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Examining the value of fire prevention inspections in commercial occupancies

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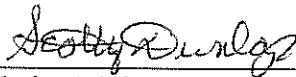
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EXAMINING THE VALUE OF FIRE PREVENTION
INSPECTIONS IN COMMERCIAL OCCUPANCIES

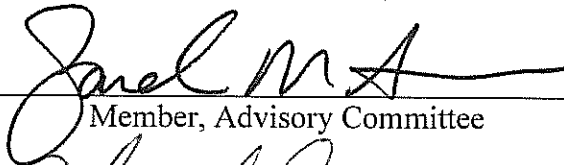
By

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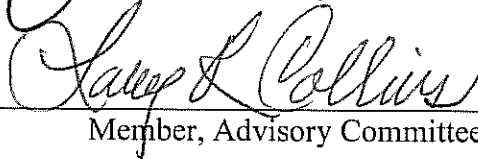
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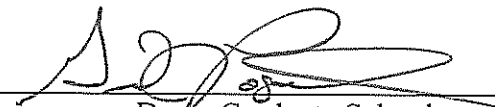
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EXAMING THE VALUE OF FIRE PREVENTION
INSPECTIONS IN COMMERCIAL OCCUPANCIES

By

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DEDICATION

To my wife, Kathryn Gairson, who supports me day and night with my compulsive fire service behavior. She is always there to listen and provide valuable insight as problems arise. She has learned more about the fire service than she ever thought possible.

To my children, Michael and Quinn, who continue to surprise me every day with their curiosity and desire to learn and explore the world around them. I am very proud of them and hope they learn to embrace their talents and accomplishments in their adult life.

To the rest of my family that never doubted for a moment that I would finish this journey, thank you.

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Abstract

This research paper will evaluate the value of conducting fire prevention inspections within the commercial occupancy and the associated reduction in the occurrence of fires. While the fire problem within the United States has experienced a decline in the number of fires and fire related injuries, the reality is that the nation continues to experience significant fire loss. With the introduction of more comprehensive codes and standards, the enforcement of fire regulations becomes paramount in maintaining a fire safe community. Typically, fire prevention enforcement is accomplished through annual fire inspections performed by the fire department. While personnel within the fire prevention division have primarily performed fire inspections, increasingly more and more departments are utilizing firefighters to perform fire inspections in order to meet the increasing demand for inspections. The ideal solution for determining the effectiveness of fire prevention activities would be to measure the number of fires abated by the efforts of fire prevention inspections. However, directly measuring what has not occurred is not a reasonable means of evaluating fire prevention effectiveness. A reasonable methodology is found in evaluating the reduction in the number of fires for a defined population through the efforts of fire prevention. This research demonstrates the positive impact that annual fire prevention inspections have on reducing the occurrence of fires in the commercial occupancy. As the demand for community dollars becomes increasingly more competitive, the need to justify and account for each dollar are substantially escalated, and the efforts of fire prevention are often the victim of budgetary reductions imposing an unintentional impact to the community.

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LIST OF ABBREVIATIONS

Executive Fire Officer	EFO
International Fire Code	IFC
National Fire Academy	NFA
National Fire Incident Reporting System	NFIRS
National Fire Protection Association	NFPA
Tenant Improvement	TI
Urban Institute	UI

1. INTRODUCTION

Background

In 2011, fire departments in the United States responded to over 1.3 million calls for service with an estimated property loss of over 11.7 billion dollars (Karter, 2011). In the U.S., the delivery of fire protection services consists of two very different methods; shared between fire prevention and fire suppression. The fire prevention bureau is tasked with the objective of stopping fires before they occur, and reducing the effect of a fire should it occur. Conversely, fire suppression focuses on responding after the fire starts, and is concentrated on how quickly the fire is extinguished. "The United States has one of the premier firefighting forces in the world, but we need to focus more on prevention and less on putting out fires once they have started. Time line data show that while the situation in the U.S. has improved, we still lag behind other countries in the relative loss of life due to fires. Other countries have demonstrated that it is possible to save lives by expending more energy and funding on fire prevention and fire education" (National Fire Data Center, 1997, p. 17).

In 1971, President Richard Nixon assembled a 20-member panel of fire prevention experts to analyze the growing fire problem in the United States. This panel also addressed the increasing needs throughout the American fire service. The panel became known as the National Commission on Fire Prevention and Control. "Destructive fire takes a huge toll in lives, injuries, and property losses, yet there is no need to accept those losses with resignation. There are many measures -- often very simple precautions -

that can be taken to reduce those losses significantly" (The Report of the National Commission on Fire Prevention and Control, 1973, p. x).

The resources dedicated to the prevention of fire in the United States are vastly different from other countries. "In the last decade, there has been a sea of change in the prevention strategy used by the British fire service that is just short of revolutionary. Since 2004, national legislation requires the fire brigades to engage in strong community safety programs as part of an overall strategy for improving fire safety. Every British firefighter is now expected to participate in prevention. A national-level Community Fire Safety Center was established in the Department of Communities and Local Government to be the focal point for developing national strategies, campaigns, and materials" (Schaenman, 2007, p. vi).

The ideal matrix for evaluating the prevention of fires would be to measure the number of fires avoided through the efforts of fire prevention. However, measuring what has not occurred is not a reasonable means of measuring fire prevention effectiveness. The analysis of fire incidents for a defined population provides the first step in a reasonable measurement methodology for fire prevention effectiveness. Analyzing the data for a defined population provides characteristics that are observed for changes, as fire prevention resources are applied. In the case of evaluating fire prevention effectiveness in commercial occupancies, an alternative method of measurement will be used that will exclude residential single-family dwellings. The single-family dwelling is removed from the analysis, since typically within the United States they are not subject to annual fire prevention inspections. "The number of commercial fires per 100 commercial occupancies could be used as the measurement of prevention effectiveness" (Schaenman

& Swartz, 1974, p. 24). In addition, fire prevention evaluation utilizing a two-city approach, "Prevention Oriented" and "Non-Prevention Oriented", in which two cities bearing similar characteristics, such as climatic conditions, the age of the buildings, and the type of fire protection services provided, can result in a measurement of prevention effectiveness.

The effects of a fire to a business can be devastating, not only to the business affected by fire and water damage, but also to the community served by the business. The lasting effects can extend far beyond the mere fire-related damage that can affect the local economy and visual appearance of the neighborhood. Depending on the extent of damage, many employers simply cannot continue business operations. This, of course, can have a negative rippling effect on tax revenues generated for the local government, as well as the impact to surrounding property values. The ripple effect of a fire, like a pebble cast into a pond, can even affect outside companies that once supplied the business with goods and services. "Unwanted fires have a monetary impact on communities because fires remove businesses from the tax rolls while the damaged building is rebuilt and reconstructed. Statistics confirm that over 40% of the businesses that experience a fire never reopen because they lose their customer base" (Stookey, 2010, p. ix).

Fires in buildings that serve more than one business, as seen in the case of multi-tenant strip malls or row buildings, can adversely affect adjoining business. These multi-tenant buildings frequently share attic spaces and utility chases that can communicate smoke and heat throughout the building from a fire occurring within just a single tenant space. Frequently, the tenant space undergoes remodeling in order to meet the needs of the individual business; this remodeling is referred to as tenant improvements (TI). TI's

performed throughout the history of a building often divide and redefine the building well beyond the original design. Many historical and downtown buildings share a common "party" wall between buildings, whereby increasing the likelihood of communicating smoke and heat during a fire. The effects of installing business equipment or communications wiring can compromise the integrity of the required building fire protection features. Breaches in walls, improperly maintained fire protection equipment, and the obstruction of fire sprinkler heads can all contribute to the rapid development and spread of a fire throughout the building. In the event of a fire, the improper storage of combustible material can quickly overwhelm the design of an installed fire sprinkler system rendering it ineffective. To assist in combating the spread of fire, modern building codes require various construction and fire resistive features that help to separate, isolate, and compartmentalize tenable spaces in buildings. Ensuring that these construction elements remain intact after construction is completed is the job of the fire inspector.

Buildings and facilities used for the assemblage of large groups of people require vigilance in maintaining the elements associated with fire and life safety. People gather into large assemblies and venues for many different reasons, whether it is for sporting events, social gatherings, or musical performances. Regardless of the event, these venues present an increased potential for panic in the case of an emergency. In the event of an emergency within the venue, the need for effective and efficient evacuation is critical to the survival of those in the building. The proper operation of all the elements within the egress system is paramount to safe and orderly evacuation.

Modern building and fire codes help to combat the design and placement of occupancies that may otherwise pose an inherent hazard based upon a given business

operation. For example, the allowable height that a building may be constructed, along with the floor area is strictly regulated in order to help provide the minimum level of safety for the building occupants, as well as reducing the effects of fire. The location of a business that utilizes hazardous materials has restrictions with respect to its location to other occupancies. Beyond the safety of the occupants within the business, consideration must also be given for the safety of firefighters and first responders. The operational readiness of fire protection systems and building services, along with the identification, storage, and handling of specialty hazards is vital to effective and efficient incident mitigation.

Fire inspections are not only limited to buildings that are occupied, but are also when the building is unoccupied. Fire inspections ensure that fire protection systems remain operational during times when the building is vacant. In addition to the protection of vacant buildings, fire prevention inspections can also help to combat vandalism and vagrancy. Modern fire codes require that the building owner maintain the fire protection system in an operational state, while also safeguarding entry from unauthorized persons. Annual fire inspections within unoccupied buildings help increase the safety of firefighters and first responders during an emergency by ensuring that minimum maintenance requirements are met. The International Fire Code (IFC) states specifically “fire alarm, sprinkler and standpipe systems shall be maintained in an operable condition at all times” (“IFC,” 2006, para. 311.2.2).

Performing regular fire prevention inspections can often identify potential hazards within a building or facility before it becomes an emergency. The fire inspector may identify potential threats regarding life safety and fire protection issues whereby bridging

the gap between the occurrence and the prevention of an incident. Due to various reasons, some jurisdictions simply do not perform fire inspections for the commercial occupancies within their jurisdiction, yet a fire inspector may ultimately be the first responder into the facility with the early identification and prevention of a fire or emergency.

Statement of the problem

A 1991 fire at One Meridian Plaza in Philadelphia, Pennsylvania quickly spread and consumed eight floors before finally being stopped by the automatic fire sprinkler system on the 30th floor. The fire cost the lives of three (3) firefighters and an estimated 100 million dollars in fire damage. At the time the building was constructed, automatic fire sprinklers were not required to be installed, however residents on the 30th floor insisted on the installation of fire sprinklers on that floor. "Designers of buildings generally give minimal attention to fire safety in the buildings they design. They are content, as are their clients, to meet the minimal safety standards of the local building code. Often both assume that the codes provide completely adequate measures rather than minimal ones. In other instances, building owners and occupants see fire as something which will never happen to them, as a risk they will tolerate because fire prevention measures can be costly, or as a risk adequately balanced by the provisions of a fire insurance policy" (The Report of the National Commission on Fire Prevention and Control, 1973, p. 2).

Despite advances in the development of standards and regulations, the United States still lags behind many other industrialized nations concerning preserving life and property from the effects of fire. The process of protecting the community from the effects of fires often involves providing the necessary inspection, education, and

mitigation efforts to minimize or eliminate the threat of fire. "A cursory review of the 2001 United States fire loss statistics show that the nation continues to suffer property loss, income loss, injury, and deaths at a significant rate. In fact, the United States and Canada are still among the worst of all industrialized nationals at controlling losses" (Boyd, 2003, p. 11).

The primary method of protecting the occupants from the effects of fire is achieved through the proper design of the egress systems from the building, and must provide an effective and efficient way of evacuating the building. The means of egress system is divided into three components;

- The exit access addresses that portion within the building leading to the exit. The exit access can include corridors, hallways and passageways.
- The exit includes the door and associated hardware including latches and release mechanisms that secure the building from the outside.
- The exit discharge provides the discernable path leading from the exit and extends to a public way considered "safe". (*Fire Inspection & Code Enforcement*, 1998)

The inclusion of passive and active fire protection systems into the design of a building provides an increased level of protection that helps to separate a fire from the occupants. In order to meet the design criteria, the means of egress must provide a method for all occupants to reach a safe area (either inside the building or outside on the public way), utilizing methods that present a minimum level of risk or injury to the occupant.

Historically, large loss of life incidents involved violations related to the means of egress elements and the associated evacuation from the building. The overcrowding of a

building places impractical demands on the egress system, often involving too few and too narrow exit doors for the number of occupants served. In addition, a frequent violation found in large loss of life incidents includes securing emergency exit doors shut, often with chains and padlocks. The common defense for barricading emergency exits is frequently cited as a security measure, in order to prevent unpaid patrons from gaining entry, as well as thwarting theft. The adherence to fundamental life safety provisions, despite greater cost or inconvenience, could have saved countless lives throughout history. The infamous Triangle Shirtwaist fire of March 25, 1911 resulted in the death of 146 workers because of locked and blocked exits. The legendary Cocoanut Grove Nightclub fire on November 28, 1942 was compounded because the occupancy load was exceeded by twice the number of occupants allowed. A 1991 fire located in a chicken processing plant in Hamlet, North Carolina killed 25 workers who were unable to escape because of locked exit doors. (U.S. Fire Administration, 1991)

While the goal of the fire prevention bureau is the prevention of fires, it also supports the efforts of fire suppression should a fire occur. Fire prevention efforts help ensure that fire apparatus have clear unobstructed access to the building, and the installed fire protection equipment is maintained in a continuous state of readiness. In the case of arson, no amount of fire prevention will stop the fire, yet the effects of the fire can be greatly reduced with properly installed, inspected, and maintained fire protection systems.

The Nation's history is littered with cases of incidents where a comprehensive fire inspection of the building might have significantly changed the outcome of the incident. Many of these incidents involved a large loss of life and property. During the time of the

incident, patron's within these buildings often found locked, blocked, or chained exits along with overcrowding that either prevented or severely delayed exiting from the building. Fire inspections provide the critical link to ensure that basic life safety elements are in place and functioning as designed in the event of a fire or other emergency. Although many tragic events occurred prior to the creation of modern fire codes and ordinances, more recent events show that even with modern codes in place, the importance of a fire and life safety inspections is paramount.

- West Warwick, Rhode Island, February 20, 2003 a fire within a nightclub killed 100 people and injured almost 200. The fire started from pyrotechnics that ignited flammable insulation foam used for sound attenuation in the building. Exits were found locked and blocked. (Grosshandler, Bryner, Madrzykowski, & Kuntz, 2005)
- Hamlet, North Carolina, September 3, 1991 a fire within a food processing plant killed 25 people and injured 54. The fire started from a 25-foot long deep fryer, with many employees unable to escape because of locked exit door. (U.S. Fire Administration, 1991)
- New York, New York, March 25, 1990 a fire within an unlicensed "social club" killed 87 people. Although started by an act of arson, patrons were unable to escape because of inadequate exits. (Bukowski, n.d.).

The likelihood that a competent fire inspector would have identified the violations should be considered. A fire inspection within any of these buildings may have identified and corrected these potentially life-threatening issues. Annual fire inspections provide a method to ensure that business operations continue to comply with the requirements set

forth within a given occupancy classification, as well as any operational permits for specific circumstances based on the business operation. The continued pursuit of annual fire prevention inspections provides the foundation for the inspector to identify changes in the business operation between inspections that may ultimately affect the occupancy classification, exiting requirements, and fire protection. Fire and life safety compliance is affected in varying degrees based upon the occupancy classification. Although the potential for loss of life is greater in some occupancy classifications compared to others, the reality is that all business occupancies are susceptible to the effects of fire.

Purpose of the study

The recurring fire problem throughout history demonstrates the public's inattention to fire safety even with the introduction of new codes and standards. This study was undertaken in order to determine if the delivery of annual fire inspections within commercial occupancies, including multi-family housing (apartments and condominiums) would result in reducing the occurrence of fires. In the business community, the occurrence of fires due to poor fire safety continues to flourish despite the advancement of various building and fire code regulations. Each tragic incident brings about changes designed to protect the citizens and the community against the effects of fire, yet fire continues to plague the nation with deaths, injuries and property loss. Without annual fire inspections, the occurrence and severity of fires will not decline despite the best intentions of adopted regulations. The identification of potentially hazardous conditions that may aid in the start or spread of a fire, as well as impending life threatening conditions can often be recognized and mitigated during the annual fire inspection. The fire inspector has the opportunity to educate business owners concerning

effective fire safety whereby avoiding business interruptions and associated losses. This research will help to demonstrate the positive impact that fire prevention inspections can have in reducing the occurrence of fire in the commercial occupancy.

Potential significance

The potential significance of this study supports the efforts of performing annual fire prevention inspections in reducing the occurrence and severity of fires. Although it is difficult to measure what has not occurred, the reduction in the number of commercial structure fires is often a direct result of effective fire prevention efforts. Furthermore, the sorting of individual occupancies will be addressed, and may prove beneficial in determining the level of risk associated with a given occupancy classification. Finally, the occupancy classification itself may serve as a means in determining the frequency of inspections as well as the priority. When fire prevention resources are increased, whether through the efforts of inspection, education, or enforcement, the business community should recognize a measurable reduction in the number of fires. Therefore, jurisdictions where fire inspections are performed on an annual basis should experience a lesser number of fires in comparison with those jurisdictions not conducting similar fire inspections.

It is understood that not all fires are preventable, such as incidents of arson. However, even the effects of intentional and malicious fires can be significantly lessened with effective fire prevention. When all fire protection systems are in place, the removal of one element often does not compromise all fire protection within a given building. For example, fire resistive construction will still be in place even if the fire sprinkler system has been rendered inoperative. The annual fire inspection also verifies the operational

readiness of installed fire protection systems. The proper inspection, testing, and maintenance of these system is critical to their performance when an emergency arises. For this reason, when a fire occurs within the commercial occupancy, the characteristics of the fire typically responds to, and reflects the effects of the installed fire protection systems. For instance, when a fire occurs in a large storage warehouse utilizing rack storage, the fire is directed upward within designated flue spaces in order to activate the fire sprinkler system as soon as possible.

Definition of terms

Building: A structure that is used or intended to be used for the location of a defined occupancy classification.

Commercial Occupancy: A building that serves as the physical location for a business operation. This classification would exclude the single-family dwelling.

Facility: A building or location that has a defined use or purpose. A facility is not limited to a physical structure but can include open yards and spaces.

Incident: The request for emergency services, as used in this paper, an incident shall mean a request for fire suppression services.

Multi-family: A building or structure that houses more than two families such as apartments and townhouses.

Multi-tenant: A building or structure that serves as the location for more than one commercial occupancy.

Occupants: Individuals that inhabit, work, or otherwise populate a building or structure. Individuals shopping or purchasing merchandise are considered occupants.

Occupancy Classification: A system of categorizing the tenable space within a building based upon the intended use and associated risk.

Occupancy Load: A method of calculating the total number of occupants that can safely occupy a building or portion of a building.

Operations: A division within the fire department responsible for emergency services such as firefighting.

Operations personnel: Individuals assigned to the operations division, and are part of the emergency response to include firefighting duties.

Party Wall: A separating wall that serves to divide two tenantable occupancies for the purpose of separating the business operation, and does not have a defined fire rating.

Prevention: A division within the fire department responsible for conducting fire inspections in order to reduce or eliminate the threat of fire.

Public Way: May consist of a street, alley, or sidewalk that is within the open air leading directly to a street that has been otherwise deed to the public for public use.

Regionalized Fire Protection: A fire department that provides fire protection services within a geographic area that often encompasses multiple jurisdictional boundaries.

Tenant: Shall mean either a business or individual that shall occupy a given location or space in a facility

Assumptions

The data obtained from the National Fire Incident Reporting System (NFIRS) represents the best available data for fire related incidents from across all participating fire department throughout the county. Although the NFIRS program is voluntary, it is

currently the only formalized resource for obtaining statistical fire related data from U.S. fire agencies. The NFIRS reporting system includes fire incident data from all states, however, because the system is voluntary some departments within a given state may not participate. It is understood that the participating fire agencies are providing the best available and most accurate data regarding their individual incidents. The research data utilized within this document uses the information provided by fire departments that participate in the NFIRS reporting system.

Limitations

The formation of NFIRS created a nationwide framework and centralized data depository for the analysis of fire-related incidents across the nation, regardless of the size or complexity of the individual fire department. NFIRS data is collected, analyzed, and administered by the National Fire Data Center, created through the Federal Fire Prevention and Control Act of 1974 (P.L. 93-498). The NFIRS program was established as part of the mandate for a nationwide standardized reporting system for incident data. Furthermore, NFIRS provides the mechanism for gathering and analyzing information concerning the extent of the nation's fire problem, as well as identifying fire related trends. NFIRS has evolved from the initial pencil and paper based system into a comprehensive web-based data collection system. Although individual agency participation within the NFIRS program is strictly voluntary, many grants and programs are contingent upon program participation.

A fundamental limitation of the NFIRS program is the interpretation and reporting of incident data between departments. Many fields of data collection are estimated values, based upon individual experience and training that can potentially cause

some inconsistencies within the collected data. A fraction of the data sent to NFIRS is reported either as invalid, unknown, or undetermined. When performing data analysis, the questionable data is computed based upon only the incident data that contains valid information. A significant shortcoming to the NFIRS program is the fact that it is voluntary. Even though NFIRS is a voluntary program, all states currently participate with more than half of all fire departments contributing. The population of participating fire departments results in a very large data set that provides good analysis of various fire problems. Within the context of this study, questionable incident data will not affect the results since the only element evaluated is the occurrence of a fire. A final limitation is that not all fires are reported to the fire service; most of these include small fires that either are self-extinguished, or are extinguished by the occupants. The occupants often do not recognize the need to report such fires to the local fire department.

Organization of the study

This study is organized into the following sections; the Introduction section provides a preamble that summarizes the study, the problem and purpose, potential significance, definition of terms, assumptions and limitations.

The literature Review section is divided into five topical categories expanding upon the core topic of fire prevention inspections. The first category, fire service functions, addresses the use of fire suppression personnel in performing fire prevention inspections. The second category, inspection measurement methodology, reviews methods to measure and capture fire prevention data. The third category is inspection effectiveness, and concentrates on capturing the essential components to determine how effective a given fire inspection is. The fourth category is, inspection practices, which

addresses the mechanics involved in performing a fire prevention inspection. The fifth and final category is inspection frequency, which deals with how often a fire inspection should be performed. This section will identify program success and challenges regarding fire prevention activities along with related information that could be used to support the claim that the performance of annual fire inspections within the commercial occupancy can reduce the instance of fires.

The methodology section will present the measurement process utilized, and the research question. In addition, quantitative research is introduced as the preferred measurement method for data collection and data analysis.

The research findings and analysis section will explore the results of the of the data analysis and provide the findings of each phase of the analysis and report the significance.

The discussion and implications section presents the findings to annual fire inspection programs. Furthermore, this study builds upon the momentum of increased fire safety throughout the nation with the landmark publication of Americas Burning in 1973, and continues forward to bolster the Vision 20/20 fire prevention campaign created in 2008.

2. LITERATURE REVIEW

Literature presented by topical category

The following literature review is a collection of the current state of knowledge regarding fire department inspections. A series of studies conducted during the early to mid-70's concerning the importance of fire prevention. This review will identify program success and challenges along with related information used to support the claim that the act of performing fire inspections within the commercial occupancy can reduce the occurrence of fires. The subsequent literature review topics were selected in order to fully capture the essential elements of performing a fire inspection.

Fire service functions

In the research conducted by Hall, et al., (1979) the findings support the thought that cities should consider using fire suppression personnel to assist in achieving the objective of inspecting all identified properties annually. The research concluded that cities using fire suppression personnel appeared to have substantially lower fire rates than cities that exclusively used full-time inspectors. The assumption of supplementing full-time inspectors with suppression personnel is based upon the supposition that typically there are not enough prevention personnel to perform the required number of annual inspections within a given jurisdiction. The study conducted by the National Fire Protection Association (NFPA) and the Urban Institute (UI), selected eleven (11) large U.S. cities representing a wide range of inspection practices whereupon detailed information on inspection practices was collected.

In the findings by Royse, (2007) research showed that the City of Wichita, Kansas experienced an increase in the frequency and severity of commercial fires when suppression personnel were no longer performing inspections. The applied research project submitted to the National Fire Academy Executive Fire Officer Program evaluated commercial occupancy fire inspections in the City of Wichita, Kansas. Priorities within the Wichita Fire Department ended the practice of suppression personnel performing fire inspections within the commercial occupancy. Royse (2007) goes on to explain that, "changes in the operations division priorities deemed commercial occupancy fire inspections were a non-priority activity." Descriptive and historical research methods were used to analyze the relationship between the increase in commercial structure fires and the last inspection performed.

In his report, Werner, (2003) found the need for fire suppression personnel to perform fire inspections was established as a result of an inspection caseload that was too great for the number of full time inspectors. Furthermore, when fire suppression personnel performed fire inspections, an increased public image was recognized as well as improved professionalism for fire suppression personnel. The study, an applied research project for the National Fire Academy (NFA) Executive Fire Officer (EFO) program, used action research to answer the question concerning the need for fire suppression personnel to conduct fire code inspections.

In his study, Jee, (1999) showed that fire departments that supplement fire prevention bureau inspections with suppression personnel have fewer fires, lower fire losses, and fewer civilian casualties within properties regulated by fire codes, when compared to cities which do not utilize fire suppression personnel. The research study

conducted for a NFA EFO research paper and utilized the action research methodology to establish the most effective means of performing inspections.

Inspection measurement methodology

In the study performed by Schaenman, Hall, Schainblatt, Swartz, & Karter, (1977) examination revealed that, "the ability to identify "relatively preventable" fires depends on the fire-cause categories used, and the reliability with which those causes are identified and recorded" (Schaenman et al., 1977, p. xvii). The joint study performed by the Urban Institute and the National Fire Protection Association found that documenting fires that are considered preventable, is a function of designing fire-cause reporting categories with that purpose in mind. It would be useful to report whether the cause of a fire could be seen or otherwise identified during a fire inspection.

In the report by Schaenman and Swartz, (1974) research found the measurement of productivity focused on the two principal functions of the fire department, fire prevention and fire suppression. In order to measure the efforts of fire prevention within the business community, it was determined that the change in incidence over time could be monitored as fire prevention resources are applied. The report, published by the National Fire Protection Association demonstrated that measuring the number of fires per 100 commercial occupancies could be used as an effective means of measurement. By analyzing the number of fires per 100 population, that the change in incidents over time could be monitored as the prevention resources are applied. The study also found that comparing a given city against other "like" city is beneficial in order to identify trends while also establishing benchmarks.

Research conducted by Cain (2008) found that establishing direct causality between inspections and a reduction in fire incidents is not necessary; one only needs to establish a plausible connection for that outcome. In the research conducted for the NFA EFO program, Cain utilized descriptive research in order to identify the appropriate method for assessing the effectiveness of fire prevention inspections whereby determining the viability of an inspection program's viability. Cain utilized mailed surveys and interviews in order to establish the necessary background and framework for the research.

Inspection effectiveness

The research conducted by Coulter, (1978) showed that disagreement among researchers concerning how to conceptualize organizational effectiveness resulted in the creation of three organizational effectiveness models:

- The behavioral-attitude model
- The processual model
- The goal attainment model

Within the context of fire prevention, the goal-attainment model provides the framework to measure inspection effectiveness. "The goal-attainment model defines organizational effectiveness in terms of the extent to which the organization achieves its goals or objectives" (Coulter, 1978, p. 65). Many factors can influence the attainment of the organizations goals, including the behaviors and attitudes of the employees as well as the internal workings of the organization. Coulter goes on to explain that organizational effectiveness must be defined as achieving goals that have been defined externally, such as community expectations. When effectiveness is defined as the level in which the fire service avoids or reduces property loss, injury, or illness from the effects of fire, then the

framework to evaluate the effectiveness of inspections is provided. The study published in the *Administrative Science Quarterly* utilized surveys mailed to fire departments, building inspections departments, and city managers in fifty of the standard metropolitan statistical areas in the United States that had less than 1.5 million residents and contained within a single state. In addition, supplemental data was utilized from the NFPA as well as the U.S. Census. Finally, the effectiveness of an organization utilizing the goal attainment model and measuring four elements; fire prevention, fire suppression, budgetary expenditures, and productivity can provide a conceptualization of organizational effectiveness that focuses on how successful the organization uses resources. The analysis showed that environmental and organizational differences can severely impact the levels of effectiveness. "How the service is delivered, by what kinds of personnel, and in what kinds of organization all seem to make a difference in the way fire service supply and demand are articulated and in the impact of fire protection on the urban environment" (Coulter, 1978, p. 79).

In their research, Hall, Flynn, and Grant, (2008) offer that for a program to be considered effective when used, the singular element needed is for it to reach its intended population. The report published by The Fire Protection Research Foundation, found that program effectiveness might also be known or suspected to be dependent on the quantity and/or quality of service delivered. Inspection quantity, directly related to the frequency of inspection, in addition to the scope of coverage. Inspection quality evaluated how well each inspection succeeds in identifying hazards, initiating a process to have those hazards quickly corrected, achieving timely hazard correction through effective follow-up, and educating and motivating safety to the occupants and managers.

In the research conducted by Ott, (2001) inspection program efficiency and effectiveness findings support the supposition that periodic evaluation of inspection programs should be conducted in order to determine program efficiency and effectiveness. The applied research project submitted to the NFA EFO program, utilized descriptive, historical, and action research methods during the research process. Surveys used comparative analysis with 55 fire departments responding to the survey from throughout Southern California. The research demonstrates that program sustainability alone, does not necessarily result in efficiency or effectiveness. The literature review also identified four measurements of effectiveness and includes, quality, productivity, efficiency, and satisfaction. Ott goes on to explain, "Departments often get caught up in the number game. Importance is placed on whether the inspections were completed instead of whether the inspections were effective in meeting their intended goals" (Ott, 2001, p. 59). Finally, a fire inspection program should contain a records management system that can provide baseline and benchmarking data for fire safety within the jurisdiction. The program should be dynamic and evaluated with quality assurance audits to ensure that the program is meeting the goals and objectives.

Inspection practices

Hall et al., (1979) found relative success in measuring fire prevention in terms of the rate of potentially preventable fires. The research selected eleven (11) cities and then performed a comparison to identify patterns, which then divided the fire cause into categories that were compared in order to determine if the cause of the fire was preventable through inspection practices. According to the report published by the NFPA and the UI, the methodology of the study divided into three primary elements. The first

element identified the type of fires and civilian fire casualties that are potentially preventable by inspection, and measured the number of such fires and casualties. This study excluded apartments since inspections did not include entering individual apartments. The second element identified potentially important characteristics of fire-code inspection practice and the difference in the practice between cities. The third element identified and studied a representative group of cities as well as other relevant source of information on the impact of differences in inspection practices. "Relative success in fire prevention was measured in terms of the rate of potentially preventable fires (i.e., fires other than incendiary, suspicious, and natural-cause fires) in public buildings" (Hall et al., 1979, p. viii).

Inspection frequency

Hall et al., (1979) found that fire rates appeared to be substantially lower in cities that performed annual fire inspections. The study conducted by the NFPA and the UI, selected eleven (11) large U.S. cities representing a wide range of inspection practices where detailed information on inspection practices was collected. The study found that the frequency of fire prevention inspections ranged from two (2) inspections per year to only one (1) inspection a year. A procedure developed and tested in the 1974-76 UI and NFPA project, measured the time since last inspection. In the study, for occupancies that had a fire, the time since last inspection was defined as the number of months between the last inspection and the fire incident. This procedure applies to bi-annual inspections as well as annual inspections. The research concluded that, "cities that annually inspected all (or nearly all) properties appeared to have lower fire rates than did cities that did not annually

inspect all (or nearly all) inspectable properties" (Hall, Koss, Schainblatt, Karter, & McNerney, 1979, p. 30).

In his research Boyd, (2003) found that the majority of structure fires occur in the residential occupancy, while only a small percentage of fires occur in business or mercantile occupancy. In addition, the sheer number of inspections required in order to perform annual fire inspections for all occupancy classifications is far beyond the available staffing of most fire departments. The report submitted to the NFA EFO program utilized a questionnaire sent to 25 suburban and urban fire agencies. The results showed that more than half of the fire departments surveyed relied upon a state law or local requirement as the impetus for performing annual inspections, while fewer than half surveyed utilized a hazard or risk analysis. While staffing levels identified the reason annual inspections were not completed, the inefficiency of inspections was also a contributing factor.

Conclusions

A review of previous research demonstrates a trend between performing fire prevention inspections and the subsequent decrease in the occurrence of fires. In addition, research supports the practice of expanding the role of fire suppression personnel in order to conduct fire prevention inspections. The expansion of duties of fire suppression personnel also helps ensure that most, if not all annual inspections within a jurisdiction would be completed.

Earlier comparative research does not account for intervening variables that may exist between fire departments. Variables such as the organizational emphasis and differences within the fire department concerning fire inspection practices, fire code

regulations, environmental considerations, social implications, and demographics may contribute to increased or reduced instance of fires. This study is a step at closing that gap.

3. METHODOLOGY

Context of the study

Following in the footsteps of Dr. John Hall Jr., with the NFPA, I utilized comparative analysis to explore fire safety practices within selected cities. The comparison utilized a two-city approach of those that share identical fire department elements with the exception of fire prevention inspection practices, where annual fire prevention inspections are performed or not performed, and the resulting impact to fire safety.

Recurring incidents involving the loss of life and property from the effects of fire routinely reaffirm the necessity of fire safety inspections. The accident/incident theory suggests that increased or improved fire safety inspections could decrease the incidence of fires. Petersen explains that human error is only part of a larger model. "A system failure, the inability of the organization to correct errors, was added as a possible mediator between errors and accidents" (Davies & Hertig, 2008, p. 255). The failure to conduct inspections or of management to take action are all examples of system failure. "An ideal safety culture is the "engine" that drives the system towards the goal of sustaining the maximum resistance towards its operational hazards, regardless of the leadership's personality or current commercial concerns" (Reason, 1998, p. 294). Non-events continue to guide the safety profession whereby decreasing the motivation that influences safe behavior. Reason, (1998) goes on to explain, "...safety is invisible in the sense that safe outcomes do not deviate from the expected, and so there is nothing to

capture the attention. If people see nothing, they presume that nothing is happening, and that nothing will continue to happen if they continue to act as before."

Within the context of fire prevention, the theory of reasoned action serves as a predictor for a person's behavior. "A central factor in the theory of planned behavior is the individual's intention to perform a given behavior. Intentions are assumed to capture the motivational factors that influence a behavior; they are indication of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior" (Ajzen, 1991, p. 181). A poor safety culture will continue to support unsafe conditions and practices, as "violations are likely to be most common in organizations where the unspoken attitudes and beliefs means that production and commercial goals are seen to outweigh those relating to safety" (Reason, 1998, p. 297).

Selection of participants

In order to limit intervening variables found between comparative cities, only jurisdictions participating in regionalized fire protection services were considered for this study. Throughout California, regionalized fire protection services have become an attractive and affordable option in maintaining fire department service while still holding down operating costs. Regionalized fire protection provides cities the ability to deliver and fund fire protection services that would not otherwise be feasible. Typically, cities enter into a contract with an established fire department or fire district for the delivery of fire services. Within these contract cities, the fire department continues to function as the city's own department, while the parent organization is responsible for operations and administrative policy.

Utilizing this framework for participant selection provides cities that have analogous fire code regulations, similar demographics, equivalent topography, geology, and seismic considerations. In this study, the comparative cities have areas of shared borders, ensuring near identical characteristics. Both cities have an arid climate, with hot and dry Santa Ana winds contributing to the rapid spread of fire and creating the need for an increased level of fire protection. Many earthquake faults run throughout Southern California. The San Andreas Fault Zone is a known active fault and runs directly adjacent to the Northern border of both cities. While the number of fire stations is not a factor in this study, it does help to visualize the likeness of the selected cities; the prevention oriented city operates two fire stations within the city limits while the non-prevention oriented city operates a single fire station.

While the delivery of fire suppression services remains constant between cities, fire prevention services vary according to the needs and desire of the city. Although some cities have enacted local ordinances creating an annual fire inspection program, others have not. This participant selection criterion provides the needed focus between performing annual fire prevention inspections and not performing annual fire prevention inspections.

Research question

Based upon the review of literature, the primary hypothesis will guide the data analysis. The primary research question is; do annual fire inspections result in fewer instances of fires in the regulated commercial occupancy? Those jurisdictions where annual fire inspections are performed in the regulated commercial occupancy will tend to

have a lower instance of fires while jurisdictions that do not perform the same annual fire inspections, will tend to experience an increased, or higher instance of fires.

Data collection

A non-experimental, comparative research design was utilized, including the NFIRS statistical fire report data for comparisons between cities of similar demographics as well as fire protection resources. The comparison method will place cities that do not perform annual fire inspections against those that do, and establish whether processes and practices are congruent with the proposed hypothesis. Incident data was collected through NFIRS as well as obtained from internal databases maintained at the fire department.

Data analysis

A comparative analysis was used to evaluate data for the number of fires that occurred in the commercial occupancy. This analysis filtered out the single family dwelling occupancy classification, resulting in occupancies regulated and subject to fire prevention inspections. In order to avoid any potentially misleading statistics, the fire rate was computed per 100 commercial occupancies. The data for the past several years shows a trend of reduced number of fires in fire prevention oriented city¹ when compared to the number of fires in non-fire prevention oriented city².

The quality of the data was checked for any extreme values that would otherwise alter the results, for which none were found. The data for two cities (prevention oriented, non-prevention oriented) of similar demographic standings with near identical topographical, geological, and environmental considerations captured the total number of

¹ Table 1, Appendix

² Table 2, Appendix

fire department responses for commercial occupancy fires within the corporate borders of each respective city. The two cities contract for fire services with the county fire department, whereby reducing the likelihood of organizational or cultural differences often found between fire departments. The community development criteria for each of the two cities is near identical, with a common set of codes and standards including the building and fire code. Because each city utilizes the same fire department, the data gathering and reporting techniques were identical and consistent. The primary difference between the two cities is that one performs annual fire inspections while the other does not.

Microsoft Excel was used for data analysis of independent samples t-tests to evaluate differences in fire rates between the two cities. The data analysis results indicate a statistically significant decrease in the rate of fire when annual fire inspections are conducted ($M = .09$, $SD = .06$) when compared to not conducting annual fire inspections ($M = .27$, $SD = .16$), ($t=2.76$, $p = .03$) with an alpha level of .05 for all statistical tests.

Subjectivities

My personal bias regarding the subject supports the supposition that fire prevention efforts are beneficial to the community. While my bias supports fire prevention efforts, the research was controlled from the stance that the data is comparative and reproducible in nature, and not subject to outside influences as might be found from other forms of research.

4. RESEACH FINDINGS AND ANALYSIS

The research findings and analysis support the practice that performing annual fire prevention inspections within the commercial occupancy does have value in reducing the incidence of fires. Previous literature and professional practices indicate a defined value in performing annual fire prevention inspections. In this case, all indications suggest that the non-prevention oriented city could recognize a reduction in the number of fire incidents by performing annual fire prevention inspections within the business community.

5. DISCUSSION AND IMPLICATIONS

This study continues to build upon previous research that supports fire prevention inspections as the primary non-emergency activity performed within the fire department. This study supports the inclusion of fire prevention services for contract cities as well as cities that maintain their own fire department. In addition, fire prevention inspections should not be held exclusive to the fire prevention bureau, but should be included within the fire suppression division as demonstrated in other countries. However, this also demonstrates the need and importance of training suppression personnel on hazard recognition before conducting fire inspections.

The value of fire prevention was first recognized with the original Presidents Conference on Fire Prevention in 1947 and continues today with the creation of Vision 20/20 in 2008. In addition, insurance companies and standards organizations continue to support the efforts of fire prevention with the inclusion of fire prevention activities within rating schedules and accreditation audits.

With the advancement of building and fire codes into the comprehensive set of codes and regulations that exist today, the need to implement these requirements is greater than ever. Although fire protection for the commercial occupancy has been in place for some time, many of the same requirements have only recently become a part of the model code for residential homes. Even then, many states and jurisdictions elect not to enforce these life safety requirements.

It is vital that the importance of fire prevention inspections be communicated throughout the fire service, such that it is acknowledged and accepted as the primary non-

emergency mission of the entire department. Research continues to support the efforts of fire suppression personnel in performing fire prevention functions. These efforts not only benefit the community, but also directly benefit the firefighter with a safer working environment during emergency response.

In order to reduce the occurrence and severity of fires in the commercial occupancy, there must be a cultural change within the fire service throughout the nation. The cultural change must focus on effectively delivering a fire prevention program to the community. Within most jurisdictions throughout the country, the fire service is responsible for enforcing the fire code requirements. However, until support is gathered from key stakeholders as well as the community, we will continue to experience unacceptable fire loss.

While this report focused on the commercial occupancy, a parallel can also be drawn to the residential occupancy. As is common in most countries, the majority of fires and fire related deaths takes place in the home despite the significant differences in homes and construction throughout various countries. Yet, within the United States, the single-family residential home is not subjected to annual fire inspections. The catalyst for increasing fire safety within the single-family dwelling may be recognized with a reduction in the overall fire problem with fewer civilian casualties and reduced property loss. While annual fire inspections are typically not conducted within the single-family dwelling, applying this model to future research may provide valuable insight into the significance of residential fire safety inspections. Furthermore, the parallel in reducing firefighter fatalities and increasing overall safety can also be drawn.

The findings in this paper support the theory that annual fire inspections reduce the occurrence of fires in the commercial occupancy as well as the severity, should a fire occurs. The delivery of annual fire prevention inspections in cooperation with fire safe education provides a comprehensive fire prevention program to the community.

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APPENDIX

Table 1
Number of fires in fire prevention oriented city

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2006	0	0	0	1	1	1	3	0	1	0	0	0	7
2007	0	0	0	1	2	0	0	1	0	0	0	0	4
2008	1	0	2	0	1	0	0	1	0	1	0	0	6
2009	1	0	0	0	0	0	1	0	0	2	0	0	4
2010	0	0	0	0	0	1	0	0	0	0	0	0	1
2011	0	0	0	0	0	0	1	0	0	0	0	1	2
2012	0	0	0	0	0	1	0	0	0	0	0	0	1

Table 2
Number of fires in non-fire prevention oriented city

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2006	2	2	1	1	1	1	0	1	0	2	0	1	12
2007	2	0	0	0	1	1	1	0	0	0	0	1	6
2008	2	2	0	0	0	2	0	1	0	2	0	1	10
2009	1	0	1	0	0	0	1	0	0	0	2	0	5
2010	0	0	1	0	0	0	0	0	0	1	0	1	3
2011	0	1	0	0	1	0	1	1	0	0	0	1	4
2012	1	0	0	0	0	0	0	0	0	0	1	0	2

VITA

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