page 69 of "America Burning" (Resource #38), the commission stated:

> **"A Question of Priorities**
> The hazards of materials in the built environment will never be eliminated completely, and they cannot be significantly reduced overnight. Tinderbox houses will remain in the environment until economic circumstances favor their replacement or until wear and tear dictate their removal. In settings where we are forced to live with hazardous materials, we must turn to engineering means-automatic sprinklers,

for example, or early-warning detection and alarm systems-to compensate for the dangers. But for the future, we as a Nation cannot rely on these systems alone to protect us; the materials themselves must be improved for fire safety. True, a building constructed of fire-safe materials and having an automatic extinguishing system as well offers a certain redundancy of protection. But one without the other leaves open possibilities of disaster."

On page 120 of "America Burning", the commission raised the issue of low cost, aesthetically pleasing, residential sprinkler systems for all homes. The commission stated:

"Automatic Fire Extinguishing Systems

Where early-warning detectors and automatic extinguishing systems are used in combination, the protection to lives and property is enhanced greatly over that afforded by detectors alone. Automatic sprinklers are expensive; while they are feasible for high-rise and other large buildings, they are too costly for installation in the average home. Research and development are needed toward automatic extinguishing systems that will be cheap, aesthetically acceptable, and adaptable to existing homes as well as new construction. **The Commission recommends that the Proposed U.S. Fire Administration support the development of the necessary technology for improved automatic extinguishing systems that would find ready acceptance by Americans in all kinds of dwelling units.**

Automatic extinguishing systems in residences would not only save lives and reduce direct losses from fire, but would also reduce other expenses to the Nation, such as the costs of treating burn and smoke injuries, insurance costs (both premiums and payouts), and the costs of maintaining fire departments. The developers of Disney World in Florida, who have installed sprinkler systems in residential buildings such as hotels and apartments (and smoke detectors in single-family dwellings), report that there have been savings in insurance rates and, just as important, savings in the costs of maintaining fire departments."

The savings indicated in "America Burning" are analyzed in an article by Kenneth Isman entitled, "Cost/Benefit to Society for Having Sprinklers in One-and Two-Family Dwellings – A Pessimistic Analysis," Sprinkler Quarterly, Fall, 2005. The article estimates the cost and savings over time if all new one and two-family dwellings are sprinklered, with a stated purpose to show that if predictions of opponents of mandatory sprinklers 'come true,' fire sprinkler systems are still cost-beneficial, and life safety beneficial, to society. The report concluded that sprinklers are cost effective to society and save lives.

In 2000, FEMA released a new report, America Burning Recommissioned (Resource #13 (2000)), which reached two major conclusions. On page 15 of America Burning Recommissioned, the first conclusion reads:

"(1) The frequency and severity of fires in America do not result from a lack of knowledge of the causes, means of prevention or methods of suppression. We have a fire "problem" because our nation has failed to adequately apply and fund known loss reduction strategies. Had past recommendations of America Burning and subsequent reports been implemented, there would have been no need for this Commission. Unless those recommendations and the ones that follow are funded and implemented, the Commission's efforts will have been an exercise in futility.

The primary responsibility for fire prevention and suppression and action with respect to other hazards dealt with by the fire services properly rests with the states and local governments. Nevertheless, a substantial role exists for the federal government in funding and technical support."

The report also addressed the issue of residential sprinklers. On page 17, Finding #2 reads:

> **"The Application and Use of Sprinkler Technology**
> The most effective fire loss prevention and reduction measure with respect to both life and property is the installation and maintenance of fire sprinklers. If the focus is limited to prevention and reduction of the loss of life, smoke alarms are also extremely effective. However, the use of sprinklers and smoke detectors has not been sufficiently comprehensive."

1.3. Historical development of codes and standards

1.3.1. Development of NFPA standards

In 1975, the National Fire Protection Association (NFPA) responded to the America Burning report with the publication of the first edition of "NFPA 13D, Standard for the Installation of Sprinkler Systems in One and Two-Family Dwellings and Manufactured Homes" (Resource #49). The standard provided requirements for a low cost residential sprinkler system that would prevent flashover in the room of fire origin, with a stated purpose to:

> **"1.2 Purpose.** The purpose of this standard shall be to provide a sprinkler system that aids in the detection and control of residential fires and thus provides improved protection against injury, life loss, and property damage. A sprinkler system designed and installed in accordance with this standard shall be expected 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. The layout, calculation, and installation of systems installed in accordance with this standard shall only be performed by people knowledgeable and trained in such systems."

NFPA 13D relies on the use of residential sprinklers that are tested and listed to *UL 1626 – Residential Sprinklers for Fire Protective Service*. This standard delineates requirements for residential sprinklers, including performance tests. The standard only allows two sprinklers to operate during a fire test. The test specifies a maximum temperature at 5'-3" above the floor and half the room length away from each wall at 200°F maximum. However, the temperature cannot exceed 130°F for more than a two minute period. The levels of carbon monoxide are also monitored during the test. It is recognized that residential sprinkler systems conforming to NFPA 13D are not property protection systems, only life safety systems. The standard is based on protecting the life of the occupants during a fire.

1.3.2. Development of International Code Council model codes

"The International Code Council (ICC) was established in 1994 as a nonprofit organization dedicated to developing a single set of comprehensive national model construction codes. The founders of the ICC are Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (SBCCI)." (from http://www.iccsafe.org/news/about/) ICC's model building code was developed primarily by the building officials and code enforcement officers employed by cities and counties.

ICC Codes are developed through consideration of code change proposals submitted to the ICC. Any interested individual or group may submit a code change proposal and participate in the proceedings in which it and all other proposals are considered. Proposals are considered in open debate, with public participation, before a code development committee comprised of representatives from across the construction industry, including code regulators and industry representatives. For each proposal, eligible voting members review recommendations of the ICC Code Development Committee, and vote to either

ratify the committee's recommendations or make their own recommendations. The results of all votes are published in the report of the ICC code development hearings.

During the ICC final action hearing for the 2006/07 code cycle, the membership reviewed a proposed code change that would mandate residential sprinklers in all one and two- family dwellings and townhouses (proposal RB86-04/05 R313.1). The change was proposed to the International Residential Code. The ICC received extensive testimony both for and against the change. At the Rochester, New York, ICC hearings of 2007, mandating residential sprinklers in all one- and two-family dwellings and townhouses received majority approval, but not the super majority of two-thirds needed to be included in the code.

In 2007, the International Association of Fire Chiefs (IAFC) approached the National Association of Home Builders (NAHB) home builders with an idea for adding pre-engineered residential sprinkler requirements to the International Residential Code in a "cookbook" fashion so that a separate standard will not be required by installers or contractors. The International Association of Fire Chiefs worked together with the National Association of Home Builders to develop a low cost alternative to NFPA 13D, but the two associations could not agree where the new section should be placed. Two proposals were submitted during the 2007/2008 code development cycle, one submitted by the IAFC that would put the requirement in the plumbing section of the IRC and the other submitted by NAHB would locate it in the appendix, which placement would make the section optional rather than part of the body of the code. The ICC members voted to include this section in the 2009 International Residential Code as P2904. NFPA 13D may also be used as an option to P2904 in the 2009 International Residential Code. P2904 is consistent with NFPA 13D, simplified and with fewer calculations required. For some more complex design situations, NFPA 13D may still be required. The addition of P2904 to the International Residential Code allows the contractor to design the residential sprinkler systems without the need to purchase an extra document or to hire an engineer. Plans may not have to be signed and sealed by a licensed professional engineer for a residential sprinkler system, which would reduce overall costs. The "cookbook" design was reviewed by the engineering community which verified the design and installation method.

Since the formation of the NYS Residential Sprinkler Committee, there was another ICC code change cycle. In September 2008, the ICC membership voted to approve three separate code changes adding sprinkler requirements to the 2009 Edition of the International Residential Code. With the vote total exceeding two thirds majority for each of the three changes, the 2009 International Residential Code will mandate residential sprinklers in all one and two-family dwellings and townhouses and add residential sprinkler design and installation requirements to Section P2904. The addition of P2904 will allow a home builder to use a "cookbook" design in the International Residential Code without the need for referencing NFPA 13D, the standard for residential sprinkler systems for one and two- family dwellings and townhouses.

The requirements that will appear in the 2009 International Residential Code are a two prong approach. Townhouses will be required to be sprinklered in accordance with either NFPA 13D or the requirements in the Section P2904 of the plumbing section of the International Residential Code. With the installation of residential sprinklers, the rating between units is lowered from two hour fire resistance rating to a one hour fire resistance rating.

For one and two-family dwellings, the 2009 ICC lists an implementation date of January 1, 2011 for mandatory residential sprinklers. The reason given by the proponents was to allow state and local jurisdictions to gear up for the change. This would require the education of inspectors, contractors and home builders on the subject of residential sprinklers (Resource #14).

1.3.3. Residential sprinklers in the NYS Uniform Code

The NYS Fire Prevention and Building Code Council (Code Council) is empowered to maintain and periodically update the Uniform Fire Prevention and Building Code and State Energy Conservation Construction Code, and to adopt higher or more restrictive local standards upon the recommendation of local governments. The members of this group represent architects, engineers, builders, trade unions, persons with disabilities, code enforcement, fire prevention, villages, towns, cities, counties, state agencies, the State Fire Administrator and the Secretary of State.

In 1999, the NYS Code Council directed the Codes Division to set up technical subcommittees to review the ICC model codes as a basis for updating the NYS Uniform Codes and for developing energy codes. In 2002, the Energy Conservation Construction Code of NYS was based on the 2000 ICC model energy conservation code, and in 2003, the NYS Code Council updated the NYS Uniform Codes based on the 2000 ICC model codes; in both cases with NYS modifications based on recommendations from technical subcommittees. Due to the lag time in developing modifications and proceeding through the NYS regulatory approval process (i.e., public comment, publication in the State Register, development of Regulatory Impact Statements and other required documents), the 2007 NYS codes were based on the 2003 ICC codes, and the proposed 2009 NYS code update is based on 2006 ICC codes.

The 2006 ICC codes do not require fire suppression sprinklers in one and two-family residences and townhouses in most cases except in an optional appendix. Since appendices are not part of the body of the codes, a municipality must specifically adopt each appendix to be part of the code. NYS did not adopt that appendix. Partly for this reason, the current NYS code update under consideration at this time does not include language requiring residential fire suppression sprinklers except per R313.3, “buildings having a height of three stories above a basement shall be equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13D”. The NYS codes update following this one is likely to be based on a modified version of the 2009 ICC codes by the process described in the preceding paragraph.

2. Statistical information of impact on safety of residents and firefighters

Section Summary: *Data published by the NYS DOS, OFPC for NYS, excluding NYC, 2002 - 2007 show an annual average of 10,322 fires, 238 civilian injuries and 47 civilian fatalities involving one and two-family homes, representing 41percent of all reported structure fires and 67 percent of civilian fatalities in all structure fires. From 2000 thru 2006 (Resource #41), 88 percent of fatalities and 86.2 percent of fatal fires occurred in homes built before the NYS building codes mandated smoke detecting alarms in new homes (1984), at which time between 82 and 90 percent of homes in NYS were built before 1984. Neither structure fires nor civilian deaths show a consistent trend in NYS from 2000 to 2006. The U. S. population grew 36 percent between 1977 to 2006, while at the same time the rate of fires per 1,000 population fell 63 percent: from 14.9 in 1977 to 5.5 in 2006. The trends noted* occurred *in the 1980s and early 1990s and have since hit a plateau (Resource #30).*

In the U.S. and NYS, fire service casualties have decreased significantly in past decades; however in recent years numbers in NYS do not show a significant change. When all fire service fatalities from 2002 thru 2007 associated with structure fires are considered, including heart attacks, traffic accidents and other casualties that did not occur while conducting interior firefighting operations, NYS data shows an annual range in fatalities from one to seven for all structures, and zero to five for one and two-family structures, with no consistent trend. The annual number of structure fires, total and residential, show a slight trend upward. From 2005 thru 2007, fire service casualties involving fires in one and two-family dwellings in NYS, excluding NYC, ranged from between 107 and 155 injuries per year and zero deaths. Review of almost 3,400 firefighter fatalities in the U. S. between 1977 and 2006 shows a drop in average annual fatalities by more than one third.

Effectiveness of sprinklers is discussed in several resource documents, several of which are listed below. The documents differ both in how they quantify effectiveness and in their determined levels of effectiveness. For instance:

- *Ahrens, Marty (Sept. 2007).* ***Home Structure Fires.*** *Quincy, MA: National Fire Protection Association. (Resource #1A) states that in apartments the death rate is 57 percent lower per 1,000 reported non-confined apartment fires when sprinkler systems were present compared to such fires without automatic extinguishing systems. The reductions in death rate for one and two-family homes were not reported due to insufficient data.*

- *Butry, D. T.; Brown, M. H.; Fuller, S. K. (Oct 2007).* ***Benefit-Cost Analysis of Residential Fire Sprinklers.*** *U.S. Dept. of Commerce; National Institute of Standards and Technology (Resource # 5) reports no civilian fatalities in one and two-family homes with wet sprinkler systems.*

- *Bukowski, Richard W., et al. (February 2008).* ***Performance of Home Smoke Alarms: Analysis of the Response of Several Available Technologies in Residential Fire Settings.*** *Washington, DC: U. S. Dept of Commerce, Fire Research Division, Building and Fire Research Laboratory. Technical note 1455-1. (Resource # 6) looked at sprinkler response time, and reports that "for flaming fires, response time ranged from 126 seconds to 246 seconds. For smoldering fires, response occurred shortly after the transition to flaming."*

- *Hall, John R., Jr. (June, 2007 and 2009).* ***U.S. Experience with Sprinklers and other Automatic Fire Extinguishing Equipment.*** *Quincy, MA: National Fire Protection Association. (Resource # 20 and #20A) Resource #20A claims that residential fire sprinklers operate "effectively in 91 percent of all reported fires where sprinklers were present in the fire area and fire was large enough to activate them," and effectiveness is defined as the sprinklers' ability to contain and*

control the fire until the responding fire department arrives to fully extinguish the fire (page 75). This excludes areas where sprinklers are not installed and fires that were not large enough to activate the sprinklers.

- *United States Fire Administration (2008).* ***Residential Fire Sprinklers.*** *Emmitsburg; FEMA. (Resource #60) states that when sprinklers alone are installed, the chances of dying are reduced 69 percent; while the chances are reduced by 82 percent if both sprinklers and smoke detection are installed. When smoke detection alone is installed, chances are reduced 63 percent.*

- *United States Fire Administration (October, 2008).* ***Residential Structure and Building Fires.*** *(Resource #61) "[A]utomatic extinguishment systems (AESs)…are reported to be present in only 3 percent of residential buildings fires nationally and 2 percent of fatal residential building fires…As a note, if a fire is extinguished by a sprinkler or other AES, it may never be reported to the fire service, and the statistics may under represent the presence of AES."*

2.1. General population statistical safety

2.1.1. NYS fires in one and two-family homes from OFPC

The NYS Fire Incidence Reporting System (NYSFIRS) is the central data collection mechanism for more than 1,800 fire departments in the State. Incident reports from the fire service provide essential information about fires and their causes and consequences, as well as descriptive data about the many other types of emergency services fire departments provide to the community. The data can help the fire service devise ways to do its job better and help the community at large improve its overall fire protection system. It is possible to use fire data to draw conclusions about the adequacy of fire and building codes and consumer product safety and to measure the effects of fire safety education programs.

The system is particularly useful in documenting the incidence of fire in one and two-family dwellings in NYS. The data published by the NYS DOS, Office of Fire Prevention & Control for the years 2002 - 2007 report an annual average of 10,322 structure fires at one and two-family dwellings, representing 41 percent of all reported structure fires.

Sadly, the system also reports that, on average, 47 people lose their lives each year in fires involving one and two-family homes representing 67 percent of civilian fatalities in all structure fires. Interestingly, while fires in one and two-family homes represent just 41 percent of all structure fires, they claim two-thirds of all the lives lost in structure fires in NYS.

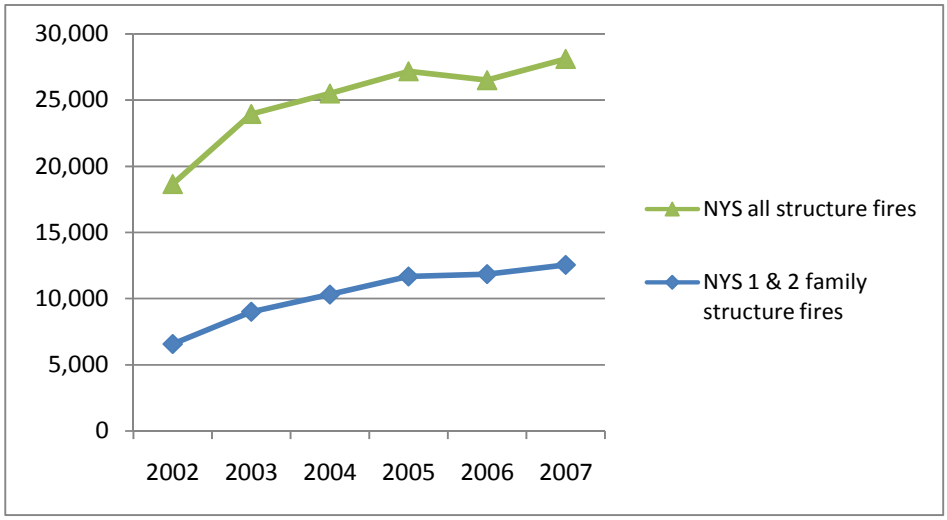
Table 2.1.1-1 below shows the number of structure fires and civilian casualties in NYS excluding New York City and the disproportionate number of civilian fatalities occurring in one and two- family structure fires.

Table 2.1.1-1: NYS excluding New York City structure fires & civilian casualties, 2002-2007

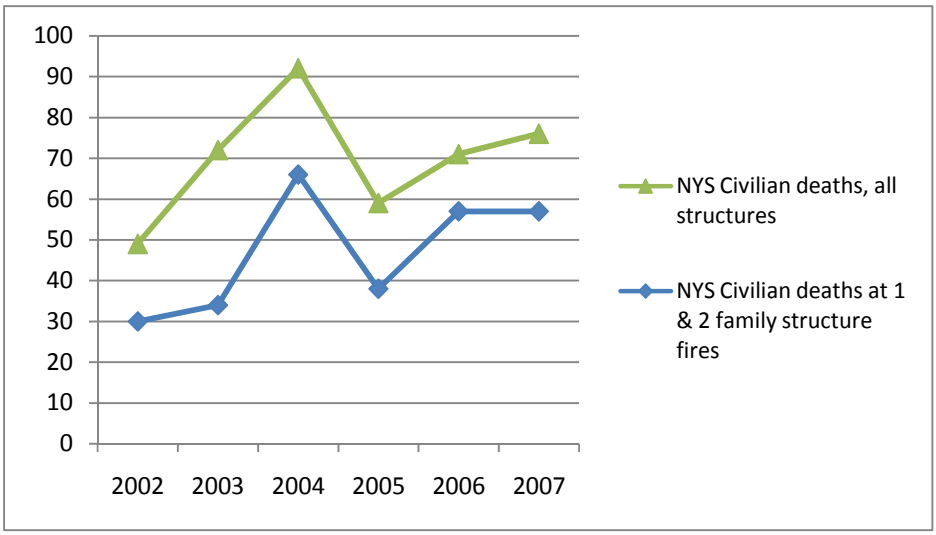
	All Structure Fires		One & Two-Family Structure Fires		
Year	**Number of Fires**	**Civilian Deaths**	**Number of Fires**	**Civilian Injuries**	**Civilian Deaths**
2002	18,645	49	6,568	167	30
2003	23,940	72	9,002	245	34
2004	25,492	92	10,298	304	66
2005	27,167	59	11,672	235	38
2006	26,498	71	11,845	232	57
2007	28,106	76	12,544	244	57
TOTAL	**149,848**	**419**	**61,929**	**1,427**	**282**
AVERAGE	**24,975**	**70**	**10,322**	**238**	**47**
			41.3%		**67.3%**

* Data from http://www.dos.state.ny.us/fire/firedata.htm. This table is based on a query of the NYFIRS database in March, 2009. The NYFIRS database is a statewide database dependent upon ongoing voluntary submissions from career and volunteer fire departments. As incident reports may be submitted some time after an event occurs, the data changes over time. The data is a snapshot of the information reported to NYFIRS as of date queried.

Graph 2.1.1-1: Structure fires in NYS 2002 – 2007 excluding New York City



Graph 2.1.1-2: Civilian deaths in NYS 2002 – 2007 excluding New York City



2.1.2. Additional statistics

2.1.2.1. From "Reducing Fatal Fires in New York State's New One- and Two-Family Homes: Is Mandating the Installation of Fire Sprinkler Systems the Best Course of Action?"

(Resource #41, New York State Builders Association Research and Education Foundation, Inc. (October, 2007)

Excerpt:

"The purpose of this study by the New York State Builders Association Research and Education Foundation (NYSBA REF) is to analyze data from fatal fires in one- and two-family residences occurring in New York State from 2000 through 2006. This will help identify factors to conclude if the proposed mandate to install fire sprinkler systems in newly constructed homes is the best course of action to reduce fire deaths.

- There were 495 fatalities at 389 locations in New York in the subject period.
- Complete data was available for 123 sites (31.6%) which in all probability represent a statistically significant sample from which to draw sufficient preliminary conclusions.
- Notably, the sample shows that the homes in which a fatal fire occurred were constructed, on average, in 1940.

Since improved building practices can result in safer homes, and evolving building codes take into account and reflect some of these practices, the ages of the subject homes provide a particularly important area of analysis.

One of the most significant fire-related changes in building codes was the mandating of smoke detecting alarm devices in New York's new home construction in 1984, which is referenced below as an important milestone in the data reviewed.

This was strengthened in 1995 when hard-wired alarms with battery back-up became mandatory for all new homes.

- Out of the sample homes having fatal fires, 106 or 86.2% were constructed prior to 1984, before New York's smoke detecting alarm mandate.
- There were 139 individuals who lost their lives in these fires, representing 88.5% of the deaths included in the sample.
- A total of 23 incidents of multiple fatalities occurred in this group. Multiple deaths happened only once in the sample homes built after 1984.
- The sample includes only eleven fatalities in homes built in the ten year period between 1997 and 2006."

Commentary:

There are many more homes in New York built before 1997; therefore, it would be expected that there will be more fatalities in homes built before 1997. The table below identifies the number of new homes compared to older homes.

Table 2.1.2.1 – 1: NYS selected housing characteristics - 2006

Selected Housing Characteristics 2006	Estimate	% of total	Cumulative %	Margin of Error
Year Structure Built				
2005 or later	40,798	0.52%	100.00%	+/-3,338
2000 to 2004	274,663	3.47%	99.48%	+/-7,810
1990 to 1999	462,578	5.85%	96.01%	+/-8,790
1980 to 1989	593,563	7.51%	90.16%	+/-11,042
1970 to 1979	823,624	10.42%	82.65%	+/-11,816
1960 to 1969	1,008,788	12.76%	72.24%	+/-12,342
1950 to 1959	1,225,071	15.49%	59.48%	+/-13,584
1940 to 1949	748,174	9.46%	43.99%	+/-12,876
1939 or earlier	2,730,255	34.53%	34.53%	+/-20,191
Total housing units	**7,907,514**			**+/-440**
Occupied housing units	7,088,376	89.64%		+/-16,391
Vacant housing units	819,138	10.36		+/-16,488

Resource: US Census Bureau at http://factfinder.census.gov/; Housing Starts 1978-2007)
Data Set: **2006 American Community Survey (Resource #55)**
Note that this table includes all dwelling units, not only one and two-family dwellings.

This information does not show that fire safety in new homes is better, as there are much fewer new homes than old homes. Human error is often involved in causing home structure fires (Resource #1A (Ahrens)), and there is no statistic that would suggest the unsafe act of leaving grease on the stove, leaving cigarettes burning in trash or unsafe use of candles is different in new homes verses older homes.

2.1.2.2. Abstract and summary of "Trends and Patterns of U. S. Fire Losses"

Ahrens, Marty; 2007 from NFPA (Resource #2)

***Abstract*:**

"Projections from NFPA's annual fire department experience data reported in Michael Karter's annual reports on *U.S. Fire Loss*, particularly *U. S. Fire Loss During 2006*, are summarized in this analysis.

Reported fires and fire deaths have fallen since 1977, the first year of available data. The drop in population-based rates is even sharper. In 2006, home structure fires accounted for 24% of the reported fires. However, these incidents caused 80% of all civilian fire deaths. Vehicle fires accounted for 17% of the reported fires and 15% of the civilian fire deaths. Roughly half of the reported fires were outside or other non-structure, non-vehicle fires."

Part of "Table 2. U. S. Fires and Losses by Incident Type in 2006
Source: Michael J. Karter, Jr. Fire Loss in the United States during 2006, Quincy, MA: National Fire Protection Association, September 2007.

Incident type	**Fires**		**Civilian deaths**		**Civilian injuries**		**Direct property damage (in millions)**	
Structure fire	524,000	32%	2,705	83%	14,350	88%	$9,636	85%
Residential structure fires	412,500	25%	2,620	81%	12,925	79%	$6,990	62%
Home structure fires	396,000	24%	2,580	80%	12,500	76%	$6,832	60%
1- & 2- family dwellings, including manufactured. homes	304,500	19%	2,155	66%	8,800	54%	$5,936	52%
Apartments	91,500	6%	425	13%	3,700	23%	$896	8%
Other residential structures fires	16,500	1%	40	1%	425	3%	$158	1%
Non-residential structure fires	111,500	7%	85	3%	1,425	9%	$2,646	23%
Vehicle fires	278,000	17%	490	15%	1,200	7%	$1,319	12%
Outside / other fires	840,500	51%	50	2%	850	5%	$352	3%

***Summary*:**

Our population grew 36 percent between 1977 to 2006, according to the U.S. Census, while at the same time the rate of fires per 1,000 population fell 63 percent: from 14.9 in 1977 to 5.5 in 2006. (Resource #2 (Ahrens), pg 1) Structure fires accounted for 32 percent of the total reported fire incidents in the U. S. in 2006, a decrease of over 52 percent when compared to the 1,098,000 reported in 1977. In 2006 the number of U.S. fire deaths was the lowest it has ever been since NFPA started recording the data in 1977. Both total fire deaths and residential fire deaths fell by more than 56 percent. (Resource #2, pg. 2**)**

Key trends of fire incidents, civilian fire deaths, firefighter deaths, civilian injuries and direct property damage (when adjusted for inflation) have declined without the assistance of sprinklers. The trends noted happened dramatically in the 1980s and early 1990s and have since hit a plateau. ("From 1997 onward home fire deaths have generally continued to decline with the number of deaths staying in the 2,580 to 3,110 area since 2001.") Direct property damage has increased steadily the last few years without adjustment for inflation, but appears relatively level when adjusted for inflation. (Resource #2, figure 9)

2.2. Firefighters statistical safety

2.2.1. NYS Firefighter statistics from DOS, OFPC

The following information on Table 2.2.1-1 and Table 2.2.1-2 is based on NYS DOS, Office of Fire Prevention and Control's advanced search of the NYS Fire Incidence Reporting System (NYFIRS) database done 11/25/08 and February 2009.

The number of firefighter casualties in Table 2.2.1-1 show all casualties, that is reported deaths and injuries, associated with structure fires, including heart attacks, traffic accidents and other casualties that did not occur while conducting interior firefighting operations, for the period from 2002 through 2007. The table shows casualties associated with structure fires in NYS outside of NYC. The NYS data shows an annual range in the number of firefighter deaths from one to seven for all structures (including one and two-family), and zero to five for one and two-family structures, with no consistent trend. The annual number of all structure fires and residential structure fires show a slight trend upward.

Table 2.2.1-1: NYS structure fires and related fire service casualties excluding New York City

	All Structure Fires		One and Two-Family Structure Fires		
Year	**# of fires**	**Fire service deaths**	**# of fires**	**Fire service Injuries**	**Fire service deaths**
2002	18,645	5	6,568	269	5
2003	23,940	3	9,002	362	1
2004	25,492	1	10,298	467	1
2005	27,167	7	11,672	520	4
2006	26,498	2	11,845	502	2
2007	28,106	1	12,544	440	0
TOTAL	**149,848**	**19**	**61,929**	**2,560**	**13**
AVERAGE	**24,975**	**3**	**10,322**	**427**	**2**

Note: Casualties include those during firefighting operations, heart attacks, traffic casualties and others.

Fire service casualties shown on Table 2.2.1-2 are limited to those occurring while conducting interior firefighting operations in one and two-family dwellings in NYS, outside of NYC, for 2005, 2006 and 2007. The table shows no fatalities and a total of 411 injuries with a general annual trend towards decreasing the number of injuries.

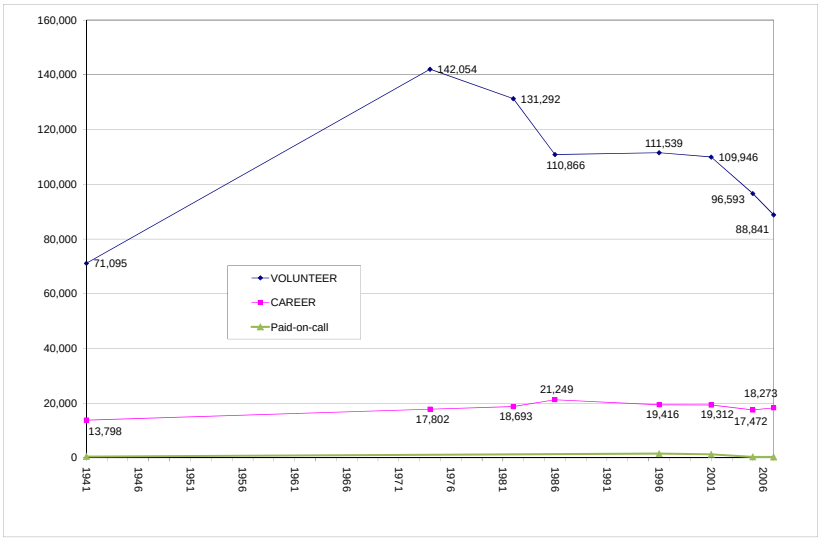
Table 2.2.1-2: Fire service casualties while conducting interior firefighting operations in one & two-family dwellings in NYS, excluding NYC

Severity of Casualty (injuries and fatalities) (Line # relates to data line in NYS OFPC database)	**2005**	**2006**	**2007**
1. Report only, including exposure	52	33	15
2. First aid only	20	12	11
3. Treated by physician, not a lost-time injury	33	40	33
4. Lost time injury, moderate severity	47	60	47
5. Lost time injury, severe	3	4	1
6. Lost time injury, life threatening	0	0	0
7. Death	0	0	0

Activity at Time of Injury	2005	2006	2007
30. Extinguishing fire	24	20	21
31. Handling charged hose lines	46	49	31
32. Using hand extinguishers	0	0	1
40. Suppression support, other	18	30	11
41. Forcible entry	1	4	1
42. Ventilation with power tools	3	1	0
43. Ventilation with hand tools	13	9	5
44. Salvage	1	1	3
45. Overhaul	36	16	24
50. Access/egress, other	0	1	4
54. Climbing ladder	0	1	0
56. Escaping fire/hazard	0	2	0
61. Searching for victim	9	10	4
91. Incident investigation, during incident	4	5	2
Factor Contributing to Injury	2005	2006	2007
11. Roof collapse	2	6	0
13. Floor collapse	5	5	5
14. Ceiling collapse	8	8	3
15. Stair collapse	1	2	1
16. Falling objects	14	20	17
20. Fire development, other	17	20	16
21. Fire progress, including smoky conditions	60	51	44
23. Flashover	0	0	3
24. Explosion	0	1	0
30. Lost, caught, trapped, or confined, other	0	0	1
31. Person physically caught or trapped	0	2	0
33. Operating in confined structural areas	14	12	1
40. Holes, other	10	2	1
41. Unguarded hole in structure	2	5	7
42. Hole burned through roof	0	1	0
43. Hole burned through floor	4	2	0
50. Slippery or uneven surfaces, other	18	13	8

The NYS DOS Office of Fire Prevention and Control (OFPC) has provided the following information regarding the number of firefighters in NYS over the past decades.

Graph 2.2.1-1: NYS fire service membership



Sources:
1941 numbers came from the untitled report of the NYS Committee on Fire Defense, Dec. 15, 1941. The first page is entitled, "Recapitulation: Personnel and Equipment, New York State Fire Departments."

1974, 1982 and 1986 are from Table 1 (page 2) of NYS Legislative Commission on State-Local Relations. New York's fire protection system: services in transition. Albany, NY: the Commission, 1988, 145p., graphs, tables. (A note to this table states the information was provided by OFPC, and that "data are estimated since all fire departments did not report relevant data and some departments reported data from previous years.")

1996 is from "Frequently Requested Fire Facts" of the first version of OFPC web pages, dated 10/15/96. (was http://www.dos.state.ny.us/firefacts.html) Source listed as OFPC Resource Inventory Program.

2001 and 2005 were from the "New York State Fire Resources" pages of the OFPC website, source listed as OFPC Resource Inventory Program.

2007 - OFPC Resource Inventory Program printout.

2.2.2. Additional fire fighter statistics

2.2.2.1. From executive summary of "Firefighter Fatality Retrospective Study"

Excerpt from Executive Summary, United States Fire Association, 2002 (Resource #59):

"Each year in the United States and its protectorates, approximately 100 firefighters are killed while on duty and tens of thousands are injured. Although the number of firefighter fatalities has steadily decreased over the past 20 years, the incidence of firefighter fatalities per 100,000 incidents has actually risen over the last five years, with 1999 having the highest rate of firefighter fatalities per 100,000 incidents since 1978."

The above excerpt refers to all types of fires and all types of structures. The report goes on to say that "twenty-eight percent of firefighter fatalities are killed during incidents on residential properties;" however, it does not differentiate between multi-family and one and two-family units.

2.2.2.2. Additional statistics from Firefighter Fatalities in the United States in 2007

Excerpts from ***Firefighter Fatalities in the United States in 2007*** (Resource #58) are below.

> Pages 2 and 3"On duty fatalities include any injury or illness sustained while on duty that proves fatal. The term "on duty" refers to being involved in operations at the scene of an emergency whether it is a fire or non-fire incident; responding to or returning from an incident; performing other officially assigned duties such as training, maintenance, public education, inspection, investigations, court testimony, and fundraising; and being on call, under orders, or on standby duty except at the individual's home or place of business. An individual who experiences a heart attack or other fatal injury at home while he or she prepares to respond to an emergency is considered on duty when the response begins. A firefighter who becomes ill while performing fire department duties and suffers a heart attack shortly after arriving home or at another location may be considered on duty since the inception of the heart attack occurred while the firefighter was on duty."
>
> Page 25 "There were 30 fatalities in 2007 where firefighters became ill or injured while on the scene or engaged in structural firefighting and the fixed property use is known. Table 14 shows the distribution of these deaths by fixed property use. In most years, residential occupancies accounted for the highest number of these fire ground fatalities. In 2007, commercial occupancy-related deaths were just as frequent as residential occupancy-related deaths. This is partially accounted for by the deaths of nine Charleston firefighters in a commercial occupancy.

Table 14 [from page 25]: Structural firefighting deaths by fixed property use in 2007

Fixed Property Use	Number	Percent
Residential	15	50%
Commercial	15	50%

Table 15 [from page 25] shows the number of firefighter deaths in residential occupancies for the past 10 years. Based on NFPA national estimates, fires in residential structures account for approximately 76 percent of all structure fires annually. Civilian fire deaths in residential structures account for approximately 97 percent of all structure fire deaths each year. Historically, the frequency of firefighter deaths in relation to the number of fires is much higher for nonresidential structures."

Table 15 [from page 25]: Firefighter fatal injury

Year	Number of firefighter deaths
2007	15
2006	15
2005	18
2004	15
2003	10
2002	21
2001	17
2000	21
1999	23
1998	17

2.2.2.3. Summary section of WHAT'S CHANGED OVER THE PAST 30 YEARS?

By Rita F. Fahy, Paul R. LeBlanc, Joseph L. Molis published by Fire Analysis and Research Division of National Fire Protection Association, June 2007 (See Resource 12))

"A review of the almost 3,400 on-duty firefighter fatalities that have occurred in the U.S. between 1977 and 2006 shows some areas where significant improvements have occurred, and highlighted areas where much work remains to be done. The average number of deaths annually has dropped by more than one-third, falls from apparatus during responses have almost been eliminated, heart attack deaths are down by a third, and improvements in everything from protective equipment to emergency medicine have reduced deaths at structure fires. However, preventable problems such as the health issues that result in increased risk of heart attack and stroke contribute to making sudden cardiac death the number one cause of on-duty firefighter deaths. Preventable deaths such as road crashes where seatbelts were not used, and training deaths where adequate precautions were not taken, continue to occur.

Snapshots of the Changes Over the Years

- The average number of firefighter deaths to occur annually has dropped by one third over the past 30 years.
- Deaths due to falls from apparatus, which claimed at least three deaths in almost all of the first 11 years, virtually disappeared in the 1990s, but have reoccurred in recent years.
- On-duty sudden cardiac deaths have dropped by more than one third, but remain the number one cause of on-duty firefighter deaths.

- Crashes continue to be the second leading cause of on-duty fatalities, and there has been no sustained trend up or down for such deaths. The victims are mainly volunteer firefighters, and personal vehicles and tankers are the types of vehicle most frequently involved.
- More training deaths occurred in the last decade than in the first 10 years, which may be due to more training activities underway today. Over half were due to sudden cardiac death."

2.2.2.4. Excerpt from NFPA's "U.S. Fire Department Profile Through 2006"

By M.J. Karter, Jr., November 2007 (Resource #30)

Year	Total	Career firefighters	Volunteer firefighters	Fire departments
1986	1,045,950	237,750	808,200	29,840
1987	1,060,000	243,200	816,800	29,741
1988	1,040,750	252,500	788,250	30,245
1989	1,020,700	250,600	770,100	30,135
1990	1,025,650	253,000	772,650	30,391
1991	1,033,600	261,800	771,800	30,587
1992	1,058,300	253,000	805,300	30,562
1993	1,055,050	259,650	795,400	30,528
1994	1,073,600	265,700	807,900	30,495
1995	1,098,850	260,850	838,000	31,197
1996	1,081,800	266,300	815,500	31,503
1997	1,079,050	275,700	803,350	30,665
1998	1,082,500	278,300	804,200	31,114
1999	1,065,150	279,900	785,250	30,436
2000	1,064,150	286,800	777,350	30,339
2001	1,078,300	293,600	784,700	30,020
2002	1,108,250	291,650	816,600	30,310
2003	1,096,900	296,850	800,050	30,542
2004	1,100,750	305,150	795,600	30,400
2005	1,136,650	313,300	823,650	30,300
2006	1,140,900	316,950	823,950	30,635

2.3. Effectiveness of residential sprinklers at increasing safety

2.3.1. Questioning the reliability of sprinklers as discussed in the NFPA 2009 report of U.S experience with sprinklers

When talking about the effectiveness of residential sprinklers, it is important to understand what is deemed "effective". The most recent NFPA report on fire sprinklers, entitled U. S. Experience with Sprinklers and other Automatic Fire Extinguishing Equipment (resource 20A, Hall 2009), says that residential fire sprinklers operate "effectively in 91% of all reported fires where sprinklers were present in the fire area and fire was large enough to activate them." (page i) According to the report, effectiveness is defined as

the sprinkler systems ability to "containment and control until the fire department can complete extinguishment" (Page 75). An effective operation does not necessarily mean the ability to extinguish the fire.

On page 29 of this report, NFPA has quantified why certain fires were included or excluded from their data sets. In determining the overall effectiveness of the systems of 91%, fires that occurred in areas outside the sprinkler coverage area are excluded such as those fire incidents that occurred in bathrooms, garages and other areas within the dwelling unit that were not required to be protected by a sprinkler in accordance with NFPA 13D. (page 29, "In this report, the analysis excludes fires where there were no sprinklers in the fire area. These fires will be a mix of fires where the fire area was not a coverage area under the applicable standard and other fires where the area of fire origin should have been covered, indicating a partial installation not compliant with the standard."), However, when all one- and two- family dwelling fire incidents that occurred in a dwelling equipped with sprinklers were evaluated for effectiveness the numbers are dramatically different, shown in the excerpt from Table 5, below, page 38 of the report. This report does not provide information on the number of fatalities that occurred in different types of reported fires (sprinkler operated and effective, not effective, fires too small to activate system.

Table 5 of Resource #20A, excerpt below, provides the full distribution for operated and effective, operated but not effective, fire too small to activate system, and failed to operate, by property class and by type of automatic extinguishing system. The majority of reported confined and non-confined fires (55% for all structures) are too small to activate sprinklers (Resource #20A, page 38).

Except from Table 5: Automatic Wet Pipe Sprinkler System Performance in United States for One & Two- Family Residences - 2003-2006 Non-Confined Structure Fires			
Operated and Effective	**Operated and Not Effective**	**Fire Too Small to Activate System**	**Failed to Operate**
40%	2%	55%	3%

Source: Table 5 of Resource #20A - Reference: http://www.nfpa.org/assets/files//PDF/OSsprinklers.pdf

The 2009 report U. S. Experience with Sprinklers by John Hall, Jr. is an important report that should be read completely to understand the benefits and limitations associated with fire suppression systems. According to the data table above, 55% of all non-confined and confined one and two-family dwelling (OTFD) fires never reached temperatures that would activate the sprinkler system (resource Hall 2009 Table 5, page 38). Sprinklers failed to operate in 3% of the OTFD and the reasons that they failed were due to insufficient amount of water released (25%), water did not reach the fire (25%), lack of maintenance (25%) or a system component was damaged (25%) (Resource #20A, Table 10 page 52).

2.3.1.1. Non-fire activation reports

In addition to providing statistics on activation due to fire incidents, the 2009 report also provides estimates on the number of fire sprinkler activations that occurred for reasons other than fires. Based on data collected in 2003 for all reported fire department responses to non-fire sprinkler activations, it was estimated that there were over 4,700 accidental sprinkler activations that occurred (Table D). Upon further examination of specific incidents in Texas, Minnesota and Massachusetts, the report was able to provide the reasons for the non-fire activation and the percentages of each category (Table E).

Table D: U. S. Non-Fire Sprinkler Activations by Major Property Use Group in the U. S. 2003
Source: Resource #20A, page 60

Property Use		
Commercial properties (public assembly, stores and office	15,900	36%
Manufacturing facilities	6,800	15%
Homes (one- or two-family dwellings, apartments)	4,700	11%
Warehouses excluding cold storage	4,100	9%
Other property use groups	12,500	28%
Total	44,000	100%

Note: Projections of national estimates from NFIRS are based on non-fire emergency responses estimated by Michael Karter from the 2003 Fire Loss Experience Survey. Source: Unpublished analysis by Jennifer D. Flynn, NFPA Fire Analysis & Research Division, January 2008.

Table E: U.S. Fire Sprinkler Activations by Likelihood of Water Release and Major Property Use Group Homes (292 incidents) [excerpt from Resource #20A, page 60]

Type of activation, based on:	
No water released	**50%**
-Definitely no water released except dry pipe system charging or release to drain or outside	(46%)
-Activation with no mention of water flow outside system	(4%)
Possibly water released	**50%**
-Break or damage to component	(27%)
-Activation with mention of water flow release outside system	(14%)
-Leak	(2%)
-Freezing	(6%)
-Nearby heat	(1%)
Total	**100%**
Confirmed water release outside system	21%

Source: Analysis of non-coded narratives from reported incidents in Austin (TX), Minnesota, and Massachusetts."

2.3.2. Resource document excerpts regarding effectiveness of fire sprinklers & smoke detectors

The following are excerpts from other resource documents regarding effectiveness of fire suppression sprinklers. In some cases, the resource document refers to all sprinklers including commercial sprinklers. Since commercial sprinkler systems are designed for property protection, the resulting effectiveness is likely to differ from that of residential sprinkler systems.

Resource #1A - Ahrens, Marty (Sept. 2007). Home Structure Fires

"In 2002-2004, sprinklers were present in 1percent of the non-confined fires reported in one and two-family dwellings and in 8 percent of the non-confined apartment fires. Table B shows that compared to fires in apartments without automatic suppression systems the death rate per 1,000 reported fires was 57

percent lower and the average loss per fire was 42 percent lower in non-confined apartment fires with sprinklers. When present, sprinklers operated in 97 percent of the non-confined apartment fires in which the fire was large enough to activate them. No further analysis of sprinkler performance was done for fires in one and two-family dwellings due to the small number of fires in such properties that had this protection" (page 18).

Table B. [from Resource #1A] U. S. Sprinkler Systems in Non-Confined Home Structure Fires – 2002 - 2004 Annual Averages

One and Two-Family Dwellings	
Percent of non-confined fires in one- and two-family dwellings with sprinkler systems	1%
Apartment fires	
Percent of non-confined fires in apartments with sprinkler systems	8%
Deaths per 1,000 non-confined apartment fires with sprinkler systems	11.0
Deaths per 1,000 non-confined apartment fires with no automatic extinguishing system present	4.7
Reduction in deaths per 1,000 non-confined apartment fires when sprinkler systems were present	57%
Average loss per non-confined apartment fire when sprinkler system was present	$15,600
Average loss per non-confined apartment fire with no automatic suppression system	$25,900
Reduction in loss per fire when sprinkler systems were present	42%

"…the death rate of 0.52 per 100 reported home fires was 53 percent lower in reported home fires in which a smoke alarm operated than in reported fires with no working smoke alarms (1.10 deaths per 100 fires)…the death rate per 1,000 reported fires was 57 percent lower and the average loss per fire was 42 percent lower in non-confined apartment fires with sprinklers" (page 17).

Resource #3 -Ahrens, Marty (April 2007).

"In 2000 - 2004, the death rate per 100 reported fires was 51 percent less in homes with working smoke alarms than in homes without this protection." (page xi) This includes all homes in U. S., not just one and two-family dwellings.

Resource #5 - Butry, D. T.; Brown, M. H.; Fuller, S. K. (Oct 2007).

"…[D]wellings [includes all homes in U. S., not just one and two-family dwellings] with smoke alarms had a lower average civilian fatality rate than those without (82 fatalities per 10,000 fires

compared to 95). Dwellings with smoke alarms and a wet pipe sprinkler system had on average lower civilian fatality and injury rates and property damage per fire than dwellings with only smoke alarms. Over the study period 2002 to 2005, there were no reported civilian fatalities in one and two-family dwellings (a 100 percent reduction in fatalities from houses without a wet pipe sprinkler system). The average rate of civilian injuries was also lower in dwellings with smoke alarms and wet-pipe sprinklers: 174 injuries per 10,000 fires compared to 403 injuries (a 57 percent reduction). Direct property damages averaged $15,028 per fire, a 32 percent reduction over dwellings with only smoke alarms. However, caution should be made before assuming that reductions in the rate of civilian fatalities and injuries and direct property damage are fully attributed to the presence of a wet pipe sprinkler system, just as in the case of comparing dwellings without smoke alarms to dwellings with smoke alarms. Causation can be inferred only if dwellings with only smoke alarms were similar in other attributes to dwellings with smoke alarms and a wet pipe sprinkler system (other than the presence of a wet pipe sprinkler system). Such a determination is difficult given the data available, and beyond the scope of this analysis."

Resource #6 - Bukowski, Richard W., et al. (February 2008).

From Section 7.4 - Smoke Alarm Performance (pages 240-241) [for all U. S. homes]

"For heat alarms and sprinklers, only a single location in the room of fire origin was included in the tests. Escape times are calculated as the time to the first alarm activation (for that type of alarm) minus the time to untenable conditions. Negative numbers thus indicate that tenability criteria were exceeded prior to alarm activation. (…) On average, all of the alarm types provided positive available egress time for all manufactured home fire scenarios, with average available safe egress times ranging from 36 seconds to 2,413 seconds. The alarms did not, however, provide positive available egress time in every test when the alarms were located only on every level but not in bedrooms. (…) As expected, alarm placement can effect the available safe egress time. For the manufactured home tests, including alarms in bedrooms in addition to those on every level increases average available safe egress time by from 3 seconds to nearly 800 seconds, depending upon fire scenario, alarm type, and alarm placement. Greater increases were noted for photoelectric (up to 794 seconds) or dual photoelectric / ionization alarms (up to 301 seconds) than for the ionization alarms (up to 138 seconds). No increase was seen for the aspirated photoelectric detector. This may be due to the periodic sampling of this detector. Additional increases were seen for the change from every level plus bedrooms to every room. For the two-story home tests, the effect was far less pronounced. This was likely due to the interior design of the home. For fires downstairs, the upstairs hallway alarms were typically the first to respond since there was no soffit to impede smoke flow from the first floor into the stairwell to the alarms at the top of the stairs."

"7.5.3 Tell-Tale Sprinklers [a tell tale sprinkler includes an alarm]

The purpose of residential sprinklers is to improve protection against injury, life loss, and property protection. In particular, the design is expected to prevent flashover in the room of fire origin and to improve the chance for occupants to escape or be evacuated [52: NFPA 13R: Installation of Sprinkler Systems in One and Two-Family Dwellings and Manufactured Homes, 1999 Edition, 2002 National Fire Codes. National Fire Protection Association, Quincy, MA, 2002.]. In the tests presented in this report, only the very early stages of a fire were studied, up to the point of incapacitation for occupants. Tell-tale sprinklers were included in the room of fire origin to provide a point of comparison between smoke alarms and sprinkler activation. For flaming fires, response time ranged from 126 seconds to 246 seconds. For smoldering fires, response occurred shortly after the transition to flaming" (page 247). "Response time for smoke detectors ranged from 32 seconds to 192 seconds (page 123)."

Resource # 20 - Hall, John R., Jr. (June, 2007).

Abstract Excerpt

"Automatic sprinklers are highly effective elements of total system designs for fire protection in buildings. When sprinklers cover the area of fire origin, they operate in 95 percent of all reported structure fires large enough to activate sprinklers. When they operate, they are effective 96 percent of the time resulting in a combined performance of operating effectively in 91 percent of reported fires where sprinklers were present in the fire area and fire was large enough to activate sprinklers. When wet pipe sprinklers are present in structures that are not under construction and excluding cases of failure or ineffectiveness because of a lack of sprinklers in the fire area, the fire death rate per 1,000 reported structure fires is lower by 80 percent for home fires, where most structure fire deaths occur, and the rate of property damage per reported structure fire is lower by 45-70 percent for most property uses. Also, when sprinklers are present in structures that are not under construction and excluding cases of failure or ineffectiveness because of a lack of sprinklers in the fire area, 94 percent of reported structure fires have flame damage confined to the room of origin compared to 74 percent when no automatic extinguishing equipment is present. When sprinklers fail to operate, the reason most often given (63 percent of failures) is shutoff of the system before fire began. (All statistics are based on 2003-2006 fires reported to U.S. fire departments excluding buildings under construction.)"

Concluding Points

"1. Fire sprinklers are highly effective elements of total system designs for fire protection in buildings. When wet pipe sprinklers are present excluding structures under construction and cases of failure or ineffectiveness because of a lack of sprinklers in the fire area, the chances of dying if a home fire occurs are reduced by 80 percent, and the average property loss per fire is cut by 45-70 percent for most property classes compared to reported fires where no automatic extinguishing equipment is present.
2. Excluding fires too small to activate a sprinkler and cases of failure or ineffectiveness because of a lack of sprinklers in the fire area, sprinklers operated in 95 percent of reported structure fires and operated effectively in 91 percent of fires. Two-thirds (63 percent) of the failures occurred because the system had been shut off.
3. There are certain fire situations where even a complete sprinkler system will have limited impact: (a) Explosions and flash fires that may overpower the system; (b) Fires that begin very close to a person (e.g., clothing ignition) or unusually sensitive and expensive property (e.g., an art gallery) where fatal injury or substantial property loss can occur before sprinklers can react; and (c) Fires that originate in unsprinklered areas (e.g., concealed wall spaces) or adjacent properties (e.g., exposure fires), which may grow to unmanageable size outside the range of the sprinkler system. These situations can arise when (a) sprinkler standards are based on design fires less severe than explosions or flash fires, as is normally the case; (b) sprinkler objectives are defined in terms of a design fire area larger than the distance implied by a victim intimate with ignition; or (c) sprinkler standards exclude certain potential areas of fire origin from their definition of complete coverage, which is typically but not always the case.
4. Sprinkler systems are so effective that it can be tempting to overstate just how effective they are. For example, some sprinkler proponents have focused too narrowly on the reliability of the components of the sprinkler system itself. If this were the only concern in sprinkler performance, then there would be little reason for concern at all, but human error is a relevant problem.

On the other hand, some people, concerned that sprinklers will be treated as a panacea to the detriment of other essential elements of fire protection, have treated human errors as intrinsic to sprinkler performance. In fact, all forms of active and passive fire protection tend to show more problems with human error than with intrinsic mechanical or electrical reliability.

It is important for all concerned parties to (a) distinguish between human and mechanical problems because they require different strategies; (b) include both as concerns to be addressed when deciding when and how to install, maintain, and rely on sprinklers and other automatic extinguishing systems; (c) strive to use performance analysis in assessing any other element of fire protection; and (d) remember that the different elements of fire protection support and reinforce one another and so must always be designed and considered as a system."

Resource #20A - Hall, John (2009)

"For all structures combined, 74 percent have flame damage confined to room of origin when there is no automatic extinguishing equipment present. This rises to 94 percent of fires with flame damage confined to room of origin when any type of sprinkler is present." page 29

"Sprinkler Reduction in Loss of Life in Fire - For 2003-2006 home fires, the death rate per 100 fires was 80 percent lower with wet pipe sprinklers than with no automatic extinguishing equipment. Table 11 shows fire death rate reductions for various property use groups. The estimated reduction was 87 percent for one or two-family dwellings and 65 percent for apartments. Most property groups average too few deaths per year in sprinklered properties to produce stable statistical comparisons." page 32

"Sprinkler Reduction in Loss of Property in Fire - For most property uses, the property damage rate per reported structure fire is 45-70 percent lower when wet pipe sprinklers are present in structures that are not under construction, after excluding cases of failure or ineffectiveness because of a lack of sprinklers in the fire area. Table 13 shows smaller reductions for one or two-family dwellings (22 percent) and warehouses (16 percent)... [O]nly 1 percent of reported dwelling fires involve sprinklered properties, which means any loss estimate for sprinklered dwelling fires will tend to be statistically unstable." page 35

Table 11. Estimated Reduction in U. S. Civilian Deaths per Thousand Fires Due to Wet Pipe Sprinklers, by Property Use. 2003-2006 Non-Confined and Confined Structure Fires

Property Use	**Without AES**	**With sprinklers**	**Percent reduction**
Residential, all types	7.7	1.8	77%
(Home)	(7.7)	(1.5)	(80%)
(One- or two-family dwelling)	(9.1)	(1.2)	(87%)
(Apartment)	(4.3)	(1.5)	(65%)
(Hotel or motel)	(4.8)	(1.3)	(74%)

The 2007 American Housing Survey (*American Housing Survey 2007*, U.S. Department of Commerce and U.S. Department of Housing and Urban Development, September 2008, Table 1C-4, 2-4, and 2-25) included a question about sprinkler usage in homes. The survey indicated 3.9% of occupied year-round

housing units had sprinklers. Usage in occupied housing units by type of housing shows usage in dwellings lag behind usage in multi-unit buildings:

- 1.5% of single family detached dwellings,
- 1.9% of single family dwellings, whether detached or attached,
- 10.6% of all housing units in multi-unit buildings,
- 2.9% of housing units in buildings with 2-4 units,

Resource #30 - Karter, Michael J., Jr. (August 2008), excerpt below.

"In all, fires in the home (one- and two-family dwellings including manufactured homes and apartments) resulted in 2,865 civilian deaths, a (sic) increase of 11.0% from a year ago, and the third lowest since 1977. Looking at trends in civilian deaths since 1977-78', several observations are worth noting… Home fire deaths were at their peak in 1978 when 6,015 fire deaths occurred. Home fire deaths then decreased steadily during the 1979-82 period except for 1981, and decreased a substantial 20% during the period to 4,820 by the end of 1982. From 1982 to 1988, the number of home fire deaths stayed quite level in the 4,655 to 4,955 area except for 1984 when 4,075 fire deaths occurred. From 1989 to 1996 home fire deaths continued to decline and stayed in the 3,425 to 4,335 area. From 1997 onward home fire deaths have generally continued to decline with the number of deaths staying in the 2,580 to 3,110 area since 2001."

Resource #60 - United States Fire Administration (2008), excerpt below.

"The Center for Fire Research at the National Institute of Standards and Technology has studied the impact of both smoke alarms and sprinklers in residential occupancies [Ruegg, Rosalie T. and Sieglinde K. Fuller, A Benefit-Cost Model of Residential Fire Sprinkler Systems, NIST Technical Note 1203, National Institute of Standards and Technology, Gaithersburg, MD, November 1984. Butry, Davit T., M. Hayden Brown and Sieglinde K. Fuller, Benefit-Cost Analysis of Residential Fire Sprinkler Systems, NISTIR 7451, National Institute of Standards and Technology, Gaithersburg, MD, September 2007.], and estimates that:
1. When fire sprinklers alone are installed in a residence, the chances of dying in a fire are reduced by 69%, when compared to a residence without sprinklers.
2. When smoke alarms alone are installed in a residence, a reduction in the death rate of 63% can be expected, when compared to a residence without smoke alarms.
3. When both smoke alarms and fire sprinklers are present in a home, the risk of dying in a fire is reduced by 82%, when compared to a residence without either."

Resource #61 - United States Fire Administration (2008), Residential Structure and Building Fires.

Excerpt below.

"Smoke Alarm Effectiveness in Confined Fires
Smoke alarms were present and effective in alerting the household in 38 percent of confined residential building fires—low-loss fires typically confined to the container of origin. Occupants were not alerted by a smoke alarm in 18 percent of these confined fires. In a large portion of residential confined building fires, 44 percent, there is no information on the alert status and effectiveness of the smoke alarm …. (While the number of "Undetermined" entries is high, this data item may be

misleading. If the fire was very small and confined to the item of origin, the alarm may not have sounded. In this case, it is not clear how this data item would be filled in correctly. If the occupant was present at the time of the confined fire, there may have been no need for a smoke alarm to notify the occupants. Again, it is unclear what the coding would be, and how the NFIRS instructions are interpreted.)

Smoke Alarm Effectiveness in Non-confined Fires
To be effective, a working smoke alarm must alert the occupants. The first step is to determine if the alarm was present and whether it operated.

Smoke alarms were present in only 43 percent of non-confined residential building fires….Non-confined fires are those fires that spread beyond the original object of origin—what is typically envisioned as a "fire." The presence or absence of alarms was not reported to NFIRS in 28 percent of non-confined residential building fires.

When smoke alarms were present in non-confined residential building fires, the alarms operated in 55 percent of the incidents. In the remaining 45 percent of incidents, smoke alarms failed to operate (14 percent), the fire was too small to activate the system (12 percent), or no information on smoke alarm operation was available (19 percent)…. (Looking at the percentage of operational smoke alarms from another perspective, at a minimum, smoke alarms were known to be present and operated in 24 percent of all non-confined residential building fires (present 43.4% x operated 54.8% = 23.8%).)

[The report] shows that, in nearly three-quarters of the non-confined residential building fires where alarms were present and operated, occupants were alerted to the fire by the smoke alarm: 72 percent of occupants were alerted and were able to respond to the warning, and an additional 3 percent were alerted but did not respond to the warning. Occupants were not alerted in 3 percent of non-confined residential building fires, and no occupants were in the residence at the time of the fire in 14 percent of these incidents. Alarm alert effectiveness information was not available in 9 percent of non-confined residential building fires. (At a minimum, smoke alarms were effective at alerting occupants in 18 percent of all non-confined residential building fires (present 43.4% x operated 54.8% x alerted occupants 75.1% = 17.9%).)

Widespread public awareness programs that focus on the proper maintenance of alarms are needed to ensure that they operate properly. A number of initiatives are focused directly on this problem. Messages are broadcast nationally when daylight savings time goes into effect, reminding the public to check and maintain their alarms. Some local fire departments in urban areas distribute free smoke alarms to households that are unprotected. All these initiatives have helped, but residences without smoke alarms and residences with nonworking alarms still have reported fires.

Current guidelines published by the [Consumer Products Safety Commission] (CPSC) recommend placing working smoke alarms on every level of the home, outside sleeping areas, and inside bedrooms. These guidelines also encourage residents to replace batteries annually and test smoke alarms monthly. (Consumer Product Safety Commission, "Smoke Alarms," March 2008, and "CPSC Daylight Saving Time Alert: Working Smoke Alarms Are Key to Surviving Home Fires," March 2008)

Presence of Automatic Extinguishing Systems
Other protection types fall in the category of automatic extinguishment systems (AESs). AESs encompass sprinkler, dry chemical, foam, halogen, and carbon dioxide systems. When found in residences, sprinkler systems are the most common type of AES. Residential sprinklers, however, are found today in only a small fraction of residences other than hotels, newer multifamily buildings, and

newer high-value custom homes. It is no surprise that they are reported to be present in only 3 percent of residential buildings fires nationally and 2 percent of fatal residential building fires…. Residential AESs represent a great potential in the future. (The presence of AESs includes only those fires with a structure fire module in NFIRS. While confined fires are allowed abbreviated reporting, some fire departments have filled out the fire and structure fire modules voluntarily for some confined fires, and AES information is collected for these incidents. Generally speaking, less than 3 percent of residential building fires are confined fires with a structure fire module.)”

3. Fire suppression options and other technical issues

Section Summary: *Residential sprinkler system design standards have been developed in NFPA 13D and the 2009 IRC section P2904 to promote life safety while reducing costs relative to commercial sprinkler systems. A variety of materials and configurations are possible within those standards. Individual residences may have specific conditions that require special design consideration; these conditions include private water supply, cathedral ceilings, seasonal use, requirements for water meters and backflow preventers, etc. It is important that the systems are designed, installed and inspected properly to minimize operation problems, especially piping in unconditioned spaces.*

3.1. Residential sprinkler system design

The term, "residential sprinkler system" as used in this report means a sprinkler system that complies with either NFPA 13D or Section P2904 in the 2009 International Residential Code. The standard that regulates residential sprinklers is Underwriters Laboratory 1626 (UL1626 – Standard for Residential Sprinklers for Fire-Protection Service.) This standard included fire tests that simulate a worst case condition for a fire in a home. The fire tests require the residential sprinkler to activate quickly to suppress the fire and prevent flashover in the room of fire origin. The tests also require the sprinkler to perform in such a manner that the levels of carbon monoxide do not exceed lethal levels during the fire test.

A residential sprinkler system is a very basic sprinkler system in design and installation. The system consists of the installation of residential sprinklers (often called "heads"), pipe connecting the sprinklers to a water supply, and a reliable water supply. The sprinkler systems are sometimes referred to as stripped down sprinkler systems because there are no requirements for special valves, gages, fire department connections, hose connections, generators, or fire pumps.

Residential sprinklers operate (or open) much quicker than standard sprinklers. The ceiling temperature at the point of operation for a residential sprinkler is typically in the range of 200 to 235 degree F.

Residential sprinkler systems are required to provide sprinkler coverage during a fire for a period of 10 minutes. For a one-story dwelling less than 2,000 square feet in area, that time factor drops to 7 minutes. The time factor is based on the occupants being capable of exiting the home and the fire department responding to continue the fire fighting operation.

A typical home has 20 to 25 sprinkler installed to provide the area of coverage. The larger the home, the more sprinklers would be required.

Sprinklers are not required for all areas of a home. Sprinklers are permitted to be omitted in bathrooms less than 55 square feet in area, closets less than 24 square feet in area with the least dimension not greater than 3 feet, and attics and crawl spaces that do not have fuel fired equipment.

A residential sprinkler discharges a much lower quantity of water than a standard sprinkler. The flow rates for residential sprinkler range from 8 gallons per minute (gpm) to 20 gpm per sprinkler. Each sprinkler is listed for a specified area of coverage. Currently, every sprinkler manufacturer markets residential pendent sprinklers with an area of coverage of 12' x 12', 14' x 14', 16' x 16', 18' x 18', and 20' x 20'. The manufacturers market sidewall residential sprinklers having an area of coverage of 12' x 12', 14' x 14', 16' x 16', 16' x 18', and 16' x 20'. As the area of coverage increases, the flow rate, and sometimes the pressure demand increases for the sprinkler.

The most popular sprinkler currently used in residential design has a flow rate of 13 gpm with a pressure demand of 7.0 pounds per square inch (psi). This sprinkler will provide an area of coverage at this flow rate and pressure demand of 16' x 16'.

The water flow rate for the residential sprinkler system is based on the flow of either one or two sprinklers. If a room or space is covered by one sprinkler, the flow rate to that sprinkler is only based on the water flow rate and pressure of that sprinkler. When a room or space has two or more sprinklers, the water flow rate and pressure must be for two sprinklers. For the most popular residential sprinkler, that would equate to a flow rate of 13 gpm at 7.0 psi for one sprinkler and 26 gpm at 7.0 psi for two or more sprinklers.

The common piping materials used in a residential sprinkler system are: CPVC pipe, PEX tube, copper tube, galvanized steel pipe, and black steel pipe. There are two types of piping systems used in a residential sprinkler system. The names used to identify the first system are stand alone, two pipe, and separate piping system. In this type of system, as the names imply, the piping for the sprinkler system is a separate piping system similar to the piping layouts for a commercial sprinkler system.

The other piping system is called a multipurpose, one pipe, or combined piping system. This type of piping arrangement is one that combines the cold water distribution system for the plumbing fixtures with the residential sprinkler system. The sprinkler system is a part of the plumbing system. When piped as a part of the plumbing system, the piping is sized for either the sprinkler flow rate or the plumbing flow rate, which ever results in the larger size pipe.

The common pipe sizes used in residential sprinkler systems are 3/4 inch and 1 inch pipe. Some installations could require a larger pipe. Section P2904 of the 2009 International Residential Code provides a quick and easy method for sizing the piping in a residential sprinkler system. The IRC Fire Sprinkler Coalition also provides a free Excel Spreadsheet for sizing residential sprinkler systems on their website, www.ircfiresprinkler.org. This program provides a more exact method of sizing based on NFPA 13D.

For the water service piping from the street to the home, the sizes range from 3/4 inch to 1-1/2 inch depending on the flow rate, length of the building from the water main, and available street pressure.

For a well system, the pipe sizes from the well to the building are typically 3/4 inch or 1 inch.

Most residential sprinkler systems are piped with potable water piping material. When the piping is installed with approval potable water piping material, a backflow preventer may not be required.

The State of New York utilizes the International Plumbing Code as the basis for the New York Plumbing Code. Section 608.16.4 of the NY Plumbing Code 2007 provides an exception for backflow protection when a sprinkler system is piped as a part of the water distribution system and does not have a fire department connection.

The section reads:

> **608.16.4 Connections to automatic fire sprinkler systems and standpipe systems.** The potable water supply to automatic fire sprinkler and standpipe systems shall be protected against backflow by a double check-valve assembly or a reduced pressure principle backflow preventer.
>
> **Exceptions:**
> 1. Where systems are installed as a portion of the water distribution system in accordance with the requirements of this code and are not provided with a fire department connection,

isolation of the water supply system shall not be required.

2. Isolation of the water distribution system is not required for deluge, pre-action or dry pipe systems.

A similar requirement appears in the plumbing section of the International Residential Code. Section P2902.5.4 reads:

> **P2902.5.4 Connections to automatic fire sprinkler systems.** The potable water supply to automatic fire sprinkler systems shall be protected against backflow by a double check-valve assembly or a reduced pressure principle backflow preventer.
>
> **Exception:** Where systems are installed as a portion of the water distribution system in accordance with the requirements of this code and are not provided with a fire department connection, isolation of the water supply system shall not be required.

For residential sprinkler systems connected to a well, the first determination that must be made is whether the well is reliable. A reliable well is a well that can provide the sprinkler flow rate for a period of 10 minutes. If the well is considered reliable, there are no special storage requirements for the well. The well system must be designed to flow the sprinkler flow rate in the event of a fire.

When the well is unreliable, a 10 minute supply of water must be stored on the premises. Typical storage tanks used for these systems are plastic tanks ranging in size from 250 gallons to 500 gallons. A well system can be installed as either a stand alone piping system or a multipurpose piping system. Appendix A includes photographs of residential sprinkler systems installed in homes that have an unreliable well.

A common water meter for public water supply is a 5/8 inch meter for single family dwellings. Other meter sizes include a 3/4 inch and 1 inch meter. The flow through older 5/8 inch meter is limited to 20 gpm. This is within the range of flow for systems designed for 2 sprinklers flowing 8 or 9 gpm. It is also within the range of any single sprinkler system.

Many residential water softeners and water filtration systems do not have the capability of flowing the sprinkler flow rate through the equipment. For this type of equipment, both NFPA 13D and P2904 require the installation of a by-pass valve. This valve opens when there is a high demand for water flow such as a sprinkler discharge.

A ½ inch drain is required for a residential sprinkler system. This drain can be an outside sillcock for the plumbing system or a dedicated valve on a stand alone sprinkler system.

There is no annual maintenance required for residential sprinkler systems. NFPA encourages homeowners to inspect the sprinklers every year to make sure that there is no paint on the sprinklers.

3.2. Flow requirements and restriction

In a "multipurpose residential fire sprinkler system" in which the fire sprinkler system plumbing is combined with building water supply plumbing, installation of a standard water softener would require design modifications, including bypass lines using flow switches for detection and alarms to provide required flow to the sprinkler system.

Water meters:
Water service meters, 5/8 inch meters in most cases, would increase to ¾ inch to accommodate a sprinkler system. Typically the meter is supplied by the municipality, which would have to increase the size and post flow rates for the equipment.

A compound or combination meter may be required, rather than a positive displacement or multi-jet typical of residential meters, due to the need to measure both high flows, as during a fire event, and low flows typical of residential use.

Backflow prevention:
A backflow preventer is used to prevent reverse flow from the residence to the municipal water system. In this case, b*ackflow* means flow of used or non-potable water from residential piping into the potable water distribution system. Backflow may be caused by numerous conditions that result in reverse pressure. The reverse pressure gradient may be due to either a loss of pressure in the supply main called back-siphonage, or by the flow from a customer's pressurized system through an unprotected cross-connection, which is called back pressure. In an unprotected situation, water from the residence will be siphoned back into the municipal system, potentially contaminating the public supply. The point at which for a non-potable substance could come in contact with the potable drinking water system is called a cross-connection. A backflow preventer is installed to prevent backflow from occurring at a cross-connection.

Backflow preventers, or backflow prevention assemblies, include air gaps, vacuum breakers, double check valves and reduced pressure assemblies. Air gaps provide the best protection; however these result in loss of line pressure and typically require a downstream booster pump. Vacuum breakers have limited applicability, as they are effective only against back-siphonage and not against back pressure. Double check valves and reduced pressure assemblies protect against back pressure and back siphonage. A reduced pressure assembly provides greater protection, and is used in situations with higher risk.

In situations in which backflow prevention devices are required by the health department or municipal water system, the devices would most likely increase in size and possible change type because of flow needed to sprinklers. Annual inspection would be required in some cases.

3.3. Technical issues regarding system design

There are many different types of residential fire sprinklers, each with their own set of advantages and disadvantages. Fire sprinkler heads are simple devices that allow water to flow when the temperature at the head exceeds a preset limit. Each head functions independent of the other (they do not go off all at once as is often depicted in Hollywood films). Some of the different system types and associated problems are as follows:

3.3.1. Wet systems

In a wet system, the fire sprinkler piping is always full of water. The advantage to this system is that it responds quickly to a fire and is less expensive than a dry system. The disadvantage to a wet system is that the water in the system could freeze if subject to below-freezing temperatures.

It is imperative that these systems are properly designed, installed, insulated and inspected, and that the temperature inside the structure allows for adequate heat to transfer through the dry wall to maintain above freezing temperature of the piping.

I. One solution to this problem is to run all sprinkler piping inside interior walls and use wall mounted sprinkler heads instead of ceiling mounted sprinkler heads when the space above the ceiling is subject to freezing temperatures. A limitation to wall-mounted sprinkler heads is that heads must be installed near the ceiling level, but in the case of a sloped or cathedral ceiling, the ceiling will continue to rise above the wall and may be too far from the sprinkler head. Fire sprinklers are routinely installed in cathedral ceilings. There are designs that require sprinklers in the ceiling. Another limitation to the wall mounted sprinkler heads is that they must meet performance requirement for wetting the opposite wall near the ceiling level. In larger rooms, this may require increased water pressure or an increase in the number of sprinklers heads to adequately protect the room. In cases of very large rooms, it is simply not possible to adequately cover large rooms with wall mounted sprinkler heads. Per NFPA 13D, coverage must be met. There are residential style "side wall" fire sprinklers that have a 16 x 20 foot reach effectively covering a 32 x 20 foot or 40 x 16 foot single room.

II. Another solution is to mix antifreeze into the water. Approved antifreeze substances are required to be of food grade materials. Over time the antifreeze level in the system decreases and must be maintained. Maintaining the proper level requires periodic draining of the system and refilling with the proper mixture. As required by NFPA 13D, maintenance is:

> "4.2.4* Antifreeze Systems. Before freezing weather each year, the following procedure shall be performed:
> (1) Solution in the entire antifreeze system emptied into convenient containers
> (2) Solution brought to the proper specific gravity by adding concentrated liquid as needed, or a new solution be prepared, in accordance with 8.3.3
> (3) System refilled with the new or remixed solution."

In its Annex, NFPA 13D recommends: "**A.4.2.4** Tests should be made by drawing a sample of the solution from valve B, as shown in Figure 8.3.3.3.1.1, two or three times during the freezing season, especially if it has been necessary to drain the building sprinkler system for reasons such as repairs or changes. A small hydrometer should be used so that a small sample is sufficient. Where water appears at valve B or where the test sample indicates that the solution has become weakened, the entire system should be emptied and then recharged as previously described."

For dropped sprinkler heads and dropped portions of dead end piping, all the sprinkler heads are removed and compressed air is blown into the system to force out the water. This maintenance is not only expensive but potentially very messy and difficult to perform in a finished house full of furniture. In many systems piping is pitched back to the riser and antifreeze samples are easily obtained from an "inspector's test connection".

Maintenance instructions for anti-freeze systems from a one major manufacturer are as follows:

> "All sections of trapped piping are to be drained. Five percent (5%) of the pendent ESFR sprinklers at all locations throughout the system are to be removed and inspected for frozen solution. If any of the pendent ESFR sprinklers are found with frozen solution, all the pendent ESFR sprinklers are to be removed and replaced with new Viking K25.2 Pendent ESFR VK510 Sprinklers prior to re-charging system with new 35% premix propylene glycol/water solution. If the 5% of removed sprinklers are not damaged, they can be re-installed in the system." From http://www.vikinggroupinc.com/databook/freezerstorage/051904.pdf

In addition, antifreeze systems that are connected to potable water supplies must be equipped with a back flow preventer. This back flow preventer is in addition to the back flow preventer that may be required by

the water company and will have to be large enough to handle fire flows. It will also require regularly scheduled inspections and maintenance, all of which add to the cost of residential fire sprinklers. Again, anti-freeze use in NFPA 13D systems is rare.

III. Another solution to prevent freezing is to install the fire sprinkler piping beneath the ceiling insulation. This requires the insulation to be installed flawlessly. Even a small non-insulated area would have catastrophic consequences. Although such a flawless job is theoretically possible it is impractical and can be easily compromised by other trades or the occupants if they disturb the insulation. Additionally, installing insulation around the piping is thought to prevent freezing. However, insulation only slows down heat transfer and after prolonged exposure to very cold temperatures the pipes will eventually freeze. This is why the *International Residential Code* and the *International Plumbing Code* specifically prohibit any domestic water systems from being installed in exterior walls or unconditioned spaces.

As long as heated areas remain at a minimum of 40 degrees F, the fire sprinkler system meets NFPA 13D requirements. Most, if not all piping, is typically installed within interior walls.

3.3.2. Types of wet systems

There are two types of wet systems that are commonly used for residential fire sprinklers, the stand alone system and the multi-purpose system. The advantages and disadvantages are as follows:

I. **Stand alone system:** The stand alone system utilizes sprinkler piping that is completely independent from potable water piping.

a) The advantage to this system is as follows:

i. Antifreeze can be used to prevent piping from freezing if a backflow preventer is installed or if the water supply is from an open storage tank that is not connected to the potable water system (see discussion of open tanks above).

ii. Problems related to public water supplies, such as size of the water service, water meter, water pressure regulator, backflow preventer and water softeners can be eliminated with the use of an open storage tank and pump.

b) Potential disadvantages of this system are as follows:

i. Unless an open storage tank is used to supply the water, the system is subject to the problems related to size of water service, flow meter, pressure regulator, backflow preventer, and water softeners. There are water meters made that can be used in NFPA 13D systems, with by-passes arrangements or "infallible" screens. (See http://www.patentstorm.us/patents/5546801/description.html and http://www.performancemeter.com)

ii. The system is rendered inoperable with the loss of power for a "tank and pump" system or a well system; however battery back-up systems are available. Pressurized tanks are still operable if there is a power outage.

II. **Multipurpose System:** The multipurpose system utilizes the cold water piping that serves the plumbing fixtures in the home to supply the sprinkler heads. A network multipurpose system is a possible type with some reduced code requirements. According to NFPA 13D, a multipurpose system and a network system are defined as:

> "**3.3.9.3 Multipurpose Piping System.** A piping system within a residential occupancy intended to serve both domestic and fire protection needs.
> **3.3.9.4 Network System.** A type of multipurpose system utilizing a common piping system supplying domestic fixtures and fire sprinklers where each sprinkler is supplied by a minimum of three separate paths.

The advantage to this system is the reduced cost of installation.

The potential disadvantages of this system are as follows:

a) Antifreeze cannot be used to prevent piping from freezing because the sprinkler piping and potable water piping are interconnected.
b) If this system is installed with a private well, it is necessary to install large pressurized tank or storage tank with pump (see description of pressurized tanks above under Private Water Supply).
c) A multipurpose system should not be used in line with typical residential water softeners, unless an automatic by-pass is installed or the softener is sized to handle potential sprinkler loads.

3.3.3. Dry systems

In a dry system the sprinkler piping is filled with compressed air. If a sprinkler head is activated by a fire, the air escapes and a control panel detects the loss of air pressure and opens a valve that allows water to enter the piping. The advantage to this system is that it is not subject to freezing.

If a dry-system is in a home, it would have to be designed, installed and maintained per "NFPA 13, Standard For The Installation Of Sprinkler Systems," a more complete, complex and expensive system. According to the National Fire Sprinkler Association, no such system is currently commercially available and approved for use NFPA 13D, residential sprinkler systems. This is largely because the time needed to expel air from the system increases the response time and prevents it from meeting the requirements of residential sprinklers. A limitation to dry systems is that NFPA 13D requires that they be approved for installation in one and two-family dwellings and there are currently more on the market that have been approved.

The disadvantage to this system is that it takes longer to respond to a fire (the air must be expelled before water can enter the piping) and it is significantly more expensive than a wet system. Additionally, dry systems require regularly scheduled inspections and maintenance and increase the overall complexity of the system. They also decrease design flexibility and available equipment choices and create a greater potential for internal corrosion of piping and equipment, all of which add to the cost of residential fire sprinklers.

3.4. Water supply options

3.4.1. Public water supply

A typical domestic water supply for one and two family dwellings includes a 5/8" water service and meter and may include a water pressure regulator and/or a backflow preventer. All of these devices are designed for a typical residential water flow rate. They may not be able to deliver the 26 gpm required by a residential fire sprinkler system. All of these devices may need to be increased in size. Increasing the size of these devices is a cost that is often overlooked because it is part of the plumber's job, and is, therefore, not included in the fire sprinkler contractor's bid. In addition there are technical problems that must be addressed as follows:

- A residential water pressure regulator (pressure reducer) that is increased in size to handle the higher fire flows may not properly reduce the water pressure when operating at the low flow rates that are typical in one and two-family dwellings.

- A water meter that is increased in size to handle the higher fire flows will not accurately register the low flows that are typical in one and two family dwellings. Additionally, many water purveyors' rates increase with the size of the water meter.

A simple solution to both of these problems is to connect the fire sprinkler system to the water service before both the pressure regulator and the water meter and to install a typical size residential pressure regulator and water meter to supply the home. Some water purveyors' require that the pressure regulator be installed before the water meter, and as they may also require that all water be metered, the fire sprinkler connection cannot be before the pressure regulator. Unfortunately, water purveyors are not regulated by building codes thus in some cases this problem may not be resolved.

Another solution to these problems is to install a seconded larger water service dedicated to the fire sprinkler system. This solution is not only expensive initially, but will have ongoing cost because many water purveyors' have a minimum monthly rate per meter (even when there is no consumption). Also rates typically increase with the size of the water meter, so the fire sprinkler meter rates will be more then the rates for the domestic water meter. Again, adding a second larger water service and meter is a cost that is often overlooked because it is part of the plumber's job, and is therefore not included in the fire sprinkler contractor's bid.

The most remote fire sprinkler requires 7 pounds per square inch (psi) at 18 to 26 gallons per minute (gpm) to operate and systems are more commonly a stand-alone system. According to the RCNYS, P29003 this requires a minimal static pressure of 40 psi and a maximum of 60 to 80 psi. Network and multi-purpose systems have the proper flow and pressure to operate the fire sprinkler demand in conjunction with the domestic demand. If a pressure regulating valve (PRV) is used on a stand-alone system, the fire sprinkler system can be installed upstream from the PRV, but downstream from the meter if necessary. There are meters on the market for larger diameter pipes that are accurate in calculation.

Fire sprinkler systems are hydrostatically tested to 200 psi (175 psi for CPVC plastic pipe). This is a significantly higher pressure than domestic plumbing. There are rarely any public water systems of this pressure.

Water purveyors have worked closely with those drafting changes in requirements in the majority of districts, that require sprinkler systems for all new one and two-family homes in their jurisdiction from rearrangements of PRVs to bypassing meters, to writing new sections in their Tariffs.

3.4.2. Private water supply (wells)

NYS Department of Health recommends that water supplied to a one and two-family home come from a private well that has a minimum flow rate of five to seven gallons per minute (gpm). A pump near the bottom of the well pumps the water into a small pressurized water storage tank (typically 40 gallons) located in the home. Increasing the size of these devices to accommodate a sprinkler system is a cost that is often overlooked because it is part of the plumber's job and is, therefore, not included in the fire sprinkler contractor's bid. In addition, there are technical problems that must be addressed as follows.

Similar to a public water supply, the well system components are sized for residential flow rates. If these devices are increased to handle the higher flow requirements of a residential fire sprinkler system they may not function properly for the home. A fire sprinkler system operates at approximately 30 pounds of gauge pressure, with flow of 30 gallons per minute; domestic components are typically sized for similar pressures and lower flows.

It is often difficult or impossible to increase the capacity of a well to accommodate the demand of a fire sprinkler system. If the capacity of the well cannot be increased, the capacity of the storage tank will need to be increased such that it can store a minimum of 260 gallons. Because only a third of the volume of a pressurized water storage tank is stored water (the balance of the tank being occupied by pressurized air), this would require a tank that is approximately 780 gallons. Not only is such a tank expensive, it would be very large and may be difficult to fit into a home.

An alternative to a pressurized water storage tank is an open (not pressurized) storage tank. The advantage to an open tank is that all of the tank's capacity is available to store water, and therefore 260 gallons of water can be stored in a 260 gallon tank. This type of tank is significantly less expensive and smaller than the pressurized tank. The disadvantage of this type of tank is that water is stagnant and therefore can only be used to supply a stand-alone or independent fire sprinkler system and not a multipurpose system (see descriptions of system types above). This type of tank requires a separate electrical pump dedicated to the fire sprinkler system. This pump adds to the cost, and to function in the event of a power failure requires a battery back-up system, like those used with a "sump pump".

4. Cost of suppression systems, capital and on-going

***Section Summary**: Cost estimates for sprinklers system vary depending on the methods used and assumptions made. There are differing estimates of associated expenses, such as water service lines, backflow prevention devices, booster pumps, storage tanks, maintenance and inspection. A study done for the Fire Protection Research Council of costs to the homebuilder of sprinkler systems installed in 30 houses found a range of total system costs from $2,386 to $16,060; and in dollars per sprinklered SF from $0.38 to $3.66. Other estimates reviewed ranged from under a dollar per square foot to $11.20 per square foot. The wide range is due to unique design elements in some homes, differing requirements for water supply, pressure, backflow prevention and metering and differing assumptions of unit costs.*

The sprinkler committee developed sample estimates that had a high total cost than the range found elsewhere. For stand alone systems, total costs ranged from $6,210 to $23,065 and cost per conditioned square foot ranged from $3.30 to 8.56. For the multipurpose system, total costs ranged from $6.856 to $9695 and $3.18 to $4.56 per square foot. Costs were higher for systems on private wells. The higher cost may be due to small sample size, higher regional costs in the northeast and specific issues with the sample homes.

4.1. Executive summary of "Home Fire Sprinkler Cost Assessment"

By Newport Partners (September 2008) for the Fire Protection Research Council (Resource #40) states**:**

> **"**Residential fire sprinkler ordinances have been adopted by several hundred United States communities for use in single-family dwellings. Such systems have been shown to provide significant life safety benefits, however the installed cost of these systems remains as a point of uncertainty and a potential barrier to broader adoption. Informal estimates of typical installation costs can vary widely and influence decision makers' views on the viability of sprinkler systems in new homes. Accordingly, the purpose of this study is to provide a national perspective on the cost of home fire sprinklers by developing data on installation costs and cost savings for ten communities distributed throughout the United States. The study also explores the range of insurance premium discounts which are available to homeowners with sprinkler systems in their houses.
>
> To obtain information on the cost of installing residential sprinkler systems, ten case study communities were selected: nine in the United States, and one in Canada. The ten communities offer diversity in terms of sprinkler ordinance status, geographic location, housing style, and sprinkler system variables such as the type of piping material and the water supply source (municipal or on-site). For each of these communities, three building plans were collected from builders and sprinkler installers, along with sprinkler system cost data and other related cost and system information.
>
> The term "sprinklered square feet" (sprinklered SF) reflects the total area of sprinklered spaces, including basements, garages, and attics when applicable. This term is used to better characterize the cost of sprinklers per unit of space which is covered by the system, especially since many of the homes have sprinklers in spaces beyond the normal living space, such as a garage. In terms of absolute costs, the total sprinkler system costs to the homebuilder ranged from $2,386 to $16,061 for the 30 houses.
>
> The cost of sprinkler systems to the homebuilder, in dollars per sprinklered SF, ranged from $0.38 to $3.66. This range represents the 30 different house plans, with the average cost being $1.61 per sprinklered SF. The low end of this range ($0.38/sprinklered SF) represents a California house in a

community with a longstanding ordinance, sprinklers in the attic and the garage (in addition to the living space), and some potential pricing benefits from a volume relationship with the sprinkler contractor. The high end of this cost range ($3.66/sprinklered SF) represents a Colorado house on well water and a system constructed with copper piping which utilized anti-freeze for freeze protection during the winter. These costs include all costs to the builder associated with the sprinkler system including design, installation, and other costs such as permits, additional equipment, and increased tap and water meter fees – to the extent that they apply. When accounting for any available tax credits given for the use of residential sprinklers (as was the case in Wilsonville, OR), the total sprinkler system costs to the builder averaged $1.49 per sprinklered SF.

Variables associated with higher cost systems included extensive use of copper piping (instead of CPVC or PEX), an on-site water supply (instead of municipal water), local requirements to sprinkler additional areas like garages or attics, and higher local sprinkler permit fees. The cost data also support the concept that communities with sprinkler ordinances in effect for more than five years tend to experience market acceptance and increased competition leading to lower system costs.

Credits or "trade-offs," which could include incentives like greater fire hydrant spacing in a community with sprinklers, were also investigated in each of the ten communities. While trade-offs may be used in communities as part of the zoning approval process for specific developments, just one of the ten communities had a credit or trade-off that applied to the houses which were analyzed. Wilsonville, OR, offers a [tax] credit of $1.21 per square foot of living space in an effort to partially offset the costs of sprinklers.

As complementary data to the cost analysis, a survey of available insurance premium discounts for homeowners with sprinkler systems was conducted. For each of the ten communities where sprinkler cost data was analyzed, the average insurance premium discount (as a percentage) was obtained from five insurers with significant market share in the state. Discount savings percentages ranged from 0 to 10% among all companies and agencies surveyed, with an average premium discount of 7%. Related issues such as limits on the overall discount allowed for protective devices, sprinkler system requirements, and any potential insurance penalties for sprinklers were also explored. There were no instances discovered of insurance penalties or extra fees associated with the use of residential sprinkler systems due to concerns such as system leakage.

Insurance quotes for a theoretical prototype house were also obtained for the nine United States communities and one Canadian community. Quotes were obtained with and without a sprinkler system in an effort to estimate the discount that may result from having a sprinkler system. Annual discount savings averaged $22, or 3.42% of the annual premium. The difference in this discount compared to the average percentage discount found in the survey is likely due to disconnect between generally quoted ranges and the real discounts allowed on real policies. As sprinkler systems become more common in given areas and this discount becomes a more common topic in the consumer-insurance agent dialogue, it is anticipated that actual discounts would more closely track with general ranges."

4.2. Summary with comments of "Benefit-Cost Analysis of Residential Fire Sprinklers."

By Butry, D. T.; Brown, M. H.; Fuller, S. K. 2007; National Institute of Standards and Technology. http://www.bfrl.nist.gov/oae/publications/nistirs/NISTIR_7451_Oct07.pdf (Resource #5)

***Abstract*:**

"This report documents a benefit-cost analysis performed to measure the expected present value of net benefits resulting from the installation of a multipurpose network fire sprinkler system [this refers to systems combined with home plumbing as opposed to separate piping] in a newly-constructed, single-family house. The benefits and costs associated with the installation and use of a fire sprinkler system are compared across three prototypical single-family housing types: colonial, townhouse, and ranch. The installation costs differ by housing types, with the colonial being the most expensive and the ranch the least.

The benefits experienced by residents of single-family dwellings with sprinkler systems, as measured in this report, include reductions in the following: the risk of civilian fatalities and injuries, homeowner insurance premiums, uninsured direct property losses, and uninsured indirect costs. The primary costs examined are for initial purchase and installation of the sprinkler system. Maintenance and repair costs are not examined because they are negligible. Results of the benefit-cost analysis show that multipurpose network sprinkler systems are economical. The expected present value of net benefits (PVNB) in 2005 dollars is estimated as $2919 for the colonial-style house, $3099 for the townhouse, and $4166 for the ranch-style house. A sensitivity analysis is performed to measure the variability of the results to changes in the modeling assumptions. The sensitivity analysis confirms the robustness of the baseline analysis. The PVNB range from $704 to $4,801 for the colonial-style house, from $884 to $4,981 for the townhouse, and from $1,950 to $6,048 for the ranch-style house. Multipurpose network systems are the lowest life-cycle cost systems because homeowners can perform their own regular inspections and maintenance, and thereby save on costs they would incur with other systems. Given that they provide a similar level of performance, in terms of fire-risk mitigation, multipurpose network systems then achieve greater cost-effectiveness over alternate systems."

Comments:

The NIST report has stripped the cost of the sprinklers down to the bare material cost (prior to mark-up), labor and design to achieve the lowest value possible for a sprinkler system. Expenses excluded from this study include backflow prevention devices, booster pumps, additional storage tanks, yearly maintenance of anti-freeze system, and inspection of dry-systems (note, typically only with NFPA 13 design), which may not be cost-beneficial.

The NIST report estimates the costs for a multipurpose network fire sprinkler system added to an existing cold-water plumbing system, the minimum standard required by NFPA 13D. According to a previous report by Brown, this system was the least expensive of all the systems that can be installed in a one- and two-family dwelling. The multi-purpose system is limited in applicability and may be cost effective only when the existing infrastructure can provide the required water supply. A multi-purpose system requires the additional cost of backflow prevention when the local water purveyor requires a mechanical separation between the fire suppression system and the domestic water system. A backflow preventer cost about $200 to purchase and about $100 per year to inspect, which would be sufficient to push the cost of fire sprinklers above the estimated benefits. Some jurisdictions allow double-check valves, which are less expensive and need no inspection.

4.3. JB Engineering cost summary

(Resource document 28) JB Engineering and Code Consulting, P.C. issued an engineering report of the cost associated with the installation of a residential sprinkler system in an affordable home. The home evaluated had 1140 square feet, 3 bedrooms and 1-1/2 baths. The costs were estimated for installing piping

of a multi-purpose system. The report indicated that the additional material cost to sprinkler the home was $125, with an additional 12.26 hours of labor to install the system. Estimated costs ranged from 0.38/ square foot to 0.98/ square foot and from $431.51 total cost to $1,044.51 total cost.

4.4. Prices of 13D systems in NYS, August 01, 2008

(Resource #31) Responses by a fire sprinkler installer to NFSA inquiries regarding the 13D system costs are summarized below. Costs are of stand-alone homes done within the Capital District by a union fire sprinkler contractor. The following are some square foot prices of NFPA 13D installations of single family homes for the Capital Region.

Table 4.1 -1: 13D square foot costs submitted by NFSA

Cost	Sq Ft *	Price Per Sq Ft
$13,800.00	5472 Sq Ft	$2.52
$14,243.00	5200 Sq Ft	$2.73
$15,200.00	5300 Sq Ft	$2.84
$17,600.00	7200 Sq Ft	$2.45
$17,000.00	6300 Sq Ft	$2.69

* Square foot as advertised, based on the floor plan square footage, basement, first and second story levels.

Notes regarding 13D pricing:

- Our Workers Comp and Liability exceed the requirements.
- Prices include design.
- No additional work or material for the water service is included.
- A five gallon per minute pump will not work. Systems require roughly 28-30 gpm.

4.5. Summary of cost estimates in appendix A

The committee developed cost estimates, presented in appendix A, that are high relative to those discussed in this section. The cost estimates were for two sample homes in three areas in NYS, both stand alone and multipurpose systems. For stand alone systems, total costs ranged from $6,210 to $23,065 and cost per conditioned square foot ranged from $3.30 to 8.56. For the multipurpose system, total costs ranged from $6.856 to $9695 and $3.18 to $4.56 per square foot. Costs were higher for systems on private wells.

Some possible reasons for cost higher than found elsewhere are that construction costs are generally higher in the northeast than elsewhere in the country; the costs were developed for specific house designs rather than getting an average of all typical construction; and the cost are for single homes rather than for several lumped together in a subdivision.

Building layout and approximate sprinkler layouts used to develop these cost estimates are shown in the appendix D. The sprinkler estimaters made some modifications to layouts provided by the engineer.

4.6. New York State Builders Association (NYSBA) fire sprinkler cost estimates

The table below presents cost estimates presented by NYSBA to the NYS Residential Sprinkler Committee for this report. The estimates were compiled in September of 2008. These costs are wholesale trade contractor costs, and do not included builder markup, overhead or profit (i.e. insurance, expenses, and management staff). The final cost to the homeowner will be considerably higher. The cost does not including engineering fees, $1,500 to $4000.

Cost	House Size, Square Feet	Region	Anecdotal
$6.80 - $11.20 per SF	NA	Northern Westchester	"As for demand for sprinkler systems, many of my clients cut back on the size of additions so they don't have to incur this added expense,(under 30% of added structure requires no sprinkler. I would estimate fewer than 5% of my clients would want to install this system if not required by the town code. One of the most asked questions when we complete a job in towns that require fire sprinklers is; 'how do I turn the system off?' because of the fear of freezing or accidental pipe breakage."
$9,500	2,800	Hudson Valley	If suitable water system is not available, there is an additional $5,200 charge for special water pump and storage unit, plus an additional cost for supplying a dedicated circuit for the unit.
$12,000	2,500	Capital Region	None available
$13,300	3,600	Hudson Valley	None available
$13,000 - $15,500	2,000 - 3,000	Rochester	None available
$17,480	2,266	Hudson Valley	None available
$20,000	3,200	Capital Region	"The customer does NOT want the sprinkler system or the burden of the added cost and is trying to appeal to the town to relinquish the requirement "
$24,000+	5,000	Orange County	"I was able to move into a new house that I had designed and built, and it incorporated a sprinkler system. I have a 5,000 +/- sq. foot house and the sprinkler added less than $25,000"

5. Potential impact on housing market

Section Summary: *Our survey of communities with mandated residential sprinklers in one and two family homes, mostly characterized as communities with high end homes and aggressive housing markets, did not identify a housing market impact of the added cost of sprinkler systems. In general, residential construction in NYS had a downturn in 2008 relative to 2007. Based on the ability to obtain a mortgage, we determined that in twelve metro areas of NYS, the number of households priced out of the market for a median priced new home by a $1,000 price increase in selling price averaged 0.17 percent, with a median of 0.19 percent (Table 5.3.-2).*

For manufactured homes, adding sprinklers will increase the sales price by a larger percentage of current costs, approximately 16 to 19 percent. This sector of the market is most likely to be unable to afford a new home. Fire fatality rates per thousand manufactured homes are similar to other dwellings, although the fatality per fire is higher in manufactured homes than other dwellings.

There has been a slight decrease in affordability of "modestly priced homes" in the US from 1984 to 2004. Over the 1996 to 2006 period, a growing share of household income was devoted to housing.

5.1. Impact identified thru survey and case studies

Our survey of communities with mandated residential fire sprinkler systems in one and two family homes did not identify an impact on the housing market. In most cases, the municipal contacts characterized the communities as high end homes with aggressive housing markets.

5.2. Residential construction statistics for 2007 and 2008

The table below shows the change in residential construction in NYS from 2007 to 2008.

Table 5.2-1: Building statistics for NYS December 2007 v. December 2008

Type of Housing	Year to Date Units 2007	Year to Date Units 2008
Single Family	10,665	8,225
Two Family	3,384	1,668
Total of 1-&2- Family	14,049	9,893
Three & Four Family	3,864	1,278
Five or More Family	28,464	34,223
Total	46,377	45,394

Source: U.S. Bureau of the Census, Manufacturing and Construction Division, Building Permits Branch.

5.3. Determining the number of households priced out of a market

From NAHB: "For most people, buying a home means taking out a mortgage. According to the U.S. Census Bureau's 2007 American Housing Survey, only 19% of recent home buyers purchased their homes for cash. Thus, the ability to buy a home depends, in most cases, on the ability to qualify for a mortgage.

For conventional mortgages, qualifying guidelines set by the secondary market lenders play a dominating role.

The major secondary market lenders for conventional mortgages are the Federal National Mortgage Association, or “Fannie Mae”, and the Federal Home Loan Mortgage Corporation, or “Freddie Mac”. Acceptability of these loans to secondary market purchasers is crucial, and institutions making conventional loans tend to follow the guidelines set forth by Fannie Mae and Freddie Mac. Even where these guidelines permit some flexibility, local lenders prefer to follow them strictly rather than risk being unable to sell the mortgages, or facing the prospect of selling them and later being forced to buy them back.

Standards to qualify for a mortgage are typically expressed as a fraction of the household’s monthly income. In the jargon of lenders, the “front end ratio” is the percentage of monthly income devoted to “PITI” -- Principal and Interest (the mortgage payment itself), as well as property taxes and property insurance. For any particular set of assumptions about the mortgage, the front end ratio can be calculated for a given income. Thus, comparing household income to PITI is a convenient way to analyze the household’s ability to buy a home.

Assumptions used in the “priced-out” computations are a downpayment equal to 10 percent of the purchase price and a 30-year fixed rate mortgage. For a loan with this downpayment, lenders would typically require mortgage insurance, so we also assume an annual premium of 45 basis points for private mortgage insurance. Local information about property taxes comes from US Census data. (For greater detail, see Paul Emrath, “Property Taxes in the 2000 Census,” *Housing Economics,* December 2002; excerpts reprinted in Nation’s Building News June 16, 2003, and Land Development Summer 2003.) Average homeowner insurance rate data were compiled by the National Association of Insurance Commissioners; the data for each state were provided by the Insurance Information Institute. We then say that a particular household can afford a house if it satisfies the front-end requirement set down by Fannie Mae and Freddie Mac: PITI should not exceed 28 percent of income. Given a distribution of household income for the market area in question, this can be used to determine the number of households priced out of the market.

A detailed 2004 income distribution is available for all states and Metropolitan Statistical Areas from the 2005 American Community Survey, but must be adjusted for income and population changes in the intervening years. Income limits are adjusted annually based on the U.S. Department of Housing and Urban Development’s list of median family incomes for all states. The number of households in each category is multiplied by a population growth factor -- generally determined by computing the average annual growth rate implied by the change in area population between 2003 and 2005 (available from the Bureau of Economic Analysis, which is part of the U.S. Department of Commerce) and assuming that the number of households in each income group grew at this rate every year since 2005.”

According to the U. S. Census at http://www.census.gov/population/www/metroareas/metroarea.html accessed April 24, 2009, metropolitan and micropolitan statistical areas (metro and micro areas) are geographic entities defined by the U.S. Office of Management and Budget (OMB) for use by Federal statistical agencies in collecting, tabulating, and publishing Federal statistics. A metro area contains a core urban area of 50,000 or more population. Each metro area consists of one or more counties and includes the counties containing the core urban area, as well as any adjacent counties that have a high degree of social and economic integration (as measured by commuting to work) with the urban core.

The below table indicated the number of household priced out of being able to obtain a mortgage for each $1,000 added to the cost of a residence.

Table 5.3-2: Households priced out of the market for a median priced new home by a $1,000 price increase

Metropolitan Statistical Area	Median new home price (1)	Income needed to qualify (2)	Number of households (3)	Households priced out (3)	% Priced out
Albany-Schenectady-Troy, NY MSA	$320,812	$94,445	337,662	548	0.16%
Binghamton, NY MSA	$225,785	$66,470	101,519	192	0.19%
Buffalo-Niagara Falls, NY MSA	$230,531	$67,867	470,832	937	0.20%
Elmira, NY MSA	$254,510	$74,926	35,119	50	0.14%
Glens Falls, NY MSA	$262,298	$77,219	50,147	89	0.18%
Ithaca, NY MSA	$240,229	$70,722	36,514	85	0.23%
Kingston, NY MSA	$339,717	$100,010	68,401	73	0.11%
New York-Northern New Jersey-Long Island, NY-NJ-PA MSA	$471,222	$138,724	6,728,463	4,170	0.06%
Poughkeepsie-Newburgh-Middletown, NY MSA	$327,560	$96,431	225,718	420	0.19%
Rochester, NY MSA	$236,673	$69,675	402,660	852	0.21%
Syracuse, NY MSA	$221,722	$65,273	256,421	580	0.23%
Utica-Rome, NY MSA	$222,396	$65,472	117,643	229	0.19%
				Average	0.17%
				Median	0.19%

(1) From HousingEconomics.com
(2) Methodology described above.
(3) Based on information from US Census.

5.4. Manufactured homes and modular housing

Manufactured and modular homes may have a different housing market than housing in general. Modular homes are subject to state building codes. Manufactured homes must meet building standards defined by the Department of Housing and Urban Development (HUD) and are defined as a movable dwelling, 8 feet or more wide and 40 feet or more long, designed to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation. No building permit is required for construction of a manufactured home, although one is needed for installation.

Installation of residential fire sprinklers can be required in both modular and manufactured homesIn a letter dated January 31, 2008, from William W. Matchneer III, HUD Associate Deputy Assistant Secretary

of the federal Regulatory Affairs and Manufactured Housing, Mr. Matchneer states, "Exterior fire resistance is an element of performance that is not addressed by the Federal Manufactured Home Construction and Safety Standards, 24 CFR 3280. Accordingly we would not consider the application of the [local sprinkler requirements] to manufactured housing to be a violation of the preemption provisions of the National Manufactured Housing Construction and Safety Standards Act, 42 U.S.C 5403(d)." from http://www.hcd.ca.gov/codes/mhp/01-08-09WUInoticeofpublication.pdf accessed May 12, 2009.

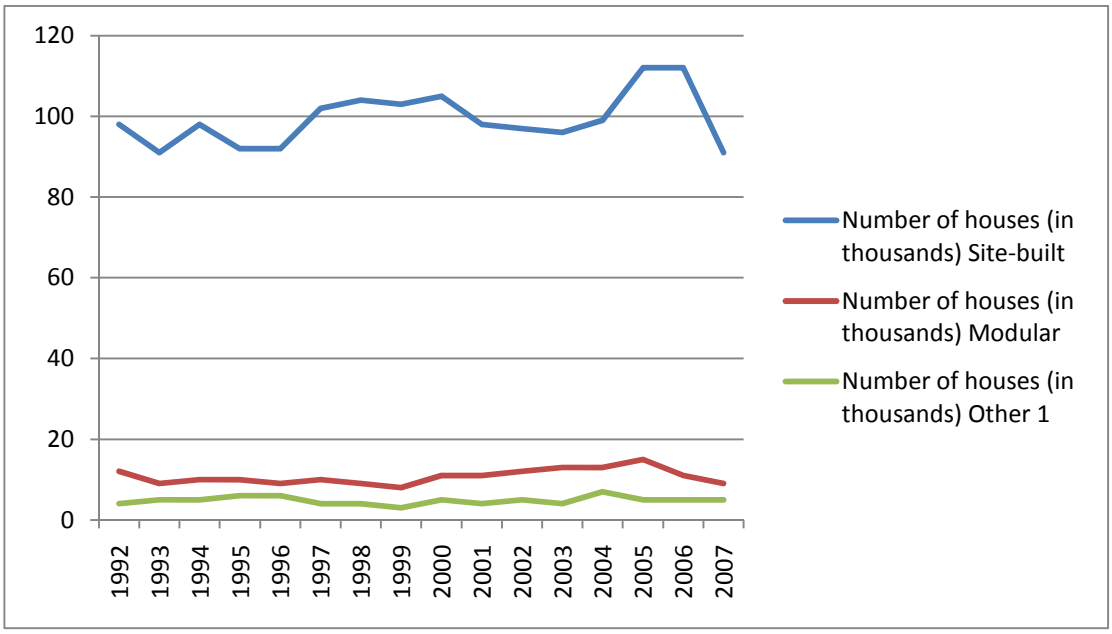
According to NFPA's "Manufactured Home Fires (2005) by John R. Hall, in the United States:

- Manufactured homes have nearly the same risk of fire death per occupied home 3.3 per 100,000 manufactured homes compared to 2-7 to 3.0 per 100,000 other dwellings.
- Manufactured homes have a higher rate of deaths per fire, but less fires.
- HUD standards provide requirements to limit or slow fire spread
- In 2001, the median household income in occupied manufactured homes was $26,100 compared to $38,400 for all occupied housing units (American Housing Survey. The percentage of households falling below the poverty line was 19% for occupied manufactured homes compared to 14% for all occupied homes.
- Studies of home (all homes) fires show that increase in poverty is associated with higher fire and fire fatality rates per household.

5.4.1. U. S. Census and other census and survey information

The US Census has information regarding modular and manufactured homes in construction statistics at http://www.census.gov/const/www/charindex.html, the Manufactured Housing Survey at http://www.census.gov/const/www/mhsindex.html, and American Housing Survey at http://www.census.gov/hhes/www/ahs.html. HUD also presents survey data on manufactured and modular housing, at: www.hud.gov/offices/hsg/sfh/mhs/mhshome.cfm. The US Census construction statistics show the numbers of different types of homes constructed, as shown below.

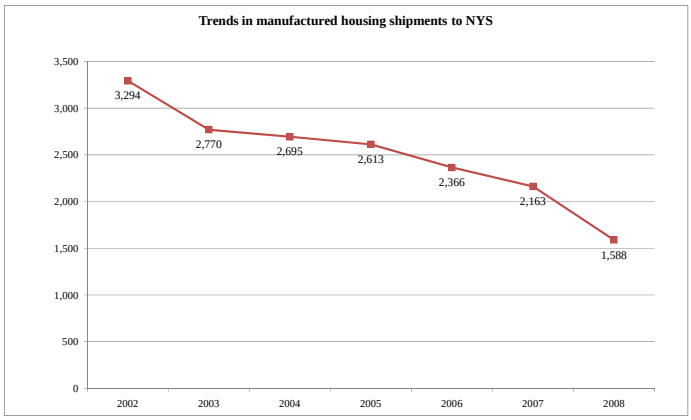
Figure 5.4.1-1: U. S. Census: type of new one-family houses completed in the Northeast



1. Other includes panelized and precut units.
Source: U. S. Census at http://www.census.gov/const/C25Ann/sftotalconstmethod.pdf

The U. S. Census Manufactured Housing Survey (MHS) provides information regarding new manufactured homes, including placements, average sales prices, and other data. It does not collect any demographic data, data on repossessed homes or resale units, or data for modular homes. The data for the Manufactured Homes Survey are collected from the dealers and not from manufacturers or homeowners; shipments figures are based on number submitted by manufacturers. The survey data relates to the initial placement of the home. The following figure and table present shipment and price trends according to the U. S. Census Manufactured Housing Survey.

Figure 5.4.1-1: Manufactured housing annual shipment to NYS



Source: U. S. Census Bureau: http://www.census.gov/const/mhs/stship.html accessed May 20, 2009

Table 5.4.1-1: NYS average sales price of new manufactured homes place by size

Year	Total(1)	Single	Double
2007	$58,900	$41,800	$69,400
2006	$62,800	$36,400	$69,000
2005	$58,200	$36,600	$64,100
2004	$53,400	$34,800	$60,200
2003	$53,200	$33,500	$58,700
2002	$53,800	$34,900	$59,000

(1) Includes manufactured homes with more than two sections.
Source: Data by the U. S. Commerce Department's Census Bureau from a survey sponsored by the U. S. Department of Housing and Urban Development.

In the U. S. from 2001 to 2007, manufactured homes ranged from 13 percent to 7 percent of all single family housing starts (source: www.census.gov/const/mhs/sitebuiltvsmh.pdf). The percentage of modular homes for the same period in the northeast US ranged from 9 to 11% per http://www.census.gov/const/www/charindex_excel.html

5.5. Home affordability trends and status

Research and reports regarding housing affordability status and trends have been published by U. S. Census. The National Housing Conference (NHC) also presents research and data regarding factory built homes and housing affordability.

U. S. Census published "Who Could Afford to Buy a Home in 2004?" By Howard Savage, which shows a slight decrease in affordability of "modestly priced homes" in the U. S. from 1984 to 2004. The report presents trends of housing affordability in the following table.

Table 5.5-1: U. S. Percentage of owner and renters who could afford to buy home

		Families			Unrelated owners / renters		
Year	Total	Total	Owner	Renter	Total	Owner	Renter
1984	52.2	60.4	79.6	12.6	33.5	60.2	13.4
1988	51.4	59.7	78.1	14.0	33.9	60.8	12.8
1991	49.4	57.6	75.2	13.1	33.4	59.0	12.2
1993	49.5	57.7	76.5	11.7	33.5	60.8	11.2
1995	48.3	55.6	74.6	9.9	34.3	62.3	10.6
2002	47.9	56.4	73.6	7.8	33.1	57.0	7.3
2004	49.1	58.4	75.7	8.3	34.2	59.8	7.0

Note: Assumes conventional, fixed-rate 30- year financing with 5 percent down payment. No report was issued between 1995 and 2002. Source: U. S. Census Bureau, Survey of Income and Program Participation, 2004.

The NHC has several reports of housing economic issues. NHC is a nonprofit nonpartisan organization that advocates for national policies and legislation that promote affordable housing. The Center for Housing Policy is NHC's research affiliate. We looked at three reports, "The Housing Landscape for America's Working Families, 2007;" "Stretched Thin – the Impact of Rising Housing Expenses on America's Owners and Renters;" and "Paycheck to Paycheck 2009."

To summarize "The Housing Landscape for America's Working Families, 2007" by Brennan and Lipman, (resource #), reported:

- "Nationally, from 1997 to 2005, the number of working families paying more than half their income for housing increased 87 percent, from 2.4 million to 4.5 million. Adding in families living in severely inadequate, or dilapidated, housing yields a total of 5.2 million working families with critical housing needs in 2005—an increase of some 73 percent over the 3 million families experiencing these problems in 1997. In the most recent two-year period from 2003 to 2005, however, the number of working families with critical housing needs grew only modestly from 5 million to 5.2 million households."

- Critical housing need is defined as spending more than have the household income on housing or living in severely inadequate housing.
- "In most of the metro areas studied, the share of working families with critical housing needs is very similar in the central city and suburbs."
- The number of households with critical housing needs in the United States increased greatly between 2003 and 2005, from 14.3 to 17.5 million, or roughly one out of every seven American households. Much of this was among nonworking retired and unemployed households, and may be due to the increase in households in these categories. The number of low- to moderate-income working families with critical needs grew modestly from 2003 to 2005; from 1997 to 2005, the number increased 73 percent, faster than any other group.

Table 5.5-2: U. S. type of critical housing need reported by working families - 2005

Year	**1997**	**1999**	**2001**	**2003**	**2005**
Severe Cost Burden	79.3%	79.7%	83.4%	84.1%	85.5%
Severely Inadequate	21.7%	22.2%	18.5%	18.2%	16.3%
Both	<1.0%	1.9%	2.0%	2.2%	1.8%

Note: Numbers do not add up to 100% due to some reporting multiple problems and to rounding. Severe cost burden is defined as paying more than half of income for housing.
Source: "The Housing Landscape for America's Working Families, 2007" by Brennan and Lipman

Table 5.5 -3: U. S. working families with critical housing needs by income

Income Distribution	1997	1999	2001	2003	2005	Number in 2005 (total of 5.2 Million)
< 30% of Median	14.2%	16.5%	18.1%	19.3%	21.6%	1,131,000
30 to 50% of Median	40.8%	36.8%	38.8%	36.8%	35.5%	1,859,000
50 to 80% of Median	30.2%	28.8%	27.0%	28.1%	26.5%	1,388,000
80 to 100% of Median	9.3%	10.6%	10.0%	9.4%	10.1%	529,000
100 to 120% of Median	5.5%	7.3%	6.0%	6.4%	6.2%	335,000

Source: "The Housing Landscape for America's Working Families, 2007" by Brennan and Lipman

Table 5.5-4: Residential location of working families with critical housing needs - 2005

Year	1997	1999	2001	2003	2005
Urban	40.1%	43.1%	39.5%	39.3%	39.9%
Suburbs	42.3%	40.0%	42.5%	41.9%	42.7%
Non-Metropolitan	17.5%	16.9%	18.0%	18.8%	17.4%

Source: "The Housing Landscape for America's Working Families, 2007" by Brennan and Lipman

Key Findings of Stretched Thin – the Impact of Rising Housing Expenses on America's Owners and Renters (Brennan and Lipman (2008)) are:

- "Over the 1996 to 2006 period, a growing share of household income was devoted to housing. In 2006, homeowners typically spent 26.2 percent of their income — up from 21.5 percent in 1996 — while among renters, housing consumed 29.4 percent of income — up from 25.6 percent ten years earlier. These averages mask wide variation. Nearly one-in-six households — nine million homeowners, nine million renters — spent more than half their income on housing in 2006 — a share of income far in excess of the 30 percent threshold generally deemed "affordable."
- "[T]he increase in housing expenses between 1996 and 2006 far exceeded increases in other essentials. Housing expenses increased by an average of $5,314 (64.9 percent) during this period, substantially more than food ($1,413 or 30 percent) and transportation ($2,126 or 33.3 percent) and even outpacing healthcare ($996 or 56.3 percent). Incomes for all households rose 35.8 percent over the same period. Over the decade, all the major categories of homeowner expenses increased faster than incomes. Mortgage payments increased 46 percent, utilities 43 percent, property taxes 66 percent, and property insurance 83 percent. By contrast, homeowner incomes increased by 36.3 percent. Rental costs also increased faster than incomes. Rents increased by 51 percent between 1996 and 2006, while renter incomes increased only 31.4 percent over the same period. Moreover, the costs of owning and maintaining rental properties have also been affected by the cost trends examined in this report — and will likely be passed along to tenants through rent increases."

The Center for Housing Policy (2009) Paycheck to Paycheck 2009 summarizes: "Many American workers cannot affordably live in the communities they serve. States and localities will need to go beyond saving or creating jobs and pay attention to the housing affordability needs in their communities. Policies can help to convert vacant or foreclosed properties into affordable rental or homeownership homes, prevent renters and owners from being displaced by foreclosure, and even create new opportunities for affordable housing despite a weakened development environment."

For the fourth quarter of 2008, modular homes were 6.9% of building permits in NYS, according to the NHMC. Excerpt from National Modular Housing Council (NHMC) (March 2009) NHMC's Quarterly Modular Housing Report Fourth Quarter 2008. "Consumer demand for modular homes typically parallels that of site-built homes. In other words, shipments of modular homes and sales of newly constructed site-built homes respond to changes in macroeconomic and housing market conditions in a similar fashion. …[T]he decline in modular home shipments in 2008 (down 33.4 percent compared to 2007) was roughly in line with the decline in site-built home sales (-37.8 percent)."

Per proposals submitted to the New York Housing Association from Marlette Homes for putting sprinkler systems in HUD Code homes in a land-leased community in PA, the average price of a double section manufactured home in NY would increase in cost 13% with addition of a sprinkler system. The increase in cost for a single section home with addition of a sprinkler system would be 19%. The cost proposals are attached in Appendix B.

6. Potential impact on residential insurance premiums

Section Summary: *Most insurance companies have provisions for discounting residential insurance premiums due to a variety of preventive conditions, including fire sprinklers. The total discount available for all preventive conditions is generally assigned an upper limit. A new home may already have premiums discounted to the upper limit, so that fire sprinklers would not add discounts. Premium deductions are likely to be less than 10%.*

6.1. Summary of resource documents - insurance

The following documents were reviewed for an overview of insurance company response to residential fire sprinklers. The documents were compiled by Thomas White, Dominic Kasmauskas, John Hofelich and NYSDOS staff.

- CHUBB Masterpiece® insurance Guide to discounts (Resource 7)
- Adirondack Insurance Exchange policy for NY (Resource 1)
- Personal Coverage, Inc.'s Homeowners Insurance Sprinkler Discounts – Report (Resource 51)
- Lanlan Xu, Fire Sprinklers and Homeowner Insurance**,** Special Studies, September 14, 2007; Published by National Association of Homebuilders (Resource 64)
- Insurance Services Office (ISO) website (Resource 25A)
- Survey by Thomas White, Survey of Insurance Response to Sprinklers (Resource 62)
- Report by Thomas White on Sprinkler Installation Insurance Credit (Resource 63)
- Insurance Information From: Dominick Kasmauskas CFPS, August 01, 2008 (Resource 32)
- Insurance Services Office Potential Changes to Fire Suppression Rating Schedule (Resource 16)

To summarize, currently residential insurance costs may be lowered in homes with fire sprinkler systems due to deductions to individual premiums. Both the current premium deduction and the potential community-wide decrease in premiums are likely to be less than 10%.

Currently the insurance entities reviewed offer deductions to residential premiums due to installation of sprinklers meeting NFPA 13, and in some cases to those meeting NFPA 13D. The deductions ranged from 5 to 15%. However the entire deduction may not apply, as each of the insurance policies reviewed have an upper limit to the amount of deductions allowed.

- The Insurance Services Office (ISO) recommends a discount in most states of 13 percent for a 13D system covering all building areas, 15 percent if smoke detectors are also provided.
- Chubb Masterpiece offers a 2% reduction for residential fire sprinklers, with total of all deductions capped at 12%.
- Personal Coverage Inc. offers 7% for 13D systems; 13% for 13 sprinkler systems, with a deduction cap at 35%.
- State Farm and Allstate Insurance customers indicate that they are allowed residential sprinkler credits from 5 to 15%. Neither company has riders for water damage either by fire or by water leaks or pipe malfunctions. All items are covered in the standard home owner's policy as if your domestic pipes broke. Deduction cap is unknown.
- Other home criteria resulting in premium deduction include new home credit (20-30% for first year, 2% by 15th year); non-smoker credit (5%); smoke detectors (2% local, 5-8% central station); burglar alarms (2% local, 5-8% central station); combined home and auto (5-10%); fire extinguishers (2-4%). Credit history and number of past claims also affect the premium.

- The New York Insurance Association (NYIA ®), a state trade association that represents the property and casualty insurance industry in NY, offers a 3% homeowner credit for a full sprinkler system installed (no mention of credit for partial systems). Most people who install sprinklers also install smoke detection and get a total 5% credit (3% for sprinkler and 2% for the smoke detectors). The sprinkler systems credit takes into account potential for collateral damage from sprinkler release or freezing and the need for routine maintenance. NYIA companies follow the ISO sprinkler credit rule of up to 13%.

- Water damage due to sprinkler release is generally covered with limitations. For instance NYIA ratings indicates that their standard Insurance Service Office homeowner's form shows building and contents are covered as long as the insured complies with conditions for the system to always operate (eg. water in the system and heat to keep lines from freezing.)

In addition to the credits applied directly to a premium, a community's Public Protection Class also impacts insurance. The presence of residential sprinklers does not currently affect this rating.

7. Survey of jurisdictions within NYS with mandated sprinklers in One and Two-Family residences and other case studies

Section Summary: *In a survey of officials from eight communities with sprinklers mandated in one- and two- family residences, three have reported fire in sprinklered residences. The sprinklers reportedly contained the fires, excepting one case in which the fire started on the roof. Reported sprinkler systems included water based and water with anti-freeze, and were installed in homes with both private and public water supplies. Some problems were reported, including freezing pipes and insufficient pressure.*

In other case studies:

- *Statistics are maintained by communities in Arizona and Maryland that have mandatory residential sprinkler requirements over ten years. There were no reported fire deaths in homes protected with residential sprinklers.*
- *Several case studies have reviewed the cost and benefit of residential sprinklers. (additional text needed).*

7.1. Overview of more restrictive local standards

The NYS Code Council is empowered to adopt higher or more restrictive standards [MRLS] upon the recommendation of local governments in accordance with Section 379 of the Executive Law. Within thirty days of such enactment or adoption of a local law or ordinance pertaining to construction, the appropriate officer of the municipality is required to notify the NYS Code Council. If the Code Council finds the MRLS is reasonably necessary because of special conditions prevailing within the local government and that such standards conform with accepted engineering and fire prevention practices and purposes of the law, the Code Council adopts such MRLS, in whole or part. Out of 1,604 eligible municipalities in NYS, 57 have adopted an MRLS, eight of which include requirements for residential sprinklers in one and/or two-family dwellings.

7.2. Summary of survey of jurisdictions in NYS with mandated sprinklers in applicable residences

This summarizes a survey of eight municipalities that have more restrictive local standards (MRLS) that require residential fire sprinkler systems in one and two-family residences, and one community which has required residential fire sprinklers although it does not have a more restrictive local standard. The eight communities include all that have approval from the NYS Code Council for a MRLS requiring residential sprinklers in one and / or two family residences. The survey consisted of a telephone interview with an official in the municipal building department, usually the code enforcement officer. In the case of the Village of Sleepy Hollow, the village architect requested that we email questions rather than conduct a verbal survey. In the towns of Greenburgh and Harrison, the code enforcement officer requested that we speak with the fire marshal as well. The completed survey forms are attached in an appendix to this report.

Responses are summarized below, and the communities are listed with a brief summary of responses in Table 1, following.

To summarize responses from the eight communities:

- Seven are in Westchester County and one in Onondaga County;

- Four are towns (one, Harrison Town and Village, includes a village within it) and the other four are villages.
- Five respondents noted some problems. These consisted of pipes freezing which caused leaks in water systems; owners draining system due to construction changes; a sprinkler head recall and the local water company lowering the delivery water pressure so that systems lacked adequate pressure.
- All municipalities had provisions for hardship variances; four had granted variances either to remove the sprinkler requirement for homes on wells or health issue or to reduce the number of sprinkler heads needs in existing building areas.
- Three of the larger municipalities have had reported fires in sprinklered residences. The Town of Harrison reported two, both of which were contained by sprinklers; The Town of Greenburgh reported some, in which the use of sprinklers has kept fires small and contained; the Town of New Castle reported several, and reported that the sprinklers generally had contained the fires except for an incident in which a fire started on the roof and had substantially destroyed the structure before the sprinklers went off.
- Most of the sprinklered residences are on municipal water; however many are on well water supply. For well water supply, a storage tank of approximately 300 gallons, and booster pump is generally installed in the basement. Some residences on municipal water also require a storage tank and booster pump due to municipal water pressure below that required by the sprinkler system.
- Most systems are wet systems, with water or water and glycol or glycerin. One community does not allow antifreeze in residential fire sprinkler systems.
- No municipality enforces maintenance, although most systems on municipal water have backflow preventers. NYSDOH requires that backflow preventers be inspected and certified annually.

Completed surveys are attached in Appendix B.

7.3. Other case studies outside NYS with mandated fire suppression

Statistics are maintained by various communities and states that have mandatory residential sprinkler requirements. (Resource 17, 18, 50, 53) Scottsdale, Arizona issued a 10 year report and a 15-year executive summary of the success of residential sprinklers in their community. There have been zero fire deaths in homes protected with a residential sprinkler system. The State of Maryland has numerous jurisdictions with mandatory residential sprinkler requirements. Prince George County issued a report in 2001 regarding their experience with mandatory residential sprinklers. There were no reported fire deaths in homes protected with residential sprinklers.

7.3.1. Discussion of "Residential Sprinklers: One Community's Experience Twelve Years After Mandatory Implementation"

Siarnicki, Ronald Jon, 2001, Prince Georges County. (Resource 53)

The Report states:

> "It is now a proven fact, through the Prince George's County experience, that in all 117 fire related cases, as part of this research, the buildup and accumulation of toxic fire gases and heat was prevented by the activation of either one or two residential sprinkler heads. This is supported by the fact that no one individual, out of the 154 that were present at the time of these reported fire occurrences or seven that were injured in these 117 fire cases, was overcome by smoke or, more tragically, succumbed to the devastating effects of the fire. Compared to the obvious number of injuries, both smoke inhalation and burns that resulted to the group of citizens that resided in non-sprinklered structures, 22 reported deaths and 46 significant burns and smoke related injuries that occurred in just four short years." Note: The non-sprinklered structure fires included 50 randomly selected events.

While the report provides some information on the fire incident, it does not go into any great detail describing the criteria used to determine if the sprinkler system was the primary factor responsible for the safe evacuation of the people in the dwelling unit. The studies conducted in Scottsdale, Arizona and Prince Georges County, Maryland both make the claim that the fire suppression system is responsible for saving over 170 people. In the reports there is no mention to the importance that smoke alarms played in these fires scenarios and the contributions made in saving those lives.

In January of 2007, NIST issued a report that documented the performance of residential smoke alarms in residential fire settings. (Resource 6 (Buckowski), Page 260) Test that were simulated and recorded by the NIST technicians and scientist included some scenarios where residential type sprinklers were present. In several of the tests it was recorded that the sprinklers activated well after the alarms activated to provide the early warning needed to escape before untenable conditions were achieved. Fire Sprinklers of the "Residential" quick response class are designed to hold a fire in check before an untenable condition occurs, per UL 1626.

The Report also states:

> "The criteria utilized by the Department, at the time of completing this activation report, were based upon the numbers of people that were in close proximity of the fire's origin or were in the immediate areas of the living unit where the fire occurred."[2]

There are several factors that affect the outcome of a structural fire that are not provided in the Prince George report. Missing information included clear definition of "close proximity" or "in the immediate areas of the living unit"; what alerted the occupant that there was a fire; if a smoke alarm present and working; and in one- and two-family dwellings where there was a fire fatality, whether they had working smoke detectors, and whether the occupants were capable of self preservation, sleeping or awake.

7.3.2. Discussion of "Saving Lives, Saving Money: Automatic Sprinklers: a 10 Year Study: A Detailed History of the Effects of the Automatic Sprinkler Code in Scottsdale, Arizona."

Ford, Jim. 1997; Frankfort: Home Fire Sprinkler Coalition. (Resource 17)

Over the ten year period [from 1985 to 1995] 19,649 (35%) of the total of 57,301 available one and two family dwellings were equipped with sprinklers. During that time a fire was reported to have occurred in 18 (0.0009%) of those single family dwelling units. Of the reported 598 fires in residences, 18 occurred in sprinklered single family homes.

It is suggested that in the ten years that sprinklers were required in Scottsdale there were 13 lives that were lost in non-sprinklered homes and no lives were lost in the sprinklered homes, therefore proponents suggest that sprinklers saved the lives of 13 people. One must look carefully at the circumstances surrounding those 13 fatalities, such as whether smoke alarms were present and whether they operated.

At the end of the first ten years there were 19,649 homes that were required to be sprinklered. Over the ten year period the cost to install a sprinkler system in a 2,000 square foot house started at $1.14/psf and dropped to $0.59/psf. That means for a 2,000 square foot home it cost $2,280 in 1986 and in 1996 it cost $1,180 to install a sprinkler system, which averages $1,713. [The report does not clarify what is included in the estimate.]

Using the average cost over the ten years would put the total cost of installing the sprinkler systems in all 19,649 homes around $33,658,000 (not including any profit or mark-up figured in). The study states that there was a potential loss of $5,393,000 that could have occurred had the sprinklers not been installed, $28,265,000 less than what was spent on average to install.

Dwelling units equipped with Sprinklers	19,649	# of fires in protected dwelling units	18	% of fires in protected	.0009%
Total cost to install sprinklers	$33,658,000	Total potential loss	$5,393,000	Total spent in excess of potential damages	**$28,265,000**

Proponents of residential fire sprinklers profess that working smoke detectors are required in all homes, new or existing. The combination of working smoke detectors and automatic residential fire sprinkler system increases the occupants' chances of survival by 82%.

There are a multitude of possible indirect costs incurred from an unwanted fire, such as lesser ISO ratings, and costs of larger traditional fire suppression forces. Property loss is merely one cost. Others include years of medical care for burn patients, fire department and equipment purchase and maintenance.

7.3.3. Summary of "U. S. Experience With Sprinklers & Other Automatic Fire Extinguishing Equipment."

Hall, John R., Jr. 2007; National Fire Protection Association. (Resource 20)
The report states that "Automatic sprinklers are highly effective and reliable elements of total system designs for fire protection in buildings. Based on 2002-2004 fires reported to U.S. fire departments, excluding cases of failure or ineffectiveness because of a lack of sprinklers in the fire area and after some recoding between failure and ineffectiveness based on reasons given, sprinklers operate in 93% of all reported structure fires large enough to activate sprinklers. When they operate [excluding fires too small to activate a sprinkler and cases of failure or ineffectiveness because of a lack of sprinklers in the fire area,], they are effective 97% of the time, resulting in a combined performance reliability of 90%."

7.3.4. Discussion of above article, "U. S. Experience…"

(from NAHB, NFSA and others)

Dr. Hall explains that sprinklered buildings tend to be better built and maintained better in terms of all the other fire safety features and fire protection measures. This point indicates that fire sprinklers will receive some credit for life savings that should be accredited to the entire integrated system**.** Table 13 in the report, reproduced below, compares the characteristics of victims reported in non-confined fire from 2002 and 2004. The table shows that when sprinklers operated there were a higher percentage of victims who

were unable to act, clothing on fire, in the area of origin or were older than 65 years of age compared to all fires and all conditions.

Table 13 [from Resource #20]

"Characteristics of fatal victims when sprinklers operate vs. all conditions. 2002-2004

Non-Confined Structure Fires [in the US]

	Percent of fire fatalities *	
Victim Characteristic	**When sprinklers operate**	**All fires and all conditions**
Victim unable to act	17%	10%
Clothing on fire	11%	3%
Victim in area of fire origin	88%	55%
Victim age 65 or older	66%	27%

* Note: Percentages are based on 2002-2004 non-confined structure fires reported in NFIRS Version 5.0 to U.S. municipal fire departments and so exclude fire reported only to Federal or state agencies or industrial fire brigades. In Version 5.0 of NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. This field is not required if the fire did not begin within the designed range of the system. Source: NFIRS and NFPA survey."

In all the reported fires from 2002 to 2004 where sprinklers were present in residential occupancies, 50% of the systems never operated due to the fire being too small, in 47% of the fires the sprinklers were effective, in 2% of the fires the sprinkler failed to operate and in 1% of the reported fires they were ineffective. (Resource #20 (Hall), pg 34, Table 5, reproduced below) Note that this table includes information about both commercial and residential sprinklers. As commercial sprinklers are implemented using different standards and are designed for a different purpose, to protect property, the results are not relevant to residential sprinkler operation, which are designed for life safety.

Table 5 [Resource #20] Automatic extinguishing system performance by property use

2002-2004 Non-Confined Structure Fires B. Wet Pipe Sprinklers Only

	Operated & effective	Operated & not effective	Fire too small to activate system	Failed to operate
Property Use				
Public assembly	36%	3%	59%	3%
(Eating or drinking establishment)	(38%)	(3%)	(55%)	(4%)
Educational	20%	0%	78%	2%
Health care*	23%	0%	75%	2%
Residential	48%	1%	49%	2%
(Apartment)	(54%)	(1%)	(43%)	(2%)
(Hotel or motel)	(37%)	(1%)	(60%)	(1%)
Store or office	37%	1%	60%	2%
Manufacturing	47%	2%	47%	3%
Storage	46%	3%	41%	10%
(Warehouse excluding cold storage)	(49%)	(3%)	(38%)	(10%)
All structures**	41%	1%	55%	3%

* Only facilities that care for the sick or the aged.
** Includes some properties not separately listed above.
Note: Percentages are based on 2002-2004 non-confined structure fires reported in NFIRS Version 5.0 to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. Figures exclude structure fires with AES operation unknown and reflect recodings explained in Introduction: Fires are excluded if the reason for failure or ineffectiveness is system not present in area of fire. Fires are recoded from operated but ineffective to failed if the reason for failure or ineffectiveness was system shut off. Fires are recoded from failed to operate but ineffective if the reason for failure or ineffectiveness is not enough agent or agent did not reach fire. Rows sum to 100% except for rounding error. In Version 5.0 of NFIRS, if multiple systems are present, the system coded is supposed to be the one system designed to protect the hazard where the fire started. This field is not required if the fire did not begin within the designed range of the system.

It is estimated that less than 2% of the new residences built in 2003 were equipped with an automatic fire suppression system and less than 1% of the reported fires occurred in homes equipped with residential sprinklers (Resource #20 (Hall), pg 30).

The majority of fires are contained at the point of origin by building occupants notwithstanding if fire sprinklers were or were not present. In Scottsdale Arizona, a community with over 50% of its single-family homes fire sprinkler protected, "The average fire loss per sprinklered incident was only $1,945 compared to a non-sprinklered loss of $17,067" (Resource #17 (Ford, 1997), page 4).

8. Other issues:

Section Summary:

- *NFPA 13D requires that the owner replace damaged sprinklers; and recommends monthly inspections. Antifreeze systems have additional requirements and recommendations. NFPA does not require additional maintenance for NFPA 13D systems.*
- *The USFA position paper supports mandating residential fire sprinklers in one and two family dwellings.*
- *In NYS contract / installer licensure in generally done at a local level. NYS does not require licensure for sprinklers installation.*
- *Contractor will use "ramp-up" time to develop expertise and staffing availability.*

8.1. Maintenance

The standards for residential systems are generally contained in NFPA 13D, which contains the following requirements for maintenance:

"4.2 Maintenance.

4.2.1 * [See explanatory material A.4.2.1 below**]** The installer shall provide to the owner/occupant instructions on inspecting, testing, and maintaining the system.

4.2.2 Operated or damaged sprinklers shall be replaced with sprinklers having the same performance characteristics as the original equipment.

4.2.3 Any sprinklers that have been painted outside of the factory shall be replaced with a new listed sprinkler.

4.2.4* [See explanatory material A.4.2.4 below**] Antifreeze Systems.** Before freezing weather each year, the following procedure shall be performed:

(1) Solution in the entire antifreeze system emptied into convenient containers

(2) Solution brought to the proper specific gravity by adding concentrated liquid as needed, or a new solution be prepared, in accordance with 8.3.3

(3) System refilled with the new or remixed solution."

In addition to the requirements listed in the text of NFPA 13D, there are further recommendations in explanatory material in the Annex of 13D:

"A.4.2.1 The responsibility for properly maintaining a sprinkler system is that of the owner or manager, who should understand the sprinkler system operation. A minimum monthly maintenance program should include the following:

(1) Visual inspection of all sprinklers to ensure against obstruction of spray.

(2) Inspection of all valves to ensure that they are open.

(3) Testing of all waterflow devices.

(4) Testing of the alarm system, where installed. Note that where it appears likely that the test will result in a fire department response, notification to the fire department should be made prior to the test.

(5) Operation of pumps, where employed. *(See NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.)*

(6) Checking of the pressure of air used with dry systems.

(7) Checking of water level in tanks.

(8) Special attention to ensure that sprinklers are not painted either at the time of installation or during subsequent redecoration. When sprinkler piping or areas next to sprinklers are being painted, the sprinklers should be protected by covering them with a bag, which should be removed immediately after painting is finished.

(For further information, see NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.)

A.4.2.4 Tests should be made by drawing a sample of the solution from valve B, as shown in Figure 8.3.3.3.1.1, two or three times during the freezing season, especially if it has been necessary to drain the building sprinkler system for reasons such as repairs or changes. A small hydrometer should be used so that a small sample is sufficient. Where water appears at valve B or where the test sample indicates that the solution has become weakened, the entire system should be emptied and then recharged as previously described."

NFPA 13D does not discuss life cycles of residential sprinklers. Generally manufacturers warrantee residential sprinklers for ten years. NFPA 25: Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems is applied to NFPA 13 and 13R systems, and contains standards for inspection, testing, and maintenance of water-based fire protection systems. NFPA 25 requires field sampling, testing of sprinkler heads generally after 50 years and every 10 years thereafter. Sampled sprinklers must be replaced. Some specific sprinklers have shorter replacement periods in NFPA 25.

Appendix D further discusses inspection, testing and maintenance post installation of NFPA 13D systems.

8.2. Discussion of USFA position paper "Residential Fire Sprinklers"

In this position paper (See resource document 60, FEMA) for the United States Fire Administration (USFA), the administration states that there is a decreasing trend in the number of fires and fire fatalities since 1977. While the decrease has shown a slight plateau over the past ten years, some believe that there is no evidence that supports the USFA assumption that there is a link between a reduction in the available escape time based on new furnishing as discussed in the NIST technical note 1455. The report concluded that in those tests where sprinklers were present, they responded long after the smoke alarms had detected and alerted the occupants of a fire.

One of the goals of the USFA administration is to reduce life and economic losses due to fire; however some believe that mandating sprinklers in new construction will not meet either of these two goals. An effective way to reach these goals is to provide more fire prevention education to US citizens and to promote the use of hard-wired interconnected smoke alarms in existing homes. Fire sprinklers are not required to be alarmed nor are designed to alert the occupants. Working smoke detectors and automatic fire sprinklers installed together increase the occupants' survival by 82 percent.

Smoke detectors are absolutely needed, but 34% of fire deaths in residences occurred with operational smoke detectors from 2000 to 2004 (Resource #1A, pg 17 Ahrens, Marty (September 2007). Fire deaths initially dropped dramatically with wide spread acceptance and installation of smoke detectors, hard wired or not. However, since year 2000, a significant plateau has developed (Resources #30 (Karter)), and some believe that fire sprinklers are the next step to get us to the zero tolerance of fire deaths. Also, if the occupant(s) is incapacitated mentally, physically, due to age or condition and cannot evacuate, smoke detectors will not enhance their chances of survival.

8.3. Licensure and staffing of fire sprinkler contractors in NYS

8.3.1. Contractor and installer Licensure

Presently, there is no New York statewide fire sprinkler contractor or installer licensure requirement. In 2008, a bill was in committee to establish licensure categories, insurance requirements, training and certification (NYS Assembly Bill #All706 / Senate Bill #S08644 of 2008; short title, "New York State water-based fire protection licensure act". (Accessed on 12/8/08 at http://assembly.state.ny.us/leg/?bn=A11706) It did not move forward before the end of the 2008 session. This bill included a classification of licensure for a NFPA 13D fire sprinkler contractor, to install systems in one and two-family and manufactured housing.

8.3.2. Fire sprinkler contractor staffing availability

With an adequate “ramp up” time, fire sprinkler contractors will realign and hire required layout technicians and field installers. NFPA 13D systems are designed to be economical and simple, and do not take months of training to understand shop drawings or learn fire sprinkler fitting.

8.4. Inspection of residential fire sprinkler systems

8.4.1. Inspection of residential fire sprinkler systems

The residential sprinkler committee members expressed interest in whether residential sprinkler systems are adequately installed, inspected and maintained. Systems that are inadequately installed or maintained may not operate correctly or could cause problems, such as freezing pipes and associated water damage.

NYS codes and regulations require inspection of the installation of sprinkler systems, along with other building systems. NYCRR Part 1203 requires inspection by a code enforcement official or by special inspection. NFPA 13D (resource 49), which is incorporated into the NYS Uniform Code by reference, provides requirements for hydrostatic testing and for installation to prevent freezing pipes; attached explanatory material provides additional guidance. NFPA 13D provides a description of hydrostatic testing needed, and has language requiring that sprinkler piping shall not be installed in areas subject to freezing. Language in the text of NFPA 13D itself does not address insulation; the explanatory material in Annex A describes several methods of insulating attic piping, which could also be used in any exterior wall where such piping is required. In conclusion, Title 19 regulations, standards and guidance are in place to provide for correct installation, inspection and testing of residential sprinkler systems.

According to the President of the NY State Fire Marshals & Inspectors Association, this is accomplished in the field when the fire sprinkler contractor calls for a “rough inspection” by the code enforcement official who makes the inspection. The contractor calls for a final flow test, and code enforcement official witnesses the test. The inspectors communicate with contractors so no delays occur or drywall goes up without an inspector seeing the “rough”.

While current legislation, standards and guidelines are in place for adequate installation and inspection of residential sprinkler systems, code enforcement officials may not be familiar with these measures due to the infrequency of NFPA 13D installation in NYS. Additional training of code enforcement officials in the area of residential sprinkler installation and inspection may help with consistent and accurate implementation of these measures. If the Uniform Codes were to change to require residential sprinklers in 1 & 2- family homes and townhouses, such training would be part of the NYS Codes update course.

8.4.2. NYS regulation of installation and inspection

Currently, NYS Title 19 NYCRR Part 1203 provides for inspection of the sprinkler system installation by the code enforcement official or by special inspection, as follow. Underlines are added to emphasize portions relevant to this report.

Title 19 NYCRR Part 1203.3: (underlines for emphasis)

"(b) Construction inspections.

(1) Permitted work shall be required to remain accessible and exposed until inspected and accepted by the government or agency enforcing the Uniform Code. Permit holders shall be required to notify the government or agency when construction work is ready for inspection.

(2) Provisions shall be made for inspection of the following elements of the construction process, where applicable:

(i) work site prior to the issuance of a permit;
(ii) footing and foundation;
(iii) preparation for concrete slab;
(iv) framing;
(v) building systems, including underground and rough-in;
(vi) fire resistant construction;
(vii) fire resistant penetrations;
(viii) solid fuel burning heating appliances, chimneys, flues or gas vents;
(ix) energy code compliance; and
(x) a final inspection after all work authorized by the building permit has been completed.

(3) After inspection, the work or a portion thereof shall be noted as satisfactory as completed, or the permit holder shall be notified as to where the work fails to comply with the Uniform Code. Construction work not in compliance with code provisions shall be required to remain exposed until it has been brought into compliance with the code, been reinspected, and been found satisfactory as completed."

Part 1203.3 requires that before a certificate of occupancy is granted, such inspections must be completed, as described below. Underlines are added to emphasize portions relevant to this report.

"(d) Certificates of occupancy; certificates of compliance, paragraph (2) "Issuance of a certificate of occupancy or a certificate of compliance shall be preceded by an inspection of the building, structure or work. Where applicable, a written statement of structural observations and/or a final report of special inspections, prepared in accordance with the provisions of the Uniform Code, must be received prior to the issuance of the certificate..."

The text of NFPA 13D is incorporated by reference into the Uniform Codes of NYS. The explanatory material is not. NFPA standards and guidance are discussed in the following section.

8.4.2. Standards and guidance

NFPA 13D has some requirements for inspection, maintenance and testing with the standard itself, and additional information in the explanatory annex A to the text. Excerpts from 13D and Annex A regarding maintenance, installation and testing are below. An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph is included in Annex A to 13D. Annex A does not contain requirements of 13D, but has additional explanatory material. Maintenance is as described in section 8.1 of this report. NFPA 13D discusses inspection during operation and during installation as follows.

"4.2.2 Operated or damaged sprinklers shall be replaced with sprinklers having the same performance characteristics as the original equipment.
4.2.3 Any sprinklers that have been painted outside of the factory shall be replaced with a new listed sprinkler.
4.2.4* Antifreeze Systems. Before freezing weather each year, the following procedure shall be performed:
(1) Solution in the entire antifreeze system emptied into convenient containers
(2) Solution brought to the proper specific gravity by adding concentrated liquid as needed, or a new solution be prepared, in accordance with 8.3.3
(3) System refilled with the new or remixed solution"

[* Explanatory material in 13D annex A:
"A.4.2.4 Tests should be made by drawing a sample of the solution from valve B, as shown in Figure 8.3.3.3.1.1, two or three times during the freezing season, especially if it has been necessary to drain the building sprinkler system for reasons such as repairs or changes. A small hydrometer should be used so that a small sample is sufficient. Where water appears at valve B or where the test sample indicates that the solution has become weakened, the entire system should be emptied and then recharged as previously described."]

"4.3* Hydrostatic Tests.
4.3.1 Where a fire department pumper connection is not provided, the system shall be hydrostatically tested for leakage at normal system operating pressure.
4.3.2 Where a fire department pumper connection is provided, the system shall pass a hydrostatic pressure test performed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*."

[* Explanatory material in 13D annex A:
"A.4.3 Testing of a system can be accomplished by filling the system with water and checking visually for leakage at each joint or coupling. Fire department connections are not required for systems covered by this standard but can be installed at the discretion of the owner. In these cases, hydrostatic tests in accordance with NFPA13, *Standard for the Installation of Sprinkler Systems*, are necessary. Dry systems also should be tested by placing the system under air pressure. Any leak that results in a drop in system pressure greater than 2 psi (0.14 bar) in 24 hours should be corrected. Leaks should be identified using soapy water brushed on each joint or coupling. The presence of bubbles indicates a leak. This test should be made prior to concealing the piping."]

NFPA has requirements for installation to prevent freezing of pipes in sections 7.7 and 8.3, along with the explanatory material to section 8.3. The relevant NFPA 13D sections are below.

"7.7 Attics. When nonmetallic piping is installed in attics, adequate insulation shall be provided on the attic side of the piping to avoid exposure of the piping to temperatures in excess of the pipe's rated temperature. "

"8.3.1*Wet Pipe Systems. A wet pipe system shall be used where all piping is installed in areas maintained above 40°F (4°C).
[Explanatory material from Annex A: A.8.3.1 "In areas subject to freezing, care should be taken to cover sprinkler piping completely in unheated attic spaces with insulation. Installation should follow the guidelines of the insulation manufacturer. Figure A.8.3.1(a) through Figure A.8.3.1(e) show several methods that can be considered."]

8.3.2 Where system piping is located in areas not maintained above 40°F (4°C), the pipe shall be protected against freezing by use of one of the following methods:

(1) Dry pipe system

(2) Antifreeze system in accordance with 8.3.3

(3) Listed standard dry-pendent or dry-sidewall sprinklers extended from pipe in heated areas into unheated areas not intended for living purposes"

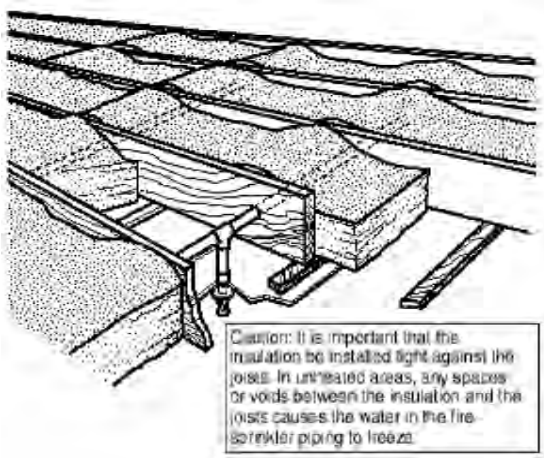


Figure A.8.3.1(a)

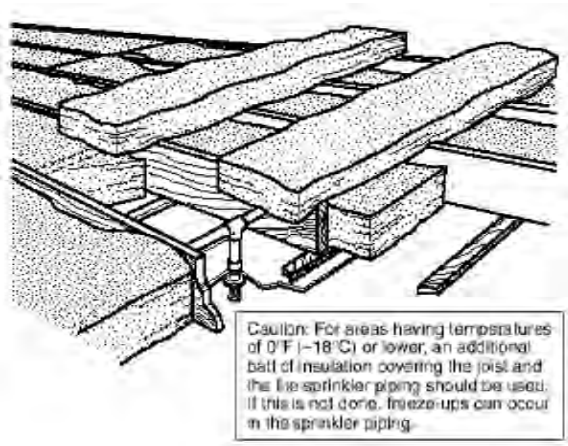


Figure A.8.3.1(b)

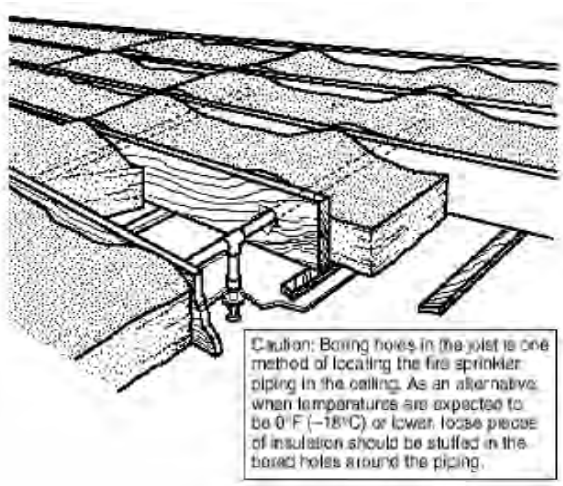


Figure A.8.3.1(c)

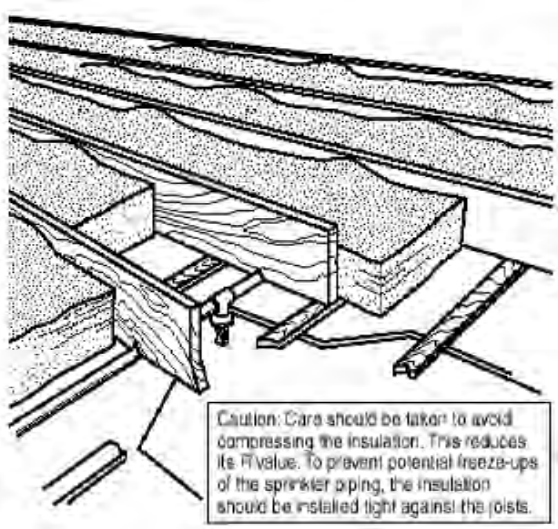


Figure A.8.3.1(d)

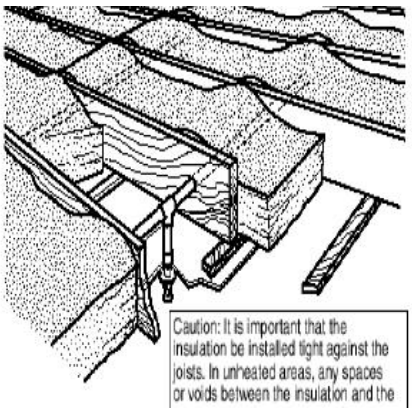


Figure A.8.3.1(d)

9. RESOURCE LIST

Original resources, alphabetical by author

1. Adirondack Insurance Exchange (August 23, 2007). ***"Policy for NY"*** - INSURANCE

1A. Ahrens, Marty (Sept. 2007). **Home Structure Fires.** Quincy, MA: National Fire Protection Association. Accessed 12/8/08 at http://www.nfpa.org/assets/files/PDF/OS.Homes.pdf. STATISTICS

2. Ahrens, Marty (Sept 2007). ***Trends and Patterns of U. S. Fire Losses.*** National Fire Protection Association. Accessed 11/3/08 from http://www.nfpa.org/assets/files//PDF/OS.firelosstrends.pdf (PDF file) - HISTORIC, STATISTICS

3. Ahrens, Marty (April 2007). ***U.S. Experience With Smoke Alarms And Other Fire Detection/Alarm Equipment***. Fire Analysis and Research Division National Fire Protection Association. Accessed 11/3/08 from http://www.nfpa.org/assets/files/PDF/AlarmExSum.pdf - HISTORIC, STATISTICS

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10. APPENDICES

Appendix A: Model cases of installation of residential sprinklers in NYS

A.1. General scope

This appendix presents cost estimates to install sprinkler systems in sample new homes. The NYSDOS Residential Fire Sprinkler Committee agreed that these cost estimates would be beneficial; and several members developed them in collaboration. In January of 2009, Rick Schunk of Wyndham homes, homebuilder representative on the NYSDOS Residential Fire Sprinkler Committee, submitted two sample building plans to Julius Ballanco, fire sprinkler engineer, and Dominick Kasmauskas, fire sprinkler industry representative, with the goal of obtaining cost estimates from fire sprinkler contractors to add sprinklers to those sample homes in different metropolitan statistical areas of New York State. (Metropolitan statistical areas are geographic entities defined by the U.S. Office of Management and Budget (OMB) for use by Federal statistical agencies in collecting, tabulating, and publishing Federal statistics. A metropolitan statistical area contains a core urban area of 50,000 or more population, and consists of one or more counties including the counties containing the core urban area, as well as any adjacent counties that have a high degree of social and economic integration, as measured by commuting to work, with the urban core.)

The two sample homes are called Andover home and Cambridge colonial home, described as follows in sales brochures.

- Andover home is 1,625 to 2,425 square feet with 2 or 3 bedrooms, 2.5 baths and a two car garage. The house is a single story with a basement. As a one story home, this residence challenges the fire sprinkler designer and installer to fit sprinkler piping in cathedral ceilings and attic space.

- The Colonial Cambridge home is 1,988 to 2,714 square feet with 2 or 3 bedrooms, 2.5 baths and a two car garage. The house has a first floor office, unfinished attic storage, a two-story foyer with cathedral ceiling and a second story loft living space. With loft and cathedral ceiling living spaces, this residence provides similar challenges to the Andover for designing and installing a sprinkler system.

Julius Ballanco developed sprinkler system designs for the sample homes and the fire sprinkler evaluation criteria below. Design for a stand alone system is based on use of sprinkler piping that is consistent with potable water. Design for a multipurpose system is based on use of potable water piping for sprinklers and for plumbing. Potable water piping will not trigger a need for backflow prevention. The system is designed for the use of a 3/4 inch water meter if connected to the public water supply.

Well connection: If connected to a well with yield above that needed for fire sprinkler flow, the system would use a Grunfos variable speed pump or equal; per a local well contractor this would add $1200 to the cost of the well in NY. If the well is not reliable, the system would have a tank and pump. The tank would have to be 350 gallons. A residential sprinkler contractor provided an estimate that the addition of a tank and pump, with labor, would add about $750 to the cost of the installation.

In order to design and develop cost estimates for these two homes, the following criteria were determined.

A.2. Fire sprinkler evaluation criteria

1. Plan Types
   a. Andover ranch plan(one story home)
      i. Conditioned space- 1880 square feet (s.f.)
      ii. Unfinished basement- 1698 s.f.
      iii. Sprinklered space -3312 s.f.
   b. Cambridge colonial plan (two story home)
      i. Conditioned space- 2830 s.f.
      ii. Unfinished basement- 2034 s.f.
      iii. Sprinklered space – 4662 s.f.
2. System Types
   a. Stand alone systems
   b. Multipurpose systems
3. Water sources
   a. Municipal water at 60 psi
   b. Individual wells with pressure switch set to on at 30 psi, off at 50 psi
   c. Design criteria
      i. Domestic water: flow rate 5gpm, pipe size 5/8", meter size 5/8", set to 50 psi at 5 gpm. On municipal water, backflow preventer ¾", water pressure regulator ¾" required.
      ii. Domestic water and fire sprinkler water: flow rate, pipe size and meter size designed to meet the domestic water and fire sprinkler flow requirements of the sample floor plans. On municipal water, the backflow preventer and water pressure regulator are required to meet the requirements of domestic and fire sprinkler flow.
4. Cost
   a. Design fee
   b. Inspection fee
   c. Installation costs only, without fees for design, inspection, and water supply
      i. Total installation costs in dollars,
      ii. Total installation costs in cost per square foot (square footage based on conditioned space only).
      iii. Total installation costs as a percent of total home construction costs (actual construction costs only, not sale price of home).
   d. Municipal water supply related fees and costs
   e. Well system upgrade costs (difference between cost for domestic water only vs. domestic water and fire sprinkler water)

A.3. Installation cost estimates for stand alone system from fire sprinkler contractor "A"

This cost estimate is for installation of a stand-alone system both on municipal water and on a private well. The cost includes travel estimated as $1,200 for homes on city water, and $1,500 for homes with private wells. The NFPA 13D Pump is UL Listed, 50gpm @ 40PSI, 3HP 230/1/60.

The sprinkler contractor submitted prices with qualifiers that this is a rough estimate that would be finalized based on exact location and site; and that prices do not include additional power wiring as needed for the pump, which he estimated as under $500 to wire to the house panel.

Table A.3. Contractor "A" cost estimate

	City water		Private well			
	Total cost	**Cost / cond. SF**	**Total cost**	**Cost / cond. SF**	**plus $500 for wiring**	**Cost / cond. SF**
Andover home		1880 conditioned SF				
Capital Region	$9,000	$4.79	$14,820	$7.88	$15,320	$8.15
Plattsburg	$9,940	$5.29	$15,910	$8.46	$16,410	$8.73
Rochester	$10,100	$5.37	$16,100	$8.56	$16,600	$8.83
Colonial Home		2830 Conditioned SF				
Capital Region	$12,700	$4.49	$20,440	$7.22	$20,940	$7.40
Plattsburg	$14,000	$4.95	$22,100	$7.81	$22,600	$7.99
Rochester	$14,200	$5.02	$22,565	$7.97	$23,065	$8.15

A.4. Installation cost estimates for stand alone system from fire sprinkler contractor "B"

June 3, 2009

Reference: FIRE PROTECTION SYSTEM, NFPA 13D Fire Sprinkler System
Cambridge/Andover Housing Models, New York

We are pleased to provide the following quotations for the NFPA-13D fire sprinkler systems for the above referenced model homes. The costs to provide a 13D fire sprinkler system in these homes will be with a city water service as well as a water storage tank with an approved pumping system and are as follows:

ALBANY

These quotations are based upon an adequate water service installed into the home by others:

Cambridge Home …… $6,930.00
Andover " …… $6,210.00

These quotations are based upon providing a water storage tank and approved fire pumping system:

Cambridge Home ……. $16,890.00
Andover " ……. $17,345.00

ROCHESTER

These quotations are based upon an adequate water service installed into the home by others:

Cambridge Home ……. $7,990.00
Andover " ……. $7,390.00

These quotations are based upon providing a water storage tank and an approved fire pumping system:

Cambridge Home ……. $19,125.00
Andover " ……. $18,920.00

WESTCHESTER

These quotations are based upon having an adequate water supply installed into the home by others:

Cambridge Home …… $ 8,120.00
Andover " …… $ 7,595.00

These quotations are based upon providing a water storage tank and an approved fire pumping system:

Cambridge Home …… $ 20,095.00
Andover " …… $ 19,920.00

Notes:

- CPVC plastic pipe and fittings will be installed concealed throughout each of the homes were possible. White pendent and or horizontal sidewall residential recessed sprinkler heads will be installed.

- Where a city water supply is not available and a water storage tank as well as a pumping system needed we will provide and install one (1) 1,500 gallon aboveground tank as well as one (1) single stage booster pump with a standard controller, with 230 volt single phase.

- All the above quotations will be provided with NICET level shop drawing, calculations, test certificates and certification of the systems.

- Exclusions are as follows
- Local permits and fees are not included
- Electrical and alarm work
- City water line installed into the home were required
- Permits and or fees
- Automatic sprinkler protection not required per NFPA-13D

- The automatic wet pipe NFPA-13D fire sprinkler system will be warranted for all parts and labor for a period of one (1) year beginning when the system is left in service

- The contractor is fully insured and upon notice to proceed will forward insurance certificates.

- Once the system is in operation, a walk thru and orientation with the owner or the owner's representative will be provided along with O&M Manuals explaining the operation, test and maintenance that will be required for the care of the system.

A.5. Installation cost estimate for network multipurpose system design from contractor "C"

Contractor "C" is a material supplier who prepared a multipurpose system design, material prices and a ballpark installation estimate. For both homes, the system designed is a "loop" design. An overhead and profit estimate of 15% was added. The costs are for a municipal water system at approximately 40 psi at the street. The cost estimates apply to all metropolitan statistical areas.

For a private well installation, a storage tank and pump in the basement or a larger pump in the well, with an approximate extra cost of $1500.

Table A.5. Contractor "C" cost estimate, on municipal water, all regions

	Material cost	Labor cost	Overhead and profit	Total cost	Cost / conditioned s.f.
On municipal system					
Andover home	$ 3,611.38	$ 2,350.00	$ 894.21	$ 6,855.59	$ 3.65
1880	conditioned s.f.				
Cambridge colonial	$ 4,292.84	$ 3,537.50	$ 1,174.55	$ 9,004.89	$ 3.18
2830	conditioned s.f.				
On private well					
Andover home	$ 4,611.38	$ 2,850.00	$ 1,119.21	$ 8,580.59	$ 4.56
1880	conditioned s.f.				
Cambridge colonial	$ 4,392.84	$ 4,037.50	$ 1,264.55	$ 9,694.89	$ 3.43
2830	conditioned s.f.				

A.5. Building layouts and approximate sprinkler layouts

THE ANDOVER

Andover Model Home – Artist's Concept

1,625 to 2,425 sq. ft.

2 or 3 Bedrooms / 2.5 Baths / 2 Car Garage

Single-floor living, No-step entry, Private Master Suite with Walk-in Closet

CHATFIELD FARMS

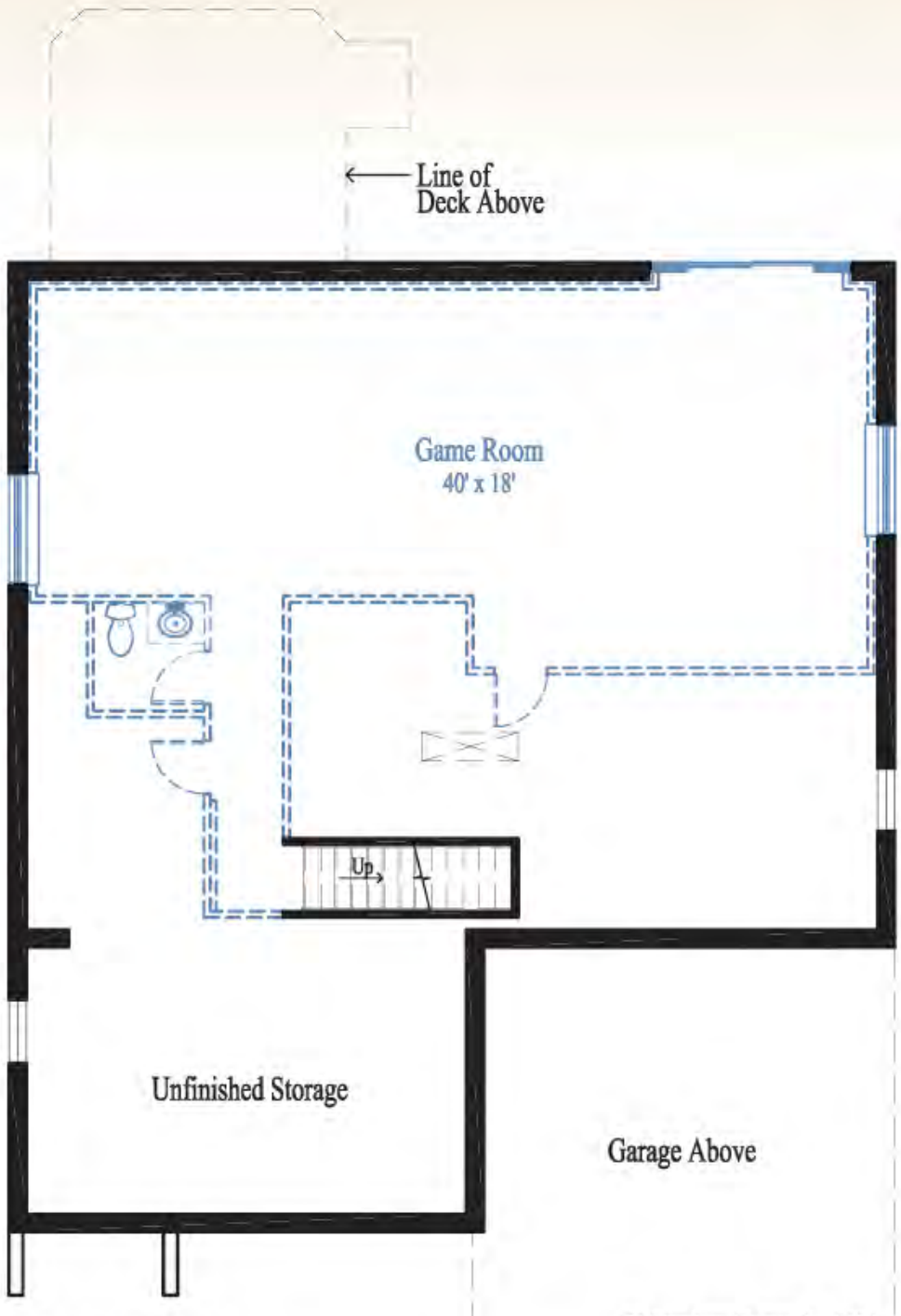
• A Wyndham Homes Active Adult Community •

CHATFIELD FARMS

• A Wyndham Homes Active Adult Community •

THE ANDOVER AS SHOWN
IN MODEL HOME

TO CREATE A HOME THAT IS
UNIQUELY YOURS!



BASEMENT

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THE CAMBRIDGE

Cambridge Model Home – Artist's Concept

1,988 to 2,714 sq. ft.

2 or 3 Bedrooms / 2.5 Baths / 2 Car Garage

Single-floor living, No-step entry, First Floor Home Office, Large double-door Coat Closet, Convenient Walk-through Laundry Room, Master Suite with His & Her Closets

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CHATFIELD FARMS

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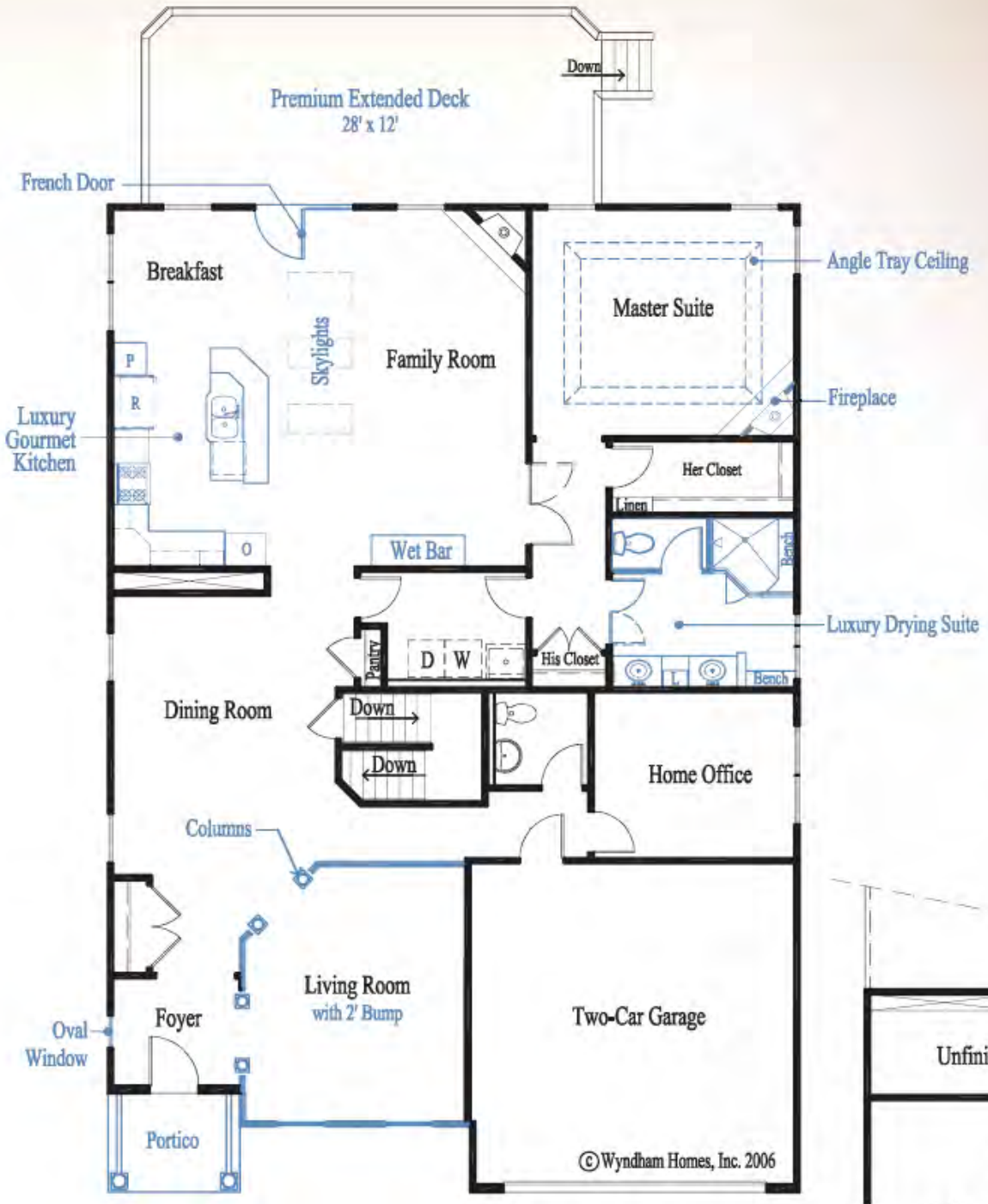
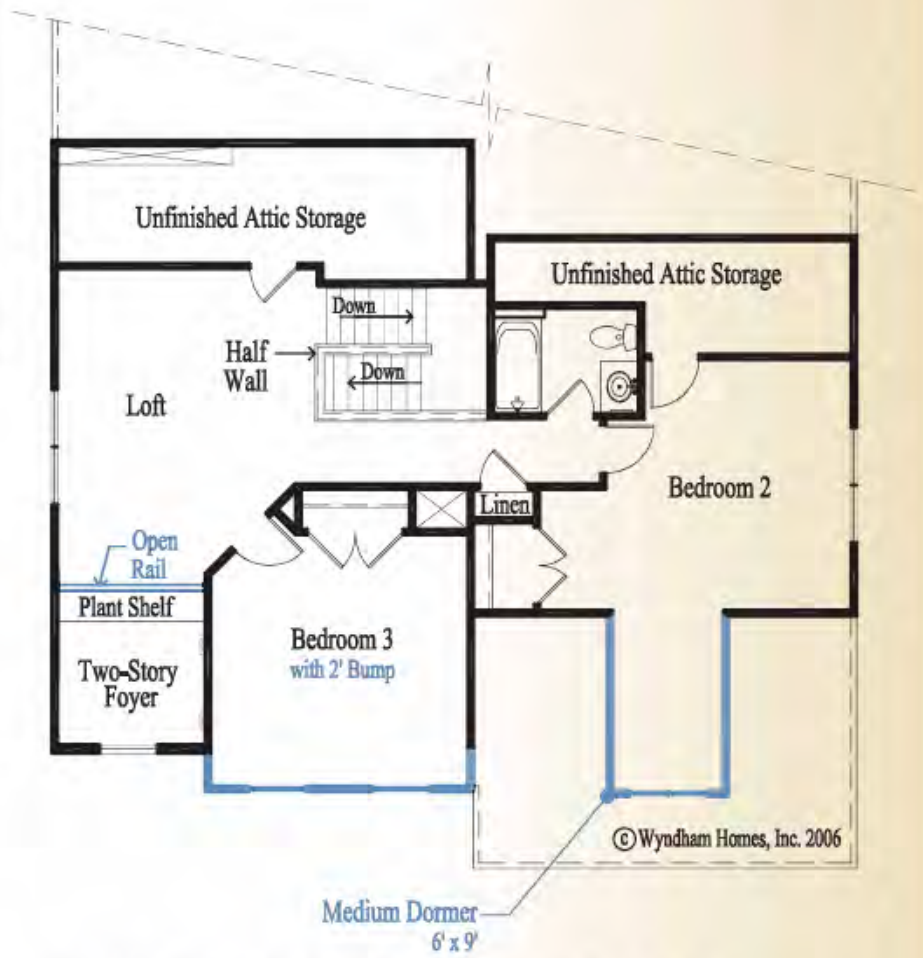
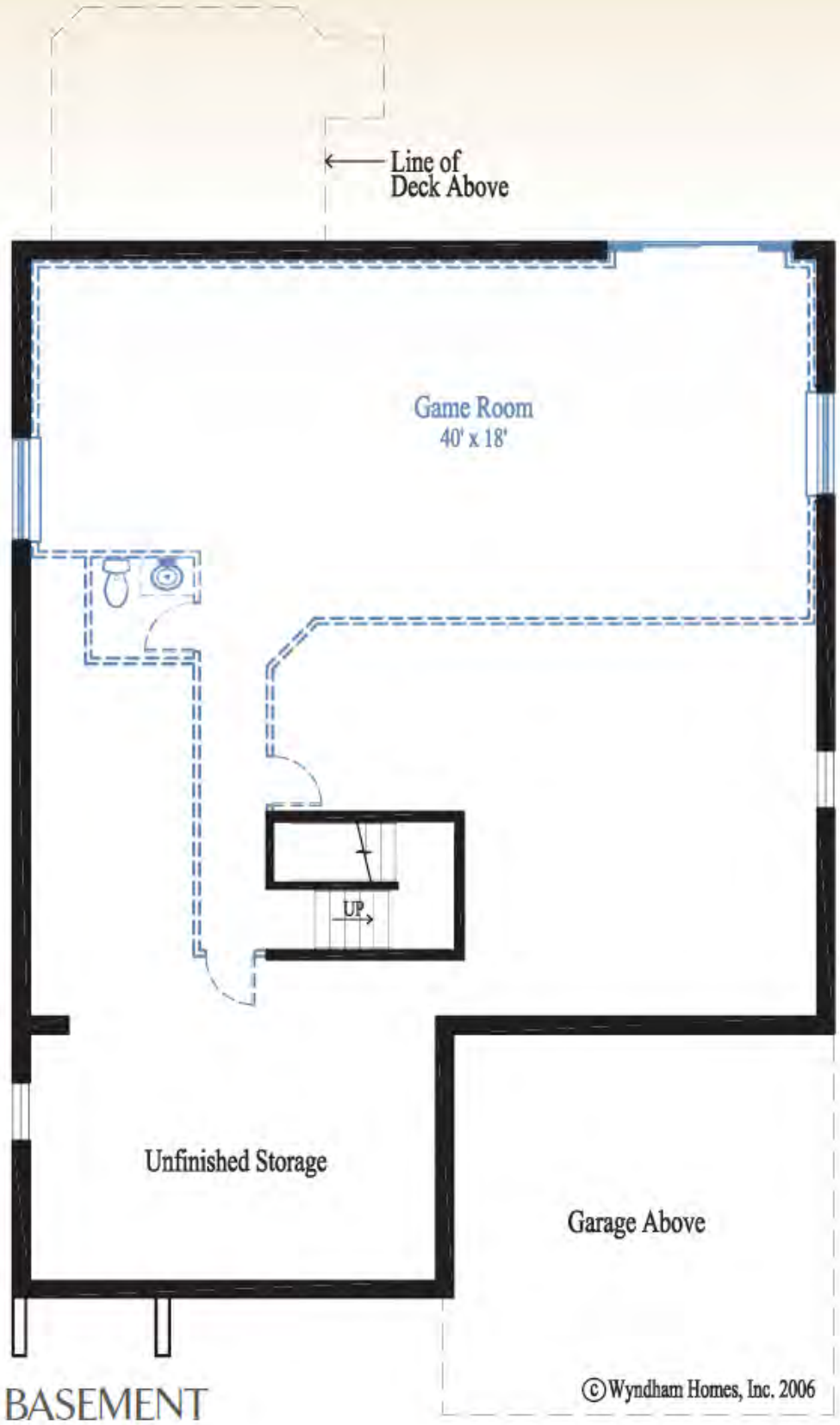


THE CAMBRIDGE
AS SHOWN IN MODEL HOME



TWO BEDROOM GUEST LOFT

TO CREATE A HOME THAT IS
UNIQUELY YOURS!



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WY-211362 2/07

Uponor sprinkler layout for “loop” multipurpose system

A. Andover home

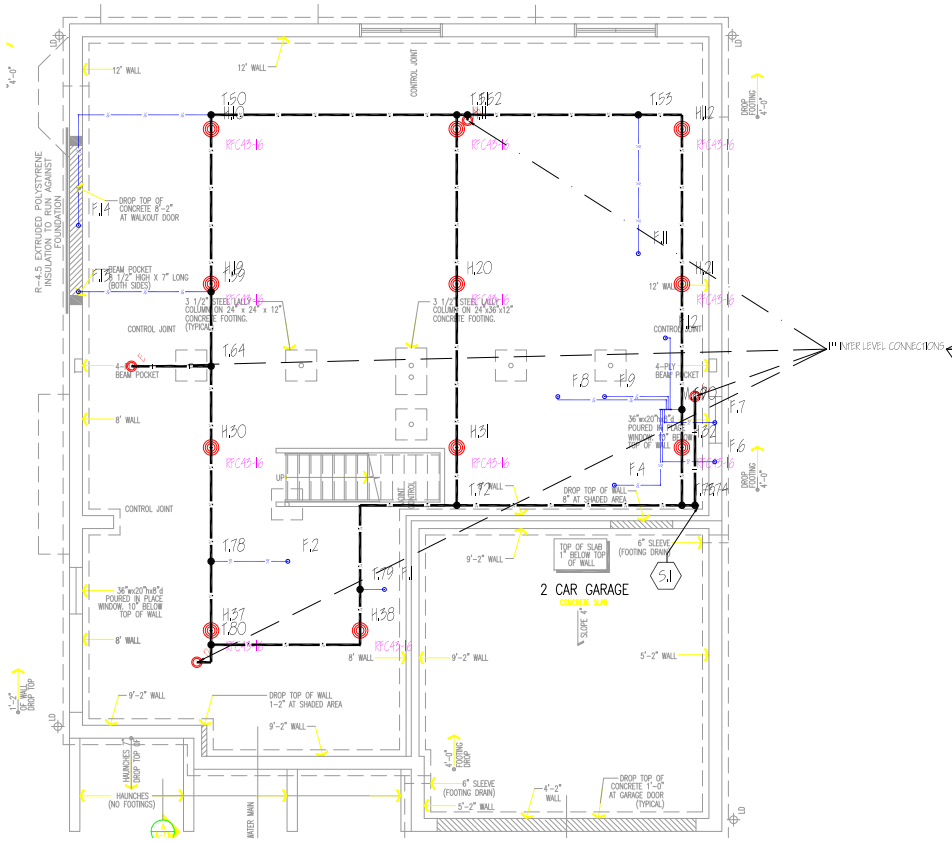
B. Cambridge colonial home

THIS SUGGESTED LAYOUT IS BASED UPON INFORMATION PROVIDED BY OTHERS. CHANGES IN CONSTRUCTION OR FIELD CONDITIONS MAY OCCUR WHICH MAY REQUIRE CHANGES TO THE LAYOUT. IT IS THE RESPONSIBILITY OF THE INSTALLER TO NOTIFY UPONOR TECHNICAL SERVICES OF SUCH CHANGES.

COLOR/LINETYPE LEGEND

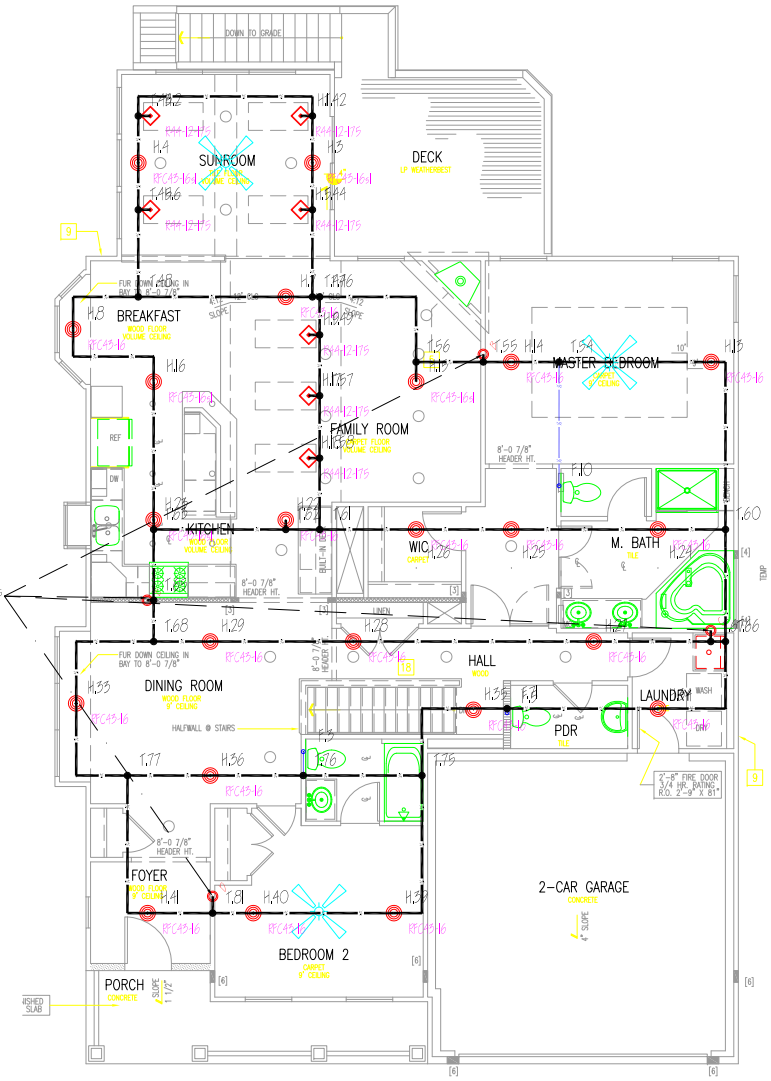
BLUE LINES= FEED TO FIXTURES (BATH, SHOWER, ETC.).
GREEN LINES= INTER-LEVEL CONNECTIONS.
BLACK LINES= SPRINKLER HEAD TO SPRINKLER HEAD.

- = 1/2" PIPE SIZE
- = 3/4" PIPE SIZE
- = 1" PIPE SIZE
- = 1 1/4" PIPE SIZE
- = 2" PIPE SIZE



1 F100 BASEMENT PLAN

1/4"=1'-0"



2 F100 MAIN FLOOR PLAN

1/4"=1'-0"

uponor

FIRE SPRINKLER

9925 148TH STREET WEST
APPLE VALLEY, MN 55124
TOLL FREE: 800-321-4759
FAX: 952-891-1409
www.uponor-usa.com

SALES REP.

RESIDENTIAL FIRE PROTECTION SYSTEM

PIPE TYPE: 1/2 - 3/4" - 1" AQUAPEX

SPRINKLER INFORMATION

# OF HEADS THIS SHEET -	41
# OF HEADS THIS JOB -	41
STATIC PRESSURE IS=	N/A

DOS SPRINKLER REPORT

ANDOVER RANCH

NEW YORK

NO.	REVISION/ ISSUE	DATE
1	PRELIM. & CONST.	06/09/09
2		
3		
4		

PROJECT #:	090609-ML
ALLIANCE ID #:	N/A
COMPANY:	N/A
CONTACT:	STEPHEN J. ZIAMANDANIS
CONTACT PHONE #:	818-489-9455
SCALE:	1/4" - 1'-0"
DESIGNED BY:	DEVON HUYNH
CHECKED BY:	DANIEL P. HUBBARD
NICET LEVEL III:	119092

F100

THIS SUGGESTED LAYOUT IS BASED UPON INFORMATION PROVIDED BY OTHERS. CHANGES IN CONSTRUCTION OR FIELD CONDITIONS MAY OCCUR WHICH MAY REQUIRE CHANGES TO THE LAYOUT. IT IS THE RESPONSIBILITY OF THE INSTALLER TO NOTIFY UPONOR TECHNICAL SERVICES OF SUCH CHANGES.

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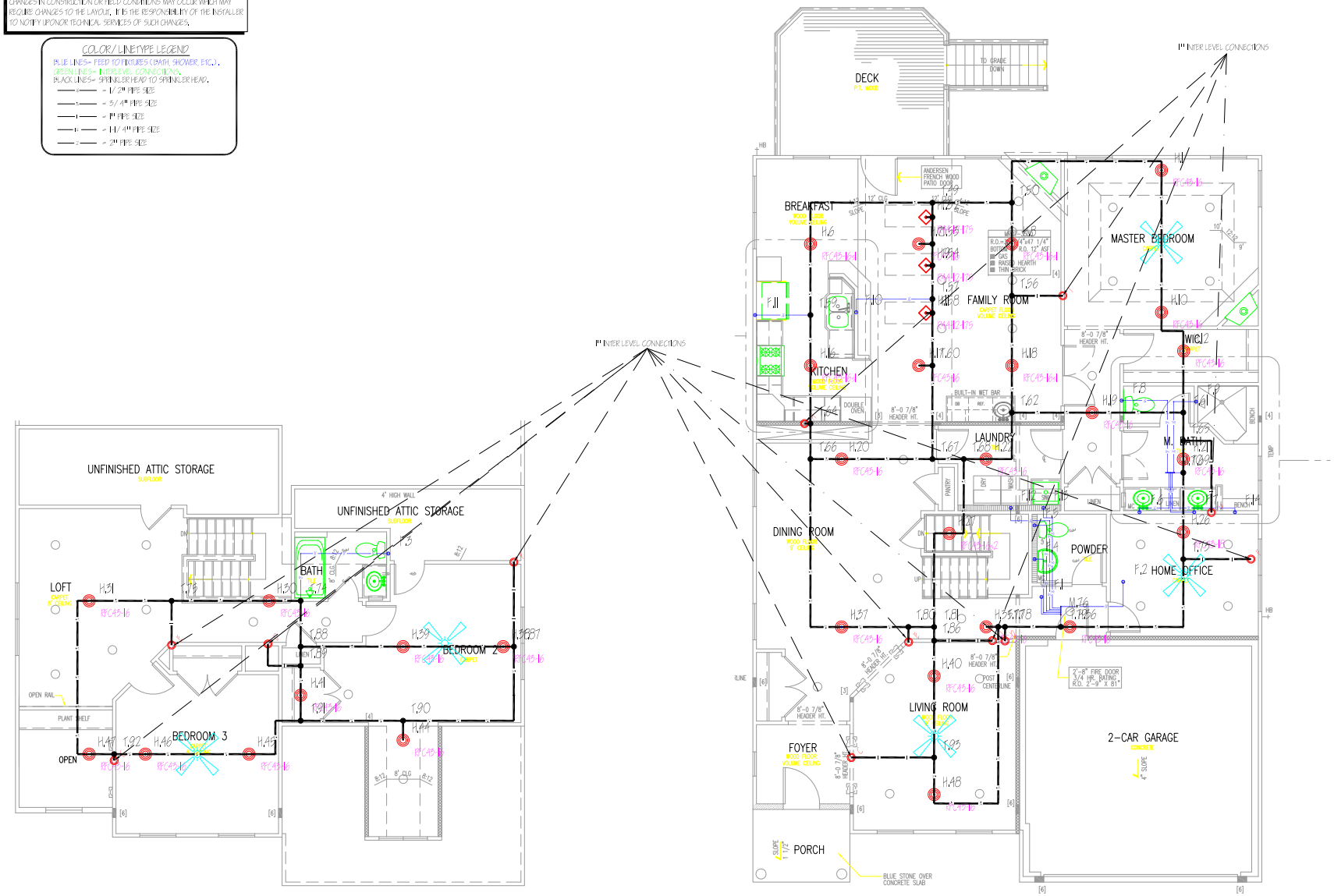

2 F200 SECOND FLOOR PLAN
1/4"=1'-0"

1 F200 MAIN FLOOR PLAN
1/4"=1'-0"

uponor

FIRE SPRINKLER

9922 148TH STREET WEST
APPLE VALLEY, MN 55124
TOLL FREE: 800-321-4759
FAX: 952-891-1409
www.uponor-usa.com

SALES REP.

RESIDENTIAL FIRE PROTECTION SYSTEM
TUBE TYPE: 1/2 - 3/4" - 1" AQUAPEX
SPRINKLER INFORMATION
OF HEADS THIS SHEET: -
OF HEADS THIS JOB: 48
STATIC PRESSURE IS: N/A

DOS SPRINKLER REPORT
CAMBRIDGE COLONIAL
NEW YORK

NO.	REVISION/ ISSUE	DATE
1	PRELIM. & CONST.	06/06/09
2		
3		
4		

PROJECT #:	090609-NL
ALLIANCE ID #:	N/A
COMPANY:	N/A
CONTACT:	STEPHEN J. ZIAMANDANIS
CONTACT PHONE #:	818-489-5455
SCALE:	1/4" = 1'-0"
DESIGNED BY:	DEVON HUYNH
CHECKED BY:	DANIEL P. HUBBARD
NICET LEVEL III:	119092

F200

THIS SUGGESTED LAYOUT IS BASED UPON INFORMATION PROVIDED BY OTHERS. CHANGES IN CONSTRUCTION OR FIELD CONDITIONS MAY OCCUR WHICH MAY REQUIRE CHANGES TO THE LAYOUT. IT IS THE RESPONSIBILITY OF THE INSTALLER TO NOTIFY UPONOR TECHNICAL SERVICES OF SUCH CHANGES.

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- = 1/2" PIPE SIZE
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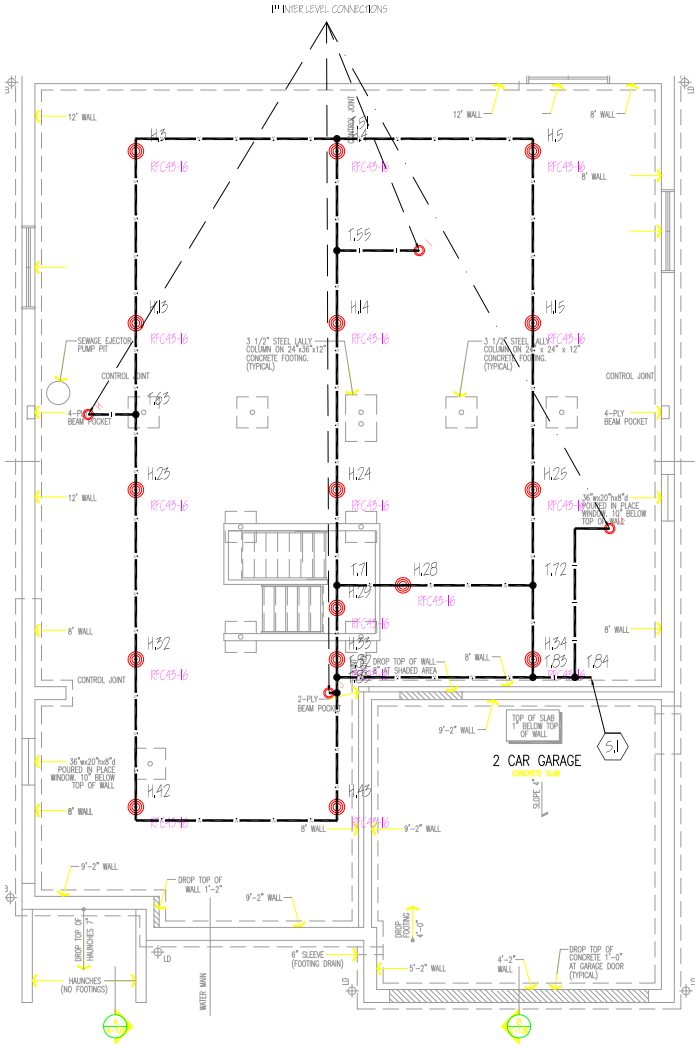
- = 1 1/4" PIPE SIZE
- = 2" PIPE SIZE



1
F100

BASEMENT PLAN

1/4"=1'-0"

uponor

FIRE SPRINKLER

5925 148TH STREET WEST
APPLE VALLEY, MN 55124
TOLL FREE: 800-321-4759
FAX: 952-891-1409
www.uponor-usa.com

SALES REP.

RESIDENTIAL FIRE PROTECTION SYSTEM
TUBE TYPE: 1/2 - 3/4" - 1" AQUAPEX
SPRINKLER INFORMATION
OF HEADS THIS SHEET -
OF HEADS THIS JOB - 48
STATIC PRESSURE IS= N/A

DOS SPRINKLER REPORT
CAMBRIDGE COLONIAL
NEW YORK

NO.	REVISION/ ISSUE	DATE
1	PRELIM. & CONST.	06/06/09
2		
3		
4		

PROJECT #:	090605-NL
ALLIANCE ID#:	N/A
COMPANY:	N/A
CONTACT:	STEPHEN J. ZIAMANDANIS
CONTACT PHONE #:	718-489-9455
SCALE:	1/4" = 1'-0"
DESIGNED BY:	DEVON HUYNH
CHECKED BY:	DANIEL P. HUBBARD
NICET LEVEL III:	119092

F100

Appendix B: Surveys of communities in NY State with more restrictive local standards for sprinklers in residences

Summary of Survey of NYS Municipalities with More Restrictive Local Standards for Residential Fire Sprinkler Systems

This summarizes a survey of eight municipalities that have more restrictive local standards (MRLS) that require residential fire sprinkler systems in one and two family residences, and one community which has requires residential fire sprinklers although it does not have a more restrictive local standard. The eight communities include all that have approval from the NYS Code Council for a MRLS requiring residential sprinklers in one and / or two family residences. The survey consisted of a telephone interview with an official in the municipal building department, usually the code enforcement officer. In the case of the Village of Sleepy Hollow, the village architect requested that we email questions rather than conduct a verbal survey. In the towns of Greenburgh and Harrison, the code enforcement officer requested that we speak with the fire marshal as well.

Responses are summarized below, and the communities are listed with a brief summary of responses in Tables 1 and 2, following.

To summarize responses from the eight communities:

- Seven are in Westchester County and one in Onondaga County;
- Four are towns (one, Harrison Town and Village, includes a village within it) and the other four are villages.
- Five respondents noted some problems. This consisted of pipes freezing which caused leaks in water systems; owners draining system due to construction changes; a sprinkler head recall and the local water company lowering the delivery water pressure so that systems do not have adequate pressure.
- All municipalities had provisions for hardship variances; four had granted variances either to remove the sprinkler requirement for homes on wells or health issue or to reduce the number of sprinkler heads needs in existing building areas.

Three of the larger municipalities have seen fires in sprinklered residences, and reported that the sprinklers generally had contained the fires except for an incident in which a fire started on the roof and had substantially destroyed the structure before the sprinklers kicked in.

- Most of the sprinklered residences are on municipal water; however many are on well water supply. For well water supply, a storage tank, approximately 300 gallons, and booster pump is generally installed in the basement. Some residences on municipal water also require a storage tank and booster pump due to municipal water pressure below that required by the sprinkler system.
- Most systems are wet systems, with water or water and glycol or glycerin. One community does not allow antifreeze in residential fire sprinkler systems.
- No municipality enforces maintenance, although most systems on municipal water have backflow preventers. NYSDOH requires that backflow preventers be inspected and certified annually.

Completed surveys follow Table 1 and Table 2.

Table 1: Comments / conditions of sprinkler operation (1)

Municipality	Year MRLS approved (enforced)	Problems	Variances granted	Fires in sprinklered residences
Greenburgh, T, Westchester Co.	1994 (1987)	None when correctly installed. Freezing when not.	Homes on wells, lower end	No records. ~500 since '82, per Fire Marshall
Harrison, T & V, Westchester Co.	1989	Freezing of water systems; owners drained glycol	None	2, fires contained
Irvington, V, Westchester Co.	1989	Early 2000, due to sprinkler head recall all heads were replaced in one development.	One (health reason, stress to owner)	No info
New Castle, T; Westchester Co.	1990	Freezing in attics. Owner drained system.	Some, for less heads in existing bldg areas	Many, fire contained; no records available
Onondaga, T; Onondaga Co.	1989	None	None	None
Rye Brook, V, Westchester Co.	1997	The local water comp. changed pressure, resulting in pressures below sprinkler design for installed systems	Reduce or exclude sprinklers in existing part of building	None
Sleepy Hollow, V, Westchester Co.	1989	None	None	None
Tarrytown, V; Westchester Co.	1992	None	None	None

(1) Backflow preventers or double check valves are required where sprinklers are installed on municipal water systems. Backflow preventers require annual inspection. No MRLS requires other maintenance.

Table 2: Types of water supply and of sprinkler systems

Municipality	# on municipal water	# or % on wells	Type of systems
Greenburgh, T, Westchester Co.	Most	A couple, more expensive homes	Most water, wet, a couple dry. Antifreeze not allowed in systems.
Harrison, T & V, Westchester Co.	Most	Few	Water, glycol, glycerin
Irvington, V, Westchester Co.	All	None	Water. Some have pressure boosters
New Castle, T; Westchester Co.	Many	Many	Water or water and antifreeze
Onondaga, T; Onondaga Co.	All	None	Water
Rye Brook, V, Westchester Co.	All	None	Water. Some have pressure boosters
Sleepy Hollow, V, Westchester Co.	All	None	Water
Tarrytown, V; Westchester Co.	All	None	Water

Questions for communities that require sprinklers in one and/ or two family residences

Municipality: **Greenburgh, Town** ***Date:*** **9/2/08**

- *Contact*: Anthony Zacarolli, CEO; Fire Marshal Larry Desimone 914 993 1500
- *Dates sprinklers required, amended*: Enforced since '87, but approved in 1994
- *Problems with systems:* No (AZ). The town does not allow use of antifreeze in sprinkler systems, so pipes must be insulated; when correctly installed, no problem. (LD)
- *Hardship variances granted:* Some variances have been granted for residences on well water. One or two homes on well water have installed sprinklers, higher end homes. For lower end homes, hardship variances have been requested and granted. (AZ)
- *Pre and post sprinkler fire conditions.* No statistics are available. According to the fire marshal, maybe 500 units with residential sprinklers have had fires since 1987.
- *# of sprinklered residences:* Of about 30,000 housing units in town, about 20% were built since the MRLS and about 60% are one and two family residences. (U. S. Census)
- *Description of fire suppression system options used*
    - *Municipal water* Most are water, a couple dry residential systems
    - *Well water* a couple
    - *Storage* Maybe 1 or 2 places on wells need storage. Cost unknown. Volume, maybe 300 gallons in the basement
    - *Other suppression* Dry, air system
- *Cost of systems in one-and two-family residences*
    - *Typical capital cost:* Not known
    - *Typical maintenance costs:* None except per NFPA 13D, not enforced; backflow preventers need annual inspection. This isn't enforced by the building department.
- *Housing market changes*: Not known
- *Change to residential insurance premiums*: Not known
- *Additional impacts:* None
- *Other comments:* From fire marshal, the use of sprinklers has kept fires small and contained. In the long run, good value.

Municipality: **Harrison, Village & Town** ***Date:*** **9/02/08**

- *Contact:* Building & Plumbing Inspector: CEO Bob Fitzsimmons 914-670-3050; Fire Marshall Steve Surace, 914 670 3131
- *Dates sprinklers required, amended*: 1989
- *Problems with systems:* Some people have drained glycol from the system due to moving heads in renovation; recharged with water. The next winter, freezing and burst pipes in attic. Five years ago this happened in nine houses at once. Since, much less.
- *Hardship variances granted?* No hardship variance granted.
- *# of homes with sprinklers:* About 1500 homes in all.
- *Pre and post sprinklers fires:* There have been two fires in sprinkled residences. In each case, the sprinkler worked and contained the fire in a small area.
- *Description of fire suppression system options used*
    - *Municipal water:* Water or glycol / glycerine. Retros are usually glycerine/ glycol
    - *Well water:* Probably 25 or 30 on pumps (low pressure) or tanks and pumps
    - *Storage*: About 300 to 350 gallons of water. Only need 10 minutes worth of water for 13D. Usually tank in basement, poly tank with pump.
        - *Approximate storage cost*: About $3000
    - *Other suppression*: None
- *Cost of systems in one-and two-family residences*
    - *Typical capital cost:* As a guess, about $200/sprinkler head, say $2 -$3 / SF of home

- *Typical annual maintenance costs:* No maintenance required for sprinklers; backflow preventers needed for most home sprinklers and these need annual inspection.
- *Housing market change and how determined*: None noted. Westchester Co. has a vigorous market.
- *Change in insurance premiums*: None known
- *Additional impacts:* None known
- *Other comments*: State should require licensing of installers if sprinklers are required.

***Municipality:* Irvington, Village** ***Date:* 9/2/08**

- *Contact:* Building & Plumbing Inspector: Building Inspector, Ed Marron, Jr., Ph: (914) 591-8335;
- *Dates sprinklers required, amended*: 1989
- *Problems with systems:* Early 2000 there was a recall of one type of head; contractor and manufacturer replaced them all at the development in which they were installed.
- *Hardship variances granted:* One hardship variance granted for health reasons; on municipal water.
- *Pre and post sprinkler fire conditions.* Not available.
- *# of sprinklered homes:* About 150 building permits a year, 10 new needing sprinklers
- *Description of fire suppression system options used*
  - *Municipal water:* All residential systems are water based and are on municipal water. All buildable area in the village is on municipal water.
  - *Well water* None
  - *Storage* Storage needed for pressure; about 2 homes/yr need pumps or storage for pressure reasons.
  - *Other suppression* none
- *Typical capital cost*: Houses start at million, Sprinklers are one or two percent of the house, based on CEOs estimate.
- *Typical annual maintenance costs:* No maintenance
- *Housing market, how determined*: No effect per CEO estimate. It's an aggressive market.
- *Change to residential insurance premiums*: Not known
- *Additional impacts:* None stated

***Municipality:* New Castle** ***Date:* 9/8/08**

- *Contact:* CEO, Bill Miskiell 914 238-4723
- *Dates sprinklers required, amended:* 1990
- *Problems with systems:* In one system, the owner shut the valve and drained the sprinkler system to his pool house, so it didn't work when needed. There have been some leaks in attics due to freezing where not properly insulated / no antifreeze in system.
- *Hardship variances granted:* There have been some granted to allow less heads due to construction difficulties when retrofitting in existing homes.
- *Pre and post sprinkler fire conditions:* Some fires have occurred in sprinklered homes. In general, they work to contain and reduce the fire. One occurred three months ago in a sprinklered home where the house was totally destroyed – the fire took the roof of and started down the walls before the sprinklers kicked in. The fire appears to have started on the roof.
- *Number of residences with sprinklers:* There are several thousand sprinklered homes at this time.
- *Description of fire suppression system options used*
  - *Municipal water* Many. Some have tanks with pumps due to pressure problems
  - *Well water* Many, with tanks and pumps
  - *Storage Volumes* about 300 gallons.
  - *Other suppression* Many have antifreeze with water
- *Cost of systems in one-and two-family residences*
  - *Typical capital cost, how determined:* Unknown.
  - *Typical maintenance costs:* No maintenance monitored
  - *Backflow preventers*: In all but houses with tanks and pumps.

- *Additional impacts:* None noted.

Municipality: **North Syracuse, in Onondaga County** ***Date:*** **9/3/08**

- *Contact:* Code Enforcement Officer/Zoning Officer: Phil Drury, codes@northsyracuse.org; Codes Clerk: Pearl Morris; Fire Chief Mark Hogan @ Fire Station 1, Phone/fax (315) 458-1920; nsfchief@twcny.rr.com Fire dept historian: Denny Mac
- *Dates sprinklers required, amended:* 1999 by L.L. No. 1-1999, Ch. 104
- *Problems with systems: Leaks, not operational, complaints?* To date don't have any residential sprinklers. They only require sprinklers in 3 family and above, per state code.

Municipality: **Onondaga, Town** ***Date:*** **9/2/08**

- *Contact*: Building Inspector/Codes Enforcement, Ronald Ryan, Phone: (315) 469-3144;
- *Dates sprinklers required, amended*: 1989;
- *Problems with systems: Leaks, not operational, complaints?* None
- *Hardship variances granted?* None
- *Pre and post sprinkler conditions.* No fires in sprinkled residential building yet.
- *Description of fire suppression system options used*
  - *Municipal water* All on municipal water
  - *Well water* None
  - Storage None
  - Other suppression None
- *Cost of systems in one-and two-family residences*
  - *Typical capital cost – any breakdown, how determined:* Per CEO, about $2000
  - *Typical annual maintenance costs:* Not known; backflow preventers are required.
- *Housing market changes*: None noted
- *Change to insurance premiums*: None known
- *Additional impacts:* None noted

Special conditions: Not known

Other comments by CEO: Too early to tell impact, as no fires in sprinkled buildings

Municipality: **Rye Brook, Village** ***Date:*** **9/8/08**

- *Contact:* Michael Izzo, mizzo@ryebrook.org, Tel: (914) 939-0668; Steven Fews, Assistant Building Inspector, stevefews@ryebrook.org; Rose D'Ascoli, Senior Office Assistant
- *Dates sprinklers required, amended:* 1997; amended LL#9-2005 to exclude 1&2 family detached homes and certain 1-family townhouses and to only require sprinklers in new construction, and in new portion of additions.
- *Problems with systems: Leaks, not operational, complaints?*
  There has been concern due to change in the municipal water pressure. The local water company has changed hands a couple times in the past 6 years, and has adjusted the water pressure down to the point that some were concerned that their sprinklers wouldn't operate. The village code department requested that in the future the water company notify them of pressure changes.
- *Hardship variances granted:* The village amended the sprinkler MRLS to require sprinklers only in new constr. and new addition. Previously some variances were granted to omit sprinklers in existing homes with difficult retrofit situations. Since then, there have been no variances.
- *Pre and post fire sprinkler conditions:* They haven't had a fire in a sprinklered residential building. The last couple events, one last year one this, have been in unsprinklered buildings.
- *# of homes sprinklered:* About 85 % of residences are newer construction, since 1980, by CEOs estimate.
- *Description of fire suppression system options used*
  - *Municipal water*: All residential sprinklers are water systems, on municipal water.
  - *Well water*: None

- *Storage Volume*: Some need storage due to water pressure problems. Volume unknown.
- *How / where supplied*: Tanks in basement. *Approximate storage cost*: Unknown
- *Other suppression*: None

- *Cost of systems in one-and two-family residences*
  - *Typical capital cost, how determined:* COE thinks between $5000 and $15,000
  - *Typical annual maintenance costs:* no maintenance beyond NFPA 13D
- *Additional impact.*: See above re water pressure, otherwise none known
- *Housing market*: None known
- *Change to insurance premiums:* None known

Other: The MRLS was adopted due to special condition that the paid fire service operates only 12 hours/ day, and the village relies on the overextended service from Port Chester for the remainder of the time.

Municipality: **Village of Sleepy Hollow** ***Date*: 9/08/08**

- *Contact:* Building: Sean E. McCarthy, Village Architect, (914) 366-5124;
  Fire Department 914/366-5199 John Korzelius, Captain
- *Dates sprinklers required, amended:* 1989, amended LL#8-1991, LL#11-1994; LL#7-1996
- *Problems with systems:* No reported problems
- *Hardship variances granted:* All building that are subject to the local law but do not require fire sprinklers as per NYS are eligible for a variance. The Village has received only one application for a variance in the past three years.
- *Pre and post sprinkler fire conditions:* No fire in sprinklered homes
- *% of homes sprinklered:* Approximately 10%
- *Description of fire suppression system options used*
  - *Municipal water* All
  - *Well water* None
  - *Storage Volumes* None needed
  - *Other suppression* None
- *Cost of systems in one-and two-family residences*
  - *Typical capital cost,, how determined:* $12,000 based on 50 heads and CPVC piping
  - *Typical annual maintenance costs:* Less than $200
  - *Backflow preventers required?* Yes
  - *Additional impacts, Other comments:* None

Municipality: **Village of Tarrytown** ***Date*: 8/25/08**

- *Contact:* Building department: Michael J. McGarvey P.E., Engineer/Building Inspector
- *Dates sprinklers required, amended:* 1992
- *Problems with systems:* None
- *Hardship variances granted:* Tarrytown has a provision for hardship, as required. There has been only one request in four years, which was denied. The entire village is on municipal water.
- *Pre and post sprinkler fire conditions.* Statistics are not available. Anecdotally, a house without sprinklers burned to the ground Thanksgiving 2007; no one was hurt. No recent fires involved homes with sprinklers.

  Number of fires, related injuries and deaths, other contributing factor: Not known
- *Description of fire suppression system options used*
  - *Municipal water* All, 8 to 10 per year
  - *Well water* None
  - *Storage Volumes* - none needed
  - *Other suppression* None
- *Typical capital cost, how determined:* $8,000- 15,000 from building inspector's discussions with contractors, home builders.
- *Typical annual maintenance costs:* Test backflow preventers annually; no other maintenance cost.

- *Housing market, how determined*. Not known
- *Change to insurance premiums*: Not known
- *Additional impacts:* Not known

Appendix C: After installation inspection, testing and maintenance of sprinkler systems using NFPA 13D

By Daniel E. Nichols

There has been extended discussion and confusion on the needs for inspection, testing, and maintenance of fire sprinkler systems installed in accordance with NFPA 13D.

The Fire Code of NYS references NFPA 25 as the only standard for Inspection, Testing and Maintenance of water-based fire protection systems. Within Chapter 1 of NFPA 25 (Section 1.1.1 in the 2007 edition), the standard states the standard shall not apply to sprinkler systems designed and installed in accordance with NFPA 13D. Therefore, the Fire Code of NYS does not require Inspection, Testing , and Maintenance of fire sprinkler systems installed in accordance with NFPA 13D.

However, if one was to open NFPA 13D looking for Inspection, Testing, and Maintenance requirements, they would be directed to Section 4.2 (both the 2002 and 2007 editions). Both documents require the following for maintenance of the system:

- The installer shall provide to the owner instructions on inspecting, testing and maintaining the system
- Operated or damaged sprinkler heads shall be replaced with sprinkler heads in kind
- Any painted sprinklers shall be replaced

Therefore, if the inspection, testing and maintenance requirements within NFPA 13D were following (which is not a referenced document for ITM of fire protection system within the Fire Code of NYS), they would be limited to an action by the homeowner and not a periodic test by the jurisdiction or third-party.

Regarding the lifespan of sprinkler heads, the Fire Code of NYS has no path to get to a required replacement schedule for sprinkler heads in NFPA 13D fire sprinkler systems. However, the requirement in NFPA 25 (Section 5.3.1.1.1 and 5.3.1.2, 2007 edition) for other types of sprinkler systems requires that sprinkler heads should be either replaced or a representative sample tested for fitness (4 heads or 1% of the total number) after 50 years. Of note, smoke alarms are required to be replaced every 10 years in accordance with NFPA 72 Section 10.4.7 (2007 edition).

In summary, there are no requirements within the Fire Code of NYS that require inspection, testing, and maintenance of fire sprinkler systems on a periodic schedule or to be done by the CEO or third-party. Replacement of sprinkler heads is not required, with NFPA 25 providing guidance that sprinklers (with the same characteristics as those used in NFPA 13D sprinkler systems) are permitted to be installed without replacement for at least 50 years. To that end, the maintenance of sprinkler systems and smoke alarms is very similar.