EVALUATING FIRE SPRINKLER INSTALLATION RATES

Evaluating the Installation Rate of Automatic Fire Sprinkler Systems for Residential Occupancies Located in Laguna Beach, California

Michael P. Macey

Laguna Beach Fire Department

Laguna Beach, California

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Abstract

The problem was that no data had been collected to identify the effectiveness of the City's residential fire sprinkler ordinance limiting the ability to objectively review recommendations for future amendments. The purpose of the research was to determine the effectiveness of the City's residential fire sprinkler ordinance, and to analyze installation rates based on altering the existing valuation threshold. The evaluative research methodology was used in formulating this project, and the research was conducted through the collection and analysis of data. Three research questions focused on residential fire sprinkler system installation rates. The results demonstrated the correlation between valuation thresholds and saturation rates. Recommendations included reducing the City's valuation threshold to increase the rate of residential fire sprinkler system installations.

Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and the appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: _____

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Introduction

The City of Laguna Beach, California, was incorporated on June 29, 1927 (City of Laguna Beach, 2006). The first mandatory residential fire sprinkler ordinance was enacted by the City of San Clemente, California in April of 1978 (Coleman, 1985). The City of Laguna Beach, adopted its first residential fire sprinkler ordinance on June 17, 2003, when the members of the Laguna Beach City Council unanimously passed Ordinance 1429. The Ordinance also mandated the installation of an automatic fire sprinkler system in existing residential occupancies when proposed additions, alterations, or repairs have a valuation of seventy-five percent or more of the building's valuation prior to the additions, alterations, or repairs. The residential fire sprinkler ordinance installation threshold is defined as a zero square foot requirement because any newly constructed residential occupancy, regardless of its size, must be equipped with an automatic fire sprinkler system.

Under the model code adoption process in the State of California, local municipalities have the ability to submit code amendments more restrictive than the State's code based on a finding of fact delineating the need based on local topographical, climatic, and geological conditions. The City of Laguna Beach used the local amendment process to establish the 2003 fire sprinkler ordinance, and the City must continue to provide findings with the adoption of new model codes. The City is interested in tracking the installation rate of residential fire sprinkler systems in order to define trends and modify future mandates. In the absence of data, decisions are more empirical than scientific. In assessing community risk reduction opportunities, it is imperative to use well researched data as a basis for future policy decisions. Therein lies the nature of the problem.

The problem is that no data has been collected to identify the effectiveness of the City's residential fire sprinkler ordinance limiting the ability to objectively review recommendations for future amendments. The City of Laguna Beach, is primarily a residential community consisting of one unit detached residential units. Information from the National Fire Data Center indicates that in 2001 the largest percentage of fire related injuries, 73.3 percent, occurred in residential structures (U.S. Fire Administration, 2004), and the National Fire Protection Association (NFPA) estimates that 87 percent of civilian fire fatalities occur in one-and two-family dwellings (Ahrens, 2007). "The majority of firefighter deaths and injuries occur at residential fires…twice as many firefighters are injured each year performing fire ground duties as there are fire injures to the civilian population (43,000 vs. 23,100 in 1998)" (Madrzykowski & Fleming, 2002, p. 4). Finally, "there has never been a civilian fire death or a firefighter death in a building protected by a 'Totally Code Compliant' (TCC) fire sprinkler system" (Pamplin, 2004, p. 69).

Based on introductory data, it appears that a correlation may exist between increasing the number of residential fire sprinkler systems in the City of Laguna Beach and enhancing firefighter and community safety. In an attempt to definitively focus on a specific and significant problem, the research will examine residential fire sprinklers in one unit detached structures. With the City's housing stock being static and considered fully developed, accuracy of future projections is improved as one component of the equation remains constant. Assuming that one can accept the City's commitment to the altruistic goal of equipping each home with an automatic fire sprinkler system, then the only component missing is to calculate the time lag between existing and future saturation levels of automatic fire sprinkler systems in residential units. Using this information as a foundation, the purpose was formulated and is identified as follows: The purpose of this research was to determine the effectiveness of the City's residential

fire sprinkler ordinance, and to analyze installation rates based on altering the existing valuation threshold.

Evaluative research will be the methodology used in formulating this Applied Research Project. Evaluative research is defined as "the systematic process of collecting and analyzing data in order to facilitate decision making" (National Fire Academy, 2003, p. II-26). The intent of this project was to explore two paths (a) the collection and analysis of data and (b) based on the outcome of the data analysis, forecast future conditions. Ultimately, the process has the potential to direct future policies and statutes. Thus, the evaluative format provided the framework to identify existing conditions, project future outcomes, and served as fodder to identify opportunities for improving community risk reduction through the use of residential fire sprinkler systems.

In an attempt to remain focused on the problem, three questions have been identified to narrow the scope while simultaneously providing an opportunity to quantify outcomes. The questions are (a) What effects have residential fire sprinkler systems had on community risk reduction for municipalities that are similar in size to Laguna Beach, California? (b) What effect did the promulgation of the residential fire sprinkler amendment have on the pace of installations in residential occupancies located in Laguna Beach, California? (c) What effect would altering the valuation threshold have on the pace of installing residential fire sprinkler systems, in the City of Laguna Beach, California?

Background and Significance

Henry Parmelee patented the first automatic fire sprinkler in 1875 (Puchovsky, 2003), and while Mr. Parmelee was marketing his invention on the east coast, the Brooks brothers were migrating west. William and Nathanial Brooks arrived in Laguna Beach, California in 1876.

The Brooks brothers have the distinction of being the "fathers of Laguna" (City of Laguna Beach, 2006, p. 8). Although the two events mark symbolic beginnings, their divergent worlds would not meet again for another 127 years. The homecoming occurred on June 17, 2003, when the City of Laguna Beach passed its first residential fire sprinkler ordinance. The statute required every new residential structure, regardless of its size, to be equipped with an automatic fire sprinkler system, and every residential structure scheduled for remodel where the renovations met the seventy-five percent valuation threshold would be retrofitted with an automatic fire sprinkler system.

Based on the 2000 census, the City of Laguna Beach has a population of 24,127 and 12,862 housing units of which 7,987 (62.1%) are one unit detached structures (United States Census Bureau, 2000). Laguna Beach is considered very nearly built-out, and the City estimates there are only "119" (City of Laguna Beach, 2001, p. IV-1) available residential parcels that are legal residential building sites. Data from the National Fire Protection Association indicates that "82% of all civilian fire deaths in 2005 resulted from home structure fires" (National Fire Protection Association [NFPA], 2006, p. 1), and "there has never been a civilian fire death or a firefighter death in a building protected by a 'Totally Code Compliant' (TCC) fire sprinkler system" (Pamplin, 2004, p. 69). The logic is as follows: If Laguna Beach is primarily a residential community, and if 82% of fire fatalities occur in the home, and if no civilian or firefighter deaths have occurred in a property protected by a totally code compliant fire sprinkler system, then installing residential fire sprinklers in homes in the City of Laguna Beach would lessen the community's chance of experiencing a residential fire fatality. Albeit a purist might argue the validity of the inference, it is likely that the general message could remain relatively intact. That is, residential fire sprinklers can alter fire fatality rates.

The triad of information that serves as the foundation for the re-examination of existing City policy is as follows: (a) The City of Laguna Beach has 7,987 existing one unit detached structures; (b) the City of Laguna Beach has only 119 undeveloped parcels; and (c) the City of Laguna Beach has a fire sprinkler ordinance that has its most restrictive application in new construction.

In review of the problem it was important to understand how the actions of the past contributed to existing conditions. Therefore, a segment of this project will focus on data analysis to determine the effects the residential fire sprinkler ordinance had on the installation rate of sprinkler systems in one unit detached structures. Another aspect is to consider potential future impacts to the community and the fire department. Analyzing installation rates under hypothetical conditions will be used to extrapolate probable outcomes. For example, What effect would changing the retrofit threshold have on saturation rates? The backdrop to future outcomes will lie with imposed assumptions. The City is in a phase where new home construction is likely to decline, and the emphasis will be on remodeling and refurbishing existing homes. Residential construction follows the ebb and flow of a myriad of outside social and economic influences. Therefore, projections of future installation rates will be subject to the realities that the future construction patterns are unlikely to duplicate the conditions that existed when the data for this research was collected.

The timing of this project melds with the State's upcoming model fire code adoption. It is during the formal code adoption process that the City of Laguna Beach will be able to submit local code amendments based on the topographical, geological, and climatic conditions unique to the community. It was a similar opportunity that the City used to adopt its 2003 fire sprinkler

ordinance. Thus, the data presented in this research is significant in its immediate and direct application to the researcher's own organization.

Although there are a number of facets to this report, it also parallels lessons learned from the National Fire Academy curriculum Leading Community Risk Reduction (LCRR). The framework of LCRR was centered on the five-step community risk reduction model. The fifth step is broadly labeled "evaluating" (National Fire Academy, 2005, p. 1-5) and contains the subsets of evaluate results, report results, and modify risk reduction initiatives. As identified in the purpose statement, this project is designed to evaluate existing conditions, and through a process of evaluating future probabilities, modify outcomes to maximize risk reduction initiatives.

The 1947 report known as the President's Conference on Fire Prevention was reviewed and evaluated during the LCRR program. The report was the genesis for shifting the concept of the three-E's (engineering, education, and enforcement) from military application to a community fire and life safety application. The National Fire Academy has included in their curriculum two additional E's: emergency response and economic incentives. Collectively, these concepts are referred to as the five-E's of community fire protection. Residential fire sprinklers will be the cornerstone of this report, and in its purist form fire sprinklers are engineered systems. However, in the context of community risk, engineering, education, enforcement, emergency response, and economic incentives are interwoven and inseparable. Therefore, this report will have components applicable to each one of the five-E's.

A direct nexus from this report to the LCRR curriculum can be found in its focus on preventing injuries to young children and older adults. Based on the data from the United States Census Bureau for 2000, children under the age of five years make up 4.2 percent of the

population in the City of Laguna Beach, and adults 60 years of age or older make up 18.4 percent of the City's population (U.S. Census Bureau, 2000). Additionally, the residential fire problem is tightly correlated to demographics, and "children 4 years of age and under and adults 60 years of age and older are more likely to die in a fire than other segments of the population" (Madrzykowski & Fleming, 2002, p. 3). Thus, one could conclude that these at-risk populations could benefit from a risk reduction point of view if their homes were equipped with a residential fire sprinkler system.

There are numerous connections between the LCRR curriculum and the analysis of residential fire sprinkler system in Laguna Beach; however, at the conclusion of the project there will likely be recommendations to change some aspect of the existing mandates. Thus, it would seem prudent to prepare for change. John Kotter has eight stages he believes are important to leading change and avoiding transformational failure. Kotter's (2003) eight stages are (a) establishing a sense of urgency, (b) forming a powerful guiding coalition, (c) creating a vision, (d) communicating the vision, (e) empowering others to act on the vision, (f) planning for and creating short-term wins, (g) consolidating improvements and producing still more change, and (h) institutionalizing new approaches. These eight stages can serve as a guide to maximize the benefits of future change.

Finally, this research has the ability to touch all five of the United States Fire Administration (USFA) Operational Objectives; however, its greatest impact is the ability to focus on reducing the loss of life to the three primary target audiences: firefighters, children 14 years and younger, and older adults 65 years and older. Albeit the research is designed to focus on life safety, it is difficult to discuss residential fire sprinklers without interweaving community risk reduction plans. The research is current and matches the objectives of the USFA.

In summary, it is hoped that through analysis of existing data, recommendations can be extrapolated and provide direction for Laguna Beach to either stay the course or vector a new path. The importance of the study is founded in the desire to enhance firefighter and community safety. With the installation of residential fire sprinkler systems, the fire fatality and fire injury rates in homes located in Laguna Beach can eventually be a vestige of the past.

Literature Review

With the focus of the research centered on the findings in the City of Laguna Beach, it is important to compare the research findings with data from other communities. This comparative analysis provides the opportunity to examine similarities, differences, and anomalies. Thus, one purpose of the literature review is to provide opinions that do not conform to the research findings when the data supports such disclosure. The literature review will be guided towards addressing the research problem, and assisting in providing data for consideration when formulating answers to the research questions. All aspects of the research center on residential fire sprinkler systems. Therefore, in an effort to place a time-stamp on events it is important to review the historical evolution of the residential fire sprinkler system.

The genesis for the invention of the automatic fire sprinkler can be traced to the period known as the second phase of the industrial revolution (1871-1914). During this period there were frequent and catastrophic fire losses in the textile industry. The first automatic fire sprinkler was developed in 1875 by Henry Parmelee (Puchovsky, 2003). Parmelee's basic core design, the fusible link, is still being manufactured 132 years later (i.e., 1875-2007). The conversion from industrial use to residential use took 103 years as it was in 1978 that the City of San Clemente, California enacted the first mandatory residential fire sprinkler ordinance in the world (Coleman, 1985). The City of Laguna Beach passed its first residential fire sprinkler

ordinance in 2003. Thus the City of San Clemente and the City of Laguna Beach share in their mandates that all new residential dwellings, regardless of their size, be equipped with an automatic fire sprinkler system.

The literature does not suggest a single causation for the century-long span between industrial and residential use of fire sprinkler systems, yet two sentinel documents are likely to have played a role in the transition. The first landmark document is known as The President's Conference on Fire Prevention or simply the '47 Report. The Report provides the findings from the National Conference on Fire Prevention that was convened at the request of President Harry S. Truman. The catalyst for the Conference was a steady increase in fire loses between 1936 and 1946. During that decade of time "an average of 10,000 people died annually from fire" (National Conference on Fire Prevention, 1947, p. 1). Although there were two broad objectives for the conference, the intent is summarized in a quote from President Truman.

> I can think of no more fitting memorial to those who died needlessly this year in the LaSalle Hotel fire in Chicago, the appalling disaster at the Winecoff Hotel in Atlanta, and the more recent New York tenement holocaust than that we should dedicate ourselves anew to ceaseless war upon the fire menace. (National Conference on Fire Prevention, 1947, p. 6)

Just as the gold ring around the USFA hotfoot emblem symbolizes leadership, wisdom, and achievement, so too did President Truman when he had the vision in 1947 to mitigate the costly personal and financial impacts to communities throughout America as a result of fire.

The *Report of Committee on Firefighting Services* ('47 Report) documented the importance of fire sprinkler systems. In the '47 Report the authors mentioned the importance of an automatic fire sprinkler system based on the need for large quantities of water to extinguish

fires that produce significant radiant heat. Even in 1947 there was recognition that fire prevention in buildings relies on a systems approach. The Committee discussed the need for fire sprinkler systems and also recognized the importance of a system of inter-related building components such as fire alarm systems and limitations to a building's maximum height and area.

Another interesting aspect of the '47 Report was its discussion of costs for municipal fire departments. "Fire department expenditures in cities of over 10,000 population were $3.69 per capita in 1946" (National Conference on Fire Prevention, 1947, p. 135). By contrast the rate for the City of Laguna Beach for fiscal year 2007-2008 was $368. This equates to an annual inflation rate of approximately eight percent over a 60 year period. As a benchmark for comparison, the average annual inflation rate for the United States for the same 60 year period was 3.78 percent, and the average annual inflation rate from 1913 to 2006 was 3.43 percent (Inflation Data, n.d., p. 1). With the pace of per capita costs for fire department expenditures at more than double the national average, fire personnel and elected officials are left to ponder the impact residential fire sprinklers could have on a community's ability to reduce or redistribute per capita costs for fire department expenditures.

The second document of significant importance is *America Burning.* Richard E. Bland was the Chairman of the report and in the content of the letter of transmittal he submitted with the final report to President Richard M. Nixon in May of 1973 he noted that annually "12,000 people are killed…by fire" and he emphasized "built in fire safety-measures which can detect and extinguish fire before it grows…" (Bland, 1973, p. III). The body of the text suggested that fire extinguishing systems are too expensive for installation in one's home. However, an important component of the report was a recommendation that the United States Fire

Administration support development of the technology necessary to develop residential fire sprinkler systems.

In reference to the death rate by fire, the report provided one statistic that displayed the information from a comparative point of view using the death totals from the Vietnam War. During the period 1961 through 1972 the number of deaths to United States military personnel from hostile forces totaled 45,925. During that same period 143,550 died from fire (U.S. Federal Emergency Management Agency). Granted the data is silent regarding the percentage of the total population, yet the numbers do provide an opportunity for reflection. From a sociological point of view one might contemplate what might have been if the nation had an anti-fire movement as strong as the anti-war movement of the 1970's. Figure 1 graphically depicts the comparative death toll for the period 1961 through 1972.

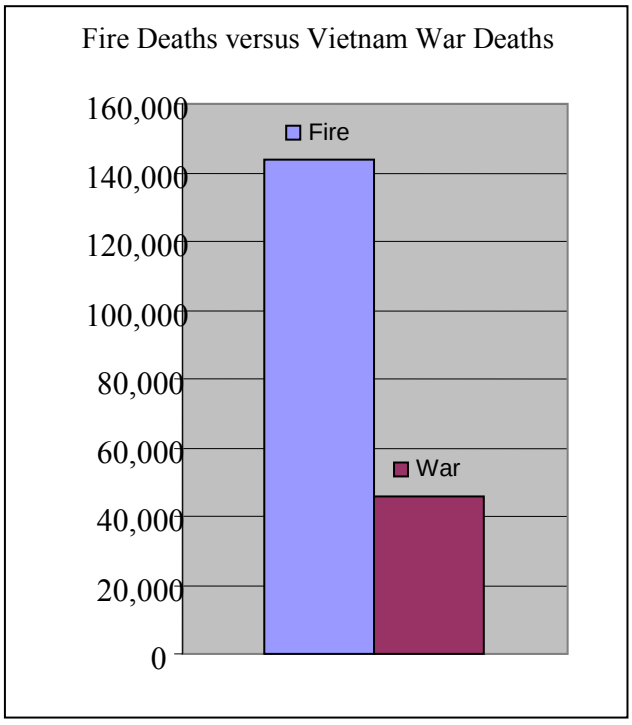


Figure 1. Comparative death totals: Fatalities from fires in the United States compared with fatalities to United States military personnel during the Vietnam War (1961 through 1972).

America Burning identifies many areas of potential fire and life safety enhancements. One segment of the report references built-in fire safety measures and specifically automatic fire extinguishing systems. The report goes further than the '47 Report as it defines where the systems should be placed. High rise buildings and low rise buildings were singled out for automatic fire extinguishing mandates.

Although the focus on this applied research project is residential fire sprinkler systems, there was one recommendation from *America Burning* that is directly linked to suppression systems. Recommendation number seven states: "The Commission recommends that local governments make fire prevention at least equal to suppression in the planning of fire department priorities" (U.S. Federal Emergency Management Agency, 1973, p. 167). Perhaps a somewhat sarcastic route to shed light on the fire services success on this recommendation is to use a common remark often heard in the fire service. A pound of suppression is more likely to be funded than an ounce of prevention.

The President's Conference on Fire Prevention and *America Burning* are pivotal documents that have defined periods in our nation's history and the associated fire problems along with recommendations to improve fire and life safety in our communities. Both documents recommend the use of automatic fire sprinkler systems. In *America Burning* the language becomes stronger and ties building types and occupancy to the requirement for automatic fire sprinkler systems. However, neither document blazes a path that joins fire sprinklers and residential structures, yet the vision had already been set by a handful of fire service leaders.

The conversion of fire sprinkler systems from commercial use to residential use is a difficult history to piece together. The literature suggests that futurists throughout the nation

were tinkering with individual theories and experiments. As is often the case, like minds began to find one another and a myriad of ideas began to form the recipe for the development of the residential fire sprinkler system. A sampling of individuals and groups instrumental in the evolution for the residential fire sprinkler system include Richard Patton who conceptualized the idea of smaller volume of water and quicker water application rate; Don and Bob Shaw who originally experimented with using plastic sprinkler pipe; John Hopkins University who conducted research on built in fire protection and its impacts on fire and life safety; Factory Mutual Research Corporation who contributed to the development of the quick response residential sprinkler, Sonny Scarff who pushed for sprinkler systems in the Marriott Hotels, Ronny Coleman who successfully passed the first residential fire sprinkler ordinance, and David Hilton who instituted a concept of trade-offs as incentive to install residential fire sprinkler systems (Coleman, 1985).

The National Fire Protection Association (NFPA) also played an instrumental role in the development of standards for fire sprinkler systems. The installation requirement of fire sprinklers to protect property in commercial and industrial buildings has its roots firmly planted in NFPA's first published standard. In 1896 the standard was titled *Rules and Regulations of the National Board of Fire Underwriters for Sprinkler Equipments, Automatic and Open Systems* (National Fire Protection Association, 2002a). The first edition of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One-and Two-Family Dwellings and Mobile Homes* was first published in "May 1975" (National Fire Protection Association, 2002b, p. 13D-1). NFPA 13 and NFPA 13D covered a broad range of occupancies and both standards offered system enhancements providing property and life safety protection. However, there were residential occupancies such as apartments, hotels, and motels that were not adequately protected by either

of the existing NFPA standards. A solution to bridge the gap between NFPA 13 and NFPA 13D was found in 1989 with the publishing of NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height* (National Fire Protection Association, 2002c).

Empirically, the fire service has pushed for inclusion of residential fire sprinklers in homes to mitigate the hideous injury and death rate from fire. However, the supporting data for residential fire sprinkler systems efficacy is a bit obscure and subject to interpretation.

Data sources from the 1970's and early 1980's mention success rates with automatic fire sprinkler systems in the 95-98 percentiles. For example, "Numerous references have been made in fire protection literature to the fact that occupancies protected by automatic sprinklers have had a 98% success rate" (Coleman, 1985, p. 31). Coleman defines success rate as the ability of the sprinkler system to control or limit the fire's growth until the arrival of firefighters. The National Fire Protection Association phased out performance and effectiveness ratings based on changes in data collection. It was believed that the data was skewed towards fires in which large numbers of sprinkler heads operated or there were large dollar losses (Puchovsky, 2003, 10-187).

Current data has trended towards the elimination of success rate, performance, or effectiveness, and suggested that the number of sprinkler heads that activate during a fire provides a correlation to the size of the fire. "In more than 90% of the incidents, the fire was controlled with 1 or 2 sprinklers activated" (Madrzykowski & Fleming, 2002, p. 13). The reader of this information is required to deduce the size, impact, and severity of the fire based on the number of sprinkler heads that activated. Even the mathematical word problem that combines 90% with one or two heads is not the most refined statistical layout. The lack of mathematical simplicity and consistency can cause obfuscation of the intended message.

Another form of explanation cited is "The installation of sprinklers provides significant protection against fire. However, this conclusion cannot be drawn from NFIRS data alone since NFIRS combines properties of different size and values in the same property class" (U. S. Fire Administration, 2004a, p. 6). Again the difficulty for the reader is that if one reads the entire document referenced, there is no explanation or definition of what the author means with the statement that sprinklers provide significant protection against fire. Without separating protection of property or life the reader has some assumptions to make and therein lies an opportunity for misinterpretation.

The most optimistic of data is "There has never been a civilian fire death or a firefighter death in a building protected by a 'Totally Code Compliant' (TCC) fire sprinkler system that was properly designed…" (Pamplin, 2004, p. 69).

Some data is more unsettling than others. "…where an automatic extinguishing system was installed, 9 deaths out of 455 were reported in the 2001 data. Further investigation into the 2001 results should be conducted" (U. S. Fire Administration, 2004b, p. 83). So one author states that automatic fire sprinklers have a success rate of 98% and one might consider that exceptional. Yet another author states that 9 deaths out of 455 occurred in residential properties that were equipped with an automatic fire sprinkler system. Albeit the second example can be set up so that it too represents a 98% success rate (i.e., 9/455); however, the reality of nine deaths just percolates at a different rate in the reader's mind. Additionally, one success rate is referencing fire growth and the other success rate is measuring fire fatalities. Obviously, with two distinct and clearly separate principle measurements it is reasonable to conclude that data out of content or void of definition can lead to an inaccurate conclusion. Some results indicated that deaths occurred in buildings protected by fire sprinkler systems. "NFPA has no record of a fire

killing more than two people in a completely sprinklered…residential building where the system was properly maintained" (Puchovsky, 2003, p. 10-188). The data points out that even with an automatic fire sprinkler system lives can and will be lost.

With over 130 years of fire sprinkler system use in commercial occupancies and nearly 30 years of fire sprinkler system use in residential occupancies, the consensus on the effectiveness of fire sprinkler systems is not without its distracting data. Only positive data could have been chosen for inclusion into this research, and in fact, simply defining data as positive, neutral, or negative is a bias trend. There is data that suggests automatic fire sprinkler systems may not be the panacea the fire service often preaches. The data reviewed by this researcher is neither consistently or uniformly defined or applied making the objectivity of the fire protection and life safety cornerstone known as residential fire sprinklers a bit fractured and subject to debate.

The developmental history of the fire sprinkler system is a journey of over a century in the making. When Ronny Coleman wrote *Alpha to Omega* in 1985 he stated the following:

> It is entirely conceivable that twenty or thirty years in the future that a person would no more think of building a home without automatic fire sprinklers than they would of constructing that same edifice without electrical outlets and solar panels to provide electricity. The idea of built-in fire protection can justifiably be viewed as an idea whose time has come. (p. 47)

Although Coleman's prediction is not reality in the City of Laguna Beach, the genesis of mitigation began in 2003 with the first residential fire sprinkler mandate. The balance of this project will provide the data needed to estimate at what future date built-in residential fire protection will be a reality in the City of Laguna Beach.

Valuation

With valuation as a component of the City's residential fire sprinkler system it is important to understand how valuation is calculated. Laguna Beach City Ordinance 1429 has fire sprinkler requirements for additions, alterations, and repairs to single family dwellings (Group R Division 3 Occupancy) and for garages (Group U Division 1 Occupancy) that are attached to single family dwellings. The ordinance indicates that if additions, alterations, or repairs are made to an existing building of these occupancies that have a valuation of seventy-five percent or more prior to the additions, alterations, or repairs the entire building must be equipped with a fire sprinkler system.

The City's applied valuation for R3 occupancies (i.e., existing dwelling and/or additions) is $160.00 per square foot, and for U1 occupancies is $34.25 per square foot. Interior remodels of R3 occupancies are valued at $115.00 per square foot. Examples one and two are sample calculations for sprinkler requirements for additions and repairs to existing homes.

Example One:

Assumes an existing 2,000 square foot home with attached 400 square foot garage, and the homeowner proposes to add 1,000 square feet of area to the house and remodel 1,000 square feet of the house.

Existing valuation:	(2,000)($160)	=	$320,000
	(400)($34.25)	=	13,700
	Total		$333,700
Valuation proposed:	(1,000)($160)	=	$160,000
	(1,000)($115)	=	$115,000
	Total		$275,000

(0.75)($333,700) = $250,275 and $275,000>$250,275: Therefore, the entire single family dwelling and attached garage must be equipped with an automatic fire sprinkler system.

Example Two:

Existing 1,500 square foot home with attached 300 square foot garage. Assume that 750 square feet of the home and 300 square feet of the garage were destroyed by fire, and twenty-five percent of the house was substantially damaged but not destroyed. The homeowner proposes to rebuild and repair the house and garage to its original area.

Existing valuation:	(1,500)($160)	=	$240,000
	(300)($34.25)	=	10,275
	Total		$250,275
Valuation proposed:	(750)($160)	=	$120,000
	(300)($34.25)	=	10,275
	(375)($115)	=	43,125
	Total		$173,400

(0.75)($250,275) = $187,706 and $173,400<$187,706: Therefore, a fire sprinkler system is not required.

Fire Sprinkler Installation – United States

Data sources provide only estimates on percent of homes protected with residential fire sprinkler systems. One common theme behind the estimates is the concern for the accuracy and consistency of data input. Most national fire statistics are the outcome of fire service data and the information is provided independently from fire departments throughout the nation. In most cases the source of the data is from the National Fire Incident Reporting System (NFIRS). Albeit the trend is standardized data, the literature often provides qualifiers as to the reliability of

the data. Most references estimate the number of one-and two-family dwellings equipped with an automatic fire sprinkler system is approximately three percent. Two examples of the estimates are as follows: "Residential sprinkler systems for one- and two-family dwellings are reported in only 3.4% of the fires in those properties" (Rohr, 2003, p. 3). "Although residential sprinkler installations are increasing, it is estimated that less than 3 percent of the one- and two-family homes in the United States have them installed" (Madrzykowski & Fleming, 2003, p, 10-247). The first example is the result of data obtained from NFIRS data secondary to fire responses.

Vancouver, British Columbia

In 1990, the City of Vancouver, British Columbia, adopted an ordinance that required all new one- and two-family dwellings to be equipped with an automatic fire sprinkler system. By 1997 it was estimated that 24 percent of the City's housing stock were equipped with a residential fire sprinkler system. The City had a 90 percent reduction in its annual fire losses and attributed the reduction to the installation of residential fire sprinkler systems (Fleming, 2000, p. 22). The genesis for the fire sprinkler ordinance in Vancouver was in part a response to the Vancouver Fire and Rescue Service (VFRS) fire death rates remaining unchanged in spite of having a standard six minute response time. "In Canada, the Vancouver Fire and Rescue Service was unable to stop or reduce the number of annual fire deaths in its area, despite having 6 minute standard response time, in line with NFPA 1710" (Pamplin, 2007, p. 39).

Orange County, California Grand Jury

The members of the Orange County, California, Grand Jury met to discuss residential fire sprinkler use in the jurisdictions they serve. After reviewing information obtained from staff reports, videos, site visits, interviews, and public comments, the members of the Grand Jury

made a formal recommendation in support of requiring residential fire sprinkler systems in the areas covered by the Grand Jury's sphere of influence. The Grand Jury report indicated the recommendations were based on a number of benefits associated with residential fire sprinklers. Specifically, the report focused on two primary issues (a) a reduction in the number of injuries and deaths from residential fires and (b) a reduction in property loss from residential fires. The study provided fire loss statistics from 1999 that demonstrated "the average residential fire loss is 60% less with sprinklers than without" (Sprinkler Age, 2001, p. 21). The report recommended adopting an ordinance aimed at residential remodels. It was recommended that residential fire sprinkler systems be required when the remodel is 50% or more of the existing floor area.

The Orange County Fire Authority (OCFA) provides fire services to 22 cities and the unincorporated regions of Orange County, California. Each jurisdiction that contracts with the OCFA has the ability to incorporate local fire code amendments. One of the unincorporated jurisdictions is the community of Emerald Bay. The community of Emerald Bay is surrounded by the City of Laguna Beach, and the Laguna Beach Fire Department provides the bulk of fire service to the 524 single family residences located in Emerald Bay. The Orange County Fire Authority requires unincorporated areas to have a 5,500 square threshold for the installation of residential fire sprinkler systems in new homes; however, Emerald Bay is located in an area designated as Very High Fire Hazard Severity Zone (VHFHSZ). The Orange County Fire Authority has a local amendment that states: "All new construction and reconstructed structures located in Special Fire Protection Area/Very High Fire Hazard Severity Zones shall be equipped with an approved automatic fire sprinkler system" (Orange County Fire Authority, 2002, p. 51). Thus all new homes in Emerald Bay are equipped with residential fire sprinkler systems.

Table 1 outlines the square foot threshold for requiring a residential fire sprinkler system in a Group R Division 3 Occupancy (Orange County Fire Authority, 2002, p. 12).

Table 1:

Building Area Exempt Amounts

City	Square feet
Aliso Viejo	5,500
Buena Park	3,600
Cypress	3,600
Dana Point	0
Irvine	5,500
La Palma	5,500
Laguna Hills	5,500
Laguna Niguel	5,500
Laguna Woods	5,500
Lake Forest	5,500
Los Alamitos	5,500
Mission Viejo	5,500
Placentia	0
Rancho Santa Margarita	5,500
San Clemente	0
San Juan Capistrano	5,500
Seal Beach	5,500
Stanton	0
Tustin	5,500
Villa Park	5,500
Westminster	5,500
Yorba Linda	5,500
Unincorporated Orange County	5,500

Scottsdale, Arizona

The City of Scottsdale, Arizona implemented a residential fire sprinkler ordinance on January 1, 1986, and produced an historical document titled *Saving Lives, Saving Money Automatic Sprinklers a 10 Year Study*. The study notes that when Scottsdale reaches its full growth potential, 65 percent of the residential homes will be protected with an automatic fire sprinkler system (Ford, 1997, p. 4). Although 65 percent far exceeds the national average of two percent, the comparative time value is difficult to extrapolate based on the use of the non-definitive conjunction--when. However, the study does provide very definitive numbers of protected homes. Of the 57,301 single family residential units in Scottsdale, 19,649 (35%) were protected with residential fire sprinkler systems (Ford, 1997, p. 31). Based on National Fire Protection Association (NFPA) statistics, Scottsdale's 35% figure is in-line with other fast-growing communities with comprehensive residential fire sprinkler requirements that have a range of installation rates of 30 to 40 percent (Fleming, 2000, p. 89).

The Scottsdale study indicates that all new residential occupancies of more than zero (0) square feet shall be equipped with an automatic fire sprinkler system. Additionally, all residential occupancies, when additions, alterations, and repairs exceed twenty-five percent of the existing structure, then an automatic fire sprinkler system shall be installed throughout the entire building (Ford, 1997, p. A-14). The City also provided broader infrastructure design alternatives to encourage builders to embrace the concept of fire sprinkler systems. Examples of design freedoms included the following: reduced fire flow requirements, reduced street widths, and increased fire hydrant spacing. Additionally, the study suggested that the sprinkler ordinance could lead to the elimination of three fire stations. The *Study* indicated the City of Scottsdale had nine fire stations in 1985. In 2007 the City was home to thirteen fire stations.

The researcher could not locate documentation or verification that indicated fire stations had been eliminated as a result of the fire sprinkler ordinance.

The study does not directly address the nexus between saturation levels of residential fire sprinkler systems and fire department resource allocation; however, the reader can infer it was a consideration based on the study's review of prevention and response. The author provides the following question: "Can the fire service afford to concentrate the available resources on activities that continually make up a smaller percentage of the request for emergency service?" (Ford, 1997, p. 28). At the pace of fire sprinkler installations in the City of Scottsdale, it is possible that the Scottsdale Fire Department will have the unique opportunity to shift priorities away from fire response. Based on the massive commitment from the International Association of Firefighters in establishing and shepherding NFPA 1710, it will be a legendary paradigm shift for the fire service and the communities they serve. Since labor remains intensely focused on the issues of wages, hours, and working conditions, it is difficult to believe that firefighters would lobby against residential fire sprinkler systems. However, studies have identified where "fire service personnel have testified against mandating the installation of residential sprinkler systems in new residences" (Milke, 2003, p. 3).

Residential fire sprinkler systems are not widely acknowledged on the political radar screens that exist in every community. However, it is possible that as residential fire sprinklers begin to provide enhanced fiscal flexibility along with enhanced life safety, the policy makers at all levels in government will value the benefits of fire sprinkler systems. With widespread acceptance of residential fire sprinkler systems, the fire service will begin a dawn of a new service delivery era, and it is interesting that fire sprinkler systems will serve as the catalyst for

setting a new course on a ship that has sailed the same fire response centered course for the last 200 years.

Another local aspect of the residential fire sprinkler debate deals with fire department response times. The Laguna Beach Fire Department has a policy that indicates it is the Department's goal to have the first fire engine on scene to a fire incident within five minutes of dispatch 90 percent of the time. Based on the Department's statistical data for 2005, the Department met that goal. This is important as the time to flashover is continually being reported in test burns at under five-minutes. For example, an article in *Sprinkler Age* compared two fire behavior models. In the first model the home was not equipped with a sprinkler system and the room of origin reached flashover in four minutes and eight seconds. In the second model the home was equipped with a fire sprinkler system and the sprinkler activated in 68 seconds and the tenability limits of smoke, heat, oxygen, and carbon monoxide never exceeded critical thresholds (Coughlin, 2000, p. 18).

National Residential Fire Sprinkler Initiative

In April of 2003, a group of fire protection representatives gathered to discuss strategies to increase the installation rates of residential fire sprinkler systems. The policy statement for the meeting was "The United States Fire Administration advocates the use of automatic fire sprinklers to save lives, reduce injuries, and protect property. Based on an identified history of success, this technology should be employed in all residential occupancies" (Milke, 2003, p. 1). The attendees developed four strategies that included: (a) advocating residential sprinkler systems in those occupancies the Federal government supports (e.g., college campus), (b) partial systems in high fire risk areas (e.g., kitchen), (c) provide technical support among partners, and (d) support research and development to advance residential fire sprinklers.

One purpose for a literature review is to examine existing data and its influence on shaping research. The historical data on the developmental phases of fire sprinkler systems is voluminous and requires filtering to limit the scope of reporting. From that aspect the data could be directly examined and compared with local findings. However, obtaining specific residential community fire sprinkler experiences proved more limiting, and ultimately the Scottsdale, Arizona report was cited and linked in nearly every historical residential fire sprinkler discussion. Thus, where one might expect to find a clear and consistent reporting pattern for residential fire sprinkler systems throughout the American experience, it was not this researcher's experience. The literature review did provide an underlying theme of data validity. In most cases, it appears the raw input data for most of the literature review citations originated from fire incident reports. Often, authors provided limiting explanations on the source and accuracy of the raw data. In short, national fire service data input is not without inconsistencies and inaccuracies. The resulting range of conclusions makes it difficult to hone a finite and piercingly clear message. Conversely, adding to the data pool may help to smooth the data and refine its conclusion.

Procedures

Prior to attending the course Leading Community Risk Reduction (LCRR) at the National Fire Academy this researcher had developed a draft problem statement and set of research questions. With the broad concept of residential fire sprinkler use in the City of Laguna Beach defined, it was important to obtain a significant sample size of City specific data. In 2001 the City purchased PTWin32™ software by Black Bear Systems and began electronically recording building permits. Thus, this researcher approached the City's Building Official with a request to query all building permits that identified the requirement for a fire sprinkler system. The query

was inclusive of the dates of January 1, 2001, through December 31, 2006. The raw data was provided in a Microsoft Excel spreadsheet format. As the focus of this project is specific to one unit detached residential structures, the data was refined by removing all commercial and multi-family units that had fire sprinkler permits. Additionally, seventeen permits were identified as being reissued permits. In all cases the original permits had expired requiring a reissue of the building permit to continue with the project. The seventeen reissued permits represented duplicate addresses and were removed from the data base.

The Building Department's address files are available to the public from 8:00 a.m. to 3:00 p.m. Monday through Friday. Address files cannot be removed from the Building Department and nothing can be removed from the files; however, City staff will make copies of any documents contained in the address file. Also, it is permissible to scan or photograph any documents in the file. The City's address files were an important resource in retrieving valuation calculation data.

While a student enrolled in LCRR at the National Fire Academy, this researcher had the opportunity to conduct focused research at the Learning Resource Center (LRC) on campus. Using the LRC online card catalog, a search was conducted using the term residential fire sprinkler systems. The initial search result was too large and required further refinement. To screen the volume into a more manageable size a date range of 2002 through 2007 was applied as a limiting qualifier. The search produced 58 records, and 31 selected records were obtained and either read in its entirety or scanned for application to the project. Of the 31 selected records all, or portions of, 18 articles, books, or journals were copied for further review, inclusion, and documentation.

The LCRR class proved to be an outstanding forum to discuss the efficacy of residential fire sprinkler systems. This was done in both group and individual environments. Of particular advantage was the opportunity to understand the breadth of political and economic environments that occur across the United States and Canada. Although there were no formal interviews, the informal and occasionally uninhibited responses served as an opportunity to explore the concepts, philosophies, and agendas held by other fire service professionals.

Part of the course material from LCRR was a CD-ROM by the United States Fire Administration titled *USFA Opportunities in Fire Prevention*. There were three documents that provided significant historical framework for this project. Although the documents were not significantly quoted in this report they provided a better understanding of the historical events that led to our nation's current level of fire prevention. The documents reviewed were *Report from the 1947 President's Conference on Fire Prevention*, *America Burning*, and *America Revisited*.

Another aspect of the research required the ability to determine the valuation of projects that were not captured by the query of fire sprinkler system permits. The goal was to review those residential remodel project's that fell outside the fire sprinkler requirement of seventy-five percent, and determine each projects percent of valuation. Located at the City's Building Department is a list of active building permits. The permits were available for review from 8:00 a.m. to 5:00 p.m. Monday through Friday. One hundred fifty seven permits were reviewed, and the permits that applied to residential fire sprinklers were identified through two permit headings: (a) new single family residential or (b) addition/remodel single family residential. From the 157 permits reviewed, 37 were identified for inclusion into the study. The scope of the permits represented a 89 day period from February 1, 2007 through April 30, 2007.

The next phase of the project required that a valuation of the remodel project be established. For every remodel project submitted to the City the applicant must submit a valuation worksheet (see Appendix A for an example). This worksheet establishes the valuation of the project, and it is from this worksheet that the determination for the seventy-five percent threshold is established, and the need for residential fire sprinklers is determined. Every worksheet is evaluated by City staff for accuracy in compliance and computation. Armed with the 37 building permits, the City's address files were searched to locate the valuation worksheet.

A valuation worksheet could not be located for 19 of the permits. When a worksheet could not be found, the researcher examined the submitted and approved architectural plans. The information needed to complete the valuation worksheet was identified on all of the 19 plans reviewed. The data from the plans was transferred to the worksheet, and the final calculations provided the opportunity to compute the percentage of valuation for all of the submitted projects. The building site plans for all active building permits are available for public review and available upon request at the City's Building Department.

Once a valuation was matched to a building permit the information was entered into a spreadsheet for display. Once the spreadsheet was completed the sorting of data by percent of valuation was performed. Ultimately, four classes of valuation were established: (a) ≥75% valuation, (b) ≥50% to <75% valuation, (c) ≥25% to <50% valuation, and (d) <25% valuation.

Phone calls were also made to a number of individuals in an attempt to locate documents and ask for guidance on certain aspects of the project. The researcher was having difficulty finding data that documented findings that resulted from the implementation of a residential fire sprinkler ordinance. In an attempt to explore opportunities to obtain data the researcher called Retired Fire Chief, Ronny J. Coleman. The phone conversation occurred on February 22, 2007.

Chief Coleman directed the researcher to Steve Hart. Mr. Hart was contacted the same day, and he provided the researcher with the following reference documents: 2003 California Sprinkler Ordinance Survey (0-square footage), 2003 California Sprinkler Ordinance Survey (Executive Summary), 2003 California Sprinkler Ordinance Survey (Residential Summary), and 2003 California Sprinkler Ordinance Survey (Questions 15b-Yes Response). The documents were reviewed for inclusion into the applied research project.

On March 8, 2007, the researcher contacted Jim Ford, Deputy Chief, with the Scottsdale Fire Department to inquire about a rumored 15 year residential fire sprinkler study. Chief Ford indicated the 15 study had not been finalized; however, Chief Ford provided the researcher with a PowerPoint presentation titled *15 Years of Built-in Automatic Sprinklers: The Scottsdale Experience*. The presentation included a slide that indicated as of January 1, 2006, 54% of the single family homes in Scottsdale, Arizona, were protected with an automatic fire sprinkler system (J. Ford, personal communication, April 21, 2007).

On March 28, 2007, the researcher called Fire Chief Jeffery Johnson from Tualatin Valley Fire & Rescue (TVFR) to inquire about the content of a journal article that referenced Chief Johnson and residential fire sprinklers. The article was titled *Planned Community to be 100% Protected by Automatic Sprinklers.* The article from January 2004, focused on requiring residential fire sprinklers throughout a planned community, Villebois, in Wilsonville, Oregon. The researcher was interested in obtaining data from the Villebois experience. The researcher never spoke with Chief Johnson but did speak and correspond with members of his staff including Katherine Stoller. No data was available from TVFR; however, the staff was very generous in sharing the history and empirical findings since the implementation of the plan. The conversational information was not included in this study.

On March 19, 2007, the researcher spoke with Tim Hawthorne from the National Fire Protection Association. The researcher needed clarification of the term dwelling unit. Mr. Hawthorne provided a detailed definition and clarified the source document to reference for the written definition (NFPA 13).

For the years 2001 through 2006 data was evaluated to establish the number of one unit detached residential structures that were identified in the building permit process to require the installation of residential fire sprinkler systems for structures that met the City's remodel threshold of seventy-five percent valuation.

There are three dates involved with the permit process. Each date symbolizes a significant event in the building process. In order of chronological progression, the first date of importance is the date the permit number is assigned (e.g., B07-343). The permit number always starts with the letter B which simply represents the permit was issued by the Building Department. The Laguna Beach Fire Department does not issue building permits. Immediately following the letter B are the last two digits of the year followed by a hyphen. The number sequence after the hyphen represents the sequential order of permits for the given calendar year. For example, B07-343 represents a building permit assigned in 2007 and it is the 343 permit initiated in 2007. The permit number is assigned to the project when the property owner first submits conceptual plans to the City's Zoning Department. This permit number is used as a tracking tool as the project works its way through the City's formal Design Review Board process. This can take 12 to 36 months depending on the scope and controversial nature of the proposed project.

Once a project has been approved by the Design Review Board the applicant can request a building permit to be issued. Thus, the second date of importance is the date that building

permit is issued. The issuance of the building permit may not occur in the same year the permit number was assigned, and the property owner cannot begin construction until the issuance of a building permit. For example, Building Permit number B03-881 entered the City system in May 2003, yet the building permit was not issued until March 2006. This lag time is important in data analysis as the data runs in the rears, and although permit numbers were entered into the City system beginning in 2001 the first building permits requiring residential fire sprinkler systems did not appear in the system until 2002.

The third date of importance is the date the permit is officially completed. The cornerstone for the completion of a building project is the permit is signed and closed by the City's Building Department. This requires that both a City building inspector and fire inspector provide a signature on the permit to indicate a final inspection has been completed and the permit is authorized to be completed. The permit is submitted to a member of the clerical staff at the Building Department who enters the data in the system and officially closes the permit. With the permit completed, the homeowner is issued a certificate of occupancy which is required before the utilities (e.g., electrical and gas) can be connected to the home. Therefore, the date the fire inspector signs and closes the building permit is an important milestone in the tracking of the project as it is the date the home's residential fire sprinkler system is officially completed.

It is important to keep the three dates (a) permit assigned, (b) permit issued, and (c) permit closed separated during the data analysis. For this report the date the permit was assigned was not used in the data analysis, yet it is provided to allow continuity of tracking and opportunities for future analysis. Both the date the permit was issued and the date the permit was closed were used to examine installation rates from two data sources.

Residential fire sprinkler plans are not always submitted with the original set of building plans. Often fire sprinkler plans are submitted at a later date and a separate building permit is issued. The permit is titled *Fire Protection*. This duplicate permit process provided an opportunity to track completed residential fire sprinkler permits. Based on the fact that the delayed plan submittal was a sporadic event, it was not a reliable basis to track data. Conversely, the City's system of issuing building permits was consistent and every building permit has a field to identify if a fire sprinkler system is required or is not required. This consistent and forced application proved more reliable in obtaining relevant data; therefore, the foundation of tracking data for this Applied Research Project is based on the issuance of a building permit. The issuance of a building permit does not guarantee the project will be completed. Another aspect used to track the rate of residential fire sprinkler installations was to tabulate the number of completed residential fire sprinkler permits.

Table 2 provides data for the calendar years 2001 through 2006 listing all single family residential units that had permits issued and required the installation of a residential fire sprinkler system (i.e., *NFPA 13D Sprinkler Systems in One-and Two-Family Dwellings and Manufactured Homes*). For the calendar year 2003 the data has been split in six month segments. This coincides with the implementation date of the residential fire sprinkler ordinance. Although the ordinance was passed on June 17, 2003, the first permit issued requiring a residential fire sprinkler system was issued after July 1, 2003.

Table 2 also demonstrates that residential fire sprinkler systems were required in single family residential units prior to the passage of the mandatory sprinkler ordinance. This was explained through the use of a provision in both the Uniform Building Code and the Uniform Fire Code that allows for alternate materials and methods (AM&M) to obtain equivalent

protection as defined in either of the prescriptive codes. In reviewing the 11 cases where alternate materials and methods were used the most commonly cited areas of non-compliance included inadequate defensible space, street width under twenty-feet, fire department access in excess of 150' and excessive street gradient. Residential fire sprinkler systems were proposed and accepted to mitigate the prescriptive requirement of the model codes. The City requires a fire protection engineer to formally review a mitigation plan for non-compliant requirements, and prior to the mandatory ordinance fire sprinkler systems were a commonly suggested code compliant equivalency.

Table 2:

2001-2006 Residential Fire Sprinkler Systems Required

Year	Type of Event	Total Fire Sprinkler Systems Required
2001	New Single Family Residence	none recorded
2001	Remodel Single Family Residence (≥75%)	none recorded
2002	New Single Family Residence	7
2002	Remodel Single Family Residence (≥75%)	0
2003[a]	New Single Family Residence	4
2003[a]	Remodel Single Family Residence (≥75%)	0
2003[b]	New Single Family Residence	6
2003[b]	Remodel Single Family Residence (≥75%)	6
2004	New Single Family Residence	39
2004	Remodel Single Family Residence (≥75%)	23
2005	New Single Family Residence	45
2005	Remodel Single Family Residence (≥75%)	24
2006	New Single Family Residence	49
2006	Remodel Single Family Residence (≥75%)	34

[a]Data from January 1, 2003 through June 30, 2003.

[b]Data from July 1, 2003 through December 31, 2003.

The data to support Table 2 is provided in the Appendices B-F. There were no residential fire sprinkler systems recorded in the system for 2001, and thus no data is listed in the Appendix. The data for the years 2002 through 2006 are referenced as follows: Appendix B: 2002

Residential Fire Sprinkler Data Sorted by Date Issued, Appendix C: 2003 Residential Fire Sprinkler Data Sorted by Date Issued, Appendix D: 2004 Residential Fire Sprinkler Data Sorted by Date Issued, Appendix E: 2005 Residential Fire Sprinkler Data Sorted by Date Issued, and Appendix F: 2006 Residential Fire Sprinkler Data Sorted by Date Issued.

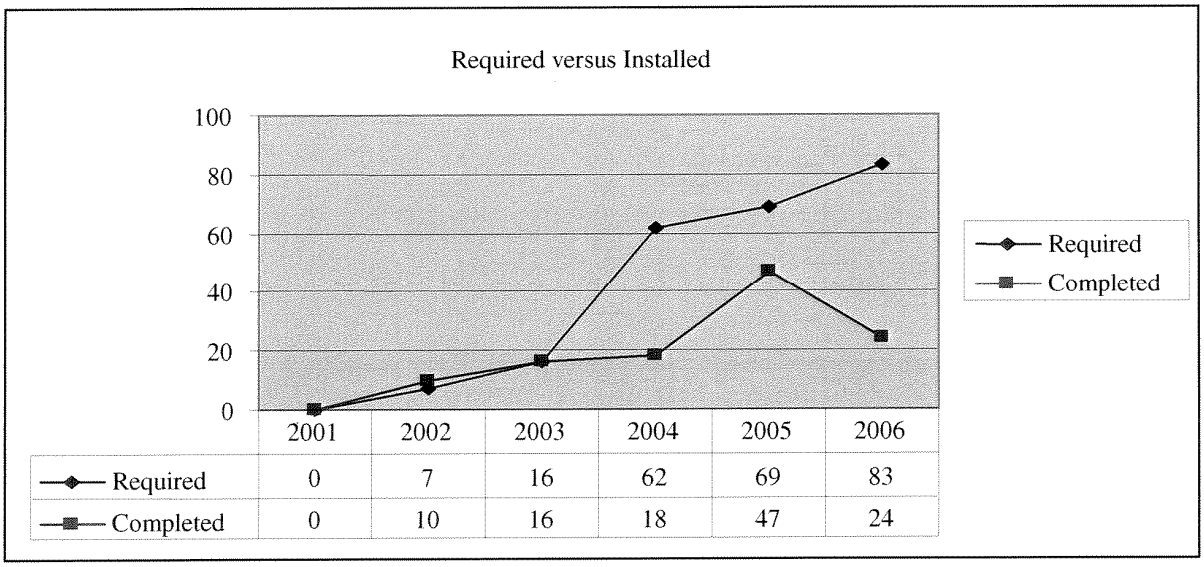
Table 3 provides the data necessary to compare the number of building permits assigned that required the installation of a residential fire sprinkler system to the number of residential fire sprinkler systems that were completed. The data collected represents a calendar year (i.e., January 1 through December 31). The permits completed were obtained through the Fire Department's permit tracking system. The Fire Department inspector logs all activities associated with an assigned building permit.

Table 3:

2001-2006 Comparison of Sprinkler Systems Required and Systems Completed

Year	Number of Fire Sprinkler Systems Required	Number of Fire Sprinkler Systems Completed
2001	None recorded	None Recorded
2002	7	10
2003	16	16
2004	62	18
2005	69	47
2006	83	24
Total	237	115

Figure 2 provides in graph form the comparison between the rate fire sprinkler systems were required per City permit, and the rate fire sprinkler systems were installed. An installed system represents a system that has successfully completed the final inspection and the home has been released for occupancy. The data showed a continual increase in the rate of fire sprinkler systems required; however, the installation rates demonstrated a peak in 2005. The cause for the spike in installations was not clearly identified.



	2001	2002	2003	2004	2005	2006
Required	0	7	16	62	69	83
Completed	0	10	16	18	47	24

Figure 2. 2001-2006 comparison between the rate fire sprinkler systems were required per City permit, and the rate fire sprinkler systems were installed.

In addition to the number of known fire sprinkler installations in single family residences the project also established the number of potential fire sprinkler installations based on differing thresholds. Two periods were selected for review. The first review was based a twelve-month period from July 1, 2003 through June 30, 2004 and the data is outlined in Table 4. The defined time period represents the first twelve months after instituting the mandatory residential fire sprinkler ordinance, and only applied to one unit detached residential structures.

Table 4:

Valuation Summary: July 1, 2003 through June 30, 2004

	Permits Issued	Percent of Total Permits Issued	Percent of Valuation	Fire Sprinkler System Required
	16	6%	≥75%	Yes
	49	18%	≥50%-<75%	No
	97	36%	≥25%-<50%	No
	108	40%	0%-<25%	No
Total	270	100%		

The second period evaluated was for the months of February, March, and April of 2007. The City's Building Department maintains a running three month file of active building permits. This file was available for the public to review. Reviewing the building permits provided the opportunity to establish two sets of requirements: (a) the requirement for a residential fire sprinkler system for a new single family residence, and (b) the requirement for residential fire sprinkler system based on a valuation threshold (≥75%). For the remainder of the permits the percent of valuation was established using valuation calculations obtained from the City's address file.

Table 5 is a summary of the data collected for the month of February 2007. The primary purpose of the data is to establish the percentage of permits issued compared to their percentage of building valuation.

Table 5:

Valuation Summary: February 2007

	Permits Issued	Percent of Total Permits Issued	Percent of Valuation	Fire Sprinkler System Required
	3	33.3%	≥75%	Yes
	0	0.0%	≥50%-<75%	No
	0	0.0%	≥25%-<50%	No
	6	66.6%	0%-<25%	No
Total	9	100.0%		

Table 6 is a summary of the data collected for the month of March 2007. The primary purpose of the data is to establish the percentage of permits issued compared to their percentage of building valuation.

Table 6:

Valuation Summary: March 2007

	Permits Issued	Percent of Total Permits Issued	Percent of Valuation	Fire Sprinkler System Required
	4	33.3%	≥75%	Yes
	1	8.3%	≥50%-<75%	No
	1	8.3%	≥25%-<50%	No
	6	50.0%	0%-<25%	No
Total	12	100.0%		

Table 7 is a summary of the data collected for the month of April 2007. The primary purpose of the data is to establish the percentage of permits issued compared to their percentage of building valuation.

Table 7:

Valuation Summary: April 2007

	Permits Issued	Percent of Total Permits Issued	Percent of Valuation	Fire Sprinkler System Required
	6	37.5%	≥75%	Yes
	2	12.5%	≥50%-<75%	No
	2	12.5%	≥25%-<50%	No
	6	37.5%	0%-<25%	No
Total	16	100.0%		

Table 8 is the cumulative total for all new residential building permits and all addition/remodel building permits issued from the period February 1, 2007, through April 30, 2007. The permits were delineated by number of permits issued, percentage of total permits issued, and percent of building valuation.

Table 8:

Combined Data for Review of Percent of Total Permits Issued: February-April 2007

	Permits Issued	Percent of Total Permits Issued	Percent of Valuation	Fire Sprinkler System Required
	13	35%	≥75%	Yes
	3	8%	≥50%-<75%	No
	3	8%	≥25%-<50%	No
	18	49%	0%-<25%	No
Total	37	100.0%		

Figure 3 represents in pie chart format the percentage each range of building valuation represents. Demonstrated is the 35 percent of the building permits during the period of February 1, 2007 through April 30, 2007, were required to be equipped with residential fire sprinkler systems in accordance with the City's ordinance. It also estimates future rates of installation if the City's ordinance was changed from its current 75 percent valuation threshold.

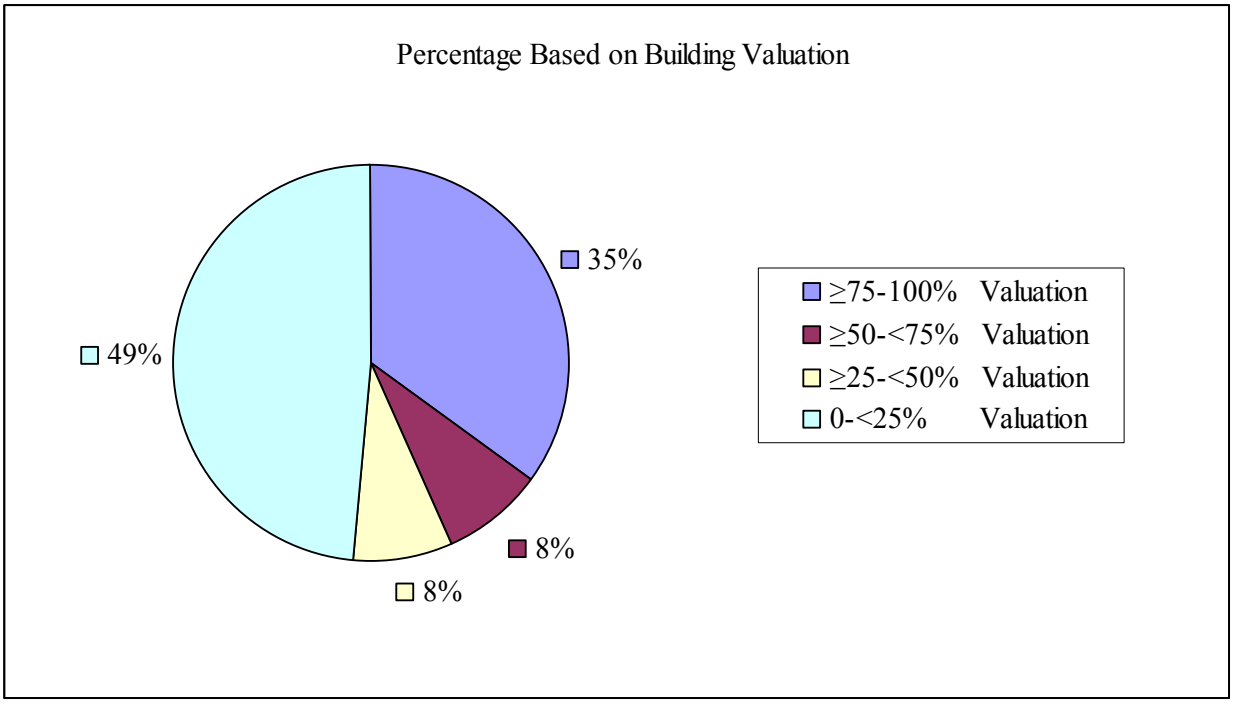


Figure 3. Percentage of total building permits based on projects percentage of building valuation for building permits issued by the City of Laguna Beach, California, for the period February 1, 2007 through April 30, 2007.

Table 9 is the cumulative total for all new residential building permits and all addition/remodel building permits issued from two separate time frames representing: July 1, 2003 through June 30, 2004, and February 1, 2007, through April 30, 2007. This timeframe represents 15 months or approximately 33% of the total timeframe reviewed (i.e., July 2003 through April 2007). The data was taken from two separate timeframes in an attempt to increase the data reliability. The permits were delineated by number of permits issued, percentage of total permits issued, and percent of building valuation.

Table 9:

Combined Data for Review of Percent of Total Permits Issued: 2003 and 2007

	Permits Issued	Percent of Total Permits Issued	Percent of Valuation	Fire Sprinkler System Required
	29	9.4%	≥75%	Yes
	52	17.0%	≥50%-<75%	No
	100	32.6%	≥25%-<50%	No
	126	41.0%	0%-<25%	No
Total	307	100.0%		

Figure 4 illustrates the estimated percentage of total permits issued based on three alternate valuation thresholds. The City's current residential fire sprinkler ordinance for an addition or alteration to a home is ≥75% valuation and represents approximately 9% of permits issued. Altering the valuation thresholds to 50-100% represents approximately 26% of permit issuance. Altering the valuation threshold to 25-100% valuation represents approximately 59% of permit issuance.

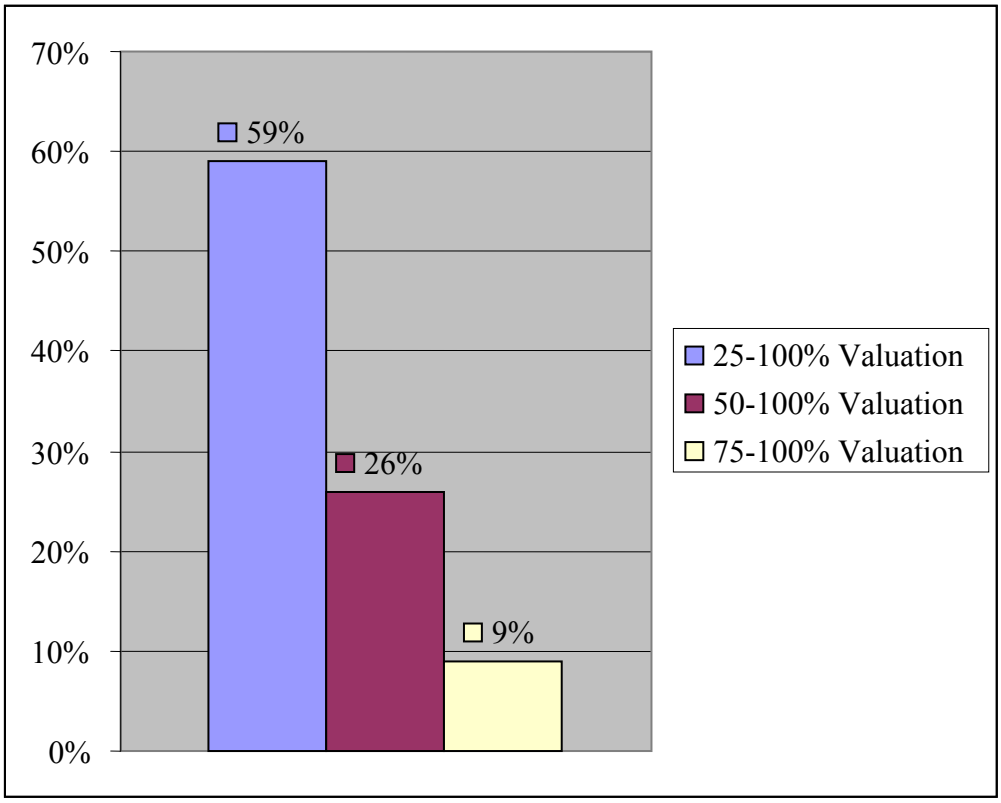


Figure 4. Percentage of building permits requiring residential fire sprinkler systems based on three ranges of valuation (a) 25-100%, (b) 50-100% valuation, and (c) 75-100% valuation.

Limitations of the Research

Certain limitations in the conduct of this study are recognized. In particular, the study was limited to the availability of public documents and the researcher's ability to retrieve archived information. Additionally, in the late 1970's the researcher worked for Fire Chief Ronny J. Coleman during the field testing and eventual incorporation of the residential fire sprinkler mandates established by the City of San Clemente in 1978. Having imprinted the value of residential fire sprinkler systems during that time, and having those beliefs validated from empirical field observations over the last 30 years the researcher must battle inherent and unintentional bias in order to provide a project that adheres to the rigors of accuracy and validity.

Definitions

The following terms were defined to clarify their use in the context of this study.

Dwelling

"Any building that contains not more than one or two dwelling units intended to be used, rented, leased, let, or hired out to be occupied or that are occupied for habitation purposes" (National Fire Protection Association [NFPA 13D], 2002b, p. 13D-6).

Dwelling Unit

"One or more rooms, arranged for the use of one or more individuals living together, as in a single housekeeping unit, normally having cooking, living, sanitary, and sleeping facilities" (National Fire Protection Association [NFPA 13D], 2002a, p. 13D-6).

Group R Division 3 Occupancy

"Dwellings and lodging units" (Uniform Building Code™, 1997, p. 1-30).

Group U Division 1 Occupancy

"Private garages, carports, sheds and agricultural buildings" (Uniform Building Code™, 1997, p. 1-31).

Results

Through evaluative research, data was collected and analyzed in an effort to evaluate the need to explore changes to the City's existing residential fire sprinkler ordinance or maintain the current trajectory towards the goal of enhanced fire and life safety through the use of residential fire sprinkler systems.

The first question that guided this research was: What effects have residential fire sprinkler systems had on community risk reduction for municipalities that are similar in size to Laguna Beach, California?

Albeit an outwardly and seemingly simplistic question the data needed to provide an answer proved difficult to obtain. There are numerous agencies that have residential fire sprinkler systems; however, few agencies have public data available. The City of Laguna Beach is an example of the broader findings. Although the City has a residential fire sprinkler ordinance the data is not systematically recorded or available to the public.

The data for national statistics places the installation rate of residential fire sprinkler systems in one-and two-family homes at less than three percent. The City of Laguna Beach has an estimated 7,987 one unit detached structures of which 115 have documented residential fire sprinkler systems. One hundred fifteen systems represent approximately 1.4 percent. An interesting point could be made that the City rate of installation is consistent with the national average of less than three percent; however, from evaluation of other data sources it appears three percent is a consistent reference. It is safe to assume that the City has more than 115 systems installed, yet without documentation it is difficult to estimate the total of residential fire sprinkler systems. Conversely, the number of systems required and likely to be installed is 237 or roughly three percent.

A few experiences from Vancouver, British Columbia parallel the City of Laguna Beach in its response times. The Vancouver Fire and Rescue Service met the six minute response time standard identified in the National Fire Protection Association (NFPA) 1710 standard, yet the annual fire deaths had not changed. The Laguna Beach Fire Department also meets the NFPA 1710 response time standard of six minutes and its fire statistics have not been appreciably altered. What is not similar among the agencies is the 90 percent reduction in annual fire losses noted by Vancouver. The difference could be attributed to the fact that Vancouver's has 24 percent of its housing stock equipped with a residential fire sprinkler system.

The Orange County, California, Grand Jury report indicated the average fire loss is 60 percent less with sprinklers than without. Laguna Beach has had only two documented residential fire sprinkler activations. The average reported loss (i.e., property and content) was $25,000. For 2005 the average reported loss (i.e., property and content) for one unit detached structures was $505,800. Data was derived from a query of *working fires* as defined by the following: all units responded code three, all units arrived on scene, and a dollar loss was reported. Additionally, the Orange County Grand Jury recommended residential fire sprinklers when the remodel is 50 percent or more of the existing floor area. Laguna Beach uses 75 percent of the building's valuation.

The Scottsdale, Arizona report indicated the national average for homes equipped with residential fire sprinkler system is two percent and the City of Scottsdale has 35 percent of their homes equipped with a fire sprinkler system. Scottsdale and Laguna Beach both have zero (0) square feet new construction ordinances, yet Scottsdale has a 25 percent threshold for additions, alterations, and repairs.

One aspect of the report that could have applicability to the City of Laguna Beach is the concept of localized fire suppression in high fire risk areas. Currently, NFPA 13D is considered to be a partial fire sprinkler system as the standard allows sprinkler heads to be eliminated from certain low risk components of the home such as attic spaces, small closets, and bathrooms. Therefore, if the data supports the concept that the bulk of residential fires start in the kitchen, then having only the kitchen area covered with a partial fire sprinkler system could enhance the life safety risk to the occupant. The authors even suggest that the systems be so simplistic that a property owner could pick up the materials at a local hardware store and install the sprinkler system in the home's kitchen.

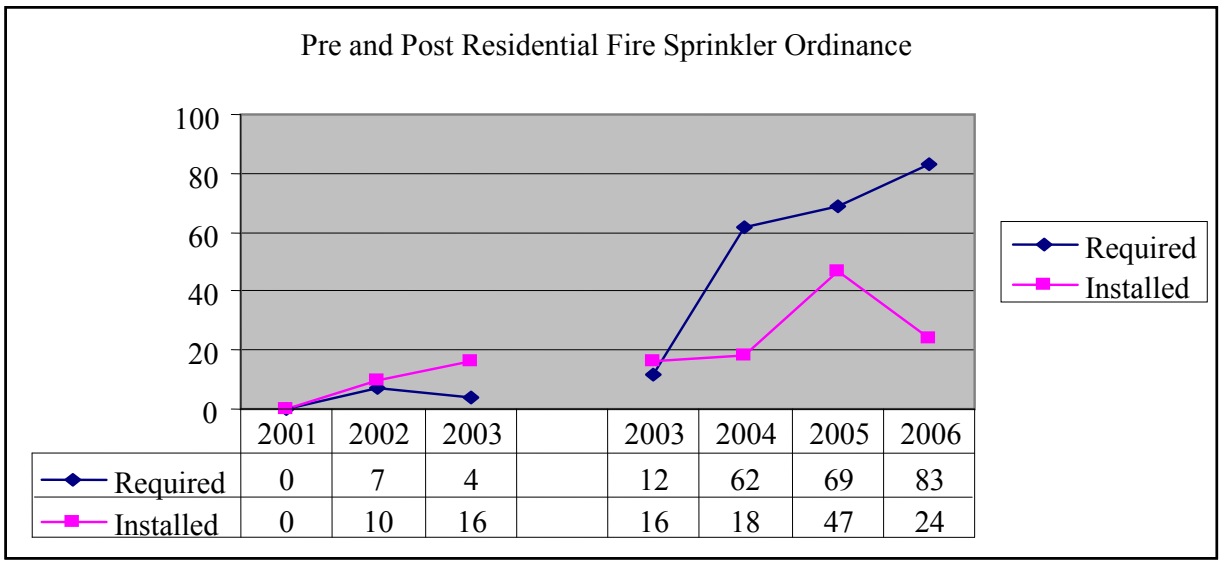
This research question identified the difficulty of comparing non-standardized data. Although the data was objectively reported, the slight difference in the data chosen makes rigid evaluation difficult. As an example when reviewing national statistics one author chose to evaluate homes involved in fires to obtain fire sprinkler installation rates, and the second author provides a statistic (3 percent); however, the origin of the data is not provided. In the end, the data is still useful in making comparative assumptions.

The second research question was: What effect did the promulgation of the residential fire sprinkler amendment have on the pace of installations in residential occupancies located in Laguna Beach, California?

This was reviewed in two formats: (a) annual average of residential fire sprinkler systems required and (b) annual average of residential fire sprinkler systems that were completed. The average for the number of fire sprinkler systems required for 2001 (0), 2002 (7), and the first six months of 2003 (4) is 4.4 (i.e., 11/2.5). Conversely, the average number of fire sprinkler systems installed in 2001 (0), 2002 (10) and the first six months of 2003 (4) is 5.6.

The average for the number of fire sprinkler systems required during July 1 through December 30, 2003 (12), 2004 (62), 2005 (69), and 2006 (83) is 64.6 (i.e., 226/3.5). The average number of fire sprinkler systems installed during July 1 through December 30, 2003 (12), 2004 (18), 2005 (47), and 2006 (24) is 28.9.

Figure 5 provides a comparison in graph form that illustrates the comparative rate of required residential fire sprinkler systems as compared to the rate of residential fire sprinkler systems installed. The gap between 2003 signifies the City's implementation date of its residential fire sprinkler ordinance, June 17, 2003.



	2001	2002	2003		2003	2004	2005	2006
Required	0	7	4		12	62	69	83
Installed	0	10	16		16	18	47	24

Figure 5. A comparison in graph form that illustrates the comparative rate of required residential fire sprinkler systems as compared to the rate of residential fire sprinkler systems installed.

The third research question was: What effect would altering the valuation threshold have on the pace of installing residential fire sprinkler systems, in the City of Laguna Beach, California? Prior to reviewing the answer to the question it is important to reiterate the assumptions that the data is limited and the pace of building construction during the review period is unlikely to be replicated over the next five year period.

For calculating future projections the most conservative estimates from the project's findings was used. Table 10 is the result of projecting the combined data for permits issued in 2003 and 2007 and projecting it over thirty years. The purpose for selecting thirty years as a time frame was that it represents the current span of a firefighter's career as determined by the maximum accrual pension benefit as defined in the California Public Employees Retirement System (i.e., 3% at age 50 formula). The rate of residential fire sprinkler requirements based on permits issued and delineated by percentage of building valuation per year is 24 (75-100%), 65

(50-100%), and 144 (25-100%). Table 10 projects those findings in 5 year increments for a 30 year period. The estimates have included the 115 residential fire sprinkler systems already in place before 2007, and there are 7,987 residential units in the City of Laguna Beach.

Table 10:

30-Year Projections of Residential Fire Sprinkler Systems Based on Permits Issued

Valuation	2006	2007	2012	2017	2022	2027	2032	2037
75-100%	115	139	259	379	499	619	739	859
50-100%	115	180	505	830	1,155	1,480	1,805	2,130
25-100%	115	259	979	1,699	2,419	3,139	3,859	4,579

Figure 6 list the data in graph format and demonstrates the rate of installation based on fire sprinkler requirements that are based on varying building valuation thresholds.

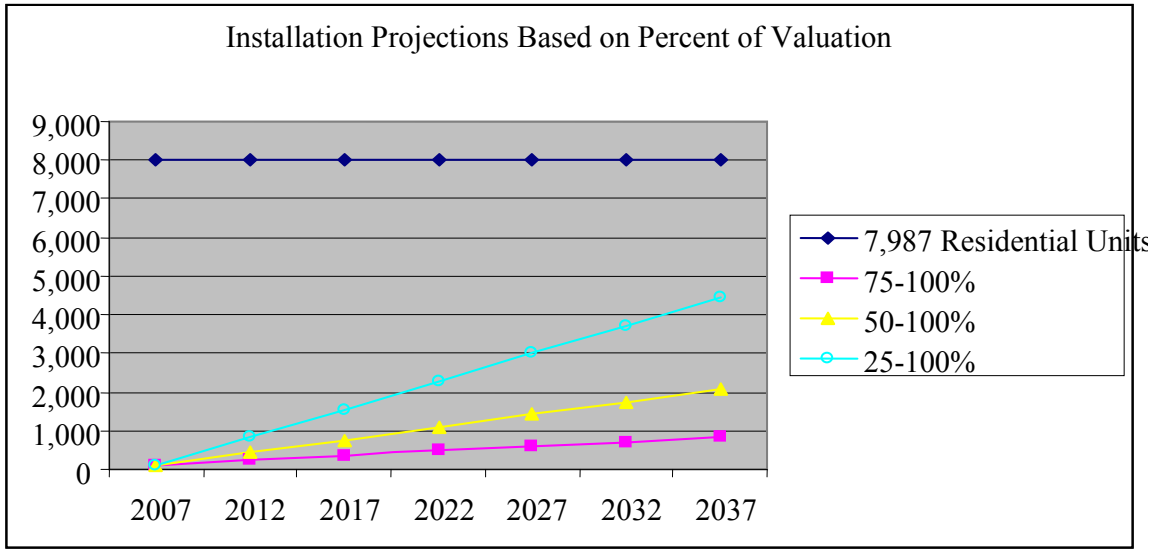


Figure 6. Provides estimated projection rates for the requirement of residential fire sprinkler systems based on percent of building valuation.

In its most exposed and simplified content, the results of evaluative research should assist in decision making. The findings have provided some clarity, yet only half of the story has been told. Perhaps analogous to having a Global Positioning System (GPS) that has mapped one's starting point and one's current location. It could be critical information, yet without a defined destination the information is of limited immediate value. Herein lies the difficulty of extrapolating that nugget of information that maps the path. Thus, as the recommendations will delineate part two of this journey is defining that tipping point of where the saturation levels of residential fire sprinkler systems in the City of Laguna Beach is at a level to allow the tinkering of resource allocation away from a suppression centered delivery system.

Discussion

A starting point for discussion is How did the results of the Applied Research Project compare to results from the literature review and interviews? In short, it is a lot of print on a lot of pages that painfully converts an empirically driven reality to a data analysis driven reality. At the City's current pace, the researcher would have to live another 327 years before one-hundred percent of the City's housing stock was protected by an automatic fire sprinkler system. However, while in the midst of writing this ARP the City of Laguna Beach had its first success story associated with a residential fire sprinkler system. On Saturday, April 7, 2007, a single engine was dispatched to a public assist to investigate a small residential fire that had already been extinguished. When the crew arrived they found a home under construction that was weeks away from receiving a final inspection following a two year remodel of a 3,500 square foot home. Upon further investigation the firefighters noted a residential fire sprinkler had activated and controlled a fire whose origin was traced to a pile of rags that were left piled in a cardboard box by the painting contractors. The contractors had spent the previous day wood staining the

kitchen cabinets and had left stain laden rags in a cardboard box that sat on a construction table in the home's living room. The home was valued at over four-million dollars, and based on the home's fire loading, lack of early fire department notification (i.e., home not occupied and no electrical power), time of the fire (early morning), and no compartmentalization (i.e., the interior doors were open) the home would have sustained significant fire and smoke damage if the fire was not controlled and extinguished by the residential fire sprinkler system. So, on April 7, 2007, this researcher reflected on the dichotomy of the situation. One aspect was euphoric knowing that the sprinkler system worked as designed and no firefighters or civilians were injured or killed. Another aspect was frustration knowing that thirty years before the lump of rags caught fire in the living room of the home located at 31512 Bluff Drive, the researcher had witnessed the genesis of the first residential fire sprinkler systems. Its historical location, the City of San Clemente, is located ten miles from the Bluff Drive incident. This researcher continually struggles to understand why residential fire sprinklers have drifted in the doldrums. The Applied Research Project has provided some results and it is important to understand the implications of those results as they apply to the Laguna Beach Fire Department.

Recommendations

It is at this point in the evaluative research process where the restless turn for the immediate answer, yet as the ancient Taoist proverb states, A journey of 10,000 miles begins with a single step. There are no immediate solutions in the recommendations and the suggestions have been postulated in one iteration or another for over twenty years. In 1985, Ronny J. Coleman wrote: "It is entirely conceivable that twenty or thirty years in the future that a person would no more think of building a home without automatic fire sprinklers than they would of constructing that same edifice without electrical outlets…" (Coleman, 1985, p. 47).

This researcher shares Coleman's optimism, yet having the luxury of hindsight it is recognized that the journey is more arduous and time consuming than its forbearers projected. However, the visionary journey of residential fire and life safety becomes less myopic with the installation of every new residential fire sprinkler system. In that vain of optimism the research has provided opportunities to suggest recommendations.

1. In an attempt to enhance the installation rate of residential fire sprinkler systems in the City of Laguna Beach it is proposed that the City reduce its valuation threshold to twenty-five percent.
2. Further analysis should be conducted on the efficacy of a significantly lower threshold when other infrastructures or operational components are present (e.g., wildland urban interface, prolonged response times, and limited access).
3. Further analysis is required to establish local trade offs that encourage the use of residential fire sprinkler systems in scenarios where the valuation threshold is less than the valuation mandate.
4. The Laguna Beach Fire Department should research the opportunity to shift its focus on fire suppression to one of community risk reduction. This evaluation should include a review of alternate staffing models that allow the Department the opportunity to enhance its efforts in the preventative arena of engineering and education.
5. The Laguna Beach Fire Department should develop a tracking program that will allow for the collection of statistical data to track the communities experience with residential fire sprinkler systems.
6. A component of this report is an address list of all existing single family residences located in Laguna Beach that are equipped with a residential fire sprinkler system.

Letters could be sent to the individual home addresses offering the homeowner the opportunity to meet with a fire department representative who could explain the theoretical and operational components of their home's residential fire sprinkler system.

7. The LCRR curriculum focused on leadership credibility. Thus this researcher should commit to retrofitting his primary residence with an automatic fire sprinkler system.
8. It is recommended that this information be shared with members of the Laguna Beach Fire Department for their own analysis and subsequent recommendations.

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Appendix A: Valuation Worksheet

Laguna Beach Building Division
Worksheet for Determination of Sprinkler Requirements for Additions
(Single Family Residence - R3 Occupancies)

Project Address: 31512 Bluff Drive Date: May 05, 2007

Existing

	Area	Value per Square Foot	Valuation
Dwelling/Main	2,230.00	$160.00	$356,800.00
Garage	290.00	$34.25	$9,932.50
Decks	-	$34.25	-
Total			$366,732.50

Proposed

	Area	Value per Square Foot	Valuation
Addition	1,266.00	$160.00	$202,560.00
Remodel	2,058.00	$115.00	$236,670.00
Garage	410.00	$34.25	$14,042.50
Decks	425.00	$34.25	$14,556.25
Total			$467,828.75

Proposed Total Area	3,496 Square Feet
Proposed Number of Stories	2.00
Is Existing Building Sprinklered	No

Sprinklers required for entire building ≥75% Valuation

Appendix B: 2002 Residential Fire Sprinkler Data Sorted by Date Issued

Number	Permit Number	Parcel Number	Project Address	Date Issued	Purpose
1	B02-371	644-291-53	2170 Crestview Drive	04/17/2002	New SF Residential
2	B02-522	644-244-21	1047 Summit Way	04/30/2002	New SF Residential
3	B02-535	644-302-15	856 Diamond Street	08/15/2002	New SF Residential
4	B02-165	641-421-38	2073 Hidden Valley Canyon Road	09/09/2002	New SF Residential
5	B02-267	641-421-37	2092 Hidden Valley Canyon Road	09/09/2002	New SF Residential
6	B02-501	641-211-16	1227 Fairywood Walk	09/16/2002	New SF Residential
7	B02-2391	644-291-93	785 Gainsborough Drive	12/27/2002	New SF Residential

Appendix C: 2003 Residential Fire Sprinkler Data Sorted by Date Issued

Number	Permit Number	Parcel Number	Project Address	Date Issued	Purpose
1	B03-198	644-291-75	777 Gainsborough Drive	01/29/2003	New SF Residential
2	B02-612	496-201-20	2485 Irvine Cove Circle	03/28/2003	New SF Residential
3	B02-352	644-244-11	921 Summit Way	04/22/2003	New SF Residential
4	B02-338	644-293-29	2220 Crestview Place	05/27/2003	New SF Residential
		June 17, 2003: Implementation of the residential fire sprinkler ordinance			
5	B02-862	644-291-89	2306 Crestview Drive	09/17/2003	New SF Residential
6	B03-951	644-304-09	719 Gainsborough Way	11/03/2003	New SF Residential
7	B02-438	644-291-26	740 Gainsborough Way	11/10/2003	New SF Residential
8	B03-261	644-093-02	611 Thalia Street	12/02/2003	New SF Residential
9	B02-2381	641-103-10	1645 Tahiti Avenue	12/08/2003	New SF Residential
10	B03-2102	644-291-87	2330 Crestview Drive	12/10/2003	New SF Residential
11	B02-1132	644-421-08	1049 Baja Street	09/30/2003	Remodel SF Residential
12	B03-1828	496-152-05	451 Hawthorne Road	10/08/2003	Remodel SF Residential
13	B03-361	056-152-31	32036 Sunset Avenue	10/30/2003	Remodel SF Residential
14	B02-2420	644-437-15	1025 Capistrano Avenue	11/10/2003	Remodel SF Residential
15	B02-74	644-235-08	742 Summit Drive	11/14/2003	Remodel SF Residential
16	B02-805	056-172-06	88 North La Senda Drive	12/19/2003	Remodel SF Residential

Appendix D: 2004 Residential Fire Sprinkler Data Sorted by Date Issued

Number	Permit Number	Parcel Number	Project Address	Date Issued	Purpose
1	B03-2435	641-491-06	1360 Moorea Way	01/28/2004	New SF Residential
2	B03-134	056-143-01	32002 Coast Highway	02/06/2004	New SF Residential
3	B02-1485	644-424-05	935 Capistrano Avenue	02/12/2004	New SF Residential
4	B03-1560	496-171-16	420 Linden Street	02/27/2004	New SF Residential
5	B02-2237	641-421-26	2355 Hillview Drive	03/01/2004	New SF Residential
6	B02-2137	641-311-04	1330 Coronado Drive	03/04/2004	New SF Residential
7	B03-1268	644-182-08	1109 Canyon View Drive	03/16/2004	New SF Residential
8	B02-541	644-291-36	2345 Crestview Drive	03/23/2004	New SF Residential
9	B02-1839	644-123-14	872 Wendt Terrace	03/26/2004	New SF Residential
10	B03-798	656-053-30	758 Bolsana Way	04/02/2004	New SF Residential
11	B03-1837	644-291-88	2320 Crestview Drive	04/23/2004	New SF Residential
12	B02-1649	496-162-29	489 Aster Street	05/26/2004	New SF Residential
13	B03-146	644-291-20	2318 Crestview Drive	06/04/2004	New SF Residential
14	B03-1722	053-162-17	847 Cliff Drive	06/09/2004	New SF Residential
15	B02-1036	644-352-03	1279 Bluebird Canyon Road	06/16/2004	New SF Residential
16	B02-811	656-062-29	591 Balboa Avenue	06/29/2004	New SF Residential
17	B03-888	644-304-06	707 Gainsborough Way	06/30/2004	New SF Residential
18	B02-2553	641-181-58	274 Canyon Acres Drive	07/06/2004	New SF Residential
19	B01-1800	641-091-08	1524 Caribbean Way	07/07/2004	New SF Residential
20	B03-492	641-373-10	533 Temple Hills Drive	07/15/2004	New SF Residential
21	B03-2162	496-191-26	110 Irvine Cove Court	08/03/2004	New SF Residential
22	B02-146	641-401-22	1845 Rimrock Canyon Road	08/20/2004	New SF Residential
23	B02-1956	056-152-32	39 North Stonington Road	08/25/2004	New SF Residential
24	B02-1553	641-222-34	1225 Victory Walk	08/30/2004	New SF Residential
25	B01-2310	056-180-10	10 S La Senda Drive	09/08/2004	New SF Residential
26	B03-1079	656-105-18	261 Highland Road	09/16/2004	New SF Residential
27	B03-1712	056-020-03	31161 Monterey Street	10/12/2004	New SF Residential
28	B03-1656	656-151-90	170 Dumond Drive	10/19/2004	New SF Residential
29	B03-80	641-181-27	140 Canyon Acres Drive	11/09/2004	New SF Residential
30	B01-2159	644-303-13	841 Diamond Street	11/15/2004	New SF Residential
31	B04-96	656-441-07	23 Shreve Drive	11/29/2004	New SF Residential
32	B02-1265	644-291-33	2329 Crestview Drive	12/01/2004	New SF Residential
33	B03-93	656-151-45	2713 Victoria Drive	12/06/2004	New SF Residential
34	B02-1098	644-291-81	782 Gainsborough Way	12/08/2004	New SF Residential
35	B01-2412	644-291-80	710 Gainsborough Way	12/13/2004	New SF Residential
36	B03-1068	644-304-23	720 Gainsborough Way	12/13/2004	New SF Residential
37	B03-828	656-151-90	174 Dumond Drive	12/14/2004	New SF Residential
38	B02-2527	056-092-38	22401 Third Street	12/15/2004	New SF Residential
39	B03-687	656-169-13	468 Ashton Drive	10/25/2004	New SF Residential
40	B03-1341	056-051-67	31332 Holly Drive	01/08/2004	Remodel SF Residential
41	B02-2046	641-062-11	3009 Zell Drive	01/22/2004	Remodel SF Residential
42	B03-383	641-033-27	3108 Tyrol Drive	01/27/2004	Remodel SF Residential
43	B02-2293	641-471-01	1388 Pacific Way	03/04/2004	Remodel SF Residential
44	B03-2185	053-112-22	445 Dartmoor Street	03/08/2004	Remodel SF Residential
45	B03-1782	641-061-01	2586 Temple Hills Drive	03/25/2004	Remodel SF Residential
46	B04-398	656-131-01	2280 Inez Street	04/01/2004	Remodel SF Residential
47	B02-2401	644-191-05	479 Oak Street	04/14/2004	Remodel SF Residential
48	B02-2010	120-561-25	2633 Riviera Drive	06/01/2004	Remodel SF Residential
49	B03-713	644-131-16	1439 Temple Hills Drive	06/11/2004	Remodel SF Residential
50	B02-2470	056-223-17	13 North Stonington Road	06/16/2004	Remodel SF Residential
51	B03-87	496-131-16	206 Grandview Street	06/30/2004	Remodel SF Residential
52	B03-1313	053-112-53	309 Dartmoor Street	07/13/2004	Remodel SF Residential
53	B03-508	644-098-03	631 Anita Street	07/14/2004	Remodel SF Residential
54	B03-1516	644-192-15	543 Brooks Street	09/14/2004	Remodel SF Residential
55	B02-2611	056-203-43	5 S La Senda Drive	10/18/2004	Remodel SF Residential
56	B03-253	644-265-13	337 Bluebird Canyon Drive	11/01/2004	Remodel SF Residential
57	B04-282	644-093-23	652 Seaview Street	11/12/2004	Remodel SF Residential
58	B03-2227	641-272-58	471 Blumont Street	11/19/2004	Remodel SF Residential
59	B04-2465	056-094-25	31642 Scenic Drive	11/24/2004	Remodel SF Residential
60	B03-1241	644-081-05	939 Catalina	12/08/2004	Remodel SF Residential
61	B04-2595	053-111-10	325 Camden Place	12/17/2004	Remodel SF Residential
62	B04-2652	496-155-24	452 Holly Street	12/23/2004	Remodel SF Residential

Appendix E: 2005 Residential Fire Sprinkler Data Sorted by Date Issued

Number	Permit Number	Parcel Number	Project Address	Date Issued	Purpose
1	B01-2169	644-291-76	775 Gainsborough Drive	01/03/2005	New SF Residential
2	B03-1369	644-265-02	1651 Catalina	01/11/2005	New SF Residential
3	B03-2322	644-191-21	645 Oak Street	01/11/2005	New SF Residential
4	B03-1285	656-201-25	30731 Driftwood Drive	01/12/2005	New SF Residential
5	B03-209	670-241-15	96 Vista Del Sol	02/03/2005	New SF Residential
6	B03-1662	056-153-31	32172 Coast Highway	02/14/2005	New SF Residential
7	B03-530	641-191-27	386 Canyon Acres Drive	02/16/2005	New SF Residential
8	B03-914	644-192-35	480 Cress Street	02/18/2005	New SF Residential
9	B03-1219	641-352-32	835 La Vista Drive	03/03/2005	New SF Residential
10	B02-407	056-153-24	34 North Stonington Road	03/09/2005	New SF Residential
11	B04-222	053-112-27	505 Dartmoor Street	03/16/2005	New SF Residential
12	B01-2232	644-123-40	645 Temple Hills Drive	04/14/2005	New SF Residential
13	B04-2038	641-272-27	450 Blumont Street	04/29/2005	New SF Residential
14	B03-1247	644-278-13	2049 Ocean Way	05/03/2005	New SF Residential
15	B03-2488	641-461-08	3335 Alta Laguna Boulevard	05/09/2005	New SF Residential
16	B02-1964	644-141-01	1339 Dunning Drive	05/20/2005	New SF Residential
17	B04-1318	644-203-12	1358 Carmelita Street	05/25/2005	New SF Residential
18	B03-124	641-171-08	338 Lewis Lane	05/26/2005	New SF Residential
19	B03-894	641-491-07	1370 Moorea Way	06/01/2005	New SF Residential
20	B01-2298	656-101-02	283 Upland Road	06/20/2005	New SF Residential
21	B03-499	656-053-29	744 Barracuda Way	06/22/2005	New SF Residential
22	B04-187	644-276-18	1860 Ocean Way	06/27/2005	New SF Residential
23	B03-2229	644-244-05	1161 Summit Place	07/11/2005	New SF Residential
24	B03-2406	056-171-24	19 North La Senda Drive	08/04/2005	New SF Residential
25	B03-2447	656-034-01	760 Bolsana Drive	08/08/2005	New SF Residential
26	B03-2329	656-165-08	2800 Terry Road	08/23/2005	New SF Residential
27	B03-2479	656-441-08	21 Shreve Drive	08/23/2005	New SF Residential
28	B05-1624	644-267-12	355 Pearl Street	09/08/2005	New SF Residential
29	B04-1415	053-102-03	1655 Hillcrest Drive	09/09/2005	New SF Residential
30	B04-307	644-073-03	1136 Gaviota Drive	09/12/2005	New SF Residential
31	B04-1021	641-102-02	1581 Caribbean Way	09/16/2005	New SF Residential
32	B02-1705	644-023-11	765 Gaviota Drive	09/26/2005	New SF Residential
33	B05-265	644-042-03	539 Reed Street	09/30/2005	New SF Residential
34	B04-1207	056-193-55	1 Barranca Way	10/03/2005	New SF Residential
35	B03-2178	056-051-19	31422 Ceanothus Drive	10/24/2005	New SF Residential
36	B02-1453	658-201-03	31401 Mar Vista Avenue	10/25/2005	New SF Residential
37	B04-556	644-442-01	1475 Capistrano Street	10/25/2005	New SF Residential
38	B04-2054	056-051-55	31232 Holly Drive	10/27/2005	New SF Residential
39	B04-535	056-042-40	31281 Brooks Street	10/27/2005	New SF Residential
40	B03-1031	641-211-19	1240 Roosevelt Lane	11/21/2005	New SF Residential
41	B05-1157	053-161-18	1031 Marine Drive	12/12/2005	New SF Residential
42	B02-1886	120-561-35	2585 Riviera Drive	12/14/2005	New SF Residential
43	B04-1092	056-042-08	31185 Brooks Street	12/22/2005	New SF Residential
44	B04-2492	644-464-15	810 Acapulco Street	03/18/2005	New SF Residential
45	B05-1917	644-463-29	988 Acapulco Street	09/21/2005	New SF Residential
46	B03-1565	641-381-04	1712 Thurston Drive	01/25/2005	Remodel SF Residential
47	B04-874	644-221-66	414 Bluebird Canyon Drive	01/26/2005	Remodel SF Residential
48	B04-22	053-141-25	362 Pinecrest Drive	02/08/2005	Remodel SF Residential
49	B03-248	644-231-15	820 Bluebird Canyon Lane	02/16/2005	Remodel SF Residential
50	B02-2240	656-151-50	2741 Victoria Drive	02/28/2005	Remodel SF Residential
51	B05-307	656-153-15	101 Sunset Terrace	03/01/2005	Remodel SF Residential
52	B04-818	053-091-26	1605 Sunset Ridge Drive	04/13/2005	Remodel SF Residential
53	B04-1964	496-173-12	107 High Drive	04/27/2005	Remodel SF Residential
54	B04-390	641-303-19	1290 Anacapa Way	04/29/2005	Remodel SF Residential
55	B04-1149	644-203-09	550 Mountain Road	05/03/2005	Remodel SF Residential
56	B05-853	656-164-15	2835 Terry Road	05/03/2005	Remodel SF Residential
57	B02-913	056-203-28	37 South La Senda Drive	05/27/2005	Remodel SF Residential
58	B04-175	644-284-19	340 Ruby Street	06/20/2005	Remodel SF Residential
59	B03-1417	053-141-05	380 Pinecrest Drive	06/29/2005	Remodel SF Residential
60	B04-302	658-113-37	31897 Circle Drive	07/05/2005	Remodel SF Residential
61	B04-2204	644-131-03	1687 Temple Hills Drive	07/12/2005	Remodel SF Residential
62	B05-337	641-181-06	1550 Arroyo Drive	07/20/2005	Remodel SF Residential
63	B04-491	644-253-03	650 Diamond Street	07/25/2005	Remodel SF Residential
64	B03-835	496-151-04	446 Hawthorne Road	08/24/2005	Remodel SF Residential
65	B05-14	644-162-31	1089 Madison Place	08/31/2005	Remodel SF Residential
66	B04-511	053-101-10	374 Ledroit Street	09/30/2005	Remodel SF Residential

Appendix E: 2005 Residential Fire Sprinkler Data Sorted by Date Issued

Number	Permit Number	Parcel Number	Project Address	Date Issued	Purpose
67	B05-879	056-086-07	31536 West Street	10/07/2005	Remodel SF Residential
68	B05-314	644-431-18	976 La Mirada Street	10/12/2005	Remodel SF Residential
69	B04-1932	056-088-13	31567 Wildwood Road	10/21/2005	Remodel SF Residential

Appendix F: 2006 Residential Fire Sprinkler Data Sorted by Date Issued

Number	Permit Number	Parcel Number	Project Address	Date Issued	Purpose
1	B04-418	656-163-12	2900 Terry Road	01/04/2006	New SF Residential
2	B04-2674	656-171-28	19 Lagunita Drive	01/10/2006	New SF Residential
3	B04-973	656-107-09	2755 Solana Way	01/11/2006	New SF Residential
4	B04-976	656-107-09	2753 Solana Way	01/11/2006	New SF Residential
5	B02-1414	656-167-26	2938 Rounsevel Terrace	02/03/2006	New SF Residential
6	B06-280	644-121-01	709 Canyon View Drive	02/08/2006	New SF Residential
7	B04-2373	053-144-20	259 Fairview Street	02/24/2006	New SF Residential
8	B02-2216	644-277-05	1885 Ocean Way	03/01/2006	New SF Residential
9	B03-2083	053-317-07	2526 Riviera Drive	03/03/2006	New SF Residential
10	B05-564	656-441-03	31 Shreve Drive	03/10/2006	New SF Residential
11	B04-2651	656-441-09	19 Shreve Drive	03/22/2006	New SF Residential
12	B03-881	644-266-04	319 Agate Street	03/23/2006	New SF Residential
13	B05-176	056-012-09	31061 Coast Highway	03/24/2006	New SF Residential
14	B03-341	056-091-19	31512 Mar Vista Avenue	03/27/2006	New SF Residential
15	B03-342	056-091-20	31510 Mar Vista Avenue	03/27/2006	New SF Residential
16	B04-730	053-161-06	1205 Cliff Drive	03/29/2006	New SF Residential
17	B04-801	053-101-09	382 Ledroit Street	04/04/2006	New SF Residential
18	B03-1256	641-291-12	636 Mystic View	04/05/2006	New SF Residential
19	B04-1696	656-211-08	30872 Driftwood Drive	04/06/2006	New SF Residential
20	B03-1626	056-180-09	8 South La Senda Drive	04/07/2006	New SF Residential
21	B04-1842	056-180-54	6 South La Senda Drive	04/10/2006	New SF Residential
22	B04-735	644-477-14	1016 Santa Ana Street	04/11/2006	New SF Residential
23	B04-2509	644-191-08	511 Oak Street	04/12/2006	New SF Residential
24	B04-2228	496-201-15	135 Irvine Cove Place	04/13/2006	New SF Residential
25	B04-1648	053-092-77	1580 Sunset Ridge Drive	05/11/2006	New SF Residential
26	B04-1656	053-092-78	1570 Sunset Ridge Drive	05/11/2006	New SF Residential
27	B04-885	644-261-09	1664 Catalina Street	05/24/2006	New SF Residential
28	B03-2302	644-291-69	2100 Crestview Drive	05/26/2006	New SF Residential
29	B03-2396	056-051-28	31462 Ceanothus Drive	05/31/2006	New SF Residential
30	B03-2514	056-051-86	31452 Ceanothus Drive	06/02/2006	New SF Residential
31	B04-2335	056-213-18	27 North Portola	06/05/2006	New SF Residential
32	B04-1057	056-051-87	31460 Ceanothus Drive	06/06/2006	New SF Residential
33	B04-1130	056-020-50	11 Camel Point Drive	06/26/2006	New SF Residential
34	B03-2183	656-151-22	2613 Victoria Drive	07/20/2006	New SF Residential
35	B04-138	644-453-16	903 Quivera Street	07/28/2006	New SF Residential
36	B05-303	656-171-46	31 Lagunita Drive	08/01/2006	New SF Residential
37	B06-478	658-113-37	31897 Circle Drive	08/02/2006	New SF Residential
38	B02-2026	644-291-77	881 Gainsborough Drive	08/15/2006	New SF Residential
39	B04-1332	644-221-14	1530 Glenneyre Street	08/24/2006	New SF Residential
40	B05-2017	053-302-10	1580 Via Majorca	09/11/2006	New SF Residential
41	B05-1455	056-031-13	31425 Monterey Street	09/12/2006	New SF Residential
42	B05-1630	656-171-14	7 Lagunita Drive	09/14/2006	New SF Residential
43	B06-1972	644-331-06	1323 Morningside Drive	09/22/2006	New SF Residential
44	B05-1564	496-152-15	454 Myrtle Street	09/26/2006	New SF Residential
45	B05-865	496-091-13	278 Cypress Drive	11/08/2006	New SF Residential
46	B04-243	644-293-16	2263 Crestview Drive	12/08/2006	New SF Residential
47	B02-1169	641-181-57	170 Canyon Acres Drive	12/15/2006	New SF Residential
48	B03-876	644-322-09	1545 Bluebird Canyon Drive	12/20/2006	New SF Residential
49	B06-2702	641-321-08	1375 Skyline Drive	12/29/2006	New SF Residential
50	B04-1574	656-165-05	2856 Terry Road	01/06/2006	Remodel SF Residential
51	B04-1407	056-086-17	31551 Eagle Rock Way	02/03/2006	Remodel SF Residential
52	B03-1834	658-101-06	31676 Seacove Drive	02/10/2006	Remodel SF Residential
53	B05-214	496-012-03	273-275 Lower Cliff Drive	02/16/2006	Remodel SF Residential
54	B05-1903	644-047-17	475 El Camino Del Mar	03/01/2006	Remodel SF Residential
55	B04-1587	644-435-25	1090 Katella Street	03/13/2006	Remodel SF Residential
56	B05-2	496-163-18	435 Holly Street	03/13/2006	Remodel SF Residential
57	B06-463	644-438-06	845 Katella Street	03/13/2006	Remodel SF Residential
58	B05-1134	053-126-39	261 La Brea Street	03/21/2006	Remodel SF Residential
59	B05-749	644-201-06	1347 Catalina	03/21/2006	Remodel SF Residential
60	B05-884	056-143-02	32006 Coast Highway	04/03/2006	Remodel SF Residential
61	B04-807	658-113-30	31885 Circle Drive	04/06/2006	Remodel SF Residential
62	B06-722	644-122-32	940 Temple Hills Drive	04/14/2006	Remodel SF Residential
63	B04-255	056-041-13	31002 Holly Drive	04/27/2006	Remodel SF Residential
64	B04-2239	644-141-03	1365 Dunning Drive	05/11/2006	Remodel SF Residential
65	B04-2590	656-171-44	28 Lagunita Drive	05/11/2006	Remodel SF Residential
66	B05-299	056-063-12	31565 Catalina Avenue	05/12/2006	Remodel SF Residential

Appendix F: 2006 Residential Fire Sprinkler Data Sorted by Date Issued

Number	Permit Number	Parcel Number	Project Address	Date Issued	Purpose
67	B05-1343	641-272-22	458 Hilledge Drive	05/23/2006	Remodel SF Residential
68	B06-1222	053-151-15	1292 Cliff Drive	06/16/2006	Remodel SF Residential
69	B05-2301	056-142-47	31981 Virginia Way	06/28/2006	Remodel SF Residential
70	B06-839	658-113-32	31889 Circle Drive	07/27/2006	Remodel SF Residential
71	B05-2536	644-222-04	756 Bluebird Canyon Drive	08/03/2006	Remodel SF Residential
72	B05-787	656-143-33	561 Alta Vista Way	08/11/2006	Remodel SF Residential
73	B04-1350	656-151-23	2615 Victoria Drive	09/01/2006	Remodel SF Residential
74	B06-1822	658-092-02	31512 Bluff Drive	09/05/2006	Remodel SF Residential
75	B05-1161	056-203-39	15 South La Senda Drive	09/21/2006	Remodel SF Residential
76	B05-1560	656-161-03	175 Dumond Drive	09/29/2006	Remodel SF Residential
77	B05-1530	656-151-10	120 Rockledge Terrace	10/05/2006	Remodel SF Residential
78	B04-474	056-086-44	31541 Eagle Rock Way	10/26/2006	Remodel SF Residential
79	B05-1169	641-394-12	2085 Temple Hills Drive	10/30/2006	Remodel SF Residential
80	B05-1774	644-437-14	970 Baja Street	11/13/2006	Remodel SF Residential
81	B05-2123	056-089-41	31532 Egan Road	11/14/2006	Remodel SF Residential
82	B05-123	056-224-14	13 South Stonington Road	11/21/2006	Remodel SF Residential
83	B06-2591	644-131-08	1585 Temple Hills Drive	12/19/2006	Remodel SF Residential