False Alarm Reduction for Heritage House Condos

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Certification Statement

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Abstract

Heritage House Condominiums (HHC) is a building known all too well by emergency responders in Greensboro, NC. This address is responsible for the most incidents in the city of Greensboro. In 2013, the Greensboro Fire Department (GFD) responded to 375 false fire alarms. The problem is that this creates an unacceptable amount of risk to residents, citizens, and the fire department. HHC is a six story building with 177 living units that are owned by 67 different individuals or companies. The purpose of this applied research project is to identify the causes of false alarms at HHC and recommend action(s) to reduce them.

This research project uses the descriptive research method and answers the following research questions: what are the causes of malicious alarms at HHC, what are the causes of unintentional alarms at HHC, and what options are available to mitigate these alarms?

Five years' worth of incident data was reviewed to determine the leading causes of false alarms at HHC. Each of these causes was analyzed to determine the best mitigating strategy for each. Fire inspections and code violation data was also reviewed to determine the number of issues that had been reported by the GFD.

The leading causes of false alarms at HHC were found to be cigarette smoke, smoke from cooking, discharged fire extinguishers, pull station activations, and those classified as unknown. These false alarms are so prevalent that residents of HHC do not evacuate or investigate the incidents.

Mitigating strategies recommended to reduce these false alarms rely mostly on education coupled with increased enforcement. Examples include changing the programming of the alarm panel, maintaining range hoods, and improving security camera ability.

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Introduction

Heritage House Condos (HHC), located at 310 W. Meadowview Road, is a significant location for the City of Greensboro. This location is responsible for generating the most emergency incidents for a single address annually in the city. Obviously, that is not a record that one location should be proud of. The address of 310 W. Meadowview is known by many emergency responders and city officials. Unfortunately, the reputation causes most to sneer when the address is even mentioned.

While there are a significant amount of incidents for the Greensboro Police Department, and a plethora of calls for Guilford County EMS, this research focused on a problem specific to the Greensboro Fire Department (GFD): false alarms. The problem is that the GFD responds to a disproportionate amount of false alarms at HHC. This is as compared to any other commercial or residential property in the City of Greensboro.

While numerous city agencies have discussed problems at HHC, very few, if any, have taken steps to specifically identify the causes of the problems in an attempt to remedy them. The purpose of this applied research project is to identify the causes of false alarms at HHC and recommend action(s) to reduce them.

In order to complete this research the descriptive method will be used. Descriptive research is “determining and reporting the current status of something” (United States Fire Administration [USFA], 2013, p. II-12). Data will be collected and analyzed by utilizing the GFD incident reporting system. This will allow the researcher to determine the primary cause of false alarms at HHC. Literature review will be used to determine if the number of alarms is abnormal and identify potential methods to reduce them. Effective forms of intervention will be recommended to reduce the number of false alarms in the future.

These forms of intervention will focus on the five "E's" as referenced in the Executive Analysis of Community Risk Reduction Student Manual from the National Fire Academy. This information will provide answers to the following research questions:

1. What are the causes of malicious alarms at HHC?
2. What are the causes of unintentional alarms at HHC?
3. What options are available to mitigate the causes for malicious and unintentional alarms at HHC?

Background and Significance

The City of Greensboro is the third largest city in North Carolina with a 2012 estimated population of 275,879. Like many municipalities, numerous citizens hold jobs within the city limits, but do not reside there. This causes Greensboro's daytime population to rise to an estimated 334,796. Greensboro covers 133 square miles, but due to areas that contract for fire protection, the Greensboro Fire Department protects a total area of 144 square miles (Williams, 2013, p. 8).

The GFD is a municipal department that employed 543 sworn personnel and 16 civilian positions in FY11/12. To show growth, it is noted that this was an increase of 35 firefighters and 2 civilian personnel from the previous fiscal year (Bowman, 2013, p. 1). GFD operates out of 24 fire stations that are divided into 5 Battalions. They respond with 23 engine companies, 10 ladder companies, a Heavy Rescue, and numerous support elements such as Hazardous Materials and Urban Search and Rescue teams. Minimum staffing for apparatus is 4 on engine companies and 3 on ladder companies. A fire company is comprised of a Captain, Engineer, and Firefighters. Call volume for FY11/12 was 30,816 incidents which included 49,189 responses by individual units. Of these incidents 1,074 were fires (Bowman, 2013, p. 5). The majority of

incidents are emergencies such as medical calls, fire alarms, vehicle accidents, etc. GFD responds to medical emergencies as first responders (Emergency Medical Technician) to assist the county-run ambulance service (Williams, 2013, p. 8).

The address of 310 W. Meadowview Road in Greensboro, NC is known as Heritage House Condos (HHC). This building was originally built in 1974 as a six story hotel. After many years of being vacant, investors developed the structure to accommodate private condominiums. The reason for private condos was decided largely because of Fire and Life Safety Code requirements. Many occupancy options would have required retrofitting the structure with sprinklers. This was financially prohibitive. Thus, privately owned condominiums became the future of 310 W. Meadowview Rd. These condos were sold as any other real estate would. Owners then began renting individual units to tenants. There are 177 units in HHC with 67 individual owners.

HHC is well known by the Greensboro Fire Department (GFD) because of the number of incidents that warrant a fire response. In fact, it is the most dispatched address in the entire city. While these responses include incidents such as medical emergencies, odor investigations, elevator incidents, etc., this research will focus on the number of fire alarms that GFD responds to on an annual basis at HHC.

This topic is relevant to the GFD for numerous reasons. While specific figures are not addressed during this project, it costs money to put fire apparatus on the road. There are intangible costs such as wear and tear on apparatus and tangible costs such as fuel consumption. There is also the human cost of putting firefighters on-scene who work to investigate the alarms.

Because of the life hazard associated with HHC, the GFD response protocol for several years was to dispatch a fire alarm at HHC as a structure fire. This called for three engines, two

ladders, a rescue, and two battalion chiefs to respond. After a couple years of responding in this manner, the response protocol was changed to a standard GFD fire alarm dispatch of two engines and one ladder. The decision to change dispatch protocol was made due to the overwhelming number of false alarms at HHC.

Some may consider this change in protocol a type of complacency. In fact, the decision to upgrade fire alarm response to HHC (years ago) was done because of the risk to life safety and concerns that an incipient fire would quickly grow into a major incident. Responders knew that a working structure fire would demand numerous fire resources to assist with emergency tasks such as citizen evacuation, standpipe operations, fire stream management, and ventilation.

From an administrative point of view however, the decision to reduce the response to a fire alarm certainly made good business sense. Research will show that the overwhelming majority of fire alarms were false; alarms caused by cooking, cigarette smoking, and other factors that were not emergencies. One could argue that the GFD was taking more risk by putting apparatus on the road as they travelled to and from these false alarms.

Not only is there a financial impact to the GFD, but there is the loss of what many would call reliability. The reliability of a specific fire apparatus is analyzed by determining how frequently the apparatus was unable to respond to an incident because they were already working a previous incident. Loss of reliability causes an increased risk to the community who relies on their closest fire station to respond when they call 911. This results in increased response times and the movement of fire resources outside of their intended geographical response area. This also relates back to the previously mentioned financial burden as the GFD is incurring additional maintenance and fuel costs for additional apparatus responding to the other incident.

Another significant impact of these false alarms is complacency by the residents of HHC.

While there are no official statistics, responders to HHC would tell you that the percentage of residents who evacuate during a fire alarm is close to zero. When the fire alarm is sounded several times per day without consequence, the residents become immune to it. The literature review revealed numerous sources that refer to this as the "cry wolf" effect. It is certainly a common problem throughout the country and significant to HHC.

Complacency is also a concern as it relates to the attitude and actions of firefighters responding to HHC. GFD firefighters are professional responders who do their best to treat each incident as a true emergency. The typical response to a high rise incident dictates that responders don PPE, gather standpipe equipment, hose, and tools, and respond to the location of the alarm. This equipment easily adds an extra 60 pounds of weight to each firefighter. A trip to the sixth floor is no simple task; it is a fitness workout! Imagine doing this three times after midnight (GFD personnel work a 24 hour shift). There is no doubt that the tendency to become complacent would naturally occur. Responders may find their attitude trending toward, "just another fire alarm," instead of preparing for a true emergency. Any study of firefighter injuries and fatalities will reveal that this attitude is often a causal factor for the negative consequence that occurred.

This research project was developed as a portion of the Executive Analysis of Community Risk Reduction (EACRR) course at the National Fire Academy in Emmitsburg, MD. The concept of community risk reduction includes strategies to both prevent and mitigate any issue which would cause the community to be vulnerable. The EACRR student manual states that, "Risk prevention involves anticipating potential hazards within a community and facilitating interventions to prevent occurrences. Risk management involves anticipating

potential hazards within a community and facilitating interventions to diminish adverse outcomes" (Executive Analysis of Community Risk Reduction, 2013, p. 1-11).

As indicated previously, the issue of numerous false alarms creates a risk to the community of HHC and the community outside HHC. If the residents at HHC and the GFD were able to reduce the number of false alarms the risks would be reduced. Should a true emergency occur, residents at HHC would be more likely to respond appropriately to the alarm (i.e. investigate and evacuate). This would also increase GFD reliability (the ability to respond to other emergencies) and decrease operating costs.

The EACRR course teaches strategies to mitigate community risk. These are referred to as the five "E's" (education, engineering, enforcement, economic incentives, and emergency response). For the purposes of this research, education and engineering will be focused on as a means to reduce the number of false alarms at HHC.

Many locales have made strong use of enforcement as a strategy to mitigate excessive false alarms. This would typically be done through local ordinances regulating false alarms and the associated monetary penalties for violation. This means of mitigation will intentionally be avoided by the researcher during this project. The reasoning for this relates to the complexity of HHC and the researcher's knowledge of the status-quo for false alarm responses. Many false alarms at HHC have no responsible party and therefore no specific person to fine for a violation. It is the researcher's belief that pursuing an enforcement approach would not be an achievable goal and therefore would not reduce risk. The hope is to establish goals that are specific, measurable, achievable, relevant, and time-framed (SMART).

In addition to the applicability to the EACRR course, this project will also meet three goals established by the United States Fire Administration's Strategic Plan. They are: reduce

risk at the local level through prevention and mitigation, improve local planning and preparedness, and improve the fire and emergency services' capability for response to and recovery from all hazards (United States Fire Administration [USFA], n.d., p. 13).

Literature Review

This research project will focus on reducing the number of false alarms at Heritage House Condos (HHC). The majority of reference materials were found while conducting a literature review via the Learning Resource Center on the campus of the National Emergency Training Center in Emmitsburg, MD.

The issue of correcting or reducing false alarms has been dealt with across our nation and other countries since the invention of the smoke alarm. Wayne Moore published an article in the NFPA Journal in which he recalls, "…what we labeled as a 'false alarm epidemic' in the late 1970's" (Moore, 2011, p. 58). At that time Moore states, "…training and education seemed to hold the key to improvement…" These same comments are just as applicable today for occupancies such as HHC.

In 2009, Robert Thilthorpe wrote in Fire Risk Management, "…reducing what is still an unacceptable waste of resources remains one of the biggest challenges that we, as an industry, have to continue to grapple with" (Thilthorpe, 2009, p. 38). He was, of course, writing about the challenge of numerous false alarms. He went on to say, "A false alarm is not simply an irritation – it costs money, it wastes resources, it is potentially dangerous, and it impacts on people's trust of automatic fire detection and alarm systems." The same sentiment is echoed in the same publication four years later when Graham Ellicott said, "…everybody agrees that false alarms are

a total waste of the fire and rescue service's and the user's time, let alone the money that is involved" (Ellicott, 2013, p. 46).

How much money are false alarms costing? The literature review revealed that in many cases, the cost associated with false alarms is difficult to determine. Many fire departments are able to determine an average cost per incident by basically dividing their operating budget by the number of incidents. For example, statistics from the Greensboro Fire Department (GFD) reveal that the cost per incident FY12/13 was $1,409. However, Battalion Chief Todd Tuttle with the GFD explained that reducing false alarms would not reduce this specific figure. The cost for apparatus and personnel would remain the same regardless of the number of calls they are responding to (T. Tuttle, personal communication, May 22, 2014). The financial benefit would come from the reduction in fuel cost and general wear and tear on apparatus and equipment.

There have been attempts to determine the cost per mile of operating emergency apparatus. Brent Batla, of the Burleson Fire Department in Texas, conducted a research project that focused on replacing fire apparatus with sport utility vehicles when responding to medical emergencies. A large part of his research focused on the cost analysis of operating typical fire apparatus. He found that in 2011, one of their ladder trucks averaged a fuel cost of $4.26 per incident. In addition, a study of maintenance costs for the same apparatus revealed that their department averaged $1 per mile (Batla, 2013, p. 19-21).

Another research project was conducted by Alan Long of Overland Park, Kansas. He also attempted to identify the cost of operating an emergency vehicle. His studies focused on a 2004 rescue vehicle weighing 52,000 pounds. The research revealed that this apparatus (Rescue 44) averaged a cost of $2.36 per mile in 2012 (Long, 2013, p. 9, 19).

Obviously, there are numerous factors that affect the cost of operating fire apparatus. These include the cost of fuel, the efficiency of the apparatus, driving habits, etc. Mr. Batla's and Mr. Long's estimates provide a good indication of cost even though a true cost analysis would need to be conducted by individual departments on specific apparatus.

One generic method to estimate cost is provided by FEMA's Schedule of Equipment Rates. Based on this, a 1250 GPM engine and a 75' ladder truck would cost $80 and $125 per hour respectively (Federal Emergency Management Agency [FEMA], 2013).

In 2009, the average cost in the United Kingdom for fire response was reported to be an estimated £1,000 per incident which equated to $1,590 at the time (Thilthorpe, 2009, p. 38). In contrast, Buckinghamshire England estimated their cost per incident at £300, or $465, in 2012 (Duggan, 2012, p. 41).

A research project written by David Thornburg in 2000 addressed some of the same false alarm issues for the Montgomery County Fire Department in Mississippi. At that time, he estimated the cost per incident at $350. Their department averaged three false alarm incidents per week for an annual total of $54,600 (Thornburg, 2000, p. 8). In comparison, the research will show that false alarms to HHC far exceed three false alarms per week for the GFD. It is not uncommon for the GFD to respond to three false alarms *per day* at this location.

As previously mentioned, there does not seem to be a consensus regarding the specific dollar amount that could be saved through a reduction in false alarms. Everyone would agree however, that reducing the number of false alarms would create a significant budgetary savings.

False alarms accounted for 2,238,000 of the United States fire service responses in 2012. This is roughly 7% of the total call volume for the US fire service. To put the severity of the issue into perspective, false alarms were the third most frequent event. The first was medical aid

incidents at 21,705,500, and second was, “all others (smoke scare, lock-outs, etc.)” at 4,155,000 (Carter, 2013, p. 24).

In 2011, the United Kingdom reported the total number of their false alarms to be 249,000. While not specific to fire service cost, they estimate these false alarms to cost the UK economy £1 billion per year; an equivalent of $1.6 billion. In London alone it was reported that the fire service responded to a false alarm every 12 minutes. The cost of these responses was estimated at £35 million per year or $56 million (McFarlane, 2013, p. 47).

In 2007, the campus of King’s College, London experienced 396 fire alarms. This campus has more than eighty buildings that are spread across an eight-mile radius. At the time there were 5,700 staff and over 21,000 students. Of the 396 fire alarms, only 15 were actual fire events. This means that 96% of the fire alarms received were false alarms (Thilthorpe, 2009, p. 39). These figures will be used in the research to compare the number of false alarms at HHC.

Ronald Dennis conducted research in 1993 of false alarms in Lake Havasu City, Arizona. Over an eighteen month period he found that the fire department had responded to 620 fire alarms. Of these, only three were true emergencies. 99.5% of their fire alarm responses were false or unwarranted (Dennis, 1993, p. 20).

In Buckinghamshire, England, Malcom Brightman was tasked in 2006 with reducing the number of false alarms. One of his strategies included analyzing data and targeting those locations that were responsible for the most alarms. The worst offender at that time was responsible for 160 false alarms in a twelve month period. He also focused on any location that experienced three or more false alarms over an eight week period (Duggan, 2012, p. 39). Again, these facts will establish a rough baseline to compare with HHC.

The literature review also yielded many writings regarding the 'human element' and the results of false alarms on citizens and firefighters. Ronald Dennis (1993) wrote:

> …the confidence in these systems by occupants has significantly deteriorated to the point that the attitudes and behaviors of citizens and firefighters alike are not at all what is expected when such alarms are activated. …the lack of confidence in the reliability of alarm systems has resulted in the assumption that a sounding alarm seldom means there is a fire. The reactions of fire personnel to such calls for service are more often 'nuisance' related than they are 'service' related. It has been determined that neither citizens nor firefighters respond to the activation of a fire alarm in an appropriate manner. (p. 5-6, 20)

In an article titled Crying Wolf, Wayne Moore (1986) wrote:

> False alarms, primarily from smoke detectors, play a major role in decreasing the credibility of a fire alarm system and their psychological impact may well be the most valuable link in our early warning systems as installed today. The "horror" stories are many: tenants refusing to leave the building (or worse not bothering to investigate) because, "it's just another false alarm." (p. 13)

Mr. Moore (1998) wrote another article addressing the issue of complacency towards fire alarms. In it, he stated:

> The residential smoke alarm has been credited with saving thousands of lives, yet the popularity of napkins stating "dinner will be ready when the smoke alarm goes off" continues to increase. Such jokes are just one sign that the credibility of residential and commercial smoke detection and alarm systems may have lessened in the minds of those who are protected by such systems." (p. 54)

In the United Kingdom, Graham Simons wrote, "…false alarms put people's lives at risk. With a loss of confidence in the fire alarm system, people could become complacent and may not behave as they should in the event of a real fire." (Simons, 2013, p. 54)

In Australia, research was conducted utilizing surveys that were distributed to residents of three residential high-rises. The research focused on the habits of individuals during an emergency. Results found that, "…residents feel they do not need to evacuate a building when the fire alarm sounds." The article also references one tenant who said:

> The first time the alarm sounded was during the day. Everyone walked out onto their balconies to check for smoke. There was none, so no one evacuated. The next time it happened was around 3 am. I got up, checked for smoke, then went back to bed with a set of earplugs. (Tooley, 2010, p. 25)

Another example of complacency comes from a study in Canada. After a fire in a residential high-rise, a researcher questioned residents about their actions during the event. Even though residents knew the proper procedures, 34% waited approximately 5 minutes before evacuating. The researcher noted, "The fire alarm was activated regularly in the building due to false alarms or fire alarm testing." While 83% did eventually evacuate, most chose to do so because of some cue other than the fire alarm. "Only 4% indicated starting evacuation after hearing only the fire alarm." This was out of 213 individuals who answered the researcher's questions. "…most occupants treat the sounding of a fire alarm as a warning and wait for further information…before starting to evacuate" (Proulx, 1999, p. 319-320).

If false alarms are such a significant issue, what are the causes for these alarms? The previously mentioned King's College, London found that in 2008 the majority of their false alarms were caused by "equipment, the action of external contractors, and cooking." In addition,

14% were caused by “hair appliances…steam, cigarette smoke, dust and aerosols…” 7% were due to “malicious intent.” In the same article, several other locations were discussed that were known for false alarm issues. One of these was the Stoke Mandeville Hospital in Buckinghamshire. Robert Thilthorpe reported that the typical cause was smoke from a cooking activity. He also discussed the Princess Yacht Company that often experienced false alarms as a result of, “industrial process which can give rise to heat, smoke, and other particulates…” (Thilthorpe, 2009, p. 40)

According to Donald McFarlane, we must understand the causes for false alarms in order to create a mitigating strategy. “Culprits range from cooking fumes and tobacco smoke, to a build-up of dust and aerosol sprays. All of these can be rectified without compromising the effectiveness of the system to deal with real fires quickly” (McFarlane, 2013, p. 48-49).

Wayne Moore lists ten contributing false alarm factors in his article “Fire Alarm Systems Crying Wolf.” They are “1) People problems, 2) Smoke detector location/application, 3) Early installation of smoke detectors, 4) Improper installation, 5) Humidity, 6) Insects, 7) Non-compatibility, 8) Radio frequency interference, 9) Induced voltage, 10) Smoke detector sensitivity.” Moore (1986) also states that:

> People cause false alarms due to their lack of knowledge of detector operation. Most common are: opening the apartment door to the hallway to vent cooking smoke, smoking directly beneath a smoke detector, not cleaning detectors at least annually, and spraying air freshener at or too near a smoke detector. (p. 13)

Once false alarms are identified as a problem, the natural course of action would be to mitigate them. There are several ways that this might be accomplished. The researcher found that most of these options fell into the categories of education, engineering, and/or enforcement.

Malcom Brightman from Buckinghamshire, England was mentioned previously in regard to his efforts in reducing false alarms. He found that, "most RPs [responsible persons] do not understand their detection and alarm system; once confronted and educated they are cooperative and are often keen to resolve the issue." When firefighters respond to find a false alarm, (called an unwanted fire signal) they document the incident and provide this documentation to Mr. Brightman. This allows for a follow up with the location and hopefully an opportunity to educate them. If this fails to fix the issue then an enforcement notice is issued (Duggan, 2012, p. 40-41).

One of the engineering methods used to mitigate false alarms in Buckinghamshire was termed the "double-knock." If a single smoke detector is activated, on-scene staff is notified so that they can investigate the cause. During this time, an alarm signal would not be sent to the fire service. If a pre-set amount of time expires before the alarm is reset, then the alarm signal would be transmitted. An alarm is automatically sent any time a heat detector, pull station, or multiple smoke detectors are activated (Duggan, 2012, p. 41).

This process has been successful for Buckinghamshire. Among the top offenders were hospitals. In 2005/2006 the Stoke Mandeville hospital experienced 160 false alarms. After mitigating strategies were utilized the hospital only experienced 8 false alarms in 2011/2012. Wycombe hospital was originally responsible for 70 false alarms and saw a 83% reduction, and Milton Keynes hospital saw a 72-77% reduction from around 50-60 false alarms down to 14 (Duggan, 2012, p. 41).

In another example, Mr. Brightman worked with a conference center that experienced numerous false alarms. After engineering options were considered, the location's insurance company was resistant to allow any changes. A meeting was held with Mr. Brightman, and the

proposed changes were further discussed. This educational opportunity allowed those involved to understand that the alarm system had become unreliable and caused staff and guests to become complacent. The changes were successfully made. Between 2007 and 2012, Buckinghamshire saw an overall reduction of 45% in all false alarms (Duggan, 2012, p. 41).

Recording the cause of a false alarm will obviously assist in determining a strategy to reduce them. Some causes and strategies can be very simple. Graham Simons says, "For example, if smoking is the problem, proper facilities should be provided away from smoke detectors." More complex causes and strategies could include the change of the occupancy or work that may occur in a specific area of the building. These issues may "… require a risk assessment and the implementation of alternative temporary fire protection measures in order to avoid any unnecessary alarm activation" (Simons, 2013, p. 55).

The type of detector selected for a specific area may also impact the number of false alarms. A kitchen area for example, would be better served by a heat detector instead of a smoke detector. Conversely, an escape route would be better served by the installation of smoke detectors instead of heat detectors (Simons, 2013, p. 56).

Donald McFarlane echoed this sentiment in a recent Fire Risk Management article when he said, "One of the simplest steps that can be taken to combat the problem of false alarms is to select the best sensor for each application." He goes on to describe the numerous types of detectors that are available. For example, there are around twelve different types of heat detectors on the market. Whether it is a heat detector, photoionization smoke detector, aspirating sensor, or beam sensor, they all have pros and cons that must be evaluated. Proper selection can reduce the number of false alarms (McFarlane, 2013, p. 48).

Mr. Simons discusses several other engineering strategies. The first he calls “delay alarms.” When a detector is activated, the actual fire alarm is delayed so that staff can investigate. The second is called “coincidence detection.” This requires the activation of two detectors before the alarm is initiated. The third is considered “day/night mode” which would change the alarm system operation when the building is occupied. This could involve disabling smoke detectors and allowing for a delay in alarm so that a signal can be investigated. However, manual pull stations would be active and immediate. Mr. Simons also writes about the previously mentioned “double knock” method as a mitigating strategy (Simons, 2013, p. 56).

Another engineering option was proposed by NFPA 72 committee members in the late 1970’s, and it was called “alarm verification.” Wayne Moore (2011) said:

> This process would allow a smoke detector in alarm to initiate a timed reset period during which the detector or control unit would wait for the detector to enter an alarm state a second time before initiating a general alarm. If the detector remained reset without entering an alarm state the second time, the panel would not report an alarm, and the system would remain in a normal standby state. (p. 58)

The literature review yielded numerous articles that were focused on the enforcement aspect of false alarms. This is typically done by creating and enforcing a local ordinance to address the issue of numerous false alarms. A monetary fine is associated with repeat offenders, and the details vary depending on the locale. The most common ordinances allow a certain number of false alarms per year before a monetary fine is levied. Subsequent alarms usually have a graduated financial penalty. For example, after three false alarms a property owner would

be charged $150 per alarm. After six false alarms this fee could increase to $250 per additional alarm. Again, these are hypothetical figures that will vary depending on the town/municipality.

While enforcement is a valid and widely used form of mitigation, the researcher has intentionally avoided it for the purposes of this project. The complexities of HHC would make collection of any fines an unattainable goal. The researcher's personal experience as a responder to HHC was a factor in this decision. Most of the false alarms at HHC cannot be associated with a responsible party. Therefore, there would be no one to apply the violation and fine to. Other associated complexities were shown in the background section of this paper.

During the literature review, the researcher noticed different terminologies relating to false alarms. This led to the review and inclusion of definitions from the current NFPA 72 standard. Being able to collect data and track the number and causes of alarms is important. The available data will obviously be skewed if firefighters across the nation use differing terminologies for the same type of incident. For example, consider a fire alarm that is activated when someone intentionally blows cigarette smoke towards a detector. One fire officer may code this as smoke detector activation while another officer may have coded it as a malicious false call.

The 2013 edition of NFPA 72 is titled the National Fire Alarm and Signaling Code. In this most recent version, the issue of improperly coded "false alarms" is addressed. In hopes of clarifying the type of incident, and obtaining more specific data, the NFPA committee uses the term "unwanted alarm" instead of the traditional term "false alarm." The specific definitions from NFPA 72, Chapter 3 (2013) are as follows:

- "Unwanted Alarm - Any alarm that occurs that is not the result of a potentially hazardous condition."

- "Malicious Alarm - An unwanted activation of an alarm initiating device caused by a person acting with malice."
- "Nuisance Alarm - An unwanted activation of a signaling system or an alarm initiating device in response to a stimulus or condition that is not the result of a potentially hazardous condition."
- "Unintentional Alarm - An unwanted activation of an alarm initiating device caused by a person acting without malice."
- "Unknown Alarm - An unwanted activation of an alarm initiating device or system output function where the cause has not been identified."

(Source: (*NFPA 72*, 2013, Chapter 3)

The literature review clearly revealed that unwanted alarms are a continual problem for the fire service. These alarms utilize valuable resources and cost fire departments, and taxpayers, a significant amount of time and money. While it is a large scale problem, this research will focus on the unwanted alarm issues specific to HHC. Facts within the literature review will allow for contrast and comparison with statistics at HHC.

This research will hopefully provide insight into the problem and reduce the number of unwanted alarms at HHC. As Ronald Dennis (1993) clearly stated in his research paper:

> To solve these problems, we must first find a way to eliminate unwanted activation of a fire detection system and restore faith in humans so that when a fire alarm sounds, it is most often a legitimate emergency, and less often a mechanical failure or unintentional activation. (p. 6)

Procedures

Conducting a formal literature review is not traditionally a research procedure. However, the researcher found many valid recommendations during this process. For example, the majority of mitigating strategies to reduce false alarms were found within the literature review. Therefore, conducting the literature review for this particular topic became a part of the procedure.

The Greensboro Fire Department (GFD) utilizes FireHouse software to manage incident reports. In order to analyze the call volume for the GFD to Heritage House Condos (HHC) the researcher used these FireHouse records. As a member of the GFD, the researcher had access to this database and could readily use it for data mining. The researcher decided to review the last five years of GFD responses to HHC.

While the National Fire Incident Reporting System (NFIRS) is very thorough, the researcher found that analyzing the cause of false alarms was quite labor intensive. Reports within the FireHouse software allowed the researcher to determine the number of false alarms to HHC during a given year. However, the cause of these false alarms is not a field of data that is collected with the NFIRS. Once the researcher obtained a list of false alarms, each incident narrative was individually read to determine the cause for the alarm. An Excel spreadsheet was maintained by the researcher in order to record these results. This allowed for the organized analysis of different causes for alarm and the ability to tally each cause.

Within the GFD there are actually two separate FireHouse databases that are maintained. One is utilized by line company personnel (those in the suppression division), and the other is utilized by the GFD Fire and Life Safety Division (FLSD.) The FLSD carries out the responsibilities of inspections, code enforcement, and formal public education programs. For the

purposes of this paper, the key component from the FLSD was inspections for compliance with the Fire & Life Safety Code at HHC.

Because the FLSD database is separate, the researcher did not have access to this information. Mrs. Dana Gibbs is an administrative assistant in the FLSD, and the researcher met with her to review this information. This allowed the researcher to determine how many fire inspections, complaints, violations, fines, etc. were associated with HHC. A detailed review for the date range of January 1, 2013 through June 26, 2014 was conducted. The researcher also reviewed information from earlier dates for significance. An example of this would include the issuance of Certificates of Occupancy in late 2004. Several relevant and interesting letters regarding citizen safety and general concerns were also found during this review.

The researcher also had several personal communications with GFD Interim Fire Marshal Kevin Pettigrew. These communications focused on the mitigation of false alarms at HHC and fire code violations. During the literature review, the researcher began to formulate recommendations and wished to discuss these with Fire Marshal Pettigrew. Several of these were later recommended to an HHC property representative during a meeting with Fire Marshal Pettigrew and Inspector Erin Price.

HHC is also a significant address for the Greensboro Police Department (GPD). As the research revealed, it is responsible for the highest call volume in the city for both GFD and GPD. The researcher met with GPD Sergeant Bateman in order to collect data relevant to the GPD. Sgt. Bateman had recently compiled data regarding HHC since this is such a significant issue for their department. He was able to provide the researcher with the number of GPD responses for 2013, the number of living units, a list of property owners, and information relevant for responders to HHC (such as gang activity).

In similar fashion, the researcher contacted Bryan Beeson, a representative with Guilford County Emergency Services (GCES). Mr. Beeson conducted some brief internal research and was able to provide the researcher with the number of ambulance responses to HHC in 2013. In Guilford County, GCES manages the ambulance service for the entire county which includes the City of Greensboro.

Results

Many of the fire alarm issues at HHC are related to the Fire and Life Safety Code. Because of this, a review was conducted of the Greensboro Fire Department's Fire & Life Safety Division (FLSD) records. During this review it was noted that Certificates of Occupancy were issued by the FLSD in late 2004. This was verification that it has been approximately 10 years since HHC has been occupied as condominiums.

Two years of FLSD records were analyzed for details. To provide the reader with an idea of the information found, a bulleted list with short hand notes is provided here.

- 2/18/13 – re-inspection fee assessed for unrepaired issues
- 5/20/13 – complaint for missing smoke detectors
- 6/12/13 – re-inspection; electrical wires exposed, fire door issues, exit signs, emergency lighting
- 8/15/13 – complaint for fire door issues and no handle on an egress door
- 8/20/13 – re-inspection
- 10/17/13 – inspection
- 4/15/14 – complaint from firefighters because of a couch blocking a stairwell, fire door closures missing, and a gasoline odor inside the building
- 4/16/14 – complaint from firefighters because of nine smoke detectors missing on the 3rd floor
- 4/21/14 – re-inspection; fire pump service checked; inspector met with one of the owners who stated that he would like to shut the building down
- 6/9/14 – complaint from firefighters because of a discharged extinguisher; two detectors out of service
- 6/12/14 – met with property representative regarding the number of malicious fire alarms; discussed changing from smoke detectors to heat detectors; asked to add "alarm verification" to the fire alarm system; gave permission to reduce the number of fire extinguishers; violations found included electrical panel issues,

exit signs, emergency lighting, fire extinguishers and door closures that were missing

- 6/25/14 – inspection; exit lighting, over 10 extinguishers missing, 13 emergency lights out, general clean up needed, 3 fire door closure missing
- 6/26/14 – re-inspection; electrical panel issues, exit signs, emergency lighting, fire extinguishers, change fire alarm to allow for "alarm verification", door closures

While reviewing records held by the FLSD, the researcher also found copies of an e-mail correspondence and letters that related to this research. One letter, dated May 2006, was written by a resident at HHC and sent to the Greensboro Fire Chief. The purpose was to request assistance with issues that the resident noted. The anonymous writer said:

> …the false alarms have continued, and escalated, with at least one and frequently more than one false alarm every night. The frequency of false alarms has caused many residents to disregard them. In the event of a real fire, I feel this would create a disaster and would result in the possible death of residents.

In September of 2006, an anonymous resident e-mailed the Greensboro Fire Marshal. The e-mail contained a list of complaints and questions regarding the management of HHC and the issue of false alarms. The resident wrote:

> What does the fire department recommend we do in order to resolve our issue concerning our fire alarms and getting in and out of the building during these alarms? There are 177 units and very few tenants leave the building because we have so many false alarms.

A review of Greensboro Police Department (GPD) incidents to HHC was also reviewed to determine their call volume to this address. While this does not directly relate to the fire service or fire alarms, it does provide insight into other issues at HHC. There is some correlation however, as the GPD currently responds to any 911 call at HHC. This includes all fire alarms, medical calls, etc. Responding in this manner began approximately three years ago after gang

activity was reported at HHC. Therefore, reducing the number of unwanted fire alarms at HHC would be beneficial to the GPD as well.

The HHC address is responsible for the most GPD calls within the City of Greensboro. As stated in the Introduction, it is also responsible for the most GFD incidents in the city. Incident data was provided to the researcher by Sergeant Bateman with the GPD. From January 1, 2013 to December 10, 2013 the GPD responded to 2,253 incidents at HHC. In regards to fire alarms, the GPD believes that gang members use the fire alarm as a signal that the police are on-scene. Sgt. Bateman knew of several instances where a GPD officer would arrive to HHC and then, moments after getting out of their car, hear the fire alarm sounding. While it is impossible to obtain real and accurate information on this, it certainly could explain numerous pull station activations and unknown causes for detector operation.

During the interview with Sgt. Bateman, the researcher also determined that there are 67 different owners at HHC for the 177 units. The number of units owned per individual or company varies, from as few as one to as many as thirty.

A detailed analysis of the GFD responses to Heritage House Condos (HHC) was conducted by the researcher. The review of GFD incident reports to HHC was conducted for a five year period beginning in 2009 and ending in 2013. The date ranges were broken down by calendar year. As the researcher compiled this data, it became clear that there were several causes for fire alarms that comprised an overwhelming majority. These were: discharged fire extinguishers, pull stations, smoke from cooking, smoke from cigarettes, and those that were listed as unknown.

Table 1 first provides the total number of emergency responses by the Greensboro Fire Department to HHC for each year. This is regardless of the type of incident. This is followed by

the number of medical responses coded in the National Fire Incident Reporting System (NFIRS) as 3111 and 3112 (Medical Assist). As an aside, data from Guilford County Emergency Medical Services showed that they responded to 213 medical calls in 2013. Next is the total number of incidents listed as any NFIRS 700 series (False Alarm & False Call). Finally, Table 1 shows the number of incidents coded as NFIRS 100 series (Fire). The 100 series incidents were noted since the fire alarm would be expected to activate during these events. Obviously, the alarm activation in these cases would be a true emergency and not what most would label as an unwanted or false alarm.

Table 1

	# of total incidents	**NFIRS 3111 & 3112**	**NFIRS 700**	**NFIRS 100**
2009	63	40	10	4
2010	153	76	55	3
2011	236	126	66	10
2012	265	113	129	5
2013	511	102	375	3

Table 2 provides data regarding the cause of false fire alarms at HHC. While there are a few causes for fire alarms not listed here, those listed were responsible for the overwhelming majority.

Table 2

	Cigarette Smoke	Smoke from Cooking	Unknown	Pull Station	Fire Extinguisher Discharge
2009	2	4	5	0	0
2010	7	27	17	10	3
2011	5	40	24	3	2
2012	51	44	18	5	6
2013	171	88	48	25	10

While the generic use of the term false alarm is still commonly used, the research questions for this project utilized the terms “malicious alarm” and “unintentional alarm.” This was done to match terminology found through the Literature Review in the NFPA 72 standard. Because the five causes of fire alarms listed in Table 2 were so prevalent, the researcher attempted to match these five causes to the proper NFPA 72 definition. The results showed that a third definition from NFPA 72, “unknown alarm,” should also be added. This was due to the fact that 48 alarms, or 13%, in 2013 were caused by an unknown reason.

The number of fire alarms that had unknown cause was totaled in two ways. The primary method, and certainly the most accurate for this research, was by reading the incident report narrative. For example, an Incident Commander may have written, “We found an activated smoke detector on the 5th floor but were unable to determine the cause of activation.” Other incident narratives may have been vague. For example, “We found an activated smoke detector on the 5th floor.” The researcher treated both incidents as unknown alarms since one indicated that responders truly did not know the cause, and the other was, for research purposes, unknown.

The leading cause of fire alarms in 2012 and 2013 was from smoking near a smoke detector. In 2012 this accounted for 40% of all fire alarms and 46% in 2013. While this research continually refers to this as cigarette smoke, the reality is that it could be from a cigar, pipe, or even marijuana usage. The incident report narratives commonly refer to "someone smoking" while the specifics of what they were smoking is not specified nor is it relevant. However, responders have reported an odor of marijuana when checking activated smoke detectors in the past.

This cause for fire alarms is hard to place in a specific NFPA 72 category. Fire department personnel do not witness the detector activation, and there are no functioning security cameras. Therefore, it is typically not known whether the smoke detector activation was done unintentionally or maliciously. Examples of this would include someone blowing smoke into the detector versus someone who was smoking while walking underneath a detector.

Smoke from cooking would certainly be an example of an unintentional alarm. Many of the incident narratives that were reviewed indicated that these were simply accidents and there was no malice involved. Examples include causes such as overheating cooking oil, or accidentally burning food. For clarification, these "smoke from cooking" fire alarms are not cooking related fires. They are incidents where a smoke detector was set off from a cooking process, but no true emergency existed. In 2013, smoke from cooking was responsible for 23% of fire alarms to HHC. This was down from 34% in 2012.

The last two causes for fire alarms, pull stations and extinguisher discharges, fall into the malicious alarm category of NFPA 72. If an individual accidentally activated a pull station, then theoretically it could be categorized as an unintentional alarm. While it is only an assumption, one would assume that a citizen unintentionally activating a pull station would meet the fire

department to inform them of the issue. In most cases of pull station activation at HHC, witnesses will report someone, or some group, running from the area of the pull station. Therefore most, if not all, of the pull station activations at HHC have been coded in the incident reports as a malicious alarm. These events accounted for 4% of fire alarms in 2012 and 7 % in 2013.

Responders to HHC have had good training on ventilation practices due to fire extinguisher discharges. Extinguishers are located in cabinets throughout the hallways of the property and are accessible to anyone who enters the building. In 2012 there were 6 of these incidents (5% of fire alarms), and in 2013 there were 10 events (3% of fire alarms). The dry chemical extinguishers fill hallways with fine powder that inevitably activates several smoke detectors. Responders typically use common ventilation techniques to remove as much powder as possible from the hallways.

As with the pull station issue, responders typically arrive to find a discharged extinguisher with no one in the area. These extinguishers are usually not replaced for some time, and many extinguishers in the extinguisher cabinets are found to be in need of service. While this is an issue that could bring legal action on the offender, the lack of witnesses and no security cameras make legal action a moot point. There is simply no way to prove that an individual was responsible for the offense.

In order to reduce the number of unwanted fire alarms at HHC, the researcher attempted to identify options that are available to mitigate these malicious and unintentional alarms. One of the easiest, economical, and far-reaching solutions could be programming the fire alarm panel for alarm verification. This possibility was noted by the researcher during the literature review.

While the details of the set-up can vary, the basis of the alarm verification engineering is as follows.

When the fire alarm system receives a signal from an activated smoke detector, it does not immediately go into alarm, but begins a timed verification process. After a pre-determined amount of time the alarm will attempt to reset the activated detector. If the detector resets, the system resets and returns to normal operation. The alarm is not sounded and the fire department is not called. During this delay however, if a second detector is activated, or if the original detector is unable to be reset, the fire alarm system will go into alarm.

A large portion of unwanted fire alarms, whether from cigarette smoke or cooking, are caused when one detector activates. By programing the fire alarm system to use alarm verification, the number of unwanted alarms at HHC could potentially be reduced. Even a malicious puff of cigarette smoke into a detector would not immediately trigger the fire alarm. From a psychological stand point, those who do this may soon realize that the action no longer gets the response that they seek. Eventually those individuals may give up and stop such foolishness.

It should be noted that in the initial phases of literature review and research, the researcher contacted the Interim Greensboro Fire Marshal, Kevin Pettigrew, to discuss this option. In addition, Engineer Nick Loflin with the GFD had obtained information on the HHC fire alarm panel, and conducted his own research to obtain an owner's manual. Engineer Loflin was able to confirm that alarm verification was a possibility with that particular alarm panel. This information was passed along to Pettigrew, and it was brought to the attention of the HHC property representative during a meeting with the FLSD on June 12, 2014.

Another mitigating strategy for reducing unwanted fire alarms is to analyze and change the type of detectors. Currently, there are only smoke detectors in the hallways of HHC. As the research revealed, three of the most common causes for alarms (smoking, cooking and extinguisher powder) cause smoke detectors to activate. However, a heat detector would not be affected by these stimuli. Due to the numerous choices on the market for detectors, further research would need to be conducted to determine the best type of detector for the application at HHC. While this seems like a simple and easy solution, it is not cost effective for the HHC owners. A heat detector is typically more expensive than a smoke detector. This was also a topic that was discussed between the FLSD and an HHC property representative.

What strategy could be employed to reduce the alarms caused by malicious fire extinguisher discharge? One solution could be to move fire extinguishers into each individual unit instead of having them in common areas. While this may not prevent the malicious discharge of an extinguisher, one would assume that the extinguisher would have originated from the individual's residence. At least the individual would only have one extinguisher to discharge only one time. This would reduce the availability of numerous extinguishers that criminals could get their hands on.

The disadvantage of this solution is that each unit is individually owned. As such, the HHC Home Owner's Association and/or the FLSD would have no ability to inspect and maintain these extinguishers. That responsibility would be left to the residents. This would potentially reduce the availability and access to extinguishers should an actual fire occur.

During the meeting with the property representative in June 2014, FLSD personnel recommending reducing the number of extinguishers in the building to meet the minimum travel distance standards. Extinguishers are currently located every 50' in hallways, and this distance

could be increased to 75' thus reducing the number of needed extinguishers. Even having one extinguisher on a hallway however, allows malicious individuals to access it and discharge.

Each unit at HHC has a small kitchen. The second leading cause of unintentional fire alarms in 2012 and 2013 was smoke from cooking. It was the number one reason in 2010 and 2011. Vent hoods are in place over each stove top and may serve as a means to exhaust smoke outside the building instead of into the room and hallways. During the research it was not possible to determine how many of the vent hoods were in working order. As stated before, the fact that each unit is privately owned severely limits the jurisdiction and access that any public agency has.

Although fire personnel have no authority to access an individual unit for inspection, a mitigating strategy that could provide fruitful is basic public education. If the GFD was able to educate the residents at HHC about these issues, it may provide some reduction in unwanted alarms. For example, a presentation on cooking safety may enlighten residents to the hazards of unattended cooking. Statistics on the threat of life and property loss along with photos of fires caused from cooking may be effective. This could also be an opportunity to inquire about the vent hoods in individual units, and recommend that repairs be made if the vent hoods were not in working order. A captive audience may also provide an opportunity for firefighters to simply ask for compliance with smoking in designated areas.

Discussion

The results of the research echo many of the same points that were found through the literature review. Unfortunately, the issue of false alarms has been an issue for the fire service and continues to plague most fire departments today. This was evident for HHC and was an

issue for the U.S. fire service as far back as the 1970's according to Wayne Moore (Moore, 2011, p. 58).

In contrast, the results showed that HHC is responsible for far more false alarms than would be expected. In 2013, false alarms made up 73% of all incidents to HHC for the Greensboro Fire Department (GFD). The average number of false alarms for the U.S. fire service in 2012 was 7%. In 2012, false alarms at HHC represented 36% of the total fire responses to HHC for the GFD.

Malcom Brightman from Buckinghamshire, England was very concerned in 2006 with a location that experienced 160 fire alarms in twelve months. It was the worst offender in Buckinghamshire (Duggan, 2012, p. 39). HHC saw a dramatic increase in false alarms from 2009 to 2013. The number of fire alarms per year was 10, 55, 66, 129, and 375 respectively. This indicates the severity of the problem at HHC and the significance of the false alarm issue for the GFD.

The cause of false alarms at HHC seems to be consistent with causes of false alarms in other locals. Smoke from cigarettes and smoke from cooking are two significant culprits at HHC. In the literature review Donald McFarlane said, "Culprits range from cooking fumes and tobacco smoke…" (McFarlane, 2013, p. 48-49). In addition, Robert Thilthorpe reported that the typical cause for false alarms at a hospital in Buckinghamshire was smoke from a cooking activity (Thilthorpe, 2009, p. 40). In regards to the causes for false alarms, Richard Moore said, "Most common are: opening the apartment door to the hallway to vent cooking smoke, smoking directly beneath a smoke detector, not cleaning detectors at least annually, and spraying air freshener at or too near a smoke detector" (Moore, 1986, p. 13).

This research did not attempt to specifically measure the number of residents that evacuate during a fire alarm. However, responders to HHC know that very few residents, if any, evacuate when the alarm is sounded. This is one of the significant reasons why reducing the number of false alarms could potentially decrease the community risk. The lack of evacuation at HHC matches the information found in the literature review. Ronald Dennis said, "…the lack of confidence in the reliability of alarm systems has resulted in the assumption that a sounding alarm seldom means there is a fire" (Dennis, 1993, p. 5-6, 20). In addition, Ronald Moore said, "The 'horror' stories are many: tenants refusing to leave the building (or worse not bothering to investigate) because, 'it's just another false alarm'" (Moore, 1986, p. 13).

Most of the methods to mitigate false alarms at HHC came directly from the literature review. The researcher began the literature review in May of 2014 while on the campus of the National Fire Academy. During subsequent discussions with the GFD Fire & Life Safety Division (FLSD), the researcher relayed these ideas to personnel who were responsible for code enforcement at HHC. A review of FLSD records revealed that FLSD personnel discussed these same mitigating strategies to an HHC property representative on June 6th, 2014.

The organizational impact for the GFD is directly related to the number of false alarms at HHC. A reduction in the number of incidents would equate to a reduction in fuel and maintenance costs. It would provide better reliability (i.e. apparatus more readily available for other emergencies), and reduce firefighter complacency. For the residents at HHC, a reduction in false alarms could provide a restored belief that a fire alarm warrants action. This would reduce the risk to the citizen as they take fire alarms seriously and evacuate during an incipient stage fire.

Recommendations

One of the first obstacles encountered while compiling data was rooted in the incident reporting system. While the National Fire Incident Reporting System is very thorough, there seems to be no way to specify the cause of a false alarm. In other words, the fire service can easily determine how many false alarms were responded to, but not the specific reason for the alarm. To capture this data, the researcher had to read the narrative written for each false alarm incident at Heritage House Condos (HHC). Obviously, this was time consuming and dependent upon the accuracy and detail of the incident narrative.

Another issue noted with the incident reporting system was the use of incident type. The researcher found that the same type of incident may be coded differently based on the individual completing the report. A discharged fire extinguisher for example, may be entered by one Captain as a false alarm, while another Captain may enter it as a malicious false alarm. While this does not change the way the incident would be handled, it would make future data collection more labor intensive and less accurate.

Because of these two incident reporting issues, it is recommended that the Greensboro Fire Department Planning Division conduct training sessions for line company personnel. This training could be completed through an online video. This would allow individual fire companies to schedule it at their leisure, and it would allow for future reference should individuals forget or new firefighters need to learn. GFD personnel need to be more educated on the differences between false alarm incident types and the importance of a detailed narrative. This would hopefully lead to more consistency in the reporting system.

In regards to reducing the number of false alarms at HHC, the GFD Fire and Life Safety Division (FLSD) should consider organizing community meetings at HHC. Assistance should

be provided by line company personnel, and these meetings should focus on general fire safety and informing HHC residents about the issues. By using the results of the research, it would seem intuitive to specifically address cooking safety and the importance of taking all fire alarms seriously. It is even possible that some residents may exhibit more care when smoking cigarettes.

Establishing designated smoking areas may seem like a simple solution to the issue of cigarette smoke activating detectors. However, the layout of HHC does not offer the opportunity to design this into the floor plan. A covered area outside would also seem to be a viable solution. However, the reality is that most residents are not going to take the time to use a designated area, and they certainly will not go outside during uncomfortable weather conditions.

The community meetings would also provide the opportunity for GFD personnel to inquire about the use of ventilation hoods over the stove top. This would tie directly into the discussion on cooking safety. By utilizing their range hoods, residents could prevent cooking smoke from drifting into the common hallways and activating a detector. Broken range hoods could potentially cause this tactic to be a failure. With each unit being privately owned, there may be resistance from owners to repair or replace any broken range hoods.

There were two other cooking safety devices that were considered as recommendations to prevent false alarms. The first was a device that automatically turns the stove and/or oven off. While there are several types of these devices on the market, they all operate on the principle of motion detection and delayed time. If the oven is on, and no motion is detected for a predetermined amount of time, the device shuts off power to the appliance. This would obviously be a benefit should someone begin cooking but leave the residence or fall asleep.

While these devices are certainly an interesting and seemingly beneficial tool in the fire prevention arena, they would not prevent a significant reduction in false alarms. Smoke from cooking is the culprit for many false alarms when the resident is present and monitoring the process. In addition, it is believed that these devices would be cost prohibitive.

The second cooking safety device considered was a product called the Stove Top Fire Stop. These devices contain a dry chemical agent and are magnetically attached to the inside of the range hood. When a fire occurs on the stove top, they open and dump an extinguishing agent onto the fire. Again, this is another very effective fire prevention tool, and the researcher believes that each HHC unit should have them. However, it would not affect the number of false alarms. In fact, the researcher was surprised to find that there were very few kitchen fires during the history of HHC.

In addition to public education and range hood use, one of the most effective means of reducing false alarms at HHC would be programming the alarm system for "alarm verification." As described in the results section of this research paper, alarm verification would not allow a fire alarm to be transmitted when only one detector is initially activated. Therefore, most cigarette smoke issues would be negated. It is believed that individuals smoking near a detector are usually walking down the hallway or blowing smoke into the detector in a malicious manner. The fire alarm system would recognize this detector activation, begin an internal timer, and then attempt to reset that detector after the predetermined time. The assumption is that the elapsed time would be sufficient to allow for the dissipation of cigarette smoke.

Alarm verification would also reduce the number of false alarms caused by smoke from cooking. It is common for responders to find a single detector activated outside of the room where cooking is occurring. As long as this exposure to smoke was momentary (i.e. someone

opening their door to enter or exit) then the fire alarm would not be transmitted. Of course, larger volumes of smoke that might enter the hallway could cause a false alarm. However, a fire alarm programmed with alarm verification would certainly reduce the number of false alarms at HHC.

It is believed that utilizing the alarm verification feature would negate the recommendation to analyze the type of detectors that are used at HHC. Currently, all detectors on the property are smoke detectors. One proposed recommendation would be to change smoke detectors to heat detectors. Because the research indicated that the vast majority of false alarms were from smoke stimuli, one would expect heat detectors to practically eliminate those causes of false alarms. The disadvantage for the property owners would be the significant cost. Unless mandated by the City of Greensboro, it is highly unlikely that owners would be willing to bear this expense.

The previously mentioned recommendations all involve education or engineering forms of mitigation. The two additional causes for false alarms are pull stations and extinguisher discharges which create the need for an enforcement strategy.

Maliciously activating a manual pull station or discharging a fire extinguisher is illegal. The problem at HHC is that a suspect is rarely identified in these cases. In cases where a resident says they know the guilty party, investigators do not pursue it because they know it is a lost cause. Simply put, it turns into a finger pointing contest with only hearsay as the evidence.

In an effort to combat this, and provide security measures, HHC installed a closed circuit camera system approximately three years ago. Almost immediately, vandals ripped cameras off the walls and rendered the system practically useless.

Pull stations in HHC were previously outfitted with covers that alarmed locally if the cover was lifted. As with the security cameras, it did not take long for many of these to be destroyed or disabled. Those that did operate were of little use. Firefighters would arrive to find the fire alarm system in alarm, and the local alarm on the pull station cover alarming. However, nobody would be there, and rarely were there any witnesses. In 2013, pull stations were responsible for 25 false alarms.

The malicious discharging of fire extinguishers is very similar to the pull station issue. There are usually no witnesses and therefore no suspects. Discharged fire extinguishers were the cause of 10 false alarms in 2013. One engineering solution for this issue would be to relocate extinguishers to the inside of each unit. There are, of course, other issues associated with this course of action. One may argue that it places extinguishers behind locked doors, which leaves them unavailable for citizens during a fire. However, the current conditions at HHC also leave many extinguishers unavailable for use as they are either empty or in need of service.

The mitigating strategy of enforcement is, of course, only reasonable if a responsible party can be identified. Based on the history at HHC, it would seem that the only method to accomplish this is the use of video surveillance. Because previous attempts have proven to be short lived and a waste of finances, it is recommended that the Greensboro Police Department work with HHC to identify options that would work under these conditions. If this could be accomplished, the GFD FLSD would have more opportunities to prosecute offenders.

Another enforcement strategy would be the increased frequency of inspections and fines from the GFD FLSD. Research revealed numerous Fire Code violations in 2013 and part of 2014. However, only one fee was assessed (in February of 2013). The reality is that FLSD inspectors know that any assessed fees will most likely not be paid. In fact, as of July 2014,

HHC owed the City of Greensboro $49,000 in unpaid water bills (Moffett, 2014). It is the researcher's belief that fines for Fire Code violations should still be assessed, as this will strengthen the case for mandated change at HHC. Also, simply ignoring the problems could expose the GFD and City of Greensboro to liability issues should there be an injury or loss of life due to Fire Code violations that were not addressed.

As a reminder to the reader, this research paper is written with the concept of community risk reduction as a focal point. The recommendations made are focused on reducing false alarms at HHC. However, the ultimate purpose in reducing false alarms is to reduce the risk to residents of HHC, the general public, and the Greensboro Fire Department.

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