

Should the City of Aurora Implement a Mandatory Residential Sprinkler System Ordinance?

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CERTIFICATION STATEMENT

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ABSTRACT

Residential Sprinkler Systems have been debated for many years to be an effective and dependable mechanism to significantly reduce fire related fatalities in residential structures, where most of the fire deaths occur. The City of Aurora has experienced significant growth over the past 50 years. There is still a potential for continued growth in areas farther from the current fire stations. It would be difficult to justify satellite stations to improve response times in these areas. Subsequently, structure fires in these areas pose a greater risk for injuries, fatalities and structural damage if a fire is experienced.

This descriptive research explores if a Residential Sprinkler Ordinance can be a practical solution to better protect the lives and properties in this areas. The following questions were to be answered: 1) What are the benefits to the community by implementing a residential sprinkler system ordinance? 2) What are the costs to construct a sprinkler system in a single family dwelling? 3) Which residential structures should be included in a residential sprinkler system ordinance? 4) What changes are necessary in the current City of Aurora water infrastructure to adequately supply all residential structures?

Many researched literature documents were used to come to the conclusion that sprinklers in residential structures can significantly reduce fire related deaths and injuries. The single most finding is that there were very few fire fatalities, if any, which resulted from fires that occurred where sprinkler systems were installed. There is a considerable reduction in property loss from fires where sprinkler systems exist. Documents also support that less water is utilized from a sprinkler head then from fire suppression hoses and that most of the fires can be controlled or even extinguished by only one or two sprinkler heads. Nationally, there are

insurance rate reductions where residential sprinklers are installed and up to 20% when accompanied by supervised smoke detectors.

The author consulted with local builders, insurance representatives, sprinkler contractors, City Department heads and other related professionals to see how these statistics could be applied to the City of Aurora. The author also, with cooperation of a local home builder, obtained quotes and information to determine exactly how much the installation of a residential sprinkler system would affect the cost of construction for a new home.

The research proved that residential sprinkler systems are relatively inexpensive comparative to other associated costs of new residential construction being about \$2.35-\$5.04 sq/ft. in areas covered by a municipal water system. Structures served by private individual well systems are almost double at \$4.85-\$7.48 sq/ft. Retro-fit installations costs are a lot higher depending on the desirability of concealment and whether a larger water main tap is required. The average insurance rate reduction in the area is consistent with national averages at 8% and 20% when accompanied by supervised smoke detectors.

Based on the findings of this research study, it is believed that, although residential sprinkler systems are proven to be a significant benefit, implementing a mandatory residential sprinkler ordinance would not be received easily. Until residential sprinkler systems are recognized as a "Standard of Safety", implementing a mandatory Residential Sprinkler Ordinance in the City of Aurora would be difficult and unpopular.

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INTRODUCTION

The City of Aurora has experienced a tremendous amount of growth since the mid 1980s. Most of this growth has been in the form of residential development substantially increasing the population. A majority of the new residences are much larger structures than the typical 1,800 sq/ft. homes previously built, most being 3,200 sq/ft or greater. In addition, multiple luxury condominiums and cluster sites are developing. Many of these developments are themed to attract retirees. As a result, the elderly population in Aurora is also increasing, causing the Aurora Fire Department to experience an increase in requests for service. There are also several large non-platted tracts of land that could be developed. It does not appear that the growth in the City of Aurora will decrease in the near future.

The Aurora Fire Department has two fire stations geographically located to serve the small lot and densely populated sections of the 25 square mile city. Fire related requests for service in this area realize a response time of four minutes or less. As the population growth continues, there is an increase in the amount of structures that are farther from the two fire stations. There is a greater potential for fire related casualties and increased property damage in these areas with longer response times. There is also a greater risk to the responding firefighters as structure fires will be involved in fire for longer periods of time before the arrival of first due fire units.

The problem this study will identify is that there is an increase in growth and development in areas where fire risks are greater, and the frequency of structure fires in this area cannot justify the costs of providing additional stations or staffing to cover this area.

The purpose of this study is to determine whether a residential sprinkler system ordinance will be beneficial to the City of Aurora in reducing fire related casualties and property loss while

evaluating the costs associated to the property owners. In addition, a determination will be made whether this ordinance will be necessary for all residential structures within the city and to what extent. The information obtained from this study will be presented to the Aurora City Administration to consider implementing a local residential sprinkler system ordinance. This descriptive research project will answer the following questions:

1. What are the benefits to the community by implementing a residential sprinkler system ordinance?
2. What are the costs to construct a sprinkler system in a single family dwelling?
3. Which residential structures should be included in a Residential Sprinkler System Ordinance?
4. What changes are necessary in the current City of Aurora water system infrastructure to adequately supply all residential structures?

BACKGROUND AND SIGNIFICANCE

The City of Aurora is located 22 miles southeast of Cleveland in Portage County and is considered a part of the Akron metropolitan area. The entire 25 square mile original Aurora Township and Aurora Village achieved city status in 1975. Like many other communities in the region, Aurora has seen an increase in construction and population since the mid 1950s transcending from a rural to semi-rural residential community. This growth dramatically expanded in the mid 1980s from a population of 8,177 to an approximate 14,300 in 2005 or approximately 74.9% in 25 years (US Census Bureau, 2000).

Aurora is surrounded by communities that are also experiencing “infill” with freeways, interchanges and commercial/industrial development impacting their growth. This, coupled with

the vast amount of undeveloped residentially-zoned land, makes Aurora an attractive area to build. The city has the potential to have a population of approximately 24,500 after “build out” around the year 2025 (Aurora Planning Committee, 1997). Aurora has purchased several large tracts of land over the past decade in an attempt to reduce this “build out” to approximately 18,500 (Mayor L. A. McGill, personal communication, May 9, 2007). This adjusted estimate still represents that there is strong potential to realize a 29.3% population increase with approximately 1,680 new residential structures during the next 20 years.

The location of Aurora, being proximal to Cleveland and Akron, along with a highly rated school system, 18th of 719 Ohio school systems (Ohio Dept. of Education, 2007), has attracted many wealthy people to build in the city. Aurora is ranked in the State’s top 5% for median income and top 8% for people in the middle class income or greater (CityTownInfo.com, 2005). As a result, several prestigious golf communities and lake oriented developments have replaced former farmland (see Appendix A). Luxury condominiums and apartments, also constructed, have attracted wealthy singles and retirees. Many of these homes are 3,200 sq./ft. or larger.

Most of the residential small lot development has been concentrated in the center (former village) and the northwestern Geauga Lake area. The municipal water and sewer systems have been erected to accommodate this density leaving the remaining outlying areas subject now to development. Subsequently, larger homes with greater fire flow requirements are being constructed in areas without the availability of hydrants in close proximity complicating our firefighting capabilities. There is an effort to maintain the semi-rural community presence where zoning in these outlying areas require parcels to be three or more acres. Being served by individual wells and septic systems, it is less likely that the municipal pressurized water system

and fire hydrants will be expanded to these areas.

The Aurora Fire Department has experienced an increase in demand for services during this same growth period. In 1980 there was 387 EMS and 110 fire incidents for a total of 507 requests. This has significantly grown in 2005 to 1,330 EMS and 429 fire incidents totaling to 1,759 representing a 246.9% increase in requests for service during the past 25 years. Like most dual service departments, most of our demand is EMS related with only 24.3% pertaining to fire incidents (Aurora Fire Department, 1980-2006). Staffing has increased during this same period from one paramedic at only one station to the current 7 staffed between two stations. The increase in EMS incidents often leaves our fire incident response grossly understaffed as personnel are more likely to be already committed to an EMS request when a fire situation occurs. There are no hospitals in Aurora further lengthening the time personnel in the ambulance are unavailable for fire response. The cost factor to increase the staffing to provide sufficient personnel for fire responses while others are functioning in the ambulance would be difficult to justify with the low frequency of fire related incidents in the community. People in Aurora already pay more in property taxes per residence than most other communities in the state, leaving the option to attempt a levy for this purpose more difficult (CityTownInfo.com, 2005).

The City of Aurora is left in a position where the risk of substantial property damage and injury to life in a fire situation is of concern considering the current fire department staffing resources. This risk increases as the development and growth continues, particularly in the areas not served by hydrants. Fire Suppression Sprinkler Systems have long been recognized as an efficient and effective way to minimize fire spread until the Fire Department can arrive while allowing the occupants more time to exit safely from a structure involved in fire. Establishing a Residential Sprinkler System (RSS) ordinance in Aurora may be a suitable solution in reducing

this risk. Communities in other parts of the country have demonstrated success with this same idea.

The desired result of this study is to determine if a RSS would be beneficial to the City of Aurora in increasing the ability to provide a better level of fire protection service with minimal staffing. Understanding the benefits, costs to property owners and potential changes necessary for municipal services to accommodate a RSS ordinance would allow the City of Aurora administration to make an informed decision while considering this option. The intention is to utilize the results of this study for that purpose.

LITERATURE REVIEW

In 2002, the National Fire Protection Agency (NFPA) changed the standards for *NFPA 13R - Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four-Stories in Height*, in an effort to make residential fire sprinkler systems more affordable and encourage their installation. Some of the significant changes in this standard were:

- Can be a part of the domestic cold water system – multisystem design
- Can be constructed with Chlorinated Poly Vinyl Chloride (CPVC)
- Fire Department Connections (FDC) are not required
- Back flow prevention is not required (local jurisdiction directs domestic system requirements)
- Not required in porches, balconies, corridors and stairs that are open and attached
- Not required in exterior closets off balconies unless there is interior access
- Not required in attic or void spaces

- Garages are not considered part of the structure

The idea of having sprinkler systems installed in residences to provide fire safety is not a new one. In May of 1973, The National Division of Fire Prevention and Control listed 90 recommendations to reduce fire loss in their study, *America Burning*. Recommendation #75 was to support the development of auto-extinguishing systems for all types of dwellings. There have been many journal articles, research papers, and promotional materials that followed dedicated to just this topic. Most of these documents strongly support the use of Residential Sprinkler Systems to provide protection from fire to occupants and personal property.

One such document is the study from the National Fire Protection Association's (NFPA) *US Experience with Sprinklers*, published in November of 2003. This study utilized data from the National Fire Incident Reporting Statistics (NFIRS), the most detailed of the national fire incident data bases, encompassing all fires reported involving sprinkler systems and the effectiveness of the sprinkler systems. This detailed research came to the conclusion, "When sprinklers are present, the chances of dying in a fire and the average property loss per fire are both cut by one-half to two-thirds, compared to fires where sprinklers are not present" (Rohr, 2003). A significant finding is that there was a 64% reduction of deaths per thousand fires if sprinklers are added to dwellings. Furthermore, the reduction of fire related deaths was further improved to 82% by having both smoke detectors and a RSS. Regarding property conservation, the findings indicate that 92% of the time, only one or two heads controlled or extinguished the fires, the biggest exception being fires involving flammable liquids. This fact supports that less property damage will occur because the fire would less likely be able to increase in size and

spread. Data from the NFIRS statistics clearly indicate that having a RSS ordinance can reduce fire related fatalities.

In June of 2007, The NFPA published an update to this document entitled *US Experience with Sprinklers and Other Extinguishing Equipment*. This document analyzed more recent NFIRS data from 2002-2004, believed to be a more accurate representation of factual data with the implementation of the latest incident reporting requirements since 2002. This document reconfirmed that sprinklers save lives and protect property from fires, usually one or two sprinkler heads are required to control the fire and sprinklers are both reliable and effective. “Sprinklers apparently are still rare in places where people are most exposed to fire, including education properties, public assembly properties, offices, most stores and especially homes, where most fire deaths occur,” (Hall, 2007), and there is considerable potential for expanded use of sprinklers to reduce the loss and life and property to fire. Another statistic is that Automatic Extinguishing Systems (AES) is least commonly seen in reported fires in one- or two-family dwellings at 1% and only 8% of fires in apartments. The National Residential Fire Sprinkler Initiative of the U.S. Fire Administration is referenced reporting that no more than 2% of all new residences are being protected by a RSS. The initiative hopes to increase interest in residential sprinkler systems among builders, developers, community officials and especially homeowners. The NFPA still does not have any report of a fire killing 3 or more people in a completely sprinkled building were the system was properly operating. Where fire fatalities did occur, the victim was located in the area that the fire started 88% of the time and 66% of the time involved people 65 years old or greater.

The Home Fire Sprinkler Coalition, a non-profit organization that is dedicated to improved fire prevention through education, clearly supports residential sprinkler systems. They

maintain a website, www.homefiresprinkler.org, for the purpose of educating consumers, builders, insurance companies and fire service professionals on the benefit of a RSS where they promote the following as facts:

- Fire sprinklers save lives, reduce property loss and can even help cut homeowner insurance premiums.
- Home fire sprinklers can contain and may even extinguish a fire in less time than it would take the fire department to arrive on the scene.
- Installing both smoke alarms and a fire sprinkler system reduces the risk of death in a home by fire by 82%, relative to having neither.
- Only the sprinkler closest to the fire will activate spraying water directly on the fire. Ninety percent of fires are contained by the operation of just one sprinkler.
- Nationally, on average, home fire sprinkler systems add 1% to 1.5% of the total building cost in new construction.
- Home fire sprinklers use only a fraction of the water used by fire department hoses.
- The odds of accidental sprinkler discharge due to manufacturing defect are 1 in 16 million.
- Modern residential sprinklers are inconspicuous and can be mounted flush with walls or ceilings.

The National Association of Home Builders (NAHB) clearly opposes the addition of RSS to the International Building Code. A Smoke Alarms Work web site, www.smokealarmswork.org, was created by NAHB as a public safety tool and to remind home owners to maintain their smoke alarm systems. The site includes helpful information about fire safety explaining that the number of fatal fires has dropped dramatically in the last 20 years as the result of changes in residential construction technology, improved building code requirements, consumer behavior and the concerted efforts of fire fighters, home builders and other safety advocates. This trend continues and is all the more impressive given the Nation's growing population and housing stock. They argue that from 1979 to 2003, the rate of death from house fires dropped by more

than 58%, based on data from the Centers for Disease Control (CDC). That trend will continue as more new housing stock is constructed and especially as home owners are educated to maintain their smoke alarm systems. They cite that the U.S. Fire Administration (USFA) and National Fire Protection Association (NFPA) data continue to affirm that the vast majority of home fire fatalities occur when there are no operational smoke alarms. Based on a 2006 U.S. Fire Administration study on the presence of working smoke alarms in residential fires, 88% of the fatal fires in single-family homes between 2001 and 2004 occurred where there were no working smoke alarms. The same study shows that only 3.7% of residential fire deaths were reported as occurring in homes with working smoke alarms. "The problem is not homes without sprinklers, the problem is homes without working smoke alarms," said Sandy Dunn, NAHB's first vice president. "The most proven, practical and affordable measure to preventing fire fatalities is ensuring that homes are equipped with smoke alarms and that they are maintained."

The Residential Fire Safety Institute publishes a newsletter for distribution every other month entitled Operation Life safety. In an article, One Sentence Can Change Fire Safety in America, author Jeffrey Shapiro, president of the International Code Consultants and well known advocate of residential sprinklers, disputes the argument made by the NAHB. He defends that Scottsdale, Arizona proves that costs for residential sprinkler systems become competitive and affordable when everyone has to comply. Scottsdale has a mandatory RSS ordinance and the average costs to builders is \$0.55-\$0.75 per square foot and smaller homes may be even less. Also, there are design options available to make homes constructed using wells affordable. Mr. Shapiro also explains that 45% of property owners surveyed by Harris Interactive desire a sprinklered home. The same survey respondents indicate that they believe a fire sprinkler system would increase the value of their home (69%) and that 38% would more likely purchase a home

equipped with this safety device but 48% of the people still have a fear of water damage associated to fire sprinklers. He also explains that RSS are now designed and installed to prevent freezing if properly installed, being a part of the domestic water system. Another point that he subscribes to is that most residential fire deaths result from fires caused directly or indirectly by people and aren't related to the home's age. "Fire-safety experts know that socioeconomic status, occupancy density and occupants' age and mobility are far more likely to contribute to fire deaths than a structure's age" (Shapiro, 2007). He in detail expresses that RSS are more reliable for life safety as they keep the fire small and often extinguish the fire entirely where smoke detectors merely notify occupants and have no extinguishing properties. Mr. Shapiro also adds that sprinkler systems have a much longer life expectancy compared to smoke detectors only lasting an average of 10 years. The author does acknowledge, however, that the use of both smoke detectors and sprinklers is the most effective method of providing safety for occupants from fires.

Another document that reports in detail that sprinklers in dwellings save lives is from the City of Scottsdale, AZ. published in 1997, *Automatic Sprinklers: A 10 Year Study* (Ford, 1997), also recognized as *The Scottsdale Report*, defines the results of having a RSS required in every new home, no matter the size, since the adoption of code in 1985. This study evaluated 10 years of data involving structure fires in their jurisdiction pertaining to fire fatalities, average property loss and estimated suppression flow. During the period of their study, they recorded no fire related deaths in homes with sprinklers compared to the 10 fatalities in homes without sprinklers. They also experienced an average total property loss of \$1,945 in sprinkler installed homes instead of \$17,067 where sprinklers were not present. An average of 209 estimated gallons of water was used to extinguish fires in homes with sprinkler systems compared to 3,290 estimated

gallons needed in homes without. Rural/Metro Fire Department, covering Scottsdale, Arizona, believes that RSS have a direct role in the saving of eight lives (Ford, 1997). It was also pointed out that there was no reduction in construction activity in their district following the adoption of this code. The experience that Scottsdale has had regarding RSS indicates that not only were lives saved from this ordinance, but also that there was considerably less personal property damage occurring.

A report by Chief Ronald Siarnicki of Prince George County Fire/EMS Department, *Residential Sprinklers: One Community's Experience Twelve Years after Mandatory Implementation* (Siarnicki, 2001), has very similar findings strongly supporting that sprinklers in residential structures significantly save lives. Prince George County is the first in the United States to implement a county-wide RSS requirement for all dwellings. No recorded fire related deaths occurred in homes equipped with a RSS. The average fire loss of \$31,667 in structures without a RSS was significantly lower where sprinklers existed at \$3,673 reduced by 88.4%. The more significant suggestion was that 154 lives were saved as a direct result of the intervention provided by sprinklers. Prince George County's study has re-enforced the statement that lives and property damage are better protected with their RSS ordinance.

Another supportive document comes from the National Fire Sprinkler Association entitled *Residential Fire Sprinklers for Life Safety – an Economic and Insurance Prospective* (Dewar, 2001). This study prepared for the Orange County, California Fire Authority investigated the economic concerns of installing a RSS in new dwellings, insurance rate reductions and the reasons that there is still a resistance to RSS ordinances. A comparison of fire related deaths in the United States with 13 other industrialized nations was performed where the U.S. ranked second highest behind Hungary. Also noted was that all of these countries death

rates have decreased at the same rate with the promotion of Smoke detectors. The research found that 88% of U.S. households were equipped with at least one smoke detector. 14.8% of residential fires involving a fatality were because the detector failed to operate, mostly because of poor battery maintenance. Smoke detectors were operating in 19% of these fires where death still resulted. In some cases, the detector has gone off too late for the occupants to have enough time to exit safely. Also re-enforced was “The cost to repair fire structural damage will always be more expensive than water damage caused by sprinklers” (Dewar, 2001) and, therefore, insurance companies will provide reduced rates for all occupancies including single family residences. With the information that there is an 82% decrease in fire related deaths with RSS and smoke detectors installed, it was calculated that an additional 4,700 in the U.S. would have survived fire death in 1995. Data collected indicated that a new house could be constructed with a RSS and only raise the cost of the project by less than 1% to have these life safety systems. As for insurance rate reductions, “Insurance reductions for sprinkler protected property is always lower than of non-sprinkler protected properties” (Dewar, 2001). A typical rate reduction is in the area of 8% (Insurance Information Institute, 2007). The Fire National Sprinkler Association, in this report, has demonstrated that new constructions with a RSS are still affordable and that there is a benefit from insurance companies in the form of a rate reduction.

A more recent report from the U.S. Department of Commerce National Institute of Standards and Technology (NIST) *Benefit-cost analysis of residential fire sprinkler systems* (Brown, Burty, & Fuller, 2007), analyzed National Fire Incident Reporting Statistics (NFIRS) data of fires between 2002 and 2005 to compare residential fires in structures only having smoke detectors and structures having smoke detectors and wet-pipe fire sprinkler systems. These authors calculated that there was a 100% reduction (none reported) in fire related fatalities in

one- and two-family dwellings during this period where both smoke detectors and fire sprinklers existed. They also reported that there was a 57% reduction in fire related injuries and a 32% reduction in direct property loss. Only 2% of the residential fires occurred in structures that were equipped with residential sprinkler systems. The authors also determined the costs to purchase and install fire sprinkler systems in three prototypical residential structures: 1) 3,338 sq./ft. two-story colonial with a basement and no garage, 2) 2,257 sq./ft. three-story townhouse, and 3) 1,171 sq./ft. single-story ranch. The following cost ranges were determined:

- | | |
|--------------|-------------------|
| 1) Colonial | \$3,371 - \$5,407 |
| 2) Townhouse | \$2,279 - \$3,656 |
| 3) Ranch | \$1,182 - \$1,897 |

These figures based from 2005 prices averaged between \$1.01 and \$1.62 sq./ft. This report clearly indicates that having a fire sprinkler system is affordable, and when coupled with smoke detectors, can have a positive impact on survivability and property loss over structures with just smoke detectors only.

The NFIRS statistical data relating to having or not having fire sprinklers, along with experiences for more than 10 years in Scottsdale and Prince George County and the recent NIST report clearly indicate that the presence of a residential sprinkler system will be beneficial in protecting life safety and personal property in a fire situation. Research from the National Fire Sprinkler Association certainly supports that these systems are affordable and that insurance companies recognize their value.

PROCEDURES

The procedures to obtain information for this descriptive research project were a three-step process. These steps were utilized to provide the necessary information to answer the

questions: (a) what are the benefits to the community by implementing a residential sprinkler system ordinance? (b) what are the costs to construct a sprinkler system in a single family dwelling? (c) which residential structures should be included in a Residential Sprinkler System Ordinance? (d) what changes are necessary in the current City of Aurora water system infrastructure to adequately supply all residential structures?

First, literature review was conducted using current journals, books, government reports and the internet. Other applied research projects from the National Fire Academy relating to this subject proved useful along with articles from the National Fire Protection Association (NFPA) and the National Fire Administration (NFA). Information and statistics from the Home Fire Sprinkler Coalition (HFSC) website also provided information specific towards this project.

Second, various area insurance agents were contacted to determine if having a residential structure equipped with a RSS will affect home insurance premiums and the criteria considered. A visit or telephone call to these agents to obtain quotations and discuss RSS easily accomplished this goal. A recently constructed model home in the community, with the cooperation of a local builder, served as a reference for various local sprinkler contractors to bid installation of a RSS. The structure chosen was a representation of a typical new construction found in the City of Aurora. The bids from the sprinkler contractors should represent the following installation and equipment scenarios: (a) during construction in an area where a municipal water system exists, (b) during construction where no municipal water system is provided, (c) retrofit installation to the structure if construction already completed. The sprinkler contractors were to consider the guidelines in NFPA 13.

Third, the Aurora City Engineers were consulted to explain the current municipal water system and distribution. They proved to be best able to discuss weaknesses or inadequacies in

this infrastructure and be the most knowledgeable of future improvement considerations. They also were best able to predict how a possible RSS ordinance would affect this water system.

All of the pertinent information was collected and interpreted to formulate conclusions related to the scope of this project and the data is presented in a logical format to support the opinions derived.

Definition of Terms

Automatic Extinguishing System. Sprinkler Suppression systems that use water (both wet and dry pipe), foam, halogen, dry chemical and carbon dioxide for the purposes of fire control and extinguishment.

Back Flow Prevention. A one way valve in a water system with purpose to prevent contaminated water from returning into the source water system.

Chlorinated Poly Vinyl Choride (CPVC). Plastic pipe used for residential domestic water systems and can be used, if rated appropriately, for fire sprinkler systems.

Fire Department Connection. Exterior access for fire departments to pump additional water into a fire sprinkler system in order to boost water pressure.

Flashover. A temperature obtained during a fire situation at which all of the contents and structural components become hot enough to rapidly ignite. These conditions most often contribute to fire related fatalities and injuries to firefighters.

Multi-system Water System. An individual water system that serves both domestic and fire sprinkler systems.

NFPA 13. National Fire Protection Association's *Standard for the Installation of Sprinkler Systems* where NFPA 13D: *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes* and NFPA 13R: *Standard for the*

Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height are defined.

Residential Sprinkler System (RSS). A wet or dry system designed to automatically provide water to an area in a residence that is involved in a fire so that the fire is suppressed and controlled to allow the occupants of the structure sufficient time to escape and prevent the fire from reaching the flashover point.

Limitations of Study

The model home represents a typical modern colonial residential structure similar to recent structures being constructed in Aurora. There are other residential structures being constructed such as townhouses and ranches that will not be represented in this study. A colonial was chosen as the model home being the most expensive of residential structures and, although it is not represented in this study, should be understood that the costs to construct a RSS in a townhouse or ranch will be slightly less than that of the costs in a Colonial.

RESULTS

Insurance Study

Various local insurance agents were contacted by telephone or in person to establish what reductions in insurance premiums were offered by having Residential Sprinkler Systems installed on a typical one family residential structure (see table 1).

There was an average of 11% insurance premium reduction offered to residential structures fully equipped with a RSS. Furthermore, the average reduction increases to 20% when the structure is also fully equipped with smoke detectors and monitored by a supervised fire alarm monitoring company. In order to receive this rate reduction, there would need to be

documentation certifying that the RSS was constructed to conform to the standards suggested in NFPA 13. The average rate reduction represented is slightly higher than the 8% insurance premium reduction national average.

Table 1

Insurance Reductions Associated to Residential Sprinklers		
Insurance Company	Sprinklers	w/Detectors
Farmers	10%	25%
Hartford	13%	20%
Westfield	13%	15%
Ohio Casualty	13%	23%
State Farm	10%	20%
Grange	0%	5%
All State	5%	11%
Liberty Mutual	13%	20%
Prudential	15%	20%
Kemper	10%	23%

All of the insurance carrier agents were unable to provide the premium rate reductions without first contacting an insurance broker representative. Some of the insurance agents required a detailed explanation of what Residential Sprinkler Systems are and how they worked. None of the agents ever had the opportunity to quote or provide these insurance premium reductions prior to this study.

Water Supply Study

The City of Aurora Engineering Department was consulted about changes that may be needed in the municipal water system to accommodate providing water supply for residential sprinkler systems. Approximately 50% of the City's geographical area contains roughly 75% of Aurora's population. This is a result of residential and commercial build out over the past 50 years to the center of the community and the Geauga Lake area. The municipal water system infrastructure developed with that growth to serve these densely populated regions, providing

supply to approximately 5000 structures. This system obtains its water from the Portage County Water System from the south with two water towers located in Aurora to maintain sufficient water supply. A supply source from the Cleveland Water System from the north is planned in the near future that will provide redundant supplemental water to the ever increasing needs of this system (see Appendix B). There are also plans in progress to connect loops to the larger “dead end” water mains to improve water quality and adequate supply. The Engineering Department believes that they can provide sufficient water to meet the demands of all structures, both commercial and residential, in the area served by this water system without any anticipated changes to the current infrastructure.

The Aurora Engineering Department explained that although infrastructure could accommodate residential sprinkler systems, individual water main tap connections could cause complications. Most of the residential areas currently developed have 3/4 inch domestic taps. RSS typically require 1 inch taps for residential structures up to 4,000 sq/ft. and 2 inch or greater size water main taps for structures larger in size. Additionally, these taps are now “stubbed” in by the developers when the utilities are provided prior to construction in the newer sub-developments. Larger water main tap fees are considerably more costly with the current tap fee schedule. Retro-Fitting a RSS to existing structures most likely could require a new larger tap and that fee should be considered in the total project cost. The Engineering Department suggested that planning for residential sprinklers prior to sub-development construction would be better cost effective.

A majority of the water system is considered to be fully developed with little further growth potential. The remaining parcels not served by the water system are zoned for larger lots and depend on private individual well water systems. Although this is the area most likely

experience residential growth, there is little potential for the water system to be expanded to supply this growth and the area will remain served by individual private well systems.

RSS Cost Study

A local builder provided the use of a model home to obtain bids for the installation of a residential sprinkler system (see figure 1). This home represented a typical modern residence being constructed in the City of Aurora. The home is a 3,150 sq/ft. 4-bedroom two-storey modern colonial that had just completed framing and enclosure at the time of this study. It is located in a new sub-division served by the municipal water system. The cost of construction was reported by the builder to be \$133 sq/ft. totaling \$558,950.



Figure 1 – Colonial Home Used as Model for Sprinkler Contractor Bids

Requests for bids were sent to local sprinkler contractors to provide a RSS for this structure while the structure was in the process of being constructed. The contractors were asked to specify costs for design, materials and labor. They were also asked to show the increases in costs if the structure was located in an area served by a private individual well system and then to provide the costs if the structure was already completed to represent a retro-fit installation. The materials desired were not specified and the only stipulation was that it had to be constructed to meet the standards of NFPA 13 (see Appendix C).

Bids were requested from 10 sprinkler contractors that agreed to participate in this study. Of those 10, only 2 bids were received to use for the purposes of this study. Bids received ranged from \$7,420–\$15,900 to provide a RSS for this residence during construction having a pressurized municipal water system available. The bids for a well supplied water system ranged from \$15,420-\$23,900. None of the contractors would commit to a price for retro-fit claiming that there were too many variables that needed specified to be able to bid competitively. Specifications were for a combination of Black pipe and CPVC plastic and allowed 32–47 heads to provide coverage. The quotations included back flow prevention, appropriate valves, permits and similar required equipment. Bids were inconsistent, however, when describing what was necessary to provide coverage to certain function rooms.

The cost to provide a RSS for this model home ranged from \$2.35-\$5.04 sq/ft. with a municipal water system representing an increase of 1.7%-3.7% additional towards the total construction costs of the home. In a well system, costs ranged from \$4.85-\$7.58 sq/ft. or a 3.6%-5.6% increase in construction costs.

DISCUSSION

There is an overwhelming amount of literature supporting that Residential Sprinkler Systems are beneficial in preventing injury or death in a residential fire situation. The most impressive being the statistics from both *Automatic Sprinklers: A 10 Year Study* (Ford, 1997), and *Residential Sprinklers: One Communities Experience Twelve Years after Mandatory Implementation* (Siarnicki, 2001), where there were no fire related deaths reported in Scottsdale, Arizona and Prince George County, Maryland when fires occurred in residential structures that were equipped with RSS. Both of these reports also represented that less water was necessary to control these fires and significantly less property damage resulted compared to structures without a RSS. It is proven that the chances of surviving a fire situation in a residential structure is further improved when the structure contains working smoke detectors, as documented in the report *U.S. Experience with Sprinklers* (NFPA, 2003).

With these statistics alone, the City of Aurora could also recognize a similar benefit in residential structure fires where the risk of life and property loss can be significantly reduced, especially in areas less populated and where the Fire Department response times are greater. The question then becomes can the City of Aurora justify the costs to the community to provide these beneficial life safety enhancements with a mandatory RSS Ordinance? The answer to this question simply comes down to economics.

There is a financial benefit in the form of insurance premium rate reductions by having RSS installed in residential structures. Aurora property owners could recognize approximately 11% reductions as discovered in this study exceeding the 8% national average represented by the report *Residential Sprinklers for Life Safety* (Dewar, 2001). The savings in insurance premiums,

however, is not enough to offset the costs of constructing a RSS and, therefore, an increased financial investment in having these systems still exists.

The municipal water system in Aurora is capable of handling the demand for RSS in all areas that it serves. These systems, however, require larger water main taps which have an increased cost, depending on the size of the structure. In planned urban developments where the water line is already constructed, a new larger tap may be required to replace the $\frac{3}{4}$ inch tap originally “stubbed” when constructed. There would be an increase in costs to developers to provide larger taps for sub-developments where the water main has not yet been constructed. In turn, this increase in cost would be forwarded to the property owner as a cost of construction.

This study shows that providing RSS in new residential constructions are relatively inexpensive adding only \$2.35-\$5.04 (1.7%-3.7%) in comparison to the overall total cost of construction. This price is higher than the costs reflected in the study, *Benefit Cost Analysis of Fire Sprinklers* (Brown, Burty, & Fuller, 2007), of \$1.01-\$1.62 sq/ft. It is believed that these costs are higher in Northeast Ohio because RSS are not prevalent in the area. The Operation Life Safety article, *One Sentence can Change Fire Safety in America* (Shapiro, 2007), suggests that these costs can be less when sprinkler contractors are in an environment where they can bid more competitively. Northeast Ohio currently is not in that environment. It was difficult to get local sprinkler contractors to participate in this study as they were not accustomed to providing RSS being solely involved in commercial applications. This was more obvious when only 2 of the 10 contractors that agreed to participate actually returned the bid quotations.

Although the costs are relatively inexpensive to provide a RSS in a new construction, the costs do not include increases for larger water tap fees that would be necessary in Aurora. These prices are also for areas that are served by the municipal water system and, for the most part,

already fully developed. Costs for areas served by private well systems are almost doubled being \$4.85-\$7.58 sq/ft. (3.6%-5.6%). Residential sprinkler systems served by private individual well systems most likely will require additional equipment like booster supply pumps and water holding tanks capable of containing 400 gallons or more to comply with the standard NFPA 13. There may be some changes to the electrical requirements to accommodate generators and these booster tanks. In all, the additional associated equipment necessary with well systems will substantially increase these costs for well serviced structures. Aurora's potential for growth is primarily in these areas.

Retro-fit installations are even more expensive. There are many variables that will influence these costs, the greatest being that a larger water tap and supply line would be needed. Other contributing factors would be related to interior aesthetics. The most cost effective application to a retro-fit installation of a RSS would be during a complete interior renovation where the pipes could be concealed during this process. The process of retro-fitting an existing residential structure would be disruptive, to say the least, to the use of the structure during this installation. Sprinkler contractors would not commit to providing actual quotations without knowing the specific details to these variables for a retro-fit installation of the model home leaving the impression that this could be of significant cost.

In all, this study has exploited the findings of the report, *U.S. Experience with Sprinklers and other Extinguishing Equipment* (Hall, 2007), where Residential Sprinkler Systems are still rare in United States. The local insurance agents were unfamiliar with these systems, the sprinkler contractors were inconsistent with design of these systems and the builders were resistant to RSS being included in residential constructions. Many of the builders, when asked to

participate in this study, recited similar apprehension to “myths” described by the Home Fire Sprinkler Association in their education campaign promoting RSS.

There are many communities in the United States that have successfully enacted RSS Ordinances, mostly for new constructions over a certain square footage. Understanding that RSS are most cost effective to new residential constructions in areas of Aurora served by the municipal water system, and that these areas are already at a point of being considered fully developed, the areas that are at greater risk for fire related death and property loss are also the areas that would have to make a larger investment to realize a benefit. The frequency of fires in this less populated area does not easily justify this increase in cost, especially in the retro-fit application. It would be difficult to obtain political or community support of a mandatory RSS Ordinance for any structure not already required by building codes. It would be easier to enact an ordinance once RSS are recognized and accepted as a “Standard of Safety” on a State or National level and efforts may be more productive towards promoting that concept.

RECOMMENDATIONS

Based on the information obtained by this study, a Residential Sprinkler Ordinance, although beneficial, may not be the most practical for the City of Aurora at this point of residential growth and development. Retrofit installations are costly and disruptive for existing structures. Areas where most of the new residential constructions could be developed are located on larger parcels where there is no municipal water system and will also require a significant investment. New constructions within the municipal water system are the most cost effective to construct but would benefit a very small percentage of the population.

Residential Sprinkler Systems should still be promoted with the goal of obtaining voluntary participation until such time that RSS are accepted and recognized as a necessary “Standard of Safety” to the community. Incentives such as water main tap fee reductions or zoning allowances should also be considered to promote this voluntary participation with the developers and private home builders.

It may be beneficial to recreate this study in the future when RSS are more accepted as a “Standard of Safety” and recognized as necessary life safety device. At that time, there may be more modern and less expensive equipment available to the area that would accommodate existing 3/4 inch water main taps or reduce the amount of water supply necessary to provide adequate coverage to obtain desirable results in reducing fire related death and property loss. It would be also beneficial to provide detailed specifications for the design of a particular system to afford the sprinkler contractors an opportunity to bid consistently and competitively on these systems.

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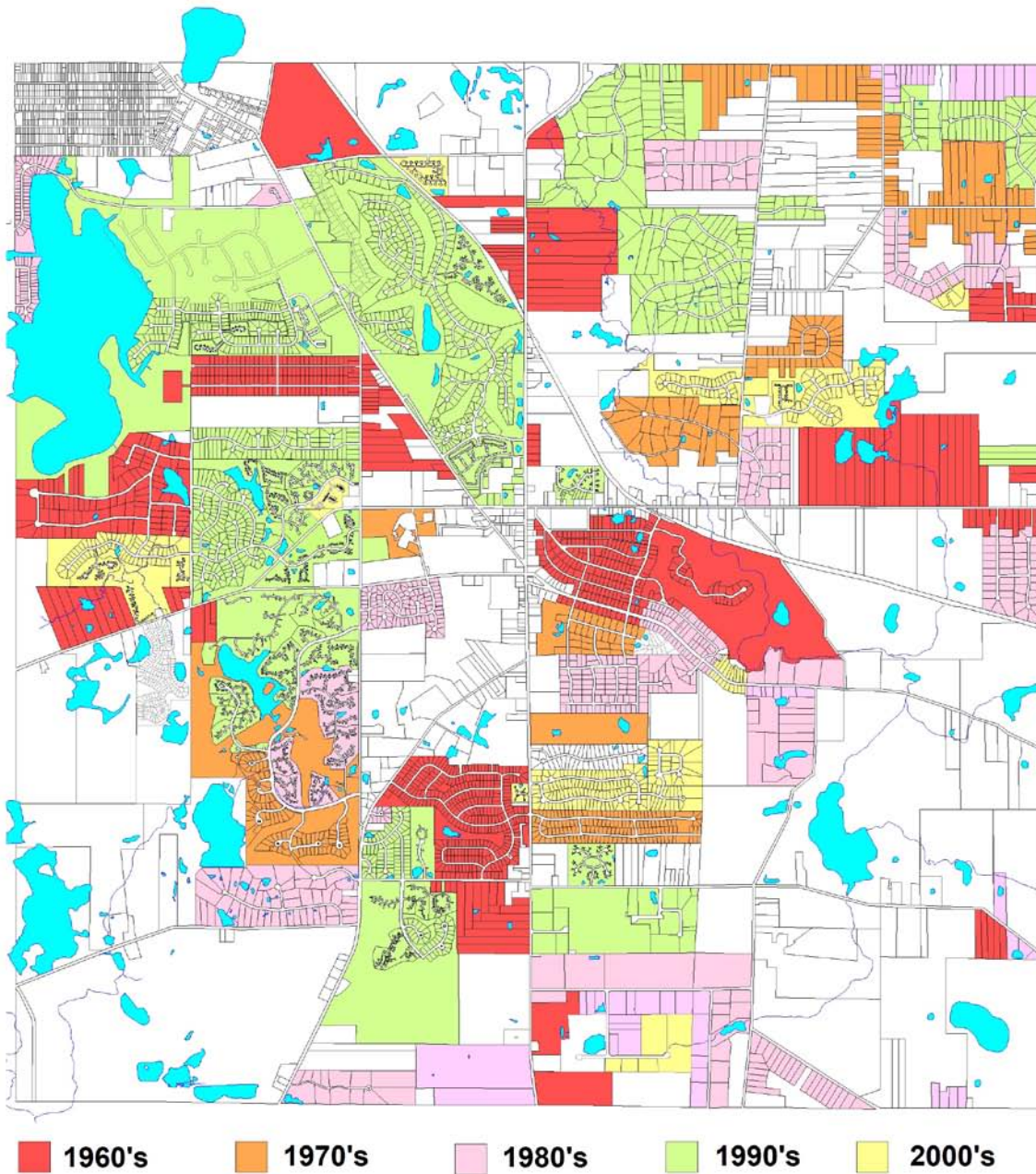
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APPENDIX 1 – DEVELOPMENT OF AURORA



APPENDIX 2 – AURORA WATER SYSTEM



APPENDIX 3 – SAMPLE LETTER TO SPRINKLER CONTRACTORS

Sample Sprinkler Contractor Company

Sample Sprinkler Contractor Address

February 25, 2008

Dear Sample Sprinkler Contractor,

Thank you for agreeing to assist me in this residential sprinkler system project.

As I explained earlier, I am working on a presentation for the City of Aurora to consider a Residential Sprinkler System (RSS) ordinance. This is part of my Applied Research Project for the Ohio Fire Executive Program sponsored by the Ohio Fire Chief's Association. I have various facts and data to support the benefits of sprinkler systems in residences.

Your assistance will help me show that the costs to install a RSS is relatively inexpensive compared to other costs associated to residential construction. Aurora is a semi-rural community with municipal water mains for most of the population density but areas served by individual well systems have recently experienced an increase in development. The plans submitted represent a typical new construction in the City of Aurora.

Please bid installation and supplies for a NFPA 13-D RSS for this structure. Assume that installation will be performed as the structure is being newly constructed and that the water supply available will be more than adequate for the system.

I will need to show:

- Breakdown of costs for various components and labor if RSS installed during construction at a location with municipal water.
- Increase in costs for equipment and labor if installed at a location with an individual well system.
- Increase in costs for equipment and labor if installed in this structure after construction completed (retrofit).

I will need this information before a presentation scheduled for the end of March. Please contact me with any questions or concerns. Thank you, again, for your assistance with this Applied Research Project. I hope that I can give a convincing presentation to the community leaders to support some form of legislation to require RSS in the future.

Respectfully,

Captain Bill Lovell

Aurora Fire Department