

A Risk Benefit Analysis of a Mandatory Residential Sprinkler System Ordinance in the City of

Mercer Island

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Certification Statement

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Abstract

The City of Mercer Island is considering on whether to adopt a mandatory residential sprinkler system ordinance for all new single-family construction. The city's building code official has asked the fire department to help determine the effects of such an ordinance. The problem is that Mercer Island has not conducted a risk/benefit analysis on the effects of instituting a mandatory residential sprinkler system ordinance for new single-family construction, and the impacts it would have on citizen and community safety. The purpose of this applied research project is to assess the possible costs, benefits, and impacts from the adoption of a mandatory residential sprinkler system ordinance for new single-family construction by the City of Mercer Island. Research questions were utilized to identify the costs, benefits, existing ordinances, and the impacts to stakeholders as well as the fire service, from the adoption of a mandatory residential sprinkler system ordinance for new single-family construction. Descriptive and historical research methods were used to answer the research questions, and included external surveys, personal interviews, and an extensive literature review. Recommendations included meetings for stakeholders to identify concerns, the development of a public education program on the benefits of sprinkler systems, drafting of an ordinance for approval by the council, and enlisting the help of fire departments who had previously been successful with this type of ordinance.

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INTRODUCTION

The City of Mercer Island has a responsibility to provide its citizens with a quality of life that includes safety. As part of its mission, the Mercer Island Fire Department (MIFD) is charged with providing this safety relative to risks associated from fires. Residential sprinkler systems have been proven to save lives for over the last 100 years, and are one of the best-proven ways to provide fire safety. Despite their proven safety record, savings from property conservation and inexpensive cost of installation, many communities have not adopted ordinances that require the installation of residential fire sprinkler systems in all new construction. Without the use of residential sprinkler systems in combating the catastrophic effects of fire, residents and emergency service personnel alike will be at an increased risk for serious injury or death when dealing with fire in these occupancies.

The problem is that Mercer Island has not conducted a risk/benefit analysis on the effects of instituting a mandatory residential sprinkler system ordinance for all new construction, and the impacts it would have on community safety.

The purpose of this applied research project is to assess the possible costs, benefits, and the impacts from the implementation of a mandatory residential sprinkler system ordinance for all new construction by the city of Mercer Island. The research will be conducted utilizing both descriptive and historical research methods, and will include external surveys, personal interviews, and an extensive literature review to answer the following research questions:

1. What are the costs associated with enacting a mandatory residential sprinkler system ordinance for new single-family construction?

2. What are the benefits associated with enacting a mandatory residential sprinkler system ordinance for new single-family construction?
3. What ordinances, codes, or standards have other jurisdictions adopted that would be relevant to Mercer island's effort in adopting a mandatory residential sprinkler system ordinance for new single family construction?
4. Who are the stakeholders, and how would they be impacted by a mandatory residential sprinkler system ordinance for new single-family construction?
5. What impacts on the Fire Service does a mandatory residential sprinkler system ordinance have from new single-family construction?

BACKGROUND & SIGNIFICANCE

The City of Mercer Island is located on Lake Washington, and is to the east of the city of Seattle, and west of the city of Bellevue in Washington State. Mercer Island is accessed via Interstate 90, which includes a floating bridge on the west and an elevated bridge on the east. It is primarily a residential community that is very affluent, and is serviced by two small retail business centers. This residential community has approximately 10,056 living units, with a mean value for a single-family residence of \$1,000,000 (Tubbs, 2009). Mercer Island occupies an area of 6.2 square miles and has approximately 22,500 residents. The MIFD is a fully career department that provides fire suppression, emergency medical services, dive rescue, surface water rescue, technical rescue, fire prevention and code enforcement, and public education. MIFD has two fire stations (91 & 92), a total of 32 employees, and responds to approximately 2,300 calls for service annually. On a daily basis, staffing consists of a Fire Chief, Deputy Chief, Fire Marshal, Administrative Assistant, and seven line personnel. The line personnel are made up

of one battalion chief, who oversees two fire companies that consist of one company officer and two firefighters each.

The City of Mercer Island has some challenging aspects that have a significant impact on the firefighting efforts of MIFD. One of the largest challenges is in relation to the issue of access for fire department apparatus. Many of the driveways for residences along or near the coast of Mercer Island have been around for many years, and do not necessarily meet current codes. Due to this factor, MIFD has not only the normal compliment of maxi pumpers, but additionally must have midi pumpers to access certain residences. These residences are identified on a large wall map at each station, and incorporated into the Computer Aided Dispatch (CAD) system. When a residential fire alarm is dispatched, crews must verify whether they require the maxi or midi pumper for their response.

Another challenging aspect of the firefighting efforts of MIFD is the fact that only seven firefighters are on duty at any given time, yet the average house fire requires a minimum of 15 firefighters to be extinguished safely and effectively (National Fire Protection Association, 2010). The average size home, according to the National Fire Protection Association (NFPA), is considered a single-family residence of approximately 2,000 square feet. Mercer Island has homes that range from 1200 square feet to 42,000 square feet. These *Mega Homes*, as they are often referred to, require more personnel and resources to fight a fire than the standard home. The MIFD must rely upon neighboring fire departments, through mutual aid agreements, to provide the additional personnel needed to extinguish a house fire. Currently, due to difficult access or a structure being over 5,000 square feet, the city does require sprinkler systems on new construction. On homes larger than 10,000 square feet, open areas such as crawl spaces and attics must be treated with NOBURN fire retardant (R. Mandery, personal communication, October 25,

2010). However, this does not completely satisfy the International Residential Code (IRC) for mandatory residential sprinkler systems included in all new residential construction.

Fire in the home poses one of the largest dangers to people within our communities. In 1971, President Nixon appointed 24 individuals to the National Commission of Fire Prevention and Control, which undertook a study focused on fire in America (Department of Homeland Security, Federal Emergency Management Agency, 2002). In 1973, *America Burning* was published in order to bring forth the nation's fire problem, and its effects on life and property. The report contained 90 recommendations and initiatives directed at reducing the number of fire fatalities by 50% within the next generation (National Commission of Fire Prevention and Control, 1973). When *America Burning* was first published, approximately 6,200 people, including 100+ firefighters, died from fire related deaths each year. Many of the recommendations were put into place and many of the commission's goals were achieved; however, fire fatalities and property loss due to fire were still at unacceptable numbers. In 2002, an updated report titled, *America at Risk – America Burning Re-commissioned* was released with 12 new findings to promote fire prevention, and provided numerous recommendations for achieving the goals of the United States Fire Administration (USFA, 2002).

In 2009, there were 377,000 residential structure fires, which accounted for 78.5% of all structure fires in the U.S. (Karter, 2010). Nearly 3,000 people per year die in U.S. home fires, and last year 84% of people who died in fires did so in one- and two- family homes (Figueroa, 2010). Many people believe that smoke detectors will provide enough escape time for occupants to get out on their own. This does not hold true, especially for the groups with the highest risk of dying in a home fire, which are older adults – over age 65; children – under 5 years old; and persons with disabilities (Figueroa, 2010). This may be attributable to the fact that younger

children spend more time in a deep sleep than older ones, and that older adults have decreased hearing, and therefore do not here the audible tone of smoke alarms. According to Karter (2010), sprinklers decrease the fire death rate per 1,000 reported home fires by 83% and the average loss per home fire by 74%.

This applied research project is being conducted as part of the Executive Analysis of Community Risk Reduction course, which is included in the Executive Fire Officer Program, through the National Fire Academy. An ordinance making residential fire sprinklers mandatory would help to accomplish the United States Fire Administration's (USFA) 5-year operational objectives. Some of these objectives are: 1. Reduce mortality from fire by 15 percent, with the sub-goal of reducing fire-related mortality rates in populations under age 14 and over age 65 by 25 percent: 2. Develop a comprehensive multi-hazard risk-reduction plan for 2,500 communities, led by the local fire service: 3. Reduce the line-of-duty deaths among firefighters by 25 percent (USFA, 2001).

LITERATURE REVIEW

The literature review for this applied research project (ARP) began at the Learning Resource Center (LRC) while attending the National Fire Academy (NFA) in Emmittsburg, Maryland in May of 2010. A risk-benefit analysis of the use and effectiveness of residential sprinkler systems is not a new issue, nor is it unique to Mercer Island. Unfortunately, the value of having mandatory residential sprinkler system ordinances has not been realized by every city in America. The author found many previous ARPs that had been written on various aspects of incorporating residential sprinklers as part of every building, and utilized these for comparison and research. Upon returning home, the author also found further information on the World Wide Web from credible sources such as the NFPA, USFA, Fire Team USA, the National Association

of Home Builders (NAHB), and The Home Fire Sprinkler Coalition (HFSC). The literature review provided information that helped the author answer the research questions posed on this vital subject.

Research Question 1 - What are the costs associated with enacting a mandatory residential sprinkler system ordinance for new single-family construction?

According to the NFPA, the cost of installing home fire sprinklers averages \$1.61 per square sprinklered foot for new construction (Figuroa, 2010). This number seems to be consistent with the figures other researchers have found in their areas as well. Hayes (2008) found that sprinkler systems for the Gainesville, FL area had an actual cost that ranged between \$1.50 and \$2.00 per square foot. Chandler (2007) found that the rate for installation costs varied from \$2.66 per square foot to a high of \$6.88 per square foot, due to the additional costs coming in the form of purveyor fees, water pumps, annual inspections of backflow prevention devices, and repair.

According to the NAHB it is a good rule of thumb to add 1 to 1 ½ percent to the cost of new construction (Xu, 2007). If this general rule were applied to a house with a building cost of \$300,000, the additional cost of adding a sprinkler system would be \$3,000 – \$4,500 dollars. In 2007, the NAHB conducted a national survey of 102 homebuilders who had built over 5,000 new homes with fire sprinklers during 2006. The survey showed that the average cost of installing sprinklers in these homes was about \$5,573, and the average size of the homes was 2,271 square feet (Xu, 2007). In addition, the NAHB also points out that the price for the homebuyer will be more than the actual construction costs due to interest from financing and broker costs. Considering these factors, the NAHB estimates that the \$5,573 increase in construction costs will actually cost the buyer \$6,677 (Xu, 2007).

The cost to install these systems can be different depending on a number of variables such as the type of system installed, the materials that are used, size of the structure, and the permitting fees/requirements of the jurisdiction. The materials that are most commonly used for sprinkler systems are, copper, steel, and chlorinated poly vinyl chloride (CPVC). According to Hayes (2008), the cost of CPVC runs about \$.26 per linear foot plus installation, and steel piping is about \$2.50 per linear foot. The author was unable to find information on copper cost per linear foot, and found that cost estimates were based upon square footage.

Research Question 2 - What are the benefits associated with enacting a mandatory residential sprinkler system ordinance for new single-family construction?

The obvious benefit for having residential sprinkler systems is increased life safety, but there are others as well. Residential sprinkler systems are not designed specifically to put a fire out. The true purpose of these systems is to prevent flashover in the room of origin (see Appendix A), thus improving the probability that occupants can escape or be evacuated (National Fire Protection Association, 2010).

In Prince George's County, MD statistics were gathered to show the benefits of residential sprinkler systems over a 15-year period. It was shown that during this period, no deaths occurred in any fire where a sprinkler system was present, but 101 people lost their lives to fires in non-sprinklered homes during the same period (Weatherby, 2009). A similar report was put together by the HFSC using data from the city of Scottsdale, AZ. Scottsdale implemented a residential sprinkler ordinance in 1986, and then analyzed the collected data in 2001. During the 15-year period, there were 598 home fires, of which 49 were in single-family residences, with no deaths reported in sprinklered residences, but 13 deaths reported in non-sprinklered residences (Home Fire Sprinkler Coalition, 2001). Further studies have analyzed the

benefits of using both sprinkler systems and smoke alarms in conjunction with each other. Chandler (2007) noted that when residential sprinklers are used in conjunction with smoke alarms, the incidence of fatality is lowered by 82% and injury by 46%.

Another benefit of sprinkler systems is for decreased property loss from both the fire itself, and the actions of the fire department. The average water output of a residential fire sprinkler is between 13-15 gallons per minute, whereas the average amount of water output from a fire hose is 95-200 gallons per minute (Weatherby, 2009). This fact will result in less damage to homeowner property from extinguishment by the sprinkler system keeping the fire contained, and the resulting decrease in water used for extinguishment by the fire department. In the Prince George's County statistics, it was shown that fire in homes without sprinklers, and no fatality, cost an average of \$9,983, and homes with sprinklers cost an average of \$4,883 (Weatherby, 2009).

Homeowners will also realize the benefit of savings in their homeowner's insurance rates when they have a residential fire sprinkler system. According to the Residential Fire Sprinkler Institute (RFSI) (2010), the average savings is 10-20% in the United States, and up to 40% in Canada. According to the HFSC (2005), seven major insurance carriers in the United States offer discounts that range from 5-30%. The actual amount of discounts varies depending on the extent of the protection systems, and the insurance company offering the discount. In addition, not all of the insurance company's offer these discounts in every state.

Research Question 3 - What ordinances, codes, or standards have other jurisdictions adopted that would be relevant to Mercer Island's effort in adopting a mandatory residential sprinkler system ordinance for new single-family construction?

Prince George's County, MD, was one of the first jurisdictions on the East coast to adopt an ordinance requiring residential sprinkler systems in single-family homes in 1987 (Cox, 2006). In addition, Cox (2006) reported that residential sprinkler ordinances were also being passed in Vancouver, BC; Studley Green Estate, England; and by the New Zealand Government. Acceptance of the value of making residential sprinkler systems is growing worldwide. To date, residential fire sprinkler ordinances have been adopted by several hundred communities in the United States, for use in single-family residences (Newport Partners, 2008). Local to Mercer Island, and according to RFSI (2009), the jurisdictions of Auburn, Black Diamond, Bothell, Dupont, King Co. Fire District 4, King County Fire Marshal, Olympia, Port Angeles, Redmond, and Tacoma have residential fire sprinkler ordinances. These vary depending on the zoning type or size to which they are applied.

Research Question 4 - Who are the stakeholders, and how would they be impacted by a mandatory residential sprinkler system ordinance for new single-family construction?

The most obvious stakeholder would be the homeowner. They would have an increased chance of surviving a fire in their residence by 80%, due to having more time to get out (Figueroa, 2010). Another impact for homeowners would be the decreased amount of property loss as a result of a fire. According to Chandler (2007), the average property damage was \$1,945 for sprinklered residences, and \$17,067 for non-sprinklered residences in the Scottsdale, AZ report. For the year 2007, fire caused \$16.6 billion dollars in reported or unreported direct property damage (Hall, 2010). Homeowners would also be impacted by the construction costs of adding sprinklers to their homes. The average cost of putting a residential sprinkler system into new construction is an average of \$1.61 per sprinklered square foot (Newport Partners, 2008).

Homebuilder's are also stakeholders in the implementation of a mandatory residential sprinkler ordinance, mainly due to increased costs. These costs come in the form of increased permit, tap, and inspection fees, as well as any costs of redesigning the home to accommodate the sprinklers (Xu, 2007). If the homebuilders are forced to add additional costs to the project by integrating a sprinkler system, these costs will be passed onto the homeowner, and as stated earlier, will be at a higher rate than the actual cost. This may have a direct impact on the homebuilder since increased costs may potentially price first time buyers out of the market (Cox, 2006).

Elected Officials are stakeholders in a mandatory residential sprinkler ordinance. They are charged with being stewards of the community, especially in the areas of local business and public safety. Both of these areas are directly tied to a sprinkler ordinance and its impacts. Builders must be able to do business in an area without being forced to price themselves out of the market through mandatory requirements. Homeowners must feel that the elected officials are ensuring their public safety through legislation, and supervision. As noted by Cox (2006) elected officials must be educated on residential fire sprinkler systems, in order to get them on board before any legislation is proposed.

Insurance Companies are also among the shareholder's effected by a mandatory residential sprinkler system ordinance. The cost of fire during 2007, which directly affected insurance agencies, was \$78.2 billion dollars. These costs came in the form of property damage (\$18.6 billion), net costs of insurance coverage (\$17.2 billion), and the estimated monetary equivalent for the deaths and injuries for fire (\$42.4 billion) (Hall, 2010). Since insurance companies are for profit businesses, it would favor them to support any type of prevention plan

that decreases their annual loss of billions. By decreasing their loss's, they are able to give their customers discounts on sprinkler systems which range from 5%-18% (HFSC, 2005).

Research Question 5 - What impacts on the Fire Service does a mandatory residential sprinkler system ordinance have from new single-family construction?

The Firefighters themselves benefit from the implementation of a residential sprinkler ordinance. This benefit comes in the form of life safety to the firefighters who arrive to extinguish the fire. Recent research reveals that new homes are more likely to include a threat to firefighters in the form of lightweight construction, and it is estimated that this type of construction is used in one-half to two-thirds of all new wood on- and two-family houses (Figueroa, 2010). Although lightweight construction is as strong as full dimension lumber when used in construction, it has been shown in different tests to fail more quickly with flame impingement (Earls, 2009). Tests run by the American Society for Testing Materials, showed that a traditionally constructed floor, without drywall to protect its underside, withstood a test fire for 18 minutes, while a similar system using engineered wooden I-beams survived for about six minutes (Earls, 2009). This translates into a high probability that by the time firefighters get on scene, the floor of a structure may already be compromised, and the structure or anyone inside may now be lost. In a study of lightweight construction and its effects on firefighter fatalities from 1980-1989, it was found that of all on-duty firefighter fatalities, 43.1% were on the fire scene where the structure could have contributed to the loss of life (Grundahl, 1992, p. 58). This highlights the importance of residential sprinkler systems for containing fires to the room of origin, and preventing *flashover*, prior to the arrival of the fire department (see Appendix D).

In summary, the results of the literature review show that we have been attempting to mitigate the problem of residential sprinkler systems in every home for a long time. The most

effective fire loss prevention and reduction measure with respect to both life and property is the installation and maintenance of fire sprinklers (Department of Homeland Security, Federal Emergency Management Agency, 2002, p.17). It is evident that all of the stakeholders need to be identified and involved prior to any attempt to legislate residential sprinkler ordinances. Updated code standards and new technology have made residential sprinkler systems an affordable solution to an old problem.

PROCEDURES

Research Methodology

This applied research project utilized descriptive and historical research methods to conduct a risk/benefit analysis to assess the possible costs, benefits, and impacts from a mandatory residential sprinkler system ordinance for all new construction by the city of Mercer Island. A comprehensive literature review was conducted at the NFA, online, and using previous ARPs on this subject. Additionally, two surveys were developed and distributed to both local builders and citizens of Mercer Island on the website surveymonkey.com®

Literature Review

The research for this ARP began at the National Fire Academy's LRC in Emmitsburg, Maryland, in May of 2010. The author used the LRC card catalog, via web search and using key words such as: residential fire sprinklers, sprinkler systems, sprinkler ordinances, and sprinkler codes, to find ARPs or articles pertaining to the research topic. Additional web searches were then conducted utilizing similar terms, including sprinkler costs/benefits, and total fire costs. Using the Google search engine, the author accessed information from numerous websites including, but not limited to NFPA, NAHB, USFA, FEMA, RFSI, HFSC, and firesprinkler.org.

The focus of this research was to evaluate what information other researchers had acquired, if it was still relevant, and if possible to expand upon it.

Survey Instrument

Two surveys were developed by the author to gather additional information from local builders and the citizens of Mercer Island. The builder survey was designed to collect information on the willingness of builders to incorporate sprinkler systems into the homes they constructed, and to highlight any obstacles that prevented these systems from being standard in all new construction (see Appendix B). The names of the builders was acquired through Mercer Island's building department, and focused on builders common to Mercer Island. The author sent a cover letter via email, which provided an explanation of the survey and its purpose, and included a hyperlink to the survey on the website Surveymonkey®.

The citizen survey was designed to measure the amount of knowledge citizens have in regard to sprinkler costs, effectiveness, availability, and benefits (see Appendix C). This survey was distributed through the City of Mercer Island Communications Coordinator, Stephanie Schwenger, via a weekly community newsletter. The author sent a cover letter explaining the purpose of the survey, requesting participation from the citizen's for the survey, and directing them to the Surveymonkey® website via a hyperlink.

Interviews

An interview was conducted with the City of Mercer Island Fire Marshal (FM), Rod Mandery on October 25, 2010. FM Mandery had an extensive knowledge of both the past and current sprinkler requirements for Mercer Island, and was instrumental in knowing the issues of access, and application of the current sprinkler code. He was also able to provide the author with

a current list of local municipalities that currently have some type of residential sprinkler ordinance.

Don Cole, the Building Code Official for the city of Mercer Island, was also very helpful in answering questions concerning a residential sprinkler ordinance, and the impacts it would create for the city. Mr. Cole also provided the author with background information on the directive for the building department and fire department to deliver a recommendation with regard to a residential fire sprinkler ordinance, in accordance with the State Building Code Council (SBCC).

Assumptions & Limitations

The author assumes that all information gathered in this ARP is accurate and unbiased. It is also assumed that the information provided in the survey responses, from builders and citizens alike, is factual and reflects accurate information.

Limitation(s) of the research came from the survey's that were sent out to builders and citizens. Of the 18 builders to whom survey requests were sent, only 11 responded to the survey. It is assumed that the statistical answers provided, would be statistically insignificant to results compared to if all 18 builders had responded. The citizen survey was sent out to 600 citizens, and only 22 replied, resulting in only .3% participation. It is assumed, due to the nature of the survey and the information being gathered, that if more recipients had responded, statistically the percentages would be similar.

Definitions

Class A Sprinklers – A classification assigned by insurance companies where sprinklers are installed in all areas including bathrooms, attics, closets, and attached structures.

Class B Sprinklers – A classification assigned by insurance companies where automatic sprinklers are partially or totally omitted in bathrooms, attics, closets, and attached structures (Xu, 2007).

Flashover - The near simultaneous ignition of all combustible material in an enclosed area.

GPM – A measurement of the flow amount of water through an orifice, measured in gallons per minute.

Incipient Stage – A term used to describe a fire that is in its initial or beginning stage, and is easily extinguished.

Maxi Pumper – Class A pumper truck capable of pumping up to 1500 gpm, and the capacity to carry 500 gallons of water.

Midi Pumper – A smaller style pumper truck used for difficult access , capable of pumping up to 500 gpm, and the capacity to carry 250 gallons of water.

The International Code Council (ICC) - Is a membership association dedicated to building safety, fire prevention and energy efficiency, develops the codes used to construct residential and commercial buildings, including homes and schools.

International Residential Code (IRC) - Is a comprehensive, stand-alone residential code that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

Mutual Aid – An agreement between emergency service agencies to provide resources in order to maintain adequate levels of service.

RESULTS

This applied research project utilized both descriptive and historical research methods to conduct a risk/benefit analysis to assess the possible costs, benefits, and impacts on stakeholders due to a mandatory residential sprinkler system ordinance for all new construction by the city of Mercer Island. Information was obtained through a search of the World Wide Web, a literature review, survey questions, personal communications, and was applied to answer the five research questions of this project.

Research Question 1 - What are the costs associated with enacting a mandatory residential sprinkler system ordinance for new single-family construction?

Research showed that there are, for lack of a better term, “hidden costs” within the installation of a residential sprinkler system. The cost of installing a residential sprinkler system can vary depending on the type of materials used, and how billing is figured to account for labor (Hayes, 2008). According to HFSC, a good rule of thumb is to estimate the cost of a residential sprinkler system to be 1% - 1.5% of total construction costs (Home Fire Sprinkler Coalition, 2009). The Fire Protection Research Foundation’s *Home Fire Sprinkler Cost Assessment* report revealed that the cost of installing home fire sprinklers averages \$1.61 per square-sprinklered foot for new construction (Figueroa, 2010, p. 4). The average cost to install a residential sprinkler system on Mercer Island, according to the survey results, ranges from \$1.50 to \$4.00 per square foot. One of the builders shared with the author that he estimated sprinkler costs at an additional \$2.00 per square foot. His last project had been a 4,900 square foot home, and he had estimated the additional cost of the sprinkler system at \$9,800 (A. Reusch, personal communication, October 16, 2010). The size of a home, and it’s location may require that the meter be upgraded from a 1” meter, to a commercial size 1.5” meter, and costs about \$4,000.00

or more. In addition, the homeowner is also required to pay about \$252 annually for a meter service fee, which would cost out to be about \$5,000.00 for the average useful life (A. Reusch, personal communication, October 16, 2010). Lastly, the NAHB points out that all of these additional costs must be looked at from a financing perspective. If the price of a home is driven up by \$9,800 dollars due to the installation of a sprinkler system, the homeowner pays significantly more if they finance it over 30 years (Xu, 2007).

Of the 18 surveys sent out to local builders concerning residential sprinkler systems, 11 builders responded. Of the 11 responses, 100% had at some point included a residential sprinkler system in a home. When asked the costs for installing a residential sprinkler system, the responses varied from \$1.50 to \$4.00 per square foot, but do not define if that is the installation cost alone, or the total cost including upgraded meters, permit fees, meter service fees, or backflow prevention inspections. When asked if they agree or disagree with the statement, the use of smoke detectors/alarms systems provide adequate protection for home owners, 72.7% agreed with the statement. When asked if they would consider installing residential sprinkler systems in exchange for concessions such as, greater hydrant spacing, lesser construction standards, or narrower street widths, 60% of the respondents said they would.

Of the 600 surveys sent out in a weekly newsletter to the citizens of Mercer Island, only 22 citizens responded. The author found that many of the respondents had a good basic knowledge of the cost, and protection afforded by a residential sprinkler system. When asked what type of fire detection systems they currently have, 90% have smoke alarms and fire extinguishers, but only 15% have a residential sprinkler system. The most common reason for not having a residential sprinkler system was that it was too costly, as reported by 56% of the respondents. This is despite the fact that when asked the total percentage of construction cost

that a residential sprinkler system adds for a new residence, 47.4% accurately answered <1.5%, and another 47.4% were close at 3%. This may be due in part to the fact that 80% of the residents answered that they feel the fire loss for Mercer Island is within acceptable limits. For the years 2005 through 2009, Mercer Island experienced a total of \$6,040,480 in property loss, with an annual average of \$1,208,096. As reported by Hall (2010), nationally property loss from fire cost \$18.6 billion, and the cost from death and injury from fire was \$42.4 billion.

Research Question 2 - What are the benefits associated with enacting a mandatory residential sprinkler system ordinance for new single-family construction?

Working smoke alarms cut the risk of dying in a home fire by 50%, but the risk of dying in a home fire is cut to over 80% when a sprinkler system is present (Figueroa, 2010).

Residential fire sprinklers have been proven to save lives since their introduction in England in 1806 (National Fire Protection Association, 2009). According to the Ahrens (2009), 84% of all U.S. fire deaths occur in the home, and as stated by Karter (2010), 3,010 civilian fire deaths occurred in 2009. This results in 2,528 people that died in a residential structure fire during 2009. The death rate per fire in sprinklered homes is lower by 83%, and property damage per fire is lower by 34%–77% (Hall, 2010). The death rate for citizens of Mercer Island as a result of fire is very low, one has not occurred since 1996. The author discovered through interviews, that Mercer Island does currently require sprinkler systems on structures over 5,000 square feet (see Appendix D), or those that have difficult access (R. Mandery, personal communication, July 26, 2010).

Residential fire sprinklers also save property and the environment. Property loss is minimized because flame damage is confined to the room of origin in 95% of the fires that occur in sprinklered properties vs. 73% confinement of fires that occur in non-sprinklered properties

(Hall, 2010). This factor becomes even more significant when looking at the fact that fire caused an estimated \$7,796,000,000 in residential property damage in 2009 (Karter, 2010). For a single-family residence, the average property loss from a fire was \$4,883 for homes with sprinklers, and \$9,983 in homes without sprinklers where there was not a fatality (Weatherby, 2009). Property loss is further decreased by the fact that sprinklers use small amounts of water to contain the fire, and allows the fire department to use less water for extinguishment. Weatherby (2009) stated that the average water output by a residential sprinkler head is about 13-15 gpm, while the average flow from a fire hose is between 95-200 gpm. This reduced property loss from water damage can be up to 90%. Additionally, it has been found that sprinklers decrease water pollution from runoff, and reduce greenhouse gases given off by building fires by up to 98% (Wieczorek & Ditch, 2010).

Insurance Savings is another benefit of having residential sprinkler systems. The literature review revealed several insurance companies in Washington State that offer savings for homes that have sprinkler systems (see Table 1).

Table 1.

Insurance companies in Washington State offering Sprinkler Discounts

State	Company Name	Market Share	Data Source	Class A	Class B
Washington	State Farm	18.11%	State Farm	10%	5%
	Farmers Ins	17.08%	Farmers	10%	5%
	Allstate Ins	13.55%	Allstate	10%	0
	Safeco	9.29%	Ins. Agent	7%	4%

In regard to insurance incentives, 50% of the respondents to the citizen survey were aware that their insurance offered this, and 50% were not sure if this cost savings was offered. The literature review did show that a study by Newport Partners revealed the annual discount

savings only averaged \$22.00 or 3.42% of the annual premium (Newport Partners, 2008). This is due in part to the fact that the quoted savings are based upon the portion of the policy that covers fire, and not the entire policy.

Firefighter safety is another benefit of having residential fire sprinklers in place. According to NFPA 1710, total response time for the first engine on scene to a fire should not be greater than 240 seconds (National Fire Protection Association, 2010). The average response time to a Mercer Island fire events is 353 seconds. This amount of time is critical in regard to the structural failure of modern lightweight construction, which is estimated to be used in one-half to two thirds of all new wood one-and two-family homes (Figueroa, 2010). Critical failure of lightweight construction has been known to occur within 10 minutes of flame impingement. This short amount of working time means that a structure maybe starting to fail at about the same time firefighters are entering the structure.

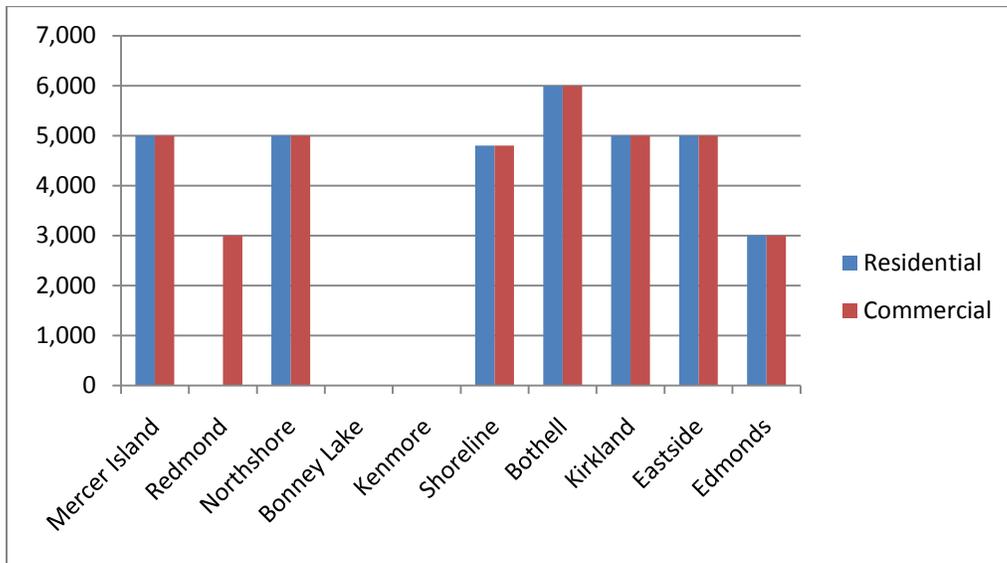
Research Question 3 - What ordinances, codes, or standards have other jurisdictions adopted that would be relevant to Mercer Island's effort in adopting a mandatory residential sprinkler system ordinance for new single-family construction?

The International Code Council (ICC) issued the International Residential Code (IRC), which includes requirements for residential sprinkler systems in all new construction. The IRC was adopted by the Washington State Building Code Council (SBCC), but they adopted it into the appendix of the State Building Code. What this means is that it is the decision of each local jurisdiction to adopt the IRC, rather than it being adopted statewide (R. Mandery, personal communication, November 1, 2010).

The following chart shows those cities that responded to requests for information on their current residential sprinkler ordinances. The colored bars represent the threshold square footage

required for sprinklers to be mandatory. Any city listed that does not have a bar is representative of those that require sprinklers in all new construction (see Figure 1).

Figure 1.
Local Cities with Sprinkler Ordinances



According to the Washington State Fire Marshal’s Office, the following communities had adopted sprinkler ordinance’s (see Table 2) by June 2009 (Matlick, 2009).

Table 2.
Washington State Communities with Sprinkler Ordinances

Bremerton	Federal Way	Pierce County
Camas	King County	Port Angeles
Clark County	Kitsap County	Redmond
Cowlitz	Maple Valley	Woodinville
Dupont	Olympia	

As demonstrated in the difference between Table 2, and Figure 1, at least nine more communities have added sprinkler ordinances since June 2009. From the information collected by the author, it appears most of these ordinance have made allowable exceptions to the IRC, which advocates for sprinkler systems in all new construction. The majority of those that allow exceptions, such as Mercer Island, generally require sprinkler systems in new construction that is over 3,000-6,000 sq ft. Mercer Island currently mandates residential sprinkler systems under certain circumstances (see Appendix C). These circumstances are related to size of the structure (>5,000 square foot), difficult access for fire apparatus, unavailable fire flow requirements from the hydrant, or the structure is too far from the hydrant (R. Mandery, personal communication, November 1, 2010). Don Cole, Building Code Official of the city of Mercer Island's Developmental Service Group, informed the author that a mandatory residential sprinkler ordinance for all new residential construction, would have had an impact on only three construction projects in 2009 (D. Cole, personal interview, September 21, 2010).

Research Question 4 - Who are the stakeholders, and how would they be impacted by a mandatory residential sprinkler system ordinance for new single-family construction?

Through the literature review, the stakeholder's have been identified as the homeowner's, builders, elected officials, and insurance companies. Each of these identified stakeholders is affected in a different way with the implementation of a mandatory residential sprinkler ordinance. In order for sprinklers to be accepted, each stakeholder must perceive and agree with the need for their existence (Chandler, 2007).

The homeowner's of Mercer Island had a surprisingly good sense as to the importance of and financial impact from residential fire sprinklers. Cost is one of the most prohibitive factors in getting sprinkler systems into more homes, as evidenced by 56.3% of the survey respondents

citing this as their reason. Some of the reluctance may also derive from the fact that some homeowner's, 45% of survey respondents, feel that fires will occur no matter what systems are installed in their homes. When asked if the current fire loss on Mercer Island was within acceptable limits, 80% responded in the affirmative.

Builders are also a major stakeholder in a mandatory residential sprinkler ordinance from an economic standpoint. Based on a 2007 study, the NAHB shows that the median cost of installing sprinklers in a 2,271 square foot home would be approximately \$5,573 (\$2.45 square foot) (Xu, 2007). This is cheaper than the \$2.00 per square foot the author found for Mercer Island, but does include costs such as increased permit fees, tap, and inspection fees, which the Mercer Island Figure does not. When those are added into the Mercer Island quote, the cost per square foot rises to about \$4.00 (A. Reusch, personal communication, October 16, 2010). The NAHB also points out that when a homeowner purchases a home, and finances these additional costs, the amount for the sprinkler system goes up quite a bit. This can have a significant impact on the builders, since if their home prices increase, some potential buyers may be priced out of the market.

Elected officials are also stakeholders from the aspect of how the decision they make in adopting a mandatory residential sprinkler policy affects the community. They must make a decision between stimulating the local economy through the building of houses, and insuring the protection of assets and safety of their citizens. The distributed survey does include the current elected officials of the city of Mercer Island, but the author does not know whom or how many of them responded to the survey.

The last of the stakeholder's are the insurance companies. As stated in the literature review, fire caused and estimated \$7,796,000,000 in residential property damage in 2009 (Karter,

2010). In Washington State during 2009, activated fire suppression systems protected \$249 million in property, and saved 97% of the property and contents, which equates to a loss of only \$7.5 million from those fires. During this same period, there were 5,800 fires in single and multi-family properties, which resulted in 59 fatalities and more than \$127 million dollars lost. Of the 59 fire fatalities, only one occurred in a building that was equipped with fire sprinklers (Washington State Fire Marshal's Office, Washington State Patrol, 2010). The insurance companies have an interest in keeping the dollars spent mitigating the impacts of fire in the loss of life and property to a minimum.

Research Question 5 - What impacts on the Fire Service does a mandatory residential sprinkler system ordinance have from new single-family construction?

Firefighter safety is increased when a residence has fire sprinklers installed, and they are properly working. Residential fire sprinklers reduce the risk of firefighter fatalities by 0.1 lives per million houses (Hayes, 2008, p. 24). With the increased use of lightweight construction in one-half to two-thirds of all wooden residential construction, these structures have become more prone to collapse from the effects of fire. Larger homes, void spaces, increased fuel loads, and changing building materials contribute in faster fire propagation, shorter time to flashover, rapid changes in fire dynamics, shorter escape time, and shorter time to collapse (Figueroa, 2010). All of these items lead to an increased risk to firefighter safety. According to NFPA 1710, response to a fire event should have the first fire engine on scene in 4 minutes. The average response by Mercer Island fire suppression units is 5 minutes and 53 seconds. This is due in part to narrow residential roadways, and difficult access to many parts of the island. In addition, NFPA 1710 also recommends that 15 personnel are necessary to fight an ordinary residential structure fire safely. MIFD staffs only seven personnel, and must rely on other fire agencies to supply the

additional personnel through mutual aid agreements, which will affect response times. In addition, Mercer Island has many residences that are not accessible by a maxi pumper. To alleviate this, MIFD has *midi* pumpers that can access these residences and act as a manifold for delivering water to hose lines. The problem with this is that each midi pumper can only carry two personnel to the scene, so the third must follow in an aid car. In addition, all incoming personnel and apparatus must park away from the scene, and walk in with their equipment. Due to the midi pumper being the only apparatus at the scene, the number of hose lines is limited, which effects water flow, and thus the ability of the firefighters to suppress the fire. Therefore, the newer properties that fall into this category are required to have a residential sprinkler system, but there are many older properties that do not. These fire protection measures are necessary to maintain the Washington Surveying & Rating Bureau (WSRB) Rating for Mercer Island. WSRB is the source of property underwriting and rating information for the insurance industry in Washington State (Washington Surveying & Rating Bureau, 2010). As the WSRB rating increases for an area, so do the cost of insurance premiums for the citizens. Each of these issues leads to a delay in extinguishment of a residential fire, increased risks and costs to citizens, and the possibility of negative impacts to firefighters. Residential sprinkler systems are designed to extinguish a fire, or contain it until the arrival of the fire department. With the fire being kept in the *incipient stage*, it requires fewer personnel to extinguish. Having a sprinkler system is like having a full time fire fighter stationed in your home, equipped and ready to work, all hours of the day and night (Washington Surveying & Rating Bureau, 2010).

DISCUSSION

The literature review and subsequent research demonstrate the need for a mandatory residential sprinkler ordinance for all new construction in the city of Mercer Island. One of the biggest factors that are cited in argument against this, by both homeowner's and builders, is the cost. The statistics showing how much property damage and loss of life occur because of fire, beg the question: how can we afford not to implement an ordinance? How can we justify not mandating that a proven life, and cost saving device not be put in all new construction? Fire sprinklers provide insurance against catastrophic loss up to and including loss of life. Like insurance, if the sprinkler system is not utilized it becomes an expenditure with no benefit realized. Yet again, like insurance, if the sprinkler system is utilized, the cost is more than justified. With all of the talk about being green, and sustainability, when will we mandate that we must implement proven life sustaining measures such as residential sprinkler systems, which encompass both of these concepts?

Research Question 1 - What are the costs associated with enacting a mandatory residential sprinkler system ordinance for new single-family construction?

National statistics show that the average cost of installing a sprinkler system is about \$1.61 per square foot (Figuroa, 2010). In communicating with a local builder, the author found that the average for Mercer Island is was closer to \$2.00 per square foot. Additionally, this cost did not take into account charges for a meter upgrade, meter service, and annual inspections, which just about double the price (A. Reusch, personal communication, October 16, 2010). The example provided to the author was for a 4,900 square foot home where the sprinkler system cost \$9,800 (\$2 x 4,900 square foot), another \$4,000 for a meter upgrade, and an additional \$5,000

over the life of the system for inspections. This results in the entire sprinkler system costing the homeowner and additional \$18,800 when they buy the home.

According to the HFSC, a good rule of thumb is to estimate the cost of a residential sprinkler system to be 1% - 1.5% of total construction costs (Home Fire Sprinkler Coalition, 2009). Using the previous example of a 4,900 square foot home on Mercer Island, the cost of that sprinkler system would break down in the following fashion. The median cost of a home on Mercer island is about \$295.00 per square foot (Zillow, 2010). This means to build a 4900 square foot home it would cost approximately \$1,445,000.00, of which \$18,800 is the sprinkler system itself. This comes out to be about 1.3% of the total construction cost of the home, and falls within the estimated cost of the HFSC. The only other possible factor to the cost of a residential sprinkler system is the fact that when a home is purchased, it is often financed for 15-30 years. The additional purchase cost of \$18,800 will end up costing \$28,557 - \$40,574, depending if financed for 15 or 30 years respectively, based upon 6% interest, over the life of the loan. One has to ask if this is significant when it comes to reducing the chances of themselves, or their loved ones, dying in a fire. In addition, what price can be put upon the loss of personal belongings, photo albums, artworks, important documents etc...?

Research Question 2 - What are the benefits associated with enacting a mandatory residential sprinkler system ordinance for new single-family construction?

The main benefit of having a mandatory residential sprinkler system ordinance is that the community as whole will be safer, and the chances of a resident dying as the result of a residential fire will decrease. Last year, 84% of people who died in fires did so in one-and two-family homes (Figueroa, 2010). The groups with the highest risk of dying in a home fire are older adults – over age 65; children – under 5 years old; and persons with disabilities (Figueroa,

2010). On Mercer Island, using these risk groups, a mandatory sprinkler ordinance would have a direct impact on 31.6% of the current residents, not including those households that include someone with a disability (Zillow, 2010). If the numbers are extended to include those citizens that are in their teens, up to 20 years of age, the number jumps to 50.9%. According to the answers provided on the survey distributed to citizens by the author, only 15% of current households have a sprinkler system. This is a significant portion of the population that is at a higher risk of dying, if caught in a residential fire.

Another benefit of sprinkler systems for Mercer Island residents is the savings on property loss due to fire. According to Cox (2006) a statewide survey of Maryland fire departments, who currently have sprinkler ordinances, revealed that 62% of these departments listed a deduction in their annual fire loss statistics due to their ordinances. In a study involving Prince George's County, MA, over a 15 year period it was shown the average property loss per fire in non-sprinklered buildings averaged \$9,983, this amount jumped to \$49,503 if there was a fatality, but was only \$4,833 per event with sprinklers activated (Weatherby, 2009). The national average for property loss due to fire in homes, that do not have sprinkler systems, was \$18,000 in 2009, but only \$5,000 in those homes with sprinkler systems (Hall, 2010). With the national average for home size being 2,200 square feet, this translates into about \$8.18 per square foot of loss due to fire in a non-sprinklered home. With the average size home on Mercer Island being 2,710 square feet, this would result in an average fire loss of \$22,173 for non-sprinklered homes, which is a 23% increase over the national average. Using the same formula as the non-sprinklered home, the average property lost due to fire in a sprinklered home, for a Mercer Island resident, would be \$6,159. The sprinklered home creates a 72% savings in property loss over the non-sprinklered home.

The environment is also benefitted from the use of residential sprinkler systems. With fires being contained or extinguished early on in the process, less water is used by the fire department. This results in less property damage and less runoff from fire department activities. This is especially important for the city of Mercer Island since much of the runoff has direct access to Lake Washington. Mercer Island has gone to great lengths to prevent the pollution of this body of water, and any pollutants from a fire scene could have significant negative impacts on the environment, and the city.

Finally, the reduction in growth needs of a fire department can be directly related to the benefit of residential sprinkler systems. In a statewide survey of Maryland fire departments, 52% of the respondents listed a reduction in growth needs of the department as a benefit of their ordinance (Cox, 2006). This is due to the sprinkler systems being able to contain the fire in the incipient stage, rather than allowing it to spread. Fires that are extinguished in this stage result in less time for crews to be out of service, and require less staffing to handle. This allows for more in service time for fire crews, including mutual aid crews that respond to Mercer Island.

Research Question 3 - What ordinances, codes, or standards have other jurisdictions adopted that would be relevant to Mercer Island's effort in adopting a mandatory residential sprinkler system ordinance for new single-family construction?

The IRC requires, since the 2009 edition, that sprinkler systems be mandatory for all new one and two-family dwellings and town homes of residential construction, so why are not all communities following it? This is because some states have State Building Code Councils (SBCC's), or similar boards, that modify the International Codes to meet local conditions and needs. In the State of Washington, the SBCC re-wrote the IRC and moved the one and two-family dwelling sprinkler requirement from the body of the main code and into the appendix.

This translates into the requirement not being a statewide mandate, but rather a requirement that each municipality adopt individually. Some states have even gone to the extent to prohibit local municipalities from adopting the residential sprinkler portion of the code, and many others have adopted the code in its entirety, with the sprinkler chapter intact (R. Mandery, personal communication, November 1, 2010). From the information the author received from inquiry, the cities of Bonney Lake and Kenmore are the only communities near Mercer Island that have fully adopted mandatory sprinkler ordinances for new construction. In addition, the city of Redmond has adopted a mandatory residential sprinkler ordinance for all new construction, but still has a square footage threshold of 3,000 Square feet for commercial properties. Many communities have either not addressed this issue, or did not respond to the information request of the author.

The results of the research show that Mercer Island already has sprinkler requirements in effect similar to many other cities (see Appendix C). The author notes that this is good progress, and Mercer Island is in line with many of its constituents, but this is not enough. The true effectiveness of residential sprinkler systems will not be realized fully until they are required for all new residential construction.

Research Question 4 - Who are the stakeholders, and how would they be impacted by a mandatory residential sprinkler system ordinance for new single-family construction?

The largest stakeholder is the homeowner's themselves. With a sprinkler system present, in the event of a fire, they would have an increased chance of getting out alive by over 80% (Figueroa, 2010). This fact becomes even more significant due to the fact that the highest risk groups for fire death are children and older adults, of which 31.6% of homes on Mercer Island have these residents. In addition, sprinkler systems significantly cut down on property loss due to fire by about 34% - 77% (Hall, 2010). With an annual average of \$1,200,000 in property loss

from fire for the years 2005 through 2009, sprinkler systems could result in savings of \$276,000 - \$792,000 on Mercer Island, using those same percentages. For Mercer Island residents, where according to Zillow (2010), the current median price of a home has fallen to approximately \$773,000, and the reduction in property loss due to a fire is an even greater impact.

Local builders are also stakeholders in this process due to direct financial impacts on their business. According to HFSC (2009) the national average cost of a residential sprinkler system adds 1% - 1.5% to the cost of a home. Despite the varying costs of a sprinkler system per square foot, and other costs such as meter upgrades, inspection fees, maintenance costs, etc..., the average cost of installing a residential sprinkler system stayed within the 1% - 1.5% total cost estimate. The author found through information supplied by one builder this figure to hold true, with the example provided costing about 1.3% for a Mercer Island resident. Builders have made the case that this additional cost would drive some potential buyers from the market, and cost them in lower numbers of home sales. In an affluent community such as Mercer Island, the author does not agree that this issue would cause a significant impact. This is supported by the fact that a mandatory residential sprinkler ordinance would have only had an effect on three new residential construction projects in 2009 (D. Cole, personal interview, September 21, 2010).

Local elected officials will receive a recommendation from the fire department on the issue of residential sprinkler systems. They have a duty to the public to keep them safe, including through legislation if necessary. They also have a duty to keep the local economy thriving, and therefore must base some of their decisions taking this criteria into account as well. The author believes that the greater good of public safety outweighs the economic impact a mandatory residential fire sprinkler ordinance would have. Through the information gathered in this

research, it is the author's intention to recommend to the building code official that a mandatory residential sprinkler system ordinance for new construction be implemented by the city council.

Insurance companies have a vested interest in this legislation as well. During 2007, fire cost insurance companies \$78.2 billion. According to Hall (2010), these costs came in the form of property damage (\$18.6 billion), net costs of insurance coverage (\$17.2 billion), and the estimated monetary equivalent for the deaths and injuries for fire (\$42.4 billion). Numbers such as these are not cost effective for any business, and it would certainly be in their best interest, and the interest of their shareholders, to decrease these pay outs by the 34% - 77% listed by Hall (2010).

Research Question 5 - What impacts does a mandatory residential sprinkler system ordinance on new single-family construction have on the Fire Service?

The effects this will continue to have on the MIFD are numerous and varied. Due to limited access to many residences, and the city as a whole, response times for MIFD are slightly higher than average. Limited access also requires the fire department to purchase and maintain specialized apparatus, midi pumpers, which allow access to these residences. With this as a factor, the ability to extinguish and/or control fires while in the incipient stage, prior to the arrival of the fire department, is even more important. This also keeps the demand on fire department staffing levels at an acceptable level into the foreseeable future. In addition, by having a sprinkler system that controls the fire, the structure has a much lower probability of being compromised from damage caused by the fire. Every year, thousands of firefighters are killed or injured while at a fire incident. In 2009, there were 27 deaths, and 32,205 injuries of firefighters at fire incidents (Karter & Molis, 2010). Many of these injuries and deaths are from

the collapse of compromised structures such as walls, roofs, and floors, and have a significant impact on firefighter safety.

RECOMMENDATIONS

Based upon the results of this ARP, the following recommendations are made by the author.

1. The MIFD should schedule and facilitate meetings with all of the stakeholders identified within this ARP, so that issues or questions involving a mandatory residential sprinkler ordinance can be answered or resolved.
2. The Mercer Island Fire Department should collaborate with potential resources such as HFSC, and Fire Team USA to put together a public education program specific to this issue. This program should include all of the stakeholder's involved, and tailored to meet the needs of each. An analysis of the fire protection needs of the community should be conducted and include:
 - Current codes that have been adopted
 - Fire Department staffing levels and response time
 - Taxes allocated to fire prevention
 - Fire department budget (suppression vs. prevention allocation)
3. The Mercer Island administrative staff, along with the building code official, should draft and submit to the city council for approval, a mandatory residential fire sprinkler ordinance for all new construction, effective January 1, 2012.
4. The MIFD should enlist help and collaboration from the Redmond fire department, based on their success, in planning the framework necessary for the success of this initiative.

In summary, residential fire sprinklers provide an invaluable solution to decreasing the devastating, and sometimes catastrophic effects of fire. The possibility of fire in the home will never be eliminated, but taking the steps to minimize it is an absolute must. As new technologies are developed, reassessment of the issue will be necessary, but until then, residential fire sprinklers provide the most viable solution for safety of citizens and firefighters alike. The cost in human lives, reduction in property loss, and impact to the environment far outweigh the cost of implementing a mandatory residential fire sprinkler ordinance for new construction.

References

- Ahrens, M. (2009). *Home Structure Fires*. Quincy, MA: National Fire Protection Association.
- Chandler, M. R. (2007). *Residential Sprinklers: Protection of Life and Property*. Emmitsburg, Md: National Fire Academy, Leading Community Risk reduction.
- Cox, M. E. (2006). *A Case for Residential Sprinklers for single Family Dwellings in Anne Arundel County, Maryland*. Emmitsburg, Md: National Fire Academy, Leading Community Risk Reduction.
- Department of Homeland Security, Federal Emergency Management Agency. (2002). *America at Risk: America Burning Re commissioned*. Washington, DC: Federal Emergency Management Agency.
- Earls, A. R. (2009, July). *It's Not Lightweight Construction. It's What Happens When Lightweight Construction Meets Fire*. Retrieved October 25, 2010, from NFPA.org: <http://www.nfpa.org/publicJournalDetail.asp?categoryID=1857&itemID=43878&src=NFPAJournal>
- Figueroa, M. (2010). *The Case for Fire Sprinklers in One-and Two- Family Dwellings*. Quincy, MA: National Fire Protection Association.
- Grundahl, K. (1992). *National Engineered Lightweight Construction Fire Research Project*. Quincy, MA: National Fire Protection Research FOundation.
- Hall, J. R. (2010). *The Total Cost of Fire In the United States*. Quincy, MA: National Fire Protection Agency.

- Hall, J. R. (2010). *U.S. Experience With Sprinklers and Other Automatic Fire Extinguishing Equipment*. Quincy, MA: National Fire Protection Association.
- Hayes, T. P. (2008). *Residential Fire Sprinklers: What do they really Cost?* Emmitsburg, MD: National Fire Academy, Executive Leadership.
- Home Fire Sprinkler Coalition. (2001). *Municipal Reports: Scottsdale 15 year Data Now Available*. Retrieved October 24, 2010, from Home Fire Sprinkler Coalition:
<http://www.homefiresprinkler.org/FS/Scottsdale15.html>
- Home Fire Sprinkler Coalition. (2009). *Protect What You Value Most*. Retrieved November 1, 2011, from Home Fire Sprinkler Coalition:
<http://www.homefiresprinkler.org/images/ProtectBroch.pdf>
- Home Fire Sprinkler Coalition. (2005). *The Solution*. Retrieved October 24, 2010, from Home Fire Sprinkler Coalition:
http://www.homefiresprinkler.org/newsletter/fall05/Fall_2005_HFSC_NL.pdf
- Karter, M. J. (2010). *Fire Loss in the United States During 2009*. Quincy, MA: National Fire Protection Association Fire Analysis and Research Division.
- Karter, M. J., & Molis, J. L. (2010). *U.S. Firefighter Injuries 2009*. Quincy, MA: National Fire Protection Association.
- Matlick, M. G. (2009, June). Washington Communities with Residential Fire Ordinance/Amendments/Incentives. *Fire Sprinkler E-News*, p. 1.
- National Commission of Fire Prevention and Control. (1973). *America Burning*. Washington, DC: United States Government Printing Office.

- National Fire Protection Association. (2009, March/April). *A Brief History of Sprinklers*. Retrieved November 1, 2010, from NFPA Journal: <http://www.nfpa.org/publicJournalDetail.asp?categoryID=1752&itemID=42356&src=NFPAJournal>
- National Fire Protection Association. (2010). *NFPA 13D: Standard for the Installation of Sprinkler Systems In One- and Two- Family Dwellings and Manufactured Homes (2010 ed.)*. Quincy, MA: National Fire Protection Association.
- National Fire Protection Association. (2010). *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. Quincy, MA: National Fire Protection Association.
- Newport Partners. (2008). *Home Fire Sprinkler Cost Assessment*. Davidsonville, MD: The Fire Protection Research Foundation.
- RFSI. (2009). *Jurisdictions With Residential Sprinkler Ordinances*. Retrieved October 24, 2010, from Residential Fire Safety Institute: <http://www.firesafehome.org/jurisdictions-with-residential-sprinkler-ordinances/#WASHINGTON>
- RFSI. (2010, September 22). *Lower Insurance Premiums*. Retrieved October 24, 2010, from Residential Fire Sprinkler Institute: <http://www.firesafehome.org/lower-insurance-premiums/>
- Tubbs, C. (2009). *Overtime and Leave Use - An Analysis of the Mercer Island Fire Department Operations*. Mercer Island, WA: City of Mercer Island.

USFA. (2001). *United States Fire Administration's Fire Research Agenda*. Emmittsburg, MD:

USFA.

Washington State Fire Marshal's Office, Washington State Patrol. (2010). *2009 Fire in*

Washington. Olympia, WA: Washington State Patrol.

Washington Surveying & Rating Bureau. (2010). *WSRB Public Education Resources*. Retrieved

November 20, 2010, from WSRB.com:

<http://www.wsrb.com/wsrbpubliced/firedemo.aspx>

Weatherby, S. (2009). *Benefits of Residential Fire Sprinklers: Prince George's County 15-year*

History with its Single-Family Residential Swelling Fire Sprinkler Ordinance. Prince

George's County, MD: Home Fire Sprinkler Coalition.

Wieczorek, C. J., & Ditch, B. (2010, April 13). *Fire Sprinklers Can Reduce Greenhouse Gas*

Emissions from Building Fires by 98 Percent, Research Finds. Retrieved November 2,

2010, from FM Global:

http://www.fmglobal.com/press_release/2010/Sprinklers_041310.html

Xu, L. (2007, September 114). *Fire Sprinklers and Homeowner's Insurance*. Retrieved October

17, 2010, from National Association of Homebuilders:

<http://www.nahb.org/generic.aspx?genericContentID=82243&fromGSA=1>

Zillow. (2010, October 5). *Mercer Island Home Prices and Home Values*. Retrieved November

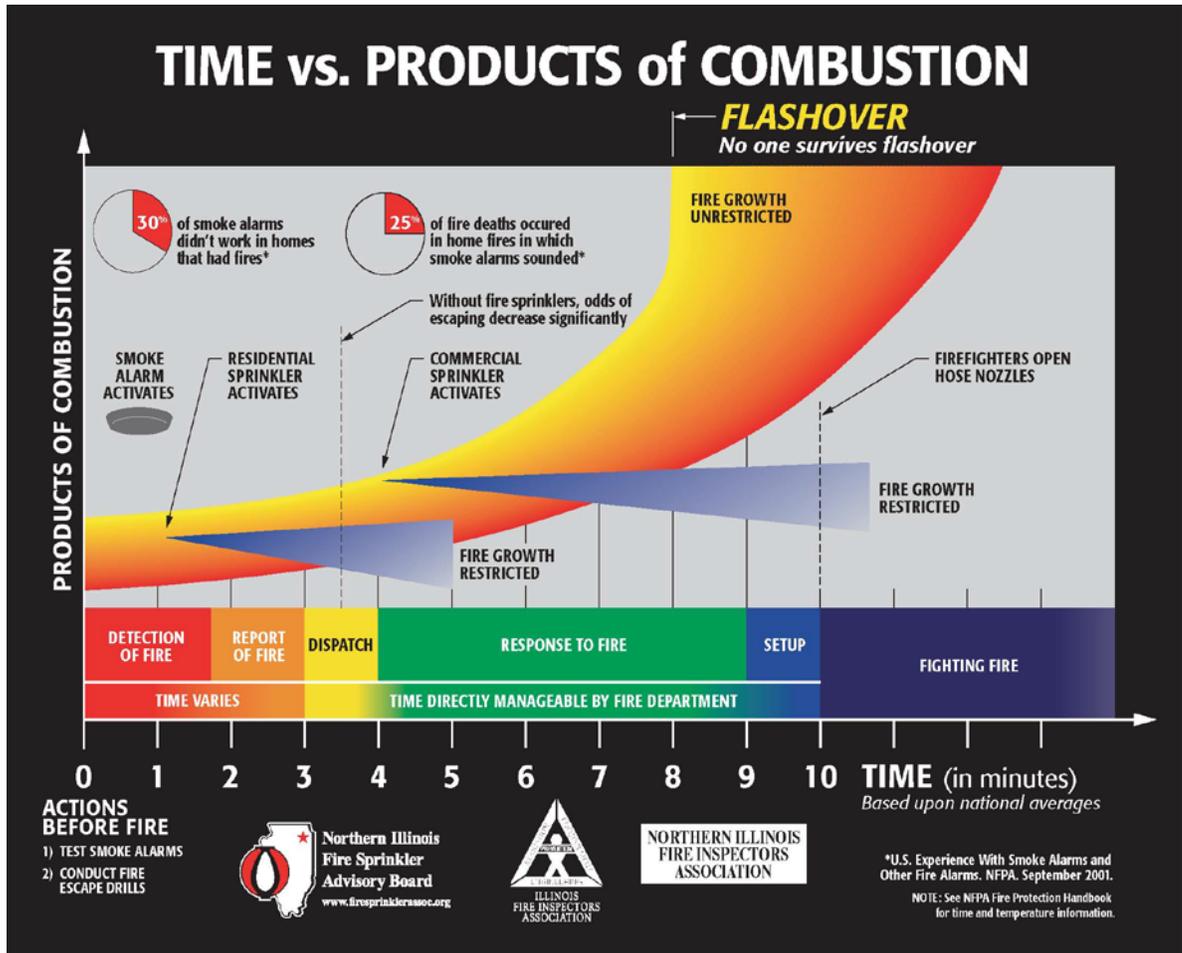
1, 2010, from Zillow.com: [http://www.zillow.com/local-info/WA-Mercer-Island-home-](http://www.zillow.com/local-info/WA-Mercer-Island-home-value/r_56365/#metric=mt%3D11%26dt%3D1%26tp%3D5%26rt%3D8%26r%3D56365%26el%3D0)

[value/r_56365/#metric=mt%3D11%26dt%3D1%26tp%3D5%26rt%3D8%26r%3D56365](http://www.zillow.com/local-info/WA-Mercer-Island-home-value/r_56365/#metric=mt%3D11%26dt%3D1%26tp%3D5%26rt%3D8%26r%3D56365%26el%3D0)

[%26el%3D0](http://www.zillow.com/local-info/WA-Mercer-Island-home-value/r_56365/#metric=mt%3D11%26dt%3D1%26tp%3D5%26rt%3D8%26r%3D56365%26el%3D0)

APPENDIX A

Time vs. Products of Combustion



APPENDIX B**Builders Survey Cover Letter**

March 29, 2011

Dear Contractor,

My name is Steve Heitman, and I am the Deputy Fire Chief for Mercer Island Fire. I am currently in my second year of the National Fire Academy's Executive Fire Officer Program. This program is comprised of four courses for which an applied research project is required at the conclusion of each one. The purpose of this letter is to ask for your assistance in obtaining data, to complete my research project. I am requesting for you take a few minutes of your valuable time to answer an eight-question survey I have developed.

I am gathering data to determine the general knowledge and importance, from a contractor's perspective, of residential sprinklers used in home fire protection systems. The data collected from this questionnaire will be used to validate current research on this topic. The survey can be completed online at:

<https://www.surveymonkey.com/s/JKQH3SF>

Please complete the survey by October 15, 2010. If you have any questions regarding this survey, please contact me at steve.heitman@mercergov.org or call me at (206)275-7961.

I would like to take the opportunity to thank you for giving your valuable time to help me with this project.

Sincerely,

Steve Heitman

Builders Survey

- 1. What type of homes do you build?**
 - a. Custom
 - b. Speculation
 - c. Both

- 2. Have you ever constructed a home that included a sprinkler system?**
 - a. Yes
 - b. No

- 3. Installing a residential sprinkler system will add an additional \$_____ per square foot to the total construction costs**

- 4. Have you ever considered making residential sprinkler systems part of the construction package?**
 - a. Yes
 - b. No

- 5. Installing a residential sprinkler system would cause delays in construction time**
 - a. I agree with the above statement
 - b. I disagree with the above statement

- 6. Residential sprinkler piping can be integrated with the domestic water piping in residential housing when certain pre-conditions are met?**
 - a. True
 - b. False
 - c. I don't know

- 7. The use of smoke detectors/alarm systems provides adequate protection to homeowners**
 - a. I agree with the above statement
 - b. I disagree with the above statement

- 8. If you were involved in sub-division development/construction, would you install sprinkler systems in each home in exchange for concessions such as: greater hydrant spacing, lesser construction standards (fire ratings), narrower street widths, etc?**
 - a. Yes
 - b. No
 - c. Do Not Know

APPENDIX C**Citizen Survey****Residential Fire Sprinklers Evaluation**

- 1. The majority of fire deaths in the United States occur in:**
 - a. Multi-family residents (apartments)
 - b. Entertainment/Assembly locations (movie theater, night club)
 - c. Business/Industrial location
 - d. Single and two-family residences
- 2. On Mercer Island, fire losses are within acceptable limits**
 - a. I agree with the above statement
 - b. I disagree with the above statement
- 3. Fire in residences will continue regardless of the prevention measures taken**
 - a. I agree with the above statement
 - b. I disagree with the above statement
- 4. Properly operating smoke detectors offer a near failsafe fire protection device**
 - a. I agree with the above statement
 - b. I disagree with the above statement
- 5. Smoke detectors will alert occupants in time to safely exit the home in case of fire.**
 - a. I agree with the above statement
 - b. I disagree with the above statement
- 6. A fire will cause all sprinkler heads in the home to activate**
 - a. True
 - b. False
- 7. Sprinkler systems are prone to accidental leaks resulting in damage to the home**
 - a. True

- b. False
- 8. Sprinkler systems will cause more dollar loss due to water damage than from the fire itself**
- a. True
 - b. False
- 9. Sprinkler systems are designed to: (mark all that apply)**
- a. Extinguish the fire every time
 - b. Extinguish the fire some of the time
 - c. Allow residents more time to escape
 - d. Contain the fire until the Fire Department arrives to extinguish it
- 10. Sprinkler systems are too costly**
- a. True
 - b. False
- 11. On average, the cost of installing a residential sprinkler system accounts for ____% of the total cost of construction of a home.**
- a. <1.5%
 - b. 3%
 - c. 5%
 - d. >5%
- 12. What current fire protection system(s) or devices do you currently have in your home (mark all that apply)**
- a. Fire extinguisher(s)
 - b. Smoke alarms
 - c. Monitored alarm system
 - d. Residential sprinkler system
 - e. CO detector

f. Other (please explain) _____

13. Sprinkler systems cannot be added to a house that is already constructed

- a. True
- b. False

14. If you do not currently have a sprinkler system installed, please check the reason(s) why:

- a. Too costly
- b. Concerned about possible damage from activation or leaks
- c. Monitored system/smoke detectors are effective enough
- d. Too unsightly (ugly)
- e. The fire department will extinguish it
- f. Not enough incentives to do so
- g. Never thought about it

15. Does your insurance company offer reductions in home insurance rates for additional fire safety measures such as alarm systems or sprinkler systems?

- a. Yes
- b. No
- c. Not sure

APPENDIX D



Mercer Island Fire Department

Fire Marshal's Office

3030 78th Ave SE

Mercer Island, WA 98040

(206) 275-7966

General RESIDENTIAL Fire Sprinkler Requirements

You will be required to provide approved fire sprinklers if:

- 1.) The wood frame structure is 5000 or more square feet of gross square footage or fire area as measured on interior walls and the outside roofline on decks. This is a Fire Code term for usable space, under the roof line whether it is heated or not and includes decks covered by the roof, storage rooms, crawl, space with hard floors and man-doors, basements, attic space used for fuel fired equipment and attached garages.
- 2.) **Your structure exceeds 3,600 square feet of “gross square feet”** (*all usable square footage under the roof including garage, storage and basement, etc. as above in item 1.*) **and the Fire Code required fire flow in gallons per minute (from the fire hydrant water main system) is not available at the site for the size structure proposed.** *See 2006 Edition of the International Fire Code Appendix “B” IFC Table B105.1*
- 3.) Any type of building of any size that has difficult access such as listed in the *2006 Edition of the International Fire Code, Chapter 5 and Appendix “D”*.
 - ❑ A fire apparatus access road (private drive, lane, driveway that fire apparatus must use to drive to a building) , more than 10% gradient over 40 feet
 - ❑ The owner **cannot provide an approved turn-around when the drive exceeds 150 feet in length.**

See 2006 Edition of the IFC, Appendix “D”

- ❑ **Fire apparatus access road (private or public) is too narrow** (the Fire Code requires a minimum of 20 feet in width and more depending upon circumstances)*See IFC Appendix “D”*.

- ❑ The fire apparatus access road cannot support imposed loading of a minimum 48,000 pounds GVW for a two-axle heavy truck.

HYDRANTS

- 4.) Your new project is located more than 300 feet from the nearest fire hydrant that would provide the **required** flow. *2006 International Fire Code Mercer Island Amendments Chapter 5, Section 508.5.1.*
- 5.) Some fire hydrants may be closer but do not meet the International Fire Code fire flow requirements. Some projects are so large that they require multiple fire hydrants. *See 2006 International Fire Code Appendix "C"*

REMODELS AND ADDITIONS

- 6.) **Remodels** that substantially increase the Fire Area and have one or more of the above deficiencies, such as access or fire flow problems, would require fire sprinklers. *See Mercer Island Ordinance 17.60, Fire Sprinklers.*
 - The structure is 5000 square feet of fire area and the remodel project equals or exceeds the current assessed value of the building per King County Assessor
 - You add more than 750 square feet bringing the structure to 5000 square feet or more of fire area.

These are basic requirements. There are other factors of a very technical Code nature that may cause fire sprinklers to be required. If you have questions, always consult with the Fire Marshal to be certain of the requirements.