Development of a Risk-Based Decision Support Tool to Assist Fire Departments in Managing Unwanted Alarms

Task 2 Deliverable – Literature Review

Final Report

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FOREWORD

From 1980 to 2009, the number of fire department emergency responses more than doubled, from 10.8 million to 26.5 million, primarily driven by the more than tripling of medical aid calls, from 5.0 million in 1980 to 17.1 million in 2009. Fire department budgets have not kept pace with this rising volume of workload, and particularly in recent years, there has been increased concern about the cost of unnecessary responses. From 1980 to 2009, the number of emergency responses to fires fell by more than half, from 3.0 million to 1.3 million, and the number of emergency responses for fires or mutual aid fell by about one-fifth, from 3.3 million to 2.6 million, but emergency responses to "false" alarms more than doubled, from 0.9 million to 2.2 million. The unwanted alarm issue changed over the past third of a century from a problem of malicious false alarms to an issue of non-fire activations of automatic detection and alarm systems.

From the point of view of the fire department, a response to a condition that does not need fire department action in order to avoid loss is both a waste of resources and a needless risk of injury during the response. Response to unwanted alarms is an issue that is receiving increasing attention at the community level.

On May 3, 2011, the U.S. Fire Administration, National Fire Protection Association and International Association of Fire Chiefs co-sponsored a national Summit to initiate a dialogue on this issue. Stakeholders representing alarm design, manufacture, and installation, standards development, and emergency responders from a range of communities were present. Design and manufacturing, installation and maintenance, and enforcement issues were discussed.

The Summit identified a number of possible approaches to the issue, including a greater understanding of the sources of unwanted alarms, deeper knowledge of how the provisions in the National Fire Alarm and Signaling Code can assist enforcement, and best practices for emergency response. Also identified was the value of a tool which can be used at the community level to assess risks, and cost/benefit of strategies to reduce these risks, including appropriate emergency response protocols, enforcement of inspection and maintenance requirements, community education, etc.

This project was initiated by the Fire Protection Research Foundation to develop and implement this tool. The goal of this project was to develop a practical, model-based tool that can be used by local fire departments with local data (to the extent possible) when deciding among courses of action to deal with unwanted alarms. The tool uses a generic model, combined with local data when available and national data when necessary, to estimate costs, fire losses and other impacts of strategies.

This report describes the literature review that was undertaken for the project.

The Research Foundation expresses gratitude to the report author Marty Ahrens, who is with the Fire Analysis and Research Division at the National Fire Protection Association located in Quincy, MA. The Research Foundation appreciates the guidance and information provided by the Project Technical Panelists, the guidance and assistance provided by the International

Association of Fire Chiefs and U.S. Fire Administration, and all others that contributed to this research effort. Special thanks are expressed to the National Fire Protection Association (NFPA) for donating their services to conduct the technical aspects of the project. Special thanks are also expressed to the sponsors of the project who covered all the direct and management costs of the project.

The content, opinions and conclusions contained in this report are solely those of the author.

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Unwanted Alarm Project -- Task 2 Deliverable

Strategies to Address Non-Household Unwanted Alarms: Literature Review

January 2013

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Introduction

> "False alarms from smoke detectors are recognized as a leading problem with alarm systems worldwide. The problem has escalated to the point that some jurisdictions will not allow direct connection of systems with smoke detectors to the fire department, or charge the building owner for each false alarms to which the fire department responds. In some cities, the fire department will not respond unless the facility telephones to confirm an alarm. Occupants of buildings with excessive false alarm rates learn to ignore the system, at least until they… see smoke or other evidence of the fire. This can result in delayed response to real fires and the potential for increased life and property loss." (Dubivsky & Bukowski, 1989)

The fire service has grown increasingly frustrated with responding to automatic fire alarms and finding no emergency. The frequency of these calls has increased since the paragraph above was written. The fire safety community has also come to recognize a need for a change in terminology. While some alarms were clearly false, in many cases, the system was reacting as designed to a non-emergency situation such as normal cooking or dust, so the term "unwanted alarm" is increasingly used. The review includes a discussion of definitions used by various organizations and agencies.

In hopes of reducing fire department responses to unwanted fire alarms in commercial properties, the International Association of Fire Chiefs (IAFC) submitted 41 proposals to the current cycle of NFPA 72®, National Fire Alarm and Signaling Code. The U.S. Fire Administration (USFA), the IAFC and NFPA sponsored the Fire Alarm Response and Management Summit in May 2011 with representatives from the fire service, industry, and alarm companies. (FEMA, IAFC and NFPA, 2011) The fire service needs to maximize efficiency by reducing the frequency of calls requiring a system response and establishing appropriate response protocols for those that still need system-wide resources. Complacency generated by unwanted alarms among stakeholders and the public was seen as a serious, increasing problem. The fire service expressed a need for data and procedures to help them establish appropriate response protocols to unwanted fire alarms. This project was undertaken was a result.

This project aims to give local fire departments a tool to weigh the risks and benefits of various strategies to handle unwanted automatic fire alarms in commercial (i.e., not one-or two-family homes) properties. In particular, fire departments need to decide whether a new strategy or policy will reduce costs by more than it increases losses – that it will reduce the frustrations associated with unwanted alarms without giving away those savings and more in reduced effectiveness in handling wanted alarms. Task 2 of the project is this literature review, which built on the 2011 NFPA report on unwanted alarms. (Ahrens, 2011)

Methodology and Structure of Literature Review

EFO papers, Google searches, contacts and prior experience were used to identify sources. A search of Executive Fire Officer (EFO) papers at the National Fire Academy's Learning Resource Center with key words "false alarms" and "unwanted alarms" identified a number of reports that officers had produced using local data and interviews, literature reviews and surveys of other fire departments. The search was repeated for articles on the subject written since 2000. A Google search on fire department false and unwanted alarm response policies identified a number of different approaches. Other articles were identified by a search for "false fire alarms" and "unwanted fire alarms" in Google and Google Scholar. Priority was given to U.S. sources. Additional works were referenced in other reports and already known to the author. Some new analyses of NFIRS data were also done, and older ones referenced.

The findings are divided into six sections based on information needed to support the design of a tool that local fire departments can use to set their own response policies for unwanted fire alarms.

1. What is an unwanted alarm and what is the size or scope of the problem?
2. Verification methods, costs and benefits
3. Fire department response protocols and associated costs
4. Procedures at scene of and penalties for unwanted alarms
5. Preventing unwanted alarms
6. Data limitations and options

Different strategies are summarized at the end.

What is an unwanted alarm? What is the size or scope of the problem?

Consistent definitions are needed, but hard to come by. While this project's focus is unwanted alarms, that term is not used consistently in the literature or by the fire service. The term "false alarms" is more commonly used. Definitions from a variety of organizations are discussed in this section. Several studies discussed later in the paper either defined the terms for their own use or sought information on how different fire departments or other parties used the terms.

NFIRS definitions are widely used by the fire service and in analyses of national data. This review uses the terms and definitions in the original works when discussing these works. Fire departments around the country use U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) to document their responses and are accustomed to the NFIRS definitions. NFIRS does not use the term "unwanted alarm." Rather, it has several categories of incident types under the heading "false alarm and false call:"

- Malicious and mischievous false alarm (710-715),
- Bomb scare, no bomb (721);

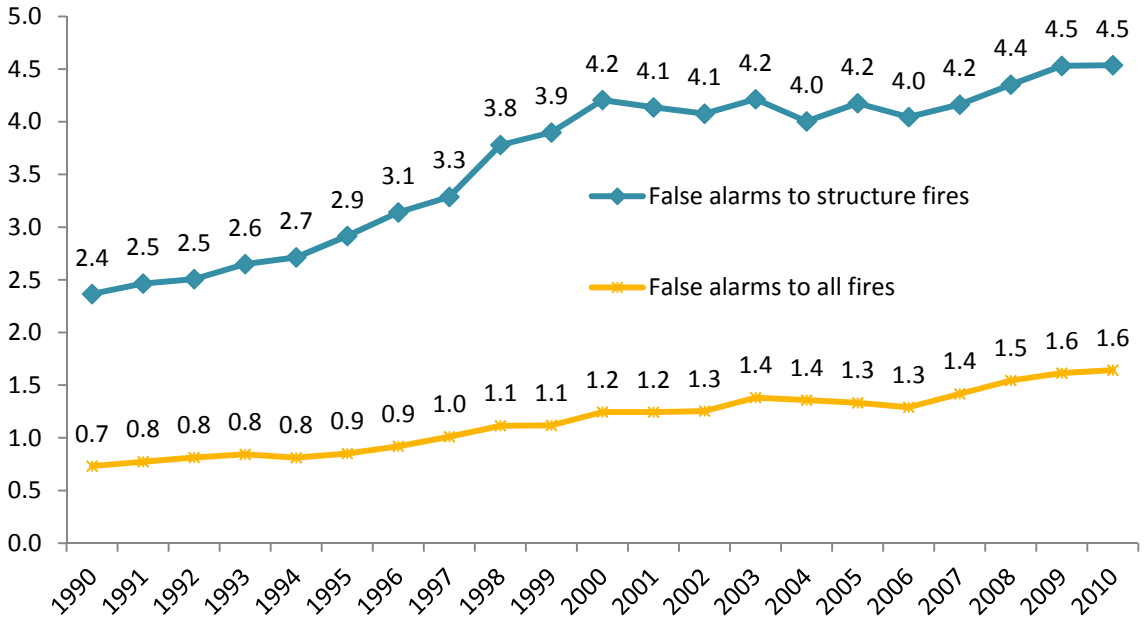
- System or detector malfunction, Includes improper performance of fire alarm system that is not a result of a proper system response to environmental stimuli such as smoke or high heat conditions. (730-736),
- Unintentional system or detector operation (no fire). Includes proper system response to environmental stimuli such as non-hostile smoke or heat, tripping an interior device accidentally, testing the system without fire department notification, (740-746)
- Biological hazard, malicious false report (751),
- Other or unclassified false alarm or false call (700). (U.S. Fire Administration National Fire Data Center, 2008)

NFIRS provides little additional detail on these definitions. Note that the *method* of alarm is not specifically captured in many of the NFIRS false alarm incident types. Some are caused by automatic fire alarms, some may have been phone calls from the public about a local fire alarm, and in some cases, no type of automatic detection may have been involved at all.

Almost 2.2 million false alarms were reported to local fire departments in 2010. NFPA's annual fire department experience survey uses NFIRS terminology to estimate the number of false alarms reported nationally. U.S. fire departments responded to an estimated 2,187,000 false alarms in 2010. (Karter, 2011) This was 4.5 times the 482,000 structure fires reported that year and 1.6 times the total 1,331,500 fires reported.

Figure 1 shows that the ratio of false alarms to structure and total fires has increased fairly steadily since 1990. The 1989 study of Veterans Administration hospitals found 15.8 unwanted activations for every real alarm, or one unwanted activation for every six devices per year. (Dubivsky & Bukowski, 1989)

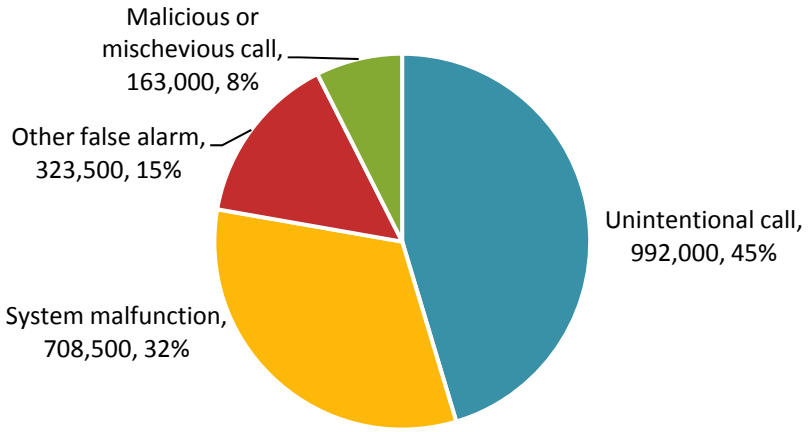
Figure 1.
Ratio of Reported False Alarms to Structure Fires and All Fires, by Year



Source: *Fire Loss in the United States series,* by Michael J. Karter

Almost half of the false alarm responses were due to unintentional activations while system malfunctions accounted for one-third. Figure 2 shows that 45% of the alarms were unintentional calls, and 32% were system malfunctions.

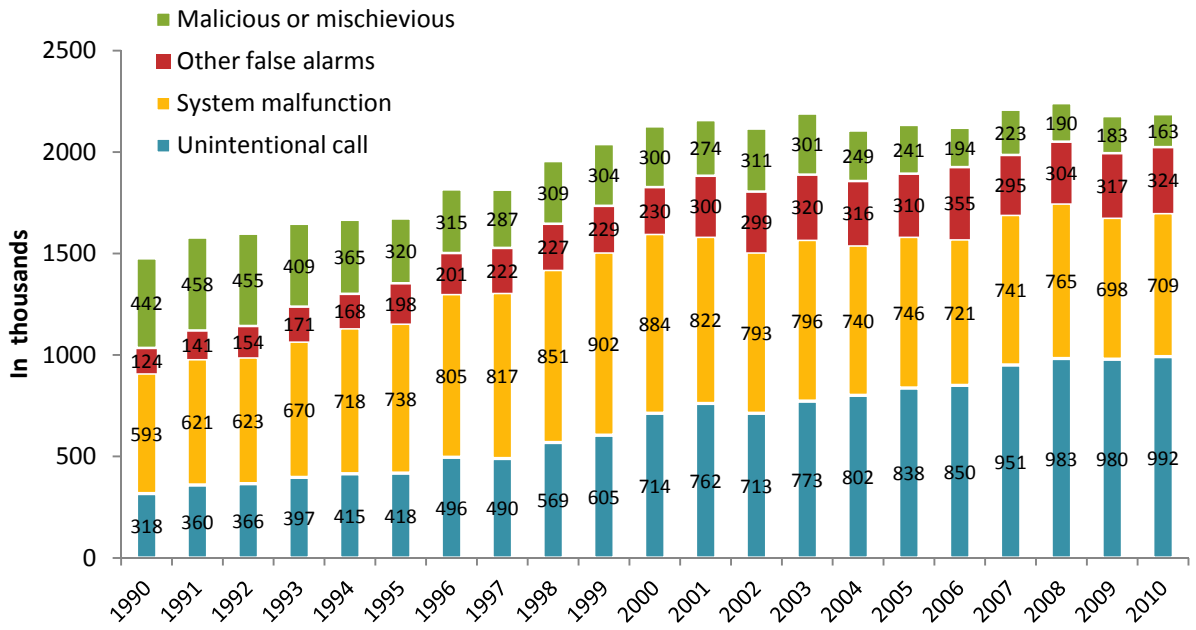
Figure 2. False Alarms Reported to U.S. Local Fire Departments in 2010



Source: Karter, 2011

Figure 3 shows that the malicious or mischievous false calls have declined 63% over the past two decades while unintentional calls more than doubled. (Evarts, 2011) System malfunctions climbed through the 1990s, peaking in 1999. They have fallen somewhat since then but are still 19% above the 1990 level. Two other incident types are sometimes associated with unwanted alarms: 1) dispatched and canceled en route, and 2) smoke or odor removal. However, NFIRS at the national level does not provide the detail necessary to determine if the incident was or was not associated with an unwanted fire alarm.

Figure 3. Fire Department False Alarm Call Trends by Incident Type

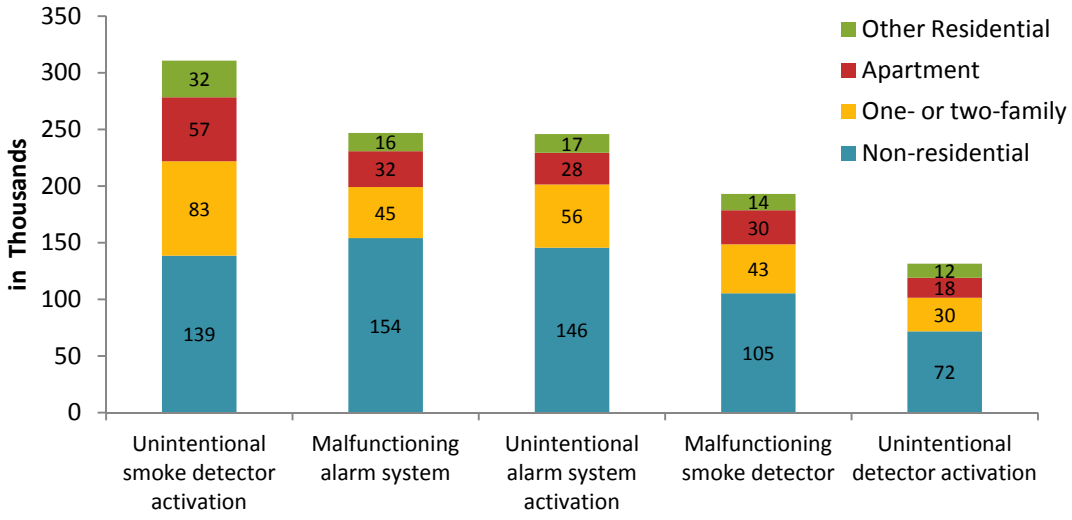


(Evarts, 2011)

The primary focus of this project will be on alarms resulting from fire detection systems. Most of these will be captured in two broad categories: system or detector malfunctions, and unintentional system or detector activations. A quick review of these incident types shows potential for overlap. Also, a sizeable portion of false alarms are coded as other, or unclassified, false alarm. Unfortunately, limited information tends to be available on these incidents. As of this writing, 2003 was the last year that the public NFIRS data release fire included all reported incidents. NFPA analyzed false alarms to local departments by NFIRS incident type for 2003.

More than half of most types of false alarms occurred in non-residential properties. Figure 4 shows the frequency of different types of false alarms for non-residential properties, one- or two-family homes, apartments and other multi-family homes, and other residential properties. While residential properties accounted for the largest share of false alarms of any single occupancy group, non-residential properties accounted for more than half of false alarm responses in all categories shown except unintentional smoke detector activations. Common areas of multi-family housing, hotels, dormitories and similar residential properties would be protected by commercial fire alarm systems.

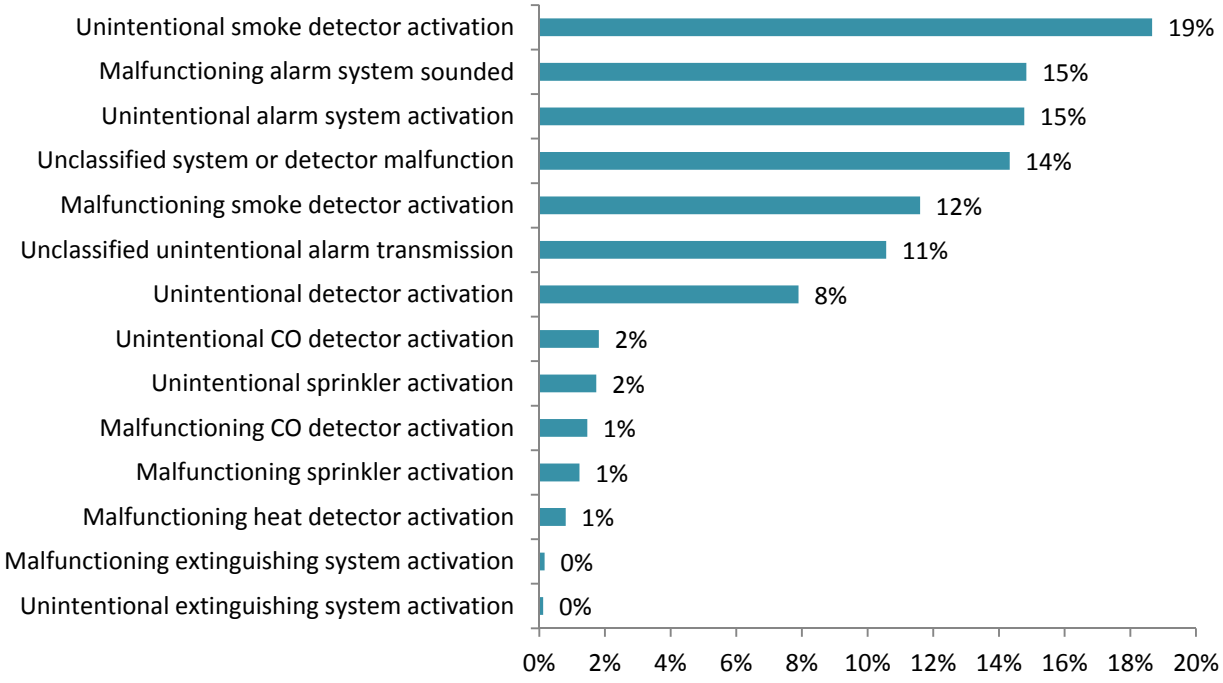
Figure 4. Fire Department Responses in 2003 to False Alarms by Property Use for Selected Incident Types



(Evarts, 2011)

Figure 5 shows the breakdown of system malfunctions and unintentional activations. This graph has been shown in several presentations to people outside of the fire service and they were unclear how fire departments might categorize a variety of different alarms into these choices.

Figure 5. Fire Department Responses to False Alarms in 2003 from Malfunctioning or Unintentional Activation of Fire Protection Equipment



(Evarts, 2011)

New definitions of unwanted alarm types were proposed for the 2013 edition of NFPA 72. Lee Richardson, staff liaison to NFPA 72, provided proposed definitional language for the 2013 edition of the code (National Fire Protection Association, 2012):

- **Unwanted Alarm:** Any alarm that occurs that is not the result of a potentially hazardous condition. **[ROC-22]**
    - ***Malicious Alarm:*** An unwanted activation of an alarm initiating device caused by a person acting with malice. **[ROC-22]**
    - ***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. **[ROC-22]**
    - ***Unintentional Alarm:*** An unwanted activation of an alarm initiating device caused by a person acting without malice. **[ROC-22]**
    - ***Unknown Alarm:*** An unwanted activation of an alarm initiating device or system output function where the cause has not been identified. **[ROC-22]**

The California Smoke Alarm Task Force developed different definitions in their discussions. The California Smoke Alarm Task Force was convened by the Office of the State Fire Marshal to document residential smoke alarm use, technology, effectiveness, in relation to current and proposed requirements. (CAL Fire- Office of the State Fire Marshal, 2011) Richard Roberts, a member of the Task Force, provided definitions developed in deliberations but not included in the final report (Roberts, 2012):

- **Malicious False Alarm:** The activation of any smoke detection device not caused by heat, smoke, fire or particulate. A malicious false alarm is exclusive of a nuisance alarm. An example of a false alarm is an act whereby a person falsely initiates a fire alarm
- **False Alarm**: The activation of a smoke detection device caused by malfunctions, electrical transients or radio frequency interferences. A false alarm is exclusive of a malicious false alarm or nuisance alarm.
- **Nuisance Alarm**: The activation of a properly functioning smoke detection device by the misinterpretation of particulate matter from non-fire sources such as cooking, moisture or accumulation of dust as a true fire signature. The activation may be the result of installation of the smoke detection device too close to a non-fire source such as a bathroom. A nuisance alarm is exclusive of a malicious false alarm, false alarm or unwanted alarm.
- **Unwanted Alarm:** The activation of a properly functioning smoke detection device by insipient fire sources not imminently threatening to life or property such as cooking and fireplaces. The unwanted activation may be the result of installation of the smoke detection device too close to an incipient fire source. An unwanted alarm is exclusive of a malicious false alarm, false alarm or nuisance alarm.

The model fire alarm ordinance distinguishes between a false fire alarm and a nuisance fire alarm. The National Burglar and Fire Alarm Association and the False Alarm Reduction Association include a number

of definitions in their model fire alarm ordinance. (National Burglar & FIre Alarm Association and False Alarm Reduction Association, 2001)

- **False fire alarm:** The activation of any fire alarm system which results in a response by the fire department and which is caused by the negligence or intentional misuse of the fire alarm system by the owner, its employees, agents or any other activation of a fire alarm system not caused by heat, smoke or fire, exclusive of a nuisance fire alarm.
- **Nuisance fire alarm:** The activation of any fire alarm system, which results in a response by the fire department, caused by mechanical failure, malfunction, improper installation, lack of proper maintenance or any other response for which the fire department personnel are unable to determine the apparent cause of the alarm activation.

Fire departments and EFO authors use a variety of different terms and definitions. In his 2005 EFO paper on false alarms in Memphis, Donald C. Pannell notes that the definition of false fire alarm from the National Burglar and False Alarm Reduction Association excluded alarms resulting from installation, maintenance or mechanical problems. He defined a false automatic alarm as one "that elicits emergency fire response which was not caused by heat, smoke, fire, other emergency condition." (Pannell, 2005) Some organizations use the term "accidental" alarm to describe what others call "unintentional.

The Oxnard, California Fire Department distinguishes between accidental and preventable alarms.

- Accidental alarms: Unforeseeable or unpreventable alarms that are not caused by poor maintenance or system design. Possible causes include lightning, earthquakes, voltage or water surges.
- Preventable alarms: Alarms that could and should have been anticipated and prevented. They include alarms due to poor maintenance, failure to correct identified problems, and alarms that occur when contractor works on the system with notifying the central station or when a monitoring contractor was notified the system being repaired or tested and still transmits a signal to Dispatch. (Oxnard, California Fire and Rescue, 2008)

Finley defined false alarms and accidental alarms. He also asked fire departments and local residents who had fire department responses which of a group of scenarios they would consider false alarms.
In his 2001 EFO paper on the verification and response dilemma for residential fire alarms, Peter Finley defined a false alarms and accidental alarms as follows.

- **False alarm:** An alarm that is transmitted for no apparent or justifiable reason due to a system or component malfunction, a maintenance problem such as dirty detectors, or a malicious action.
- **Accidental alarm:** An alarm that is activated by a legitimate cause other than an uncontrolled fire situation. Activations which may fall into this category include smoke from cooking, candles fireplace, etc., steam from the shower, or accidental activation of a panic button on an alarm panel.

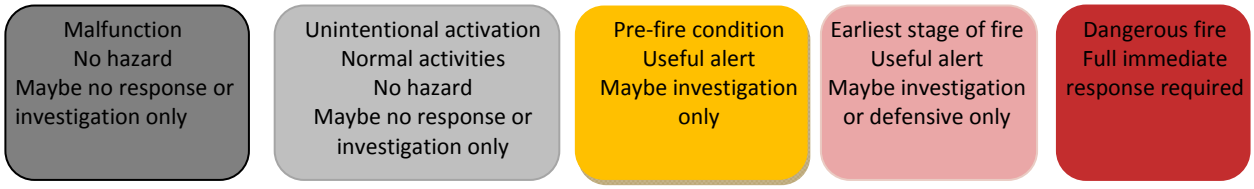
Finley also asked other fire departments which of the following they would consider to be false alarms. Eleven percent said smoke from cooking, 30% said smoke from candles, fireplaces, etc. and 69% said shower steam. (Finley, 2001)

He also asked people who had received fire department responses to automatic residential alarms. Based on those who expressed an opinion,

- Steam from the shower was considered false by 90%;
- Performing alarm system maintenance or cleaning was considered false by 79%;
- Alarm system malfunction was considered false by 69%; and
- Smoke from cooking or burnt food was considered a false alarm by 64%;

The different definitions suggest a continuum of reasons for non-malicious fire alarm activations. Historically, alarm activations have been viewed in a binary fashion. Either detection was triggered by a fire or it was not. However, real life is more complicated than that. Figure 6 illustrates the continuum of fire detection system activations and desired response if the actual situation were known at the time the alarm was handled. Everyone is frustrated by alarm malfunctions. Although unintentional activations are annoying, their causes are often obvious. In some cases, the system may be operating as designed. Occupants of the involved space will typically be most appreciative of alerts to pre-fire conditions and to fires in the earliest stages of development. An alert that prevents a situation from developing into a dangerous fire is a success. However, from a fire department's perspective, a call to a situation that requires no assistance may not feel successful.

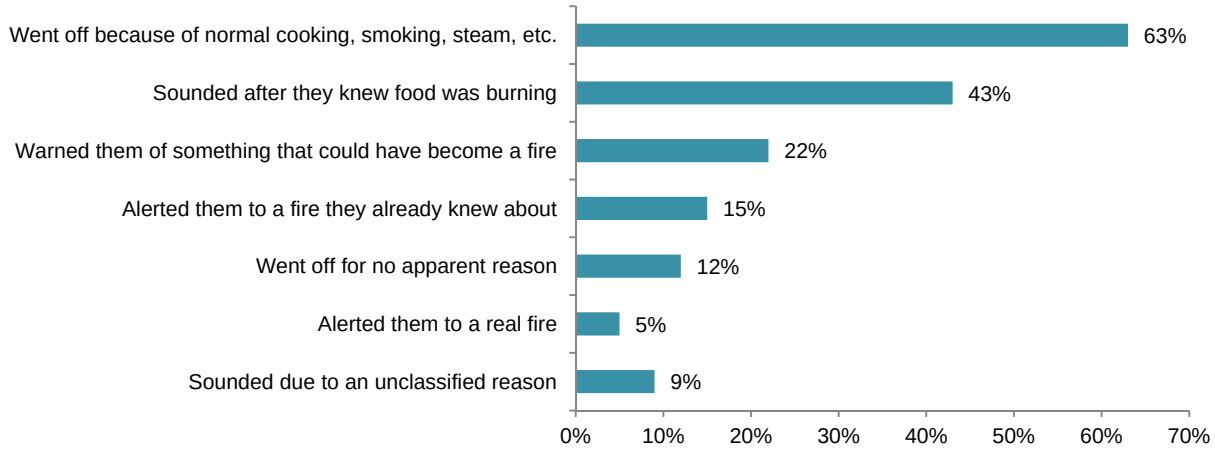
Figure 6. Fire Detection Activations and Desired Fire Department Response: A Continuum



In a survey done for NFPA, none of the people who had a home smoke alarm activate in the past year initially said the activation was due to fire. Specific questions identified substantial portions were pre-fire alerts, burning food of fires they already knew about, and some were actually alerted to fires. (Harris Poll National Quorum, 2010) Respondents who had a smoke alarm go off in the past year were asked the reason. Almost three-quarters said cooking. None said a fire. Only one answer was allowed. In another question, they were asked to agree or disagree to a statement that began "The last time a smoke alarm sounded, it…" Figure 7 shows the results. The 12% that went off for no apparent reason were likely malfunctions. Almost two-thirds (63%) said the alarm went off because of normal cooking, smoking, steam etc. These would be the unintentional activations in Figure 6. Twenty-two percent were warned of something that could have become a fire. In other words, they experienced a pre-fire alert. The warning from detection feels less useful when the individual is already aware of the situation. This was the case when an alarm sounded after they knew food was burning or in response to a fire they already

knew about. However, 5% agreed the alarm alerted them to an actual fire. Since no one mentioned it initially, it is likely that most of these alerts were to fires in the earliest stages and were handled by the occupants.

Figure 7. The Last Time a Home Smoke Alarm Sounded, It...



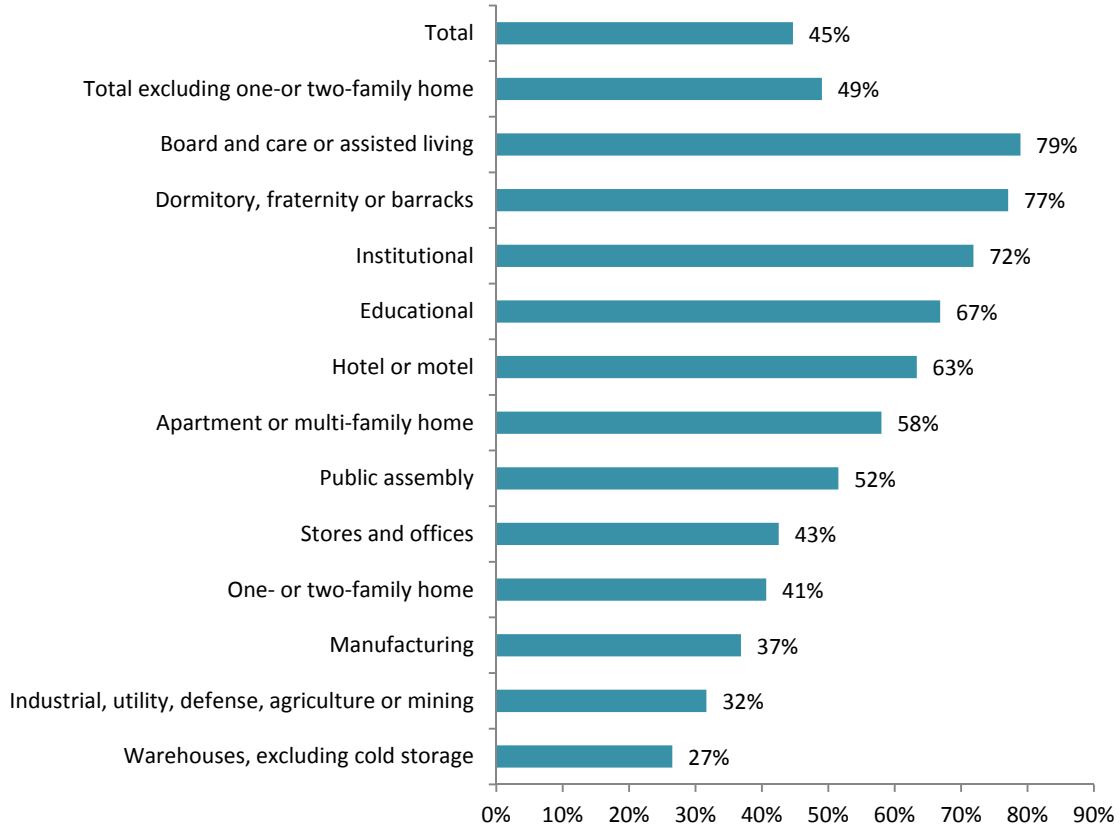
(Harris Poll National Quorum, 2010)

CPSC found that only 3% of home fires were reported to the fire department.
In CPSC's survey of unreported residential fires, 97% of home fires were handled without fire department assistance. (Greene & Andres, 2009)

NFPA 72 has provisions limiting the reach of smoke detection in dwelling units in hotels, dormitories, and other residential properties with more than two units. Section 29.5.2.2 of the 2010 edition of NFPA 72® states that "unless otherwise permitted by the authority having jurisdiction, audible fire alarm signals shall sound only in an individual dwelling unit, suite of rooms, or similar area and shall not be arranged to operate fire-warning equipment or fire alarm systems outside these locations." Unless or until smoke from a dwelling unit triggered a detector in a common area, an automatic alarm would not be transmitted and the full building not evacuated. Opinions may differ about whether a fire department response to such activations would be needed or desired.

NFPA found that extinguishment was not listed as one of the actions taken in roughly half of all reported structure fires. Figure 8 shows that in roughly half of the reported structure fires (excluding those in one- or two-family homes) in 2006-2010, the fire department did not list extinguishment as one of the actions taken.

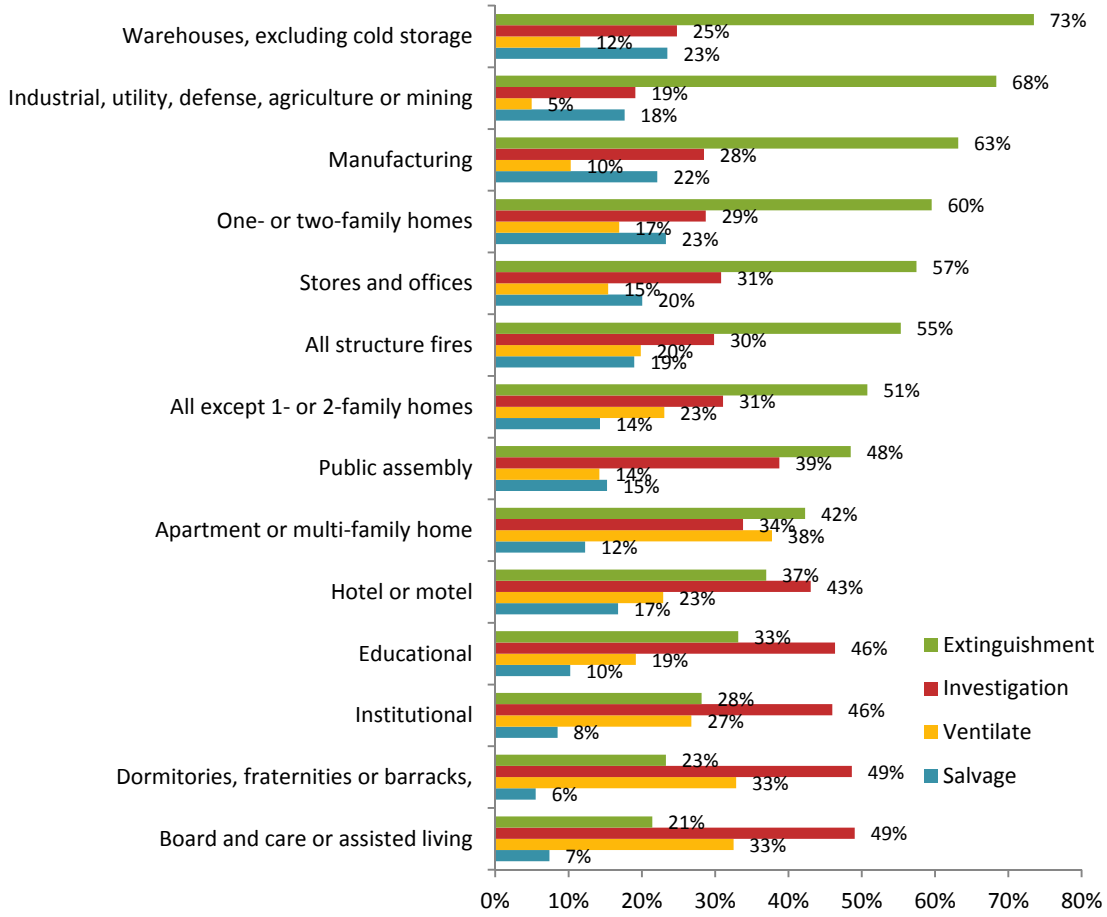
Figure 8. Reported Structure Fires in Selected Occupancies in which Extinguishment was NOT an Action Taken: 2006-2010



Source: NFIRS and NFPA survey

The fire department was more likely to perform extinguishment at fires reported in warehouses, industrial, and manufacturing properties. Figure 9 shows that the percentage of fires in which extinguishment as an action taken varies considerably by property use. Overall, fire departments perform extinguishment at roughly half the reported structure fires. However, in some occupancy groups, such as educational, institutional, dormitory-type properties, board and care or assisted living facilities, extinguishment is done at most at one-third of the fires. Investigation and ventilation were more likely to be listed as actions taken in fires in which extinguishment did not take place.

Figure 9. Reported Structure Fires in Selected Occupancies by Leading Actions Taken: 2006-2010 (Up to 3 entries allowed)



Source: NFIRS and NFPA survey

Verification methods, costs and benefits

Given the high rate of unwanted fire alarm responses, fire departments are evaluating the costs and benefits of different response levels to automatic alarms for which no supporting information has been obtained. Verification can be done at several points, including the detector or system itself, the monitoring station, or the Public Safety Answering Point (PSAP).

Provisions of NFPA 72 generally require AHJ permission. Where permitted, NFPA 72 allows positive alarm sequences and other methods to confirm a signal before transmitting the alarm to the monitoring station. If the authority having jurisdiction permits, Section 23.8.1.3 of NFPA 72® allows for "positive alarm sequences." In these situations, trained personnel acknowledge an alarm at the control panel within 15 seconds and then have up to 180 seconds to evaluate the situation and reset the system. If the signal is not acknowledged within 15 seconds, if the system is not reset within three minutes, or if a second detector or initiating device is activated, the notification signals sound and remote signals are immediately activated.

Section 23.8.5.4.1 states that systems may have verification features that that will only be enabled if:

1) Conditions or occupant activities are expected to cause nuisance alarms in that area. Verification must be enabled by password or limited access.
2) A smoke detector continuously subjected to smoke concentrations above the threshold does not delay system performance for more than one minute and
3) Actuation of another alarm initiating device causes the system functions to operate immediately.

Some systems may require two automatic detectors to initiate the alarm response. This configuration is not allowed if the alarm verification feature is used.

Where permitted, NFPA 72 currently allows monitoring systems to attempt verification of automatic dwelling unit fire alarms prior to transmission. The IAFC would like this provision expanded to cover commercial properties. Section 29.7.8.2 of NFPA 72®, *Fire Alarm and Signaling Code,* addresses verification of automatic alarms in dwelling units by monitoring stations. "Remote monitoring stations shall be permitted to verify alarm signals prior to reporting them to the fire service, provided that the verification process does not delay the reporting by more than 90 seconds." This applies to household alarms as well as detection in multi-family housing, hotels, dormitories and other residential occupancies. (National Fire Protection Association, 2010) The IAFC submitted proposals to NFPA 72® that would permit verification of commercial automatic alarms.

The Annex (A 29.7.8.2) contains the following additional information. "When 29.7.8.2, which provides for screening alarm signals to minimize response to false alarms, is to be implemented, the following should be considered:

(1) Was the verification call answered at the protected premises?
(2) Did the respondent provide proper identification?
(3) Is it necessary for the respondent to identify the cause of the alarm signal?
(4) Should the public service fire communications center be notified and advised that an alarm signal was received, including the response to the verification call, when an authorized respondent states that fire service response is not desired?
(5) Should the public service fire communications center be notified and advised that an alarm signal was received, including the response to the verification call, for all other situations, including both a hostile fire and no answer to the verification call?
(6) What other actions should be required by a standard operating procedure?" (National Fire Protection Association, 2010)

According to the NBAA/FARA Model Fire Alarm Ordinance, fire alarm businesses must offer owners of monitored household systems the verification option, and when appropriate, forward signal cancellation from household alarms to fire department.

Finley found that the majority of fire departments responding to his survey felt that having civilians decide if a household fire alarm signaled an emergency posed a greater *liability risk than the risk of*

responding. Fire departments weigh the risks and benefits before deciding whether to accept residential verification.

The questions about verification of residential fire alarms apply also to commercial alarms. Finley asked other fire departments about their positions on residential alarm verification. (Finley, 2001) Three-quarters (78%) did not permit verification prior to response. Sixty-two percent felt greater liability was associated with untrained civilians deciding an alarm was a system problem than in responding.

The Las Vegas Fire and Rescue Department has directed alarm monitoring companies to verify automatic fire alarms in most occupancies. If the alarm cannot be verified, the fire department will not respond. Gammon (Gammon, 2005) of the Las Vegas Fire and Rescue Department described their then new response policy for response to automatic fire alarms. They had responded to more than 3,600 fire signal calls from alarm monitoring companies in the previous year. More than 3,400 had no supporting information. None of these 3,400 involved an actual fire. In most cases, firefighter actions at the scene involved checking to see if there was an emergency and resetting the panel, activities the author sees as primarily the responsibility of the alarm monitoring company.

Firefighters face a risk while responding, as does the public when they try to move out of the way of emergency vehicles. Now, before a response, someone must check the premises. The alarm monitoring company will contact the location's responsibility party. An alarm company who erroneously reports that a representative is at the scene will be fined for reporting a false alarm. There are a few exceptions, including government buildings, schools, and hospitals. When a private individual calls to report an operating fire alarm and states there is no flame, smoke, or smoke smell, one engine will respond. A full response is dispatched to waterflow alarms without a reset, but no response is made if reset occurred. After the policy was implemented, total calls (including those not from alarm companies) fell by about 3,700.

The Tualatin Valley Fire and Rescue Department now requires alarm monitoring companies to attempt verification of automatic commercial fire alarms. Only one unit is sent to unverified alarms. After discovering that in the five year period of 2003-2007, they had responded to a total of more than 10,000 automatic commercial fire alarms with very few working fires, the Tualatin Valley (Oregon) Fire and Rescue Department decided to require fire alarm verification in commercial properties as well as dwellings. (Tualatin Valley Fire & Rescue, 2010) As of December, 2010, supervising stations are required to attempt verification of fire alarm signals prior to retransmission to the PSAP. In addition to the 90 seconds allowed for retransmission of verified residential alarms in NFPA 72, 90 seconds are also allowed to initiate contact. When the absence of fire or emergency is confirmed, no alarm is transmitted. If no contact or verification is made, the alarm is immediately retransmitted. Table 1 shows that false alarms or good intent calls[1] accounted for 95-97% of the commercial automatic alarms

[1] NFIRS coding was used. Good intent calls include calls that were dispatched and cancelled prior to arrival; smoke odor, steam or other gas, mistaken for hostile fire' controlled burning, wrong locations; EMS calls where the patient is no longer at the scene, and hazardous material investigations with nothing found

received in 2007-2011. The number of automatic false alarms fell sharply after the policy was implemented. However, there was an increase in calls that were dispatched and cancelled en route. These calls are captured under the good intent calls. (Forster, 2012)

Table 1. Automatic Commercial Alarms Reported to Tualatin Valley Fire and Rescue

Year	Alarms	Fires	Extinguishment as Action Taken	Good Intent, including Cancelled	False Alarm	Good Intent or False Alarm	Other Incident Type
2007	1,943	11	2	189	1,675	1,864	68
2008	1,978	11	0	124	1,794	1,918	49
2009	1,855	10	3	135	1,630	1,765	80
2010	1,625	21	3	231	1,334	1,565	39
2011	1,370	9	5	397	927	1,324	37

(Forster, 2012)

Types of responses and associated costs

Detailed cost data were provided in only few sources. Pannell considered lifetime apparatus cost, fuel costs, mileage, average hourly wage, and number of staff responding in calculating the cost of a Memphis false alarm call. Pannell obtained cost data from various Memphis officials for his 2005 EFO paper. (Pannell, 2005) Their fire engines were purchased for $330,000 in fiscal year 2004 with an expected 15 year lifespan. They average six miles per gallon. The average false alarm call was three miles round trip and took 15 minutes from initial response to return.

Annual staff costs for false alarms per fire department vehicle were calculated with the following equation:

Average time per false alarm * average hourly wage * number of staff per vehicle * number of false alarms in year

Fuel costs were calculated by

(Average miles per response ÷average miles per gallon) * average cost per gallon of fuel

Costs per piece of equipment were calculated by

(Purchase price ÷ expected apparatus life span) * number of false alarm responses

Using this approach and local figures, he calculated an average cost of $105.34 for one engine to respond to a false alarm in 2005. Note that his calculations did not include costs of benefits and other overhead expenses. (Pannell, 2005)

Reese found that a second call was received during 14% of their false fire alarm responses, requiring resources from a different station.

In his EFO paper on reducing risks from false alarms, Eugene Reese reported that while the Appleton, Wisconsin Fire Department was investigating 53, or 14%, of their 370 false fire alarms, another call (often not fire) was received. Because multiple units were required, resources would have to come from a different station. (Reece, 2008)

While less than 1% of the automatic fire alarms received by the Grandview, Missouri Fire Department were to working fires, the same staffing and resources would be required if unwanted fire and EMS alarms were reduced. The greatest risk from unwanted alarms was to morale. James Toone wrote about the Grandview, Missouri Fire Department in his EFO paper. (Toone, 2008). From 2005 to 2007, the Grandview, MO Fire department responded to a total of 801 automatic fire alarms. Only one, or 0.1% of the responses due to automatic alarms, was a working fire. Looking at both unwanted fire alarms and unnecessary EMS, 24% of their calls were considered unnecessary. With a total average of 8.8 calls of all types per day, and an average length per call of the 38 minutes, the department had a daily average of 1.75 simultaneous calls. An average day had 66.5 minutes with two simultaneous alarms. Three simultaneous alarms occurred at an average of 0.57 per day, with an average of 2.4 minutes. It could handle two alarms with its own resources, but mutual aid would be required when three or more incidents occurred at the same time. Multiplying the daily average of 2.4 minutes at three alarms by the 24% unnecessary left about 35 seconds per day in which the community faced a risk of unavailable resources.

Toone noted that staffing and resources would not have changed with 24% fewer runs. "Reducing the load of unnecessary alarms would, in actuality, have a minimal impact on the financial aspect of community risk." The author noted that poor responder morale was likely the greatest risk from unnecessary alarms. A group interview indicated potential for sub-standard service to both the party that caused the unnecessary alarm and to subsequent responses.

For career departments, if sufficient staff are available to respond to all alarms, personnel costs are less of an issue. Time spent responding to an alarm means that time is not available for other activities. The Tualatin Valley Fire and Rescue Department noted that the direct cost savings due to fuel and vehicle maintenance is small, but the primary value is "improved reliability and response due to not having crews tied-up on a non-emergency call when an actual fire or medical emergency occurs." They also note that a reduction in unnecessary calls can offset growing resource demands in other areas. (Tualatin Valley Fire and Rescue)

Unwanted alarm responses are a problem for volunteer companies in terms of retention and recruitment. Finley noted that in his combination department, the volunteer companies felt that these responses were hurting morale, recruitment and retention He noted that within the combination department, some the question of pre-response verification as a career vs. volunteer issue. If verification was not allowed, the department would need to hire more full-time firefighters. (Finley, 2001) In most of the literature, complaints were made about firefighter complacency and lack of evacuation by building occupants because of frequent automatic alarms.

Every response has a small risk of collision resulting in injury or death. The risk of vehicle collision and firefighter injury or fatality during response or return is often cited as a reason to reduce unwanted alarms. This risk is real, but low. According to NFPA statistics, 11 firefighters died in motor vehicle collisions in 2010. None were to false alarms. (Fahy, LeBlanc, & Molis, 2011) An analysis of 1998-2007 firefighter fatalities in road vehicle crashes found that over the 10-year period, a total of 148 firefighters had been killed in 133 such crashes. Only five were killed while responding to or returning from false alarms. (Fahy R. F., 2008) In 2010, 14,200 collisions involving fire department vehicles occurred during response or return to more than 28.2 million incidents of all types, including fires, EMS, and unwanted alarms. (Michael J. Karter & Molis, 2011) Collisions occurred in about one-tenth of one percent (0.1%) of all calls. These collisions caused 775, or 1%, of all firefighter injuries. In addition, firefighters' personal vehicles were involved in 1,000 collisions during response or return, resulting in an estimated 75 injuries. Unfortunately for this study, information on the associated incident types is not collected. Consequently, it is impossible to determine the number of collisions or associated injuries resulting from false alarm responses.

The biggest potential cost of verification is potential time lost before an alarm is actually received at the fire station. Table 2 shows that many different factors may be in play depending on the different systems and local requirements and procedures. The table uses the times NFPA standards. A 2010 study of fire and EMS mobilization times in a group of career or mostly career fire departments found that 80% of the fire and EMS calls were handled within 60 seconds. The authors noted that NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communication Systems,* (Upson & Notarianni, 2010) set a benchmark of 90% of calls processed within 60 seconds. In the study, 90% of the fire calls were handled within 92 seconds. Karyl Kinsey analyzed automatic fire alarm calls received by the Austin, Texas fire department. She noted that call processing tends to be much faster when the call is received from an alarm company because the alarm companies know exactly what information is required in what order. (Kinsey, 2012)

After the call has been processed, and firefighters notified, additional time is spent turning out and responding. Turnout was completed in the 80 seconds required in NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments,* in 60% of the fire calls. In 90% of the calls the fire calls, turnout was completed in 123 seconds. Turnout times tended to be longer at night. Turnout was completed within 80 seconds in only 21% of the fires reported between midnight and 6:00 a.m. In 90% of the fire calls during these hours, turnout was completed within 158 seconds.

Table 2. Time from first signal until alarm is received at the fire station

Time on premises
Possible ignition prior to time zero
Initial signal triggered at time zero
By 15 seconds, signal in positive alarm sequence acknowledged at control panel or sound and notification activated (NFPA 72)
By 195 seconds, system is reset or notification and sound activated (NFPA 72)
More variability with multi-criteria detectors
Time at monitoring station if verification is permitted,
Monitoring station may take up to 90 seconds for residential verification (NFPA 72)
Tualatin Valley Fire and Rescue allows 90 seconds additional to initiate contact
Time at monitoring station if verification is required before alarm transmission
No time limit and no response without verification
Time at Public Safety Answering Point
Call handling (NFPA 1221)
95% of alarms on emergency lines to be answered within 15 seconds
Most emergency alarm processing shall be completed within 60 seconds
Transfer procedure for calls from the primary public safety answering point to a secondary answering point should generally not take more than 30 seconds
Receipt of additional calls indicating false alarm or fire

In the absence of confirming information, some fire departments send a reduced response to automatic fire alarm calls. As already noted, with only a few exceptions, the Las Vegas Fire and Rescue accepts unverified automatic alarms from only a few occupancy groups. One unit is typically dispatched to these properties. (Gammon, 2005) Tualatin Fire and Rescue sends only one unit in non-emergency mode to unverified alarms instead of the 6-8 units dispatched in emergency mode to a verified alarm. (Tualatin Valley Fire & Rescue, 2010) The Cumru, Pennsylvania Fire Department sends only the first apparatus in emergency mode. (Township of Cumru, PA Fire Department, 2008) Others respond non-emergency unless additional information indicates an actual emergency. The Menasha, Wisconsin Fire Department adopted a similar policy. (Menasha, WI Fire Department, 2003) If additional information is received indicating a false alarm, one unit proceeds to the scene in non-emergency mode to collect information. Oxnard Fire and Rescue policy allows for a reduced response when the property has a history of false alarms and there is no supporting evidence of a fire. (Oxnard, California Fire and Rescue, 2008)

Finley surveyed departments protecting populations of 47,000 to 67,000 and asked about their response policies to residential automatic alarms. Table 3 shows that responses varied from only one engine, to two engines, one ladder, and one chief. None of the surveyed departments sent only one officer or police only. Table 4 shows that almost two-thirds sent all units in emergency response mode. Table 5 shows that the majority of fire departments modified their response if new information became available.

Table 3. Responses Dispatched to Automatic Residential Fire Alarms in Departments Protecting Populations of 47,000 to 67,000

Resources Dispatched	Responses	Percent
1 Engine	13	19%
1 Engine, 1 ladder	5	7%
1 Engine, 1 ladder, 1 chief	2	3%
2 Engines, 1 ladder	1	1%
2 Engines, 1 ladder, 1 chief	28	42%
Other	18	27%
Total	67	100%

(Finley, 2001)

Table 4. Response Mode to Automatic Residential Fire in Departments Protecting Populations of 47,000 to 67,000

Response Mode	Responses	Percent
All units emergency	42	65%
First due emergency, others reduced speed	18	28%
All units reduced speed	2	3%
Other	3	5%
Total	65	100%

(Finley, 2001)

Table 5. Response Mode to Automatic Residential Fire Alarms Reported to be False in Departments Protecting Populations of 47,000 to 67,000

Response Policy	Responses	Percent
Do not modify when new information is received	7	12%
First due continues at emergency speed, others reduce speed	11	18%
All units reduce speed	3	5%
Return all but first due engine	28	47%
Return all apparatus, chief proceeds to scene to investigate	1	2%
Return all units, no further response or investigation	6	10%
Other	4	7%
Total	60	100%

(Finley, 2001)

Reece obtained similar information 24 of the 100 departments he surveyed for his EFO paper on reducing risks from false alarms in Appleton, Wisconsin. Eleven responded to false alarms with all units in emergency mode, eleven had only the primary in emergency mode, one had all in non-emergency mode and one did not answer the question. Two departments sent one piece to an activated alarm, four sent two, four sent three , five sent four, three sent five, and six sent more than five. (Reece, 2008) The Appleton Fire Department traditionally responded to automatic fire alarms with two engines, one ladder truck and a shift commander. When no additional information was received about an alarm sounding during regular business hours, only the first-in unit was considered emergency response. If a false alarm was verified while en route, the first-in would downgrade to non-emergency and the other units would become available for reassignment. Outside of regular business hours (nights and weekends) all responding units would switch to non-emergency response. (Reece., 2008)

Officers in Appleton, WI had concerns about a proposed response policy based on hazard designation and time of day. A draft department alarm response guide detailed separate response protocols for normal hazard occupancies, including those with low hazards, fire protection, no historic fire vent history, and protected high/or special occupant demographics. Office buildings, manufacturing facilities, schools and residential properties would be considered normal. The proposal called for one engine and a shift commander, and would be considered non-emergency if no further information was received. For high hazard occupancies such as those with special hazards, unprotected high or special occupant demographics, or building taller than four stories, the two engines, one ladder truck and the shift commander will respond with the first-in units in emergency mode and others non-emergency. If additional information indicates a false alarm during normal business hours, the first-in will respond non-emergency and the others will be available. For nights and weekends, all units would switch to non-emergency mode.

A number of concerns were raised by officers. One felt that only buildings with full sprinkler coverage should be considered normal occupancy due to the risk of a developing fire. An apartment building with eight or more units should be considered high hazard because of evacuation challenges. Another said that it can take more than one crew at night at large facilities to locate the problem or building representatives. If the change goes forward, buildings with pre-engineered structural components such as floor and roof trusses should be considered high hazard*, as these features were allowed because of alarm systems*. Buildings without full sprinkler protection or with communications issue such as dead spots, sub-grade areas, should also be covered by the existing protocol. One individual was concerned about the possible risk to firefighters if a full response is delayed and only a small crew arrives at the scene of a serious fire.

Most homeowners in Finley's survey had tried to prevent the fire department from responding to false alarms. However, two-thirds would appreciate fire department input and assistance if one engine came without lights or sirens. When Finley surveyed homeowners who had fire department responses to automatic residential alarms, he found that 84% of the 53 Vineland, New Jersey respondents tried to notify their alarm company that the alarm was false and wanted them to stop the fire department from responding. When asked if they would want the fire department to respond when their fire alarm

activates to make sure everything was okay, knowing the fire department could check for fire spread, assist with smoke removal, determining the cause of the alarm, restoring the system, provide information to minimize unintentional alarms, 52% would want them to respond while 48% would want to be able to decide themselves if fire department response was necessary. When asked if they wanted a response if only one engine came without lights or sirens, 69% of those answering said they would. (Finley, 2001)

Procedure at scene of and penalties for unwanted alarms

The best solution to the problem of fire department responses to unwanted alarms is to reduce the number of unwanted alarms that occur. This would also reduce alarm fatigue and complacency among the public. However, such programs have their own costs, require fire department involvement, and may involve some risk of delayed notification of working fire, depending on the methods used.

The Kirkland, Washington Fire department outlined steps for the public in event of an automatic fire alarm. All alarms should be treated as emergencies until safety is verified. Alarm systems should not be silenced or reset until the fire department evaluates the situation. They note that most fire alarm systems have an alarm silencing provision that disabled the audible signal and will not reactivate in a real fire. A reset alarm will sound in a fire situation, but may not retain information about the activation. When an alarm is reset, responding firefighters have to check the whole building, not just one zone. Premature resetting can make it difficult to identify an issue that might have caused a false alarm. (Kirkland, Washington Fire Department)

The Cumru, Pennsylvania Fire Department outlines firefighter procedures to find unwanted alarm causes. (Township of Cumru, PA Fire Department, 2008) If the Communication Center confirms a false alarm, either the Officer in charge or first due apparatus can collect information. If no emergency exists upon arrival, firefighters confirm that a holder has been contacted and/or is en-route. At the Fire Alarm Control Panel, the alarm system status is checked to find out the reason for activation. Systems can be silenced while the premises are inspected to find the device that activated, but the panel should NOT be reset. If no cause can be found, the system can remain in silence mode until the emergency contact resets it. The first unit on scene should remain to advise the emergency contact. If the contact does not come, the information should be relayed to occupants.

In many communities, a determination of the cause of the alarm is required to determine what, if any penalties should be applied.

The NFFAA and FARA's Model Fire Alarm Ordinance outlines the steps and provisions involved in establishing a fire alarm ordinance and suggests provisions. (National Burglar & FIre Alarm Association and False Alarm Reduction Association, 2001) They advise communities to begin with a fire alarm advisory board with representatives from the fire department, alarm industry, community and business groups, and other stakeholders. Under ordinance provisions, alarm systems are registered with,

responsible party and fire alarm company contact information is provided to, and systems are certified by the fire department. Systems are inspected and tested at least annually and maintained according to codes and manufacturer specifications. Fire departments are encouraged to use software for tracking and enforcement.

In the event of fire alarm activation, the contact person shall be notified and shall respond to the property. Fire alarm businesses must offer owners of monitored household systems the verification option, and when appropriate, forward signal cancellation from household alarms to fire department. The fire department will give the building owner or representative on scene a fire alarm activation report which will indicate if the activation as due to a fire, nuisance fire alarm of false fire alarm. The fire alarm activation report for nuisance alarms requires owners to return a service or report within 15 days verifying that the system has been examined by a qualified technician and efforts were made to find and fix the probable cause of the nuisance alarm.

They recommend a grace period of 45 days following installation for false alarms, after that a limit of three false alarms per year. They also propose a fee structure based on a multiplier. The first three false and nuisance alarms would be free. A fee of X would be charged for the 4th false alarm, 2x for the 5th, and 4 X for the 6th or more. For nuisance alarms, the fee would be ½ X for the 4th nuisance alarm, X for the 5th, and 2X for the 6th or more. Fees of 10 X would charged if a service/report report was not returned of if the false fire alarm was caused by an on-site alarm company employee. Late fees, appeals fees and reconnect fees would be ½ X. The fire department can order a system disconnected or deactivated and a fire watch initiated at owner expense due to repetitive alarms or revoke occupancy certificate if requirements are not met and fees not paid. Provisions are included for appeal, reconnection, and government immunity.

Some departments use penalties only when identified issues are not corrected.
Oxnard Fire and Rescue helps people to address accidental fire alarms, but bills if corrective action is not taken to address an identified cause. (Oxnard, California Fire and Rescue, 2008) Owners and property managers are billed for three or more alarms in a year. Contractors are billed for each false alarm during testing, maintenance, installation, etc. The Monitoring Company is billed for three or more alarms from properties they monitor. Billing is considered a tool, and special circumstances can be addressed. Billing is based on hourly personnel rate for responding firefighters (minimum of one hour) with an additional 1.5 hours charged.

The percentage of "repeat offenders" varies by community.
Although repeat offender penalties are part of their strategy, the Tualatin Fire and Rescue Department found that repeat offenders accounted for less than 15% of their unwanted alarms in a given year. Regular maintenance is important but it does not address the human-caused alarms such as those from burnt toast or welding. They note that responsible parties are contacted for all automatic alarm activations. They have simply changed the order of notification. In contrast, the Hopkins, Minnesota Fire Department noted that 75% of their fire alarm calls come from 25% of their alarmed buildings. (Hopkins, Minnesota Fire Department, 2012)

Pannell asked other fire departments about their experience with false alarm ordinances. Most used words such as marked, significant, or effective to describe the impact, but few provided a quantitative answer. Captain Darrel Brown of Gainesville Fire Rescue was an exception. He told Pannell that false alarm responses in Gainesville dropped from 2,157 in 2004 to 1,688 in 2005 after having a false fire alarm ordinance enforced for six months. (Pannell, 2005) Dell'Orfano found that increased business and complaint inspection activity in 2008 and 2009 by the South Metro Fire Rescue Authority at properties with the most false alarms led to a decrease in the number of false alarms. (Dell'Orfano, 2010)

Policies related to false burglar alarms

The Center for Problem-Oriented Policing guide recommends verified response before police are called. Like the fire service, the law enforcement community has been trying to determine the most appropriate way to handle unwanted activations of burglar and other security alarms. While there experience has much to offer, there are some important differences. Burglar and security alarms are generally voluntary and not mandated by code. In addition, sounding alarms or even the presence of a security system can serve as a deterrent. A fire is unaffected by sounding alarms. Even with these differences, many of the issues are similar to those fire departments face in addressing unwanted fire alarms. The Center for Problem-Oriented Policing's guide to handling false burglar alarms explored the growing problem, resource use and costs, and the likely effectiveness of a variety of strategies. (Sampson, 2011)

In 2002, U.S. police departments responded to roughly 36 million alarm activations, usually burglar alarm activations. False alarms accounted for 94-98% of the activations. When an alarm activates, the monitoring company, which may be in another state, calls the owner. If no contact is made or the wrong code is given, the company calls the police.

The leading causes of false burglar alarms are user errors; defective or inappropriate equipment; and improper installation. Because commercial properties tend to have more complex systems and more people involved, the rate of false alarms is higher than at residential properties. The author notes that "chronic false alarm activations are often due to inadequate employee training or inferior systems that have not been upgraded." (p. 9)

Costs associated with false burglar alarms include: personnel and costs associated with dispatch and call-taking, back-up personnel and equipment, alarm analysis, permitting, billing, notifications, and education programs; facilities and equipment for managing false alarms; publication production costs; time that could have been spent on other things; and delay or displacement of response to other calls because resources were already in use. Noise is also a problem.

Some companies offer free monitoring for a few months, while insurance companies offer premium discounts. The author noted that residential burglary rates are highest in low-income areas, yet burglar alarms are more common in affluent areas. False alarms can lead to more police response to areas with

lower crime rates, yet there is little to suggest that burglar alarms help police catch burglars. Taxpayers are in effect subsidizing the alarm industry by paying for police responses, particularly when no fees are charged for the first three false alarms per year.

The author lists stakeholders who should be included when addressing false alarms. In addition to alarm owners, security and alarm companies, building managers, the author advised that local government finance officials and community members who do not have alarms also be included.
The author concluded that verified response, which requires alarm companies to respond to the scene or have visual information indicating a crime has occurred before contacting the police, is the most effective strategy to reduce false burglar alarms.

Alarm permits with escalating fines for false alarms and cost-based recovery fees have substantial administrative costs and low collection rates. Administrative costs for permits and fines can be reduced by charging the companies directly, but cooperation from the companies is required. Outsourcing permit, fine and fee administration can help manage, but not solve, the false alarm problem. Alarm companies may be required to make two calls to owners with activations before contacting police. This works better when owners have several call numbers. Alarm companies covering multiple jurisdictions can have difficulty determining which policies are used where, and some may worry about liability if they don't call police immediately. Accepting dispatch cancellations from the alarm company reduced time spent, but does not reduce number of calls or dispatched responses. Alerting alarm companies to false alarm abusers requires police staff time and alarm company cooperation. This approach is most effective if alarm companies, as well as alarm owners, are penalized.

Withholding police response for chronic sites or sites without a permit can be combined with a modified verified response is an option when police have quick access to database and owners are informed of the intent to suspend. Recordkeeping is critical.

Publishing alarm companies' false alarm rates can motivate alarm companies to improve performance, particularly with advance notice allowing companies to take corrective action prior to publication. Record-keeping is essential. Verified response may be required for companies with high false alarm rates.

Classes for alarm users can reduce human errors. These work best when taught at the premises by the installers or monitoring company. If police lead classes, they need expertise in alarm systems and false alarm causes. Should the public sector educate about a private product?

The call priority for automatic alarms can be lowered. This assumes sufficient resources to respond, but does nothing to address causes or reduce calls to dispatchers.

The author does not recommend providing a high-priority response to unverified burglar alarm calls. This in effect gives police full responsibility for all automatic alarm activations.

Preventing unwanted fire alarms

Little change has been seen in causes of unwanted alarms since the VAMC study was published in 1989. Among the causes cited for false alarms in Veteran Affairs Medical Centers facilities were: smoking (in groups); dust; humidity; high air velocity; defective detectors or components; transient (electrical); lack of maintenance; insects; steam; construction work; housekeeping that used aerosol, solvents, etc.; cooking and baking.; fumes (inside or outside); water; malicious; or a combination of factors that together increase detector sensitivity. The authors made a series of recommendations to the medical centers, the central office, detector manufacturers, system designers, etc. While this study is now more than 20 years old, the issues remain. (Dubivsky & Bukowski, 1989)

The three leading causes of human error false alarms in Appleton were burnt food (21%), activated pull stations (16%), and contractors doing maintenance work (13%). (Reece, 2008) Reece also cited findings from "Result Minneapolis" by the Minneapolis Fire Department showing the ten leading cause of unwanted fire alarms in Minneapolis in 2007 (commercial):

1. Maintenance personnel working on the system, construction work, and dust
2. Proper response to environmental stimuli
3. Malfunction (improper performance)
4. No reason found
5. Malicious- manual pull stains activated
6. Heat detector activation without heat
7. Malicious false telephone calls not connected to an alarm
8. Sprinkler testing or broken pipes
9. Carbon monoxide alarms
10. Central station malicious alarms without further explanation

Reece also surveyed fire departments about their experience and policies about false fire alarms in all occupancies. The ranks from the 24 responses are shown below.

1. Burnt food
2. Alarm technician failing to notify the alarm company of their work.
3. Alarm company was not notified of testing
4. Construction
5. Activated pull stations

Roughly one in five false alarms at the Seattle campus of the University of Washington were due to construction projects, with dust, steam and other particles the common culprits. The posted information about their false alarm experience on their website. (University of Washington Environmental Health and Safety, 2009) The Seattle Campus had 161 false fire alarms in 2008. This was the lowest number since 2004, but still enough to give them third place among single businesses or companies in Seattle. They received a Notice of Violation and were required to devise and implement procedures to reduce false alarms. University recommendations called for pre-construction meetings to discuss false alarm prevention procedures, including temporary fire partitions and dust barriers; consultation with the fire protection engineer about removal, bagging or disabling fire alarm devices; fire watch requirements in case fire alarm components are temporarily disabled; any project-related false alarms that occur and

how to prevent them; and steps for contractual "final clean" and removal of detector covers after the fire alarm system is approved by the fire department.

NFPA 72 provides AHJs tools and options to reduce unwanted fire alarms. NFPA 72, *National Fire Alarm and Signaling Code,* gives the AHJ considerable authority and discretion as well as a critical role in plans review and inspections. Section 10.18.1.1 states that "The AHJ shall be notified prior to installation or alteration of equipment or wiring." The AHJ should encourage fire alarm system designers to involve the AHJ in the planning stages. The AHJ can set local requirements for permits, licensure, training or certification requirements for system designers, installers, and service personnel. AHJs can require detailed specifications, drawings and calculations. After installation, the AHJ can require a preliminary record of completion and as-built drawings. The latter should be made available for inspection and testing. NFPA 72 also provides guidance for AHJ system installation checks and visual inspections. The document also requires that affected parties be notified before testing to prevent unnecessary response. The AHJ should ensure that testing and documentation are completed. The AHJ can require written statements of compliance and verification of compliant installation with third party certification.

Once the fire alarm system has been commissioned, the building owner is responsible for inspection, testing and maintenance (ITM). This responsibility may be delegated, in writing, to qualified staff or to a service provider. NFPA 72 provides requirements for maintenance, testing and inspection procedures, frequency, and documentation and requirements that defects or malfunctions be corrected or the owner notified within 24 hours.

When system modifications go beyond a simple repair or replacement in kind, the planning and design requirements are the same as for a new system. The extent of reacceptance testing depends on the extent of the modifications.

While NFPA 72 explains how systems should be installed, other codes such as NFPA 1, *Uniform Fire Code,* and NFPA 101, *Life Safety Code,* provide occupancy-specific requirements. The 2012 edition of NFPA 1 references the provisions of NFPA 72 in Section 13.7.4 in its section on automatic fire detectors. In addition, Section 13.7.5 1 states that "Fire alarm systems that have produced five or more nuisance alarms in a 365-day period shall be classified as chronic nuisance alarm prone systems. The AHJ shall be authorized to require central station service be provided for chronic nuisance alarm prone systems… The system owner shall replace required fire alarm systems that cannot be serviced or repaired to eliminate system impairments or chronic nuisance alarms."

NFPA's book, Fire Alarm and Signaling Systems, provides some guidance for designers, installers, and technicians. (Bukowski & Moore, 2003) Some smoke detectors have features that can be used to verify an actual alarm. Detectors with pulsing normal operation may require several pulses be counted before signaling an alarm. Sensitivity may be reduced somewhat in some cases. The detector may have a delay reset time of 5-30 seconds in which the signal is held and reset. The alarm is only transmitted if smoke is sensed after reset. Field procedures can also reduce false alarms. The building should be evaluated to ensure that smoke detectors are not in areas that are likely to be humid, dusty, smoky, or home to

insects. Temperature extremes or excess RF noise or electrical noise could also cause false alarms. Detector heads should not be installed until after construction and plaster dust has been cleared away. Smoke detectors should be cleaned according to manufacturers' directions and sensitivity regularly checked and documented. Units that have drifted need to be replaced. Care should be taken in relation to air supply and return ducts.

Finley's multi-faceted recommendations for dealing with unwanted residential fire alarms would also apply to commercial alarms. Finley concluded that the issue of unwanted residential alarms needed a multi-faceted approach. (Finley, 2001) Most of his recommendations would also apply to commercial alarms, including:

1) An aggressive public relations campaign on the importance of alarm service and maintenance;
2) Alarm system plan review prior to installation, followed by inspection and testing before a certificate of approval, to ensure code compliance
3) Registration of all fire alarm systems, with a stipulation of adherence to NFPA 72, with a specific mention of maintenance by a qualified technician every three years and replacement of detectors when they hit ten years of age. Registration should be renewed every three years. Renewal would require documentation of servicing and aged detector replacement.
4) Penalties or fines should be implemented for repeated alarm malfunctions or nuisance alarms, with incremental increases based on number of responses. Penalties should also be considered for failure to register alarm systems.
5) When an automatic fire alarm is received, the first due engine should respond In emergency mode with other apparatus at normal speed. If notified that the alarm was false, only the first due should proceed to scene, but should go at reduced speed without lights or sirens

UL Certification addresses installation, testing, maintenance, monitoring, and transmission.
The Underwriters Laboratories (UL) Certificate Service includes a field examination of installations and records, as well as field tests of service response. Service and signal handling records, the alarm system installation, and the operating procedures are all examined. This goes substantially further than product certification, addressing six sources of fire alarm system problems:

1) a lack of maintenance and testing,
2) improper installations,
3) modifications,
4) devices that weren't working,
5) initiating devices that were not set up to send signals to the central station; and
6) faulty monitoring and retransmission.

Certification verifies code compliance, improves accountability, ensures signals are dispatched properly and that systems are repaired, tested, and maintained. (Presnack, 2009)

In a follow-up e-mail, Presnak explained that in most communities that require fire alarm certification, the requirements apply first to new construction. (Presnak T. , 2012) Some jurisdictions require certification when occupancies change, renovations or additions are done, or when the fire alarm equipment is changed. Some require certification for specific occupancy groups. Properties that have more than a certain number of unwanted alarms over a specified period may be required to get the system certificated. False alarm fees may be waived if the system is certificated. The program is designed to be customizable for each community.

Stephen Schmit provided more details about how the certification process works. The cost of certification is incurred by the alarm service company (ASC). (Schmit, 2012) Each ASC or company location pays a one-time fee to obtain a UL listing and the right to issue UL Certificates As part of the process, installation, service, maintenance, monitoring, and where applicable, runner services, are thoroughly evaluated. To maintain their listing, the ASCs pay an annual fee and are audited at least once a year by UL staff. The audit uses records review, property examination, interviews, and surprise service tests.

Sterling Heights, Michigan instituted a requirement for UL certification for new, modified, or problematic systems. (Mankiewicz, 2004) At the time the PowerPoint presentation was prepared, ten properties had been certificated. The presentation contained results from three properties that had been certificated for a year. These properties showed substantial drops in false alarms from the year before, with one retail establishment dropping from 17 false alarms to zero; false alarms at an office building fell from 12 to three, and nursing home false alarms dropped from 10 to seven.

Without follow-up, the problems will continue. Reece noted that follow-up on false alarms due to system malfunctions was rare in Appleton. He favored a combination of engineering, education and enforcement. These include enhanced monitoring of installations, modifications and replacements for code compliance the possibility of using UL's Alarm Certification Program, improving records management system for clearer identification of false alarm situations as the NFIRS incident types were not sufficiently detailed, training for fire department staff on investigating, addressing and documenting false alarms, training materials for property owners and occupants upon fire alarm system certification, sponsor annual training of technicians, updating false alarm ordinance to allow billing of responsible party instead of owner, instituting annual registration system, follow-up with a fire prevention officer after multiple alarms. (Reece, 2008) Dell'Orfano found that increased business and complaint inspection activity in 2008 and 2009 by the South Metro Fire Rescue Authority at properties with the most false alarms led to a decrease in the number of false alarms. (Dell'Orfano, 2010)

After the Calgary Fire Department proposed fines for repeated false alarms, Brookfield Properties established revised procedures, expanded training, increased management oversight, and reduced the number of alarms. In his *NFPA Journal* article, "Nuisance Alarms," Glen Kitteringham described the approach used by the Brookfield Properties management group in addressing the false alarm problem in three multi-towered commercial high-rise buildings in Calgary, Alberta, Canada. (Kitteringham, 2007) During this period, the Calgary Fire Department proposed fines when properties had three or more false

alarms. From 2002-2006, the three properties had experienced 244 fire alarms. Seventy percent were false. Legitimate alarms accounted for only 21% of the alarms. It was unknown whether the remainder were legitimate or false. False alarms were divided into four categories:

1) User error;
2) Work done without notification;
3) System malfunction; and
4) Damage to the system.

They expanded training on the fire alarm system for building personnel. Building personnel were trained to ask contractors for details about hot work, dust, painting, equipment movement, or other activities that might trigger an alarm. When work was done on the fire alarm system, the security personnel, building engineers and contractors would have daily meetings. Training sheets explained how to manage the panels, take one point off-line when work was being done, etc. Procedures were tightened to ensure that contractors worked *with* building staff rather than bypassing them. When false alarms occurred, the fines were passed on to the tenants and/or contractors who caused them.

An internal reporting process to inform senior management about alarm frequency, cause of the alarms and necessary corrective action was instituted. All alarms are reported and investigated. Training and system changes are documented. Potential impacts of any change on other parts of the system are considered. In 2003, the properties experienced 60 alarms. In 2006, after these procedures had been instituted, only 30 alarms occurred. The author noticed that the 2006 total also saw a decrease in legitimate alarms. He also noted that any large, complicated system will occasionally have a component fail.

Testing and inspection identify approximately equal shares of problems in most situations. For duct detectors, testing identified more problems. An analysis of inspection, testing and maintenance data from 2004 to 2007 was done by a fire protection service contractor. He found that annual smoke detector testing identified one failure per 300 detectors tested. The most common problem was detectors out of their sensitivity ranges. The issue was seen more often in ionization detectors than photoelectric units. For most detectors, inspections and testing identify roughly equal shares of problems. However, 85% of duct detector failures were identified by testing. (Carter, 2008)

If dormitory and apartment residents with dwelling unit activations from burnt food opened windows instead of doors to common areas, common area detectors are less likely to be triggered. Several colleagues have experienced numerous fire alarms in apartment buildings and dormitories after the smoke alarm activated in response to burned food in an individual unit or room. When the unit's door opened, smoke entered the common hallway, activating the commercial alarm system in the common areas, resulting in a building evacuation and fire department response. A member of the Project panel reported that his fire department had some success in educating apartment residents to get rid of smoke from burned food by opening windows rather than doors to common areas. This approach might also work in dormitories.

Stickers on panels could remind contractors and maintenance staff to notify the alarm company before working on the system. Another member of the panel mentioned that stickers with the alarm company's phone number and a reminder to call before testing or servicing could be attached to the panel or other locations.

The Fire Alarm Response and Management Summit identified cost of upgrades, and time from code proposal to adoption and implementation as impediments. System service and maintenance requirements are frequently not enforced. All stakeholders, including building owners and managers, must be part of the solution. Better data are needed. A number of suggestions were made at the Fire Alarm Response and Management Summit. (FEMA, IAFC and NFPA, 2011) Participants noted that despite tremendous technical progress, most systems are based on technology that is 40 years old. Aging systems that are poorly or not maintained, a need for improved training and education, and a lack of necessary system upgrades are all problems, but these problems cannot be addressed by one group alone. The band-aid approach is often used on old systems. Financial issues were identified as a major impediment. Multi-criteria technology can screen out commonly occurring triggers such as normal cooking fumes. Point ID technology should be used to provide better data about causes and frequencies of specific types of unwanted alarms. Addressable systems make dispatching, testing and inspection easier. Proposed changes to code requirements take years to be first adopted into the code, and then adopted by state and local authorities, and finally implemented.

Summit participants also noted that building staff are often responsible for alarm system maintenance, but they are not trained in or certified for these tasks. Requirements to have a system are typically enforced, but service and maintenance requirements are not.

Summit participants reached consensus on a number of points. Commercial fire alarm systems are generally operating as designed. Most challenges are in the "physical, operational, or response environment." Long-term technological solutions are promising, but the situation must be addressed now with interdisciplinary stakeholder collaboration on immediate actions, intermediate research, and long term approaches. Building owner and manager participation, buy-in, and accountability are critical to the success of any new approaches. All stakeholders need data, and data should be shared across disciplines. Stakeholders from the different disciplines all need education about how the issues are seen by and impact each other for interdisciplinary solutions to succeed.

Data limitations and options

Summit participants were frustrated by the lack of necessary data. They noted that NFIRS does not capture incident dispatch type. (FEMA, IAFC and NFPA, 2011) Consequently, analyses cannot be done comparing what the call was reported as with the actual situation found. They proposed a pilot study among a group of representative communities to explore how to get additional required data without imposing a burden on the firefighters.

Local data quality is also an issue. Incident, occupancy and inspection databases are often hard to link. Dell'Orfano recommended improvements in the incident type, device type and activations cause fields in their Record Management System. (Dell'Orfano, 2010) The department had supplemented the NFIRS with custom unwanted alarm categories that were frequently not being used. Their system had, for a period of time, a default entry of unintentional alarm system activation when an incident report was opened for an alarm. He maintains that the activation cause field needs to be more specific. He also recommended incorporating an occupancy/complex ID so that incident, occupancy, and inspection databases can be analyzed together more easily.

As discussed earlier, a wide variety of definitions and interpretations of definitions exist, even within NFIRS codes. Steve Forster of Tualatin Fire and Rescue provided an analysis of automatic commercial alarm calls by broad incident type for 2007-2011. While 84% of the calls had a false alarm incident type, 12% were classified as good intent calls, and 2% were service calls. Only 1.5% of calls were considered emergency with incident types indicating fires or explosions, overpressures, EMS or rescue calls, or hazardous conditions. (Forster, 2012) Good intent calls could include calls that were dispatched and cancelled while en route (NFIRS incident type 611), as well as smoke scare or odor of smoke (651), steam, vapor, fog or dust thought to be smoke (652), smoke from barbecue or hostile fire (653) or "steam, other gas mistaken for smoke, other." Incident type 531, "smoke or odor removal," is in the service call category. (U.S. Fire Administration National Fire Data Center, 2008) Analyses to measure progress will need definitions that are applied consistently. If response protocols or penalties are used for different types of unwanted alarms, local PSAPs and firefighters will need the same consistency.

NFIRS has options for greater detail and special studies. Local departments may choose to use the "plus one" or four special studies fields in NFIRS to collect additional or more specific information. For example, a plus one code could be attached to incident type to describe how the alarm was reported and whether or not confirming information was received. A special study field could be used to track the type of incident originally reported or the cause of an unwanted alarm.

Consensus is somewhat lacking on how to handle fire alarms in response to burnt food. In many cases, it is likely that the system was operating as designed. The alarm may have alerted occupants to a developing situation or sounded after occupants were dealing with the situation.

Summary of alternatives

Table 6 outlines a number of approaches that might be used to reduce the burden of unwanted alarms on fire departments. Note that different policies may be established for different occupancy classes or different times of day.

In almost all cases, the authority having jurisdiction must decide if the parties with responsibility will use these approaches. Fuel and apparatus costs are associated with every response and are not shown. A small risk of vehicle crash or firefighter injury is possible for every response. For career departments with sufficient personnel to handle responses, personnel costs only become an issue if more are needed to meet the total call demand. Fire departments with firefighters who are paid by the call face the greatest direct cost, particularly if firefighters are paid for a minimum number of hours per call. Uncompensated volunteer fire departments may face greater indirect costs associated with recruitment and training caused by the departure of firefighters discouraged by unnecessary calls. Costs to firefighter morale are real in career and volunteer departments. Unfortunately, they cannot be easily quantified.

Any policy calling for reduced response to automatic alarms has a provision to upgrade the response should an actual fire be discovered or confirmed at any point. Any reduced response, by definition, has the potential for insufficient resources upon arrival at a true emergency.

Fire departments are using a variety of definitions to describe unwanted alarms. In some cases, systems are operating properly and activating in response to burnt food or a developing problem that occupants can and do easily address. Proposed language for the 2013 edition of NFPA 72 defines an unwanted alarm as any alarm that occurs that is not the result of a potentially hazardous condition. In some cases, systems are operating properly and activating in response to burnt food or a pre-fire condition that occupants can easily address. The NFIRS good intent call code 651 captures smoke scares or odor of smoke. This may be a more accurate description of a pre-fire alert than the false alarm category of unintentional system or detector operation. Burnt food might be a confined cooking fire (Incident type 113). After all, something burned. Ideally, fire departments will ensure consistent use of NFIRS codes and definitions prior to implementing new policies. Without consistent definitions, it is very hard to evaluate the success of new approaches.

Fire departments may also want to add a field or plus one coding to their record management systems to indicate if a call came in from an automatic alarm. A similar approach could be used to document more information about causes of unwanted alarms. If the response protocol allows calls to be completely cancelled when subsequent information indicates a response is needed, the NFIRS incident type should be 611 -dispatched and cancelled en route. Such an incident would not be captured in the NFIRS false alarm category.

Fire departments have a wide variety of approaches they can take to minimize the impact of unwanted alarms, ranging from approaches focused on detection system installation, technology, testing, maintenance and user education, to verification requirements or lesser response to unconfirmed automatic alarms. Penalties can be imposed for repeated unwanted alarms.

Every change can have unintended consequences. Public perception is important. Would the wrong message be sent if penalties were assessed for fire department responses to unintentional activations pr pre-fire conditions but not to situations that had been allowed to progress to actual fires? Will property owners decide that detection systems are not important if the fire department will not automatically respond? This review has focused mainly on the impact of unwanted alarms on the fire service. Ultimately, firefighters serve and protect the public. At present, we know little about how the different changes would be perceived by the public.

Table 6. Possible Approaches to Addressing Unwanted Alarms

Approach	Primary parties involved	Fire department role other than response	Pros and Cons
Non-incident			
Plan design and installation with emphasis on potential triggers of unwanted alarms	Plan designer, installer, facilities manager, building owner, AHJ	Plan review, inspection	Pro: Prevent unwanted alarms from occurring Con: May be harder to implement in existing systems; cost of training for plan review and inspection
Install multi-criteria detection	Plan designer, installer, facilities manager, building owner, AHJ	Plan review, inspection	Pro: Reduce alarms from non-threatening triggers: Con: Cost
Replace old systems or components	Plan designer, installer, facilities manager, building owner, AHJ	Inspection	Pro: Reduce alarms from sensitivity drift or defects Con: Cost
Use point ID and/or addressable panels	Plan designer, installer, facilities manager, alarm company, maintenance company, building owner, AHJ	Plan review, inspection	Pro: Identify which detector activated or has trouble Con: Cost
Use sticker reminders to notify alarm company before working on system	Alarm company, AHJ	Communicating policy, enforcement	Pro: Inexpensive; can prevent unwanted alarms caused by system work without notification Con: Passive approach; relies on technician complying; need for enforcement
Require fire department input into renovation permits	AHJ including fire and building departments; contractor, property owner or manager	Review, permitting, and enforcement	Pro: Can avoid alarms from construction dust while ensuring continued protection Con: Adds layer of bureaucracy; need for enforcement and fire department resources; cost
Institute alarm system registration/permitting with stipulation of NFPA 72 adherence, testing maintenance documentation	Alarm company, property owner or manager, AHJ	Permitting authority, possible enforcer	Pro: Establishes requirements across field and documents Con: Requires administrative structure and tracking; must be enforced

Table 6. Possible Approaches to Addressing Unwanted Alarms (Continued)

Approach	Primary parties involved	Fire department role other than response	Pros and Cons
Non-incident (continued)			
Require alarm system certification	Certification organization, alarm company, property owner or manager, AHJ to enforce	Possible enforcer	Pro: Verifies code compliance and provides greater accountability to prevent unwanted alarms Con: Must be enforced; cost.
Educate building owners and managers about how to test and maintain their fire alarm systems	Property manager and or owner, fire department, alarm company		Pro: Can reduce alarms triggered by system work Con: Hard to reach all involved; cost of providing training
Educate multi-family and dorm residents occupants who have smoke alarms in their unit sounding due to non-threatening smoke to open window rather than door to common area where smoke could trigger detection in common areas and fire department response	Property manager and/or owner, fire department, tenant association	Developing appropriate materials (in whatever languages necessary) and disseminating same	Pro: Relatively low cost. Reduces embarrassment from triggering building evacuation. Con: Approach could discourage people from evacuating or reporting real fire; cost of developing and communicating information
Require some type of verification, positive actions sequence or multiple signals before transmission to monitoring station	System designer and installer		Pro: Prevents unwanted alarms in facility and to fire department Con: May be harder to implement in existing systems; builds in some delay
Inform public of procedures (not resetting before getting information) and penalties for unwanted alarms	Alarm company, fire department	Setting and communicating policy and procedures. Clearly define what is an unwanted alarm subject to penalty and who will be liable	Pro: Provides financial incentive to fix problems Con: Threat of penalties may inspire disabling or other unwanted behavior

Table 6. Possible Approaches to Addressing Unwanted Alarms (Continued)

Approach	Primary parties involved	Fire department role other than response	Pros and Cons
Alarm company verification and fire department response			
Do not send any fire department response without verification by monitoring company	Monitoring company and designated responsible party at site	Communicating policy and any exceptions	Pro: No cost to or effort from fire department Con: Fires in areas with less human activity may grow for long period without being seen; premises representative may mistakenly conclude no fire
Require monitoring company to attempt verification before transmitting alarm	Monitoring company must try to contact designated representative	Enforcement	Pro: Reduction in calls or response if unwanted alarm is verified Con: Delay in notification and response
Send full response to verified fire alarm	Monitoring company property representative	Response	Pro: Full resource complement is sent Con: Verification has introduced some delay, allowing fire to grow
Send limited response to verified unwanted alarm	Alarm company, property representative	May send one unit non-emergency to investigate, document, reset, and advise	Pro: Opportunity to investigate, document, and ensure proper reset Con: Should the verification be in error, resources for actual fire may be insufficient; value of even a reduced response may not be worth the cost of an unwanted alarm
Have alarm companies handle verified unwanted alarms without notifying fire department	Alarm company, property representative	None	Pro: No cost to or effort from fire department Con: Fire department may know nothing about a problem that could lead to disabling or occupant disregard of fire alarm; information could be wrong
Have alarm companies notify fire department of verified unwanted alarm but do not send an immediate response	Alarm company, property representative	May send inspector or include in inspection flags	Pro: Less use of resources Con: Information could be wrong; risk of increasing public disregard of fire alarms unless efforts are made to prevent future alarms

Table 6. Possible Approaches to Addressing Unwanted Alarms (Continued)

Approach	Primary parties involved	Fire department role other than response	Pros and Cons
Response to unverified alarm			
Send structure fire response to unverified alarm	Alarm company attempted to verify		Pro: Prepared for structure fire; opportunity to investigate, document and ensure proper reset Con: Delay due to verification attempt; resource overuse and unavailability
Send reduced response to unverified alarm with first unit emergency, others non-	Alarm company attempted to verify		Pro: Reduces risk of collision with most units non-emergency but ensures prompt arrival and assessment; opportunity to investigate, document, and ensure proper reset Con: Delay due to verification attempt; delay while other resources arrive if reduced response is inadequate; resource overuse and unavailability if alarm is unwanted
Respond to unverified alarm with one unit, non-emergency			Pro: Reduces risk of collision and overuse of resources with one non-emergency -unit while obtaining assessment; Opportunity to investigate, document, and ensure proper reset Con: Delay due to verification attempt. Insufficient resources for actual fire
Alarm company verification not permitted	PSAP fielding calls		
Send structure fire response to any automatic fire alarm			Pro: Prepared for structure fire; no delay from alarm company verification; opportunity to investigate, document, ensure proper reset Con: Resource overuse and unavailability if alarm is unwanted

Table 6. Possible Approaches to Addressing Unwanted Alarms (Continued)

Approach	Primary parties involved	Fire department role other than response	Pros and Cons
Alarm company verification not permitted (continued)			
Send reduced response to automatic alarm with first unit emergency, others non-emergency			Pro: No delay during alarm company verification; reduces risk of collision with most units non-emergency but ensures prompt arrival and assessment; Opportunity to investigate, document, and ensure proper reset Con: Delay while other resources arrive; resource overuse and unavailability if alarm is unwanted
Modification of response to automatic alarm with calls without verification but with later information confirming unwanted	PSAP fielding calls		
Continue response without modification			Pro: If an actual fire, as ready as they would have been with original response; opportunity to investigate, document, and ensure proper reset Con: Resource overuse and unavailability
Reduce all but first unit to non-emergency			Pro: First unit is on scene quickly in case information is wrong; resources will soon be available; opportunity to investigate, document, and ensure proper reset; risk of collision is reduced in non-emergency response Con: Resource overuse and unavailability

Table 6. Possible Approaches to Addressing Unwanted Alarms (Continued)

Approach	Primary parties involved	Fire department role other than response	Pros and Cons
Modification of response to automatic alarm with calls without verification but with later information confirming unwanted (continued)	PSAP fielding calls		
Return all but one unit which continues in emergency mode			Pro: First unit arrives soon; opportunity to investigate, document, and ensure proper reset Con: Risk of increasing public disregard of fire alarms unless efforts are made to prevent future alarms
Return all but one unit which continues in non-emergency mode			Pro: Opportunity to investigate, document, ensure proper reset; risk of collision is reduced in non-emergency response Con: Risk of increasing public disregard of fire alarms unless efforts are made to prevent future alarms
Cancel all units			Pro: No additional use of fire department resources Con: Risk of increasing public disregard of fire alarms unless efforts are made to prevent future alarms
At scene of unwanted alarm			
Require alarm system technician to respond promptly, evaluate, correct any problem, and rest	Alarm company technician, building manager or owner, AHJ	Enforcement	Pro: Any problems can be promptly documented and addressed Con: Cost
Assist in resetting or interacting with service personnel		Ensuring alarm system is back in order	Pro: Good community relations; can reduce future unwanted alarms Con: Use of resources
Investigate, document and communicate		Investigation	Pro: Can reduce unwanted alarms if cause identified, penalties imposed. Con: Use of resources

Table 6. Possible Approaches to Addressing Unwanted Alarms (Continued)

Approach	Primary parties involved	Fire department role other than response	Pros and Cons
Post incident			
Issue warnings, penalties, or fines	AHJ		Pro: Threat of sanctions can motivate properties to fix problem systems Con: Threats may lead to disabling rather than fixing
Set reduced response policy to repeat offender	AHJ		Pro: Reduce resource use to properties in which experience suggests alarm is likely to be unwanted. Con: Properties with frequent unwanted alarms may not pay attention to other aspects of safety, may have occupants who ignore alarms. Fire department may be unprepared for actual fire
Discontinue response to repeat offender	AHJ		Pro: Avoid resource use to properties in which experience suggests alarm is likely to be unwanted Con: Properties with frequent unwanted alarms may not pay attention to other aspects of safety, may have occupants who ignore alarms

Annotated Bibliography

Ahrens, M. (2011). *Unwanted Fire Alarms: A Problem for the Fire Service and the Public.* Quincy, MA: National Fire Protection Association.

This analysis is included in the larger NFPA report, *Unwanted Fire Alarms,* which also contains Ben Evart's analysis*, False Alarms by Incident Type and Occupancy*. The full report was prepared in anticipation of the Fire Alarm Response and Management Summit. It summarizes false alarm statistics from Karter's *Fire Loss in the Unites States* series, and findings from Evarts analysis of 2003 false alarm data. (Unfortunately, the public release of NFIRS data for 2004-2010 did not include false alarm data.). Some findings from the literature are also included.

Bukowski, R. W., & Moore, W. D. (2003). *Fire Alarm Signaling Systems.* Quincy, MA: National Fire Protection Association.

This handbook provides non-technical explanations of provisions of NFPA 72, including those related to preventing unwanted fire alarms. Some smoke detectors have features that can be used to verify an actual alarm. Detectors with pulsing normal operation may require several pulses be counted before signaling an alarm. Sensitivity may be reduced somewhat in some cases. The detector may have a delay reset time of 5-30 seconds in which the signal is held and reset. The alarm is only transmitted if smoke is sensed after reset. Field procedures can also reduce false alarms. The building should be evaluated to ensure that smoke detectors are not in areas that are likely to be humid, dusty, smoky, or home to insects. Temperature extremes or excess RF noise or electrical noise could also cause false alarms. Detector heads should not be installed until after construction and plaster dust has been cleared away. Smoke detectors should be cleaned according to manufacturers' directions and sensitivity regularly checked and documented. Units that have drifted need to be replaced. Care should be taken in relation to air supply and return ducts.

CAL Fire- Office of the State Fire Marshal. (2011). *California State Fire Marshal Smoke Alarm Task Force Final Report Analysis and Recommendations: Understanding, Utilization, and Effectiveness of Smoke Detection Technology inckuding Ionization, Photoelectric, and Other Technologies.*

The California State Fire Marshal Smoke Alarm Task Force, an interdisciplinary group with representatives from the fire service, state and local government, code development organizations, industry and others, was created to provide California with the best possible information about use and effectiveness of smoke detection technology used in residential properties. Special attention was paid to photoelectric and ionization alarms, and unwanted alarms.

Carter, S. (2008). Inspection, Testing and Maintenance Records: A Window into System Reilaibility. *Suppression and Detection Research and Applications – A Technical Working Conference (SUPDET 2008).* Orlando, FL: National Fire Protection Association.

The author of this paper on inspection, testing and maintenance and reliability utilized a fire protection contractor's database containing four years of data on detectors and notification appliances. Analyses were performed based on detector types, (photoelectric, ionization, duct, and restorable and non-restorable heat), total inspections, failures, and whether failures were identified by visual inspection or testing.

Dell'Orfano, M. E. (2010). *Analysis of False Alarms in Commercial Occupancies for South Metro Rescue Authority.* Emmitsburg, MD: National Fire Academy Executive Fire Officer Program.

This EFO paper on false alarms in commercial occupancies investigated the service demand from commercial false alarms handled by the South Metro Rescue Authority, as well as the causes and factors contributing to these false alarms. Analyses were done on frequency, types of false alarm, call duration, as well as properties involved, building age, and device types and locations. Data quality and incompatibility of databases were identified as problems.

Dubivsky, P. M., & Bukowski, R. W. (1989). *False Alarm Study of Smoke Detectors in Department of Veterans Affairs Medical Centers (VMACS).* Gaithersburg, MD: U.S. Department of Commerce, National Institute of Standards and Technology.

This study of false fire alarms in 133 VA medical centers with roughly 37,000 system-type smoke detectors is one of the most detailed analyses of the subject. Data were obtained from forms, site visits and interviews. Information was provided about causes and circumstances of false alarms. Detailed recommendations were made relating to maintenance and testing, existing system features, coordination of construction activities, smoking policies and practices, possible design improvements and code changes, and customer education.

Evarts, B. (2011). *False Alarms by Incident Type and Occupancy.* Quincy, MA: National Fire Protection Association.

This analysis uses 2003 data from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) and NFPA's 2003 fire department survey to estimate the frequency of responses made by local fire departments to incidents with NFIRS codes for false alarms. An overview table is provided on specific incident types. Tables showing the frequency of incidents at different property uses are shown for false alarms caused by: system malfunctions or unintentional operation; smoke detector activations due to malfunctions; heat detector activations due to malfunctions; alarm system activations due to malfunctions; unintentional smoke detector activations; and unintentional detector activation to environmental stimuli such as heat.

Fahy, R. F. (2008). *U.S. Firefighter Fatalities in Road Vehicle Crashes.* Quincy, MA: National Fire Protection Association.

Using data obtained from reports all reports on firefighter deaths resulting from on-duty events, Fahy analyzed the causes and circumstances of 148 firefighter deaths that resulted from 133 road-vehicle crashes over the 10-year period of 1998-2007. This analysis was a companion piece to the report on firefighter deaths in 2007.

Fahy, R. F., LeBlanc, P. R., & Molis, J. L. (2011). *Firefighter Fatalities in the United States-2010.* Quincy, MA: National Fire Protection Association.

NFPA's annual report about the victims, causes and circumstances of on-duty firefighter deaths showed that the 72 such deaths in 2010 was the lowest recorded since NFPA began the study in 1977. Unlike most of NFPA's statistical reports, reports on firefighter fatalities are based on all fatal injuries or illness that occurred while the victim was on duty, rather than a sample.

FEMA, IAFC and NFPA. (2011, May 3). *Fire Alarm Response and Management Summit.* Retrieved May 16, 2012, from www.nfpa.org/assets/files/PDF/FireAlarmResponseSummit.pdf

The IAFC, NFPA and USFA sponsored this summit of stakeholders concerned with unwanted alarms in commercial properties. Panels were held on design and manufacturing, installation and maintenance practices, and emergency response models. Participants want more and better data. There is frustration that systems that are operating as designed result in many calls in which a full fire department assistance seems unnecessary.

Finley, P. J. (2001). *Residential Fire Alarm Systems: the Verification and Response Dilemma.* Emmitsburg, MD: National Fire Academy Executive Fire Officer Program.

In this award-winning paper, Finley explored the potential costs and benefits of permitting verification of residential fire alarms in Vineland, New Jersey. Using data from the local fire department, a literature review, and surveys of comparably-sized fire departments (protecting populations of 47,000-67,000) and of local homeowners who had experienced a fire department response to an automatic fire alarm, he addressed ten points. These include:

1) the primary cause of residential fire alarm activations and the percentage of times the fire department provides any service at these calls,
2) the percentage of departments allowing verification prior to dispatch,
3) fire department perception of the liability risk of responding or not responding to residential fire alarm activations,
4) fire department response protocols to residential fire alarm activations,
5) policies for handling repeat false fire alarm offenders,
6) frequency of and reasons for homeowner attempts to stop fire department response after fire alarm activation
7) receptiveness of homeowners to limited fire department response to fire alarm activations
8) any differences in homeowner's opinions and reactions when children are home alone,

9) potential impact on insurance rates based on verification and response policies, and
10) an explanation for why NFPA 72 allowed verification of residential fire alarms only.

Forster, S. (2012). Automatic Commercial Alarms 2007-2011. Tualatin, Oregon: Tualatin Valley Fire and Rescue.

This was one of four reports on dispatch call types of automatic commercial alarms provided to the project. Reports were received for dispatch call types for 1) automatic commercial alarms, and 2) automatic residential alarms for two time periods, 2007-2011 and 2003-2007. All reports have data for each year in all three tables in each report. The first shows the number of automatic alarms (either commercial or residential), the number that had a fire incident type, and the number that had extinguishment as an action taken. The second shows the broad NFIRS categories of incident type found for incidents from automatic alarms, including fires, overpressures, EMS or rescue, hazardous conditions, service calls, good intent calls, false calls, natural conditions, and other situations. The third table provides a breakdown by specific NFIRS incident type of good intent calls and false alarms. Good intent calls are important to this study because they include Dispatched and cancelled en route and smoke scares.

Gammon, G. (2005). Reducing Unnecessary Response Runs. *Fire Department Intergrated Risk Analysis and Management.* Fairfax, VA: Public Entity Risk Istitute (PERI).

This paper describes limited response policy to automatic fire alarms implemented by the Las Vegas Fire and Rescue Department in response to the growing number of responses to automatic fire alarms with no supporting information. and the very small number of fires found. In 2004, the department had responded to 3,400 automatic fire alarms without supportive information and not one was an actual fire. Under the provisions of the new policy, the fire department would not respond to automatic alarms from most occupancies unless the caller or alarm company had someone at the site who saw or smelled smoke or fire. One piece would be dispatched to alarms from government buildings, day, care, schools and hospitals. Response protocols are also described for: waterflow alarms, Halon system activations, fire alarms called in by a member of the public or business rather than an alarm monitoring company, medical alarms, and carbon monoxide alarms.

Greene, M. A., & Andres, C. (2009). *2004-2005 National Sample Survey of Unreported Residential Fires.* Bethesda, MD: Consumer Product Safety Commission.

This report documents the findings of a survey done for the CPSC that collected data on non-fire households and on households that had fires. This allowed for estimates of fires not reported to fire departments. They provided also comparisons between fire and non-fire households on demographic measures, amount of smoke alarm coverage, and extinguishers. Data provided on fire households included whether the fire department was called, how the fire was discovered in relation to level of detection, fire causes, areas of origin, injuries and losses, and how the fire was extinguished. Detailed discussions of methodology and recall periods were also included.

Harris Poll National Quorum. (2010). National Fire Protection Association: Smoke Alarms Septembe r 8-12, 2010.

This telephone survey of roughly 1,000 households was done for Fire Prevention Week. Questions were asked about smoke alarm presence, locations, interconnectivity, testing age, and age at which smoke alarms should be replaced, as well as any smoke alarms activations and reasons for activations. Information was also collected about escape plans, fire sprinkler presence, and opinions about fire sprinklers. Demographic information was also collected.

Hopkins, Minnesota Fire Department. (2012). *Fire Alarm Systems.* Retrieved April 17, 2012, from http://www.hopkinsmn.com/fire/alarms.php

This web page describes fire alarm system registration and maintenance requirements. It also explains what assistance firefighters will provide in the event they are called to a false alarm and the responsibilities of the building owner or representative, and of the fire alarm company. Billing policies for false alarms are clearly explained, as are steps that building owners or managers can take to reduce false alarms.

Karter, M. J. (2011). *Fire Loss in the United States during 2010.* Quincy, MA: National Fire Protection Association.

Annual reports in this series provide an analysis of summary data collected by NFPA's annual fire department experience survey. Each January, the survey is sent to all local fire departments protecting populations of at least 50,000 and a sample, stratified by population, of departments protecting small populations. Fire departments provide data on numbers of responses to: structure fires by broad occupancy groups, vehicle fires, and various types of outside fires. Information is also collected on non-fire responses, with a breakdown by broad categories of false alarms. Estimates are also provided by census region and community size. The survey uses NFIRS coding conventions in framing its questions.

These reports are particularly important because they are used with NFIRS to calculate national estimates of specific fire problems. Because NFIRS is not based on a statistical sample, the survey results are divided by NFIRS totals to develop multipliers that can be applied to NFIRS to compensate for fires that are reported to local fire departments but not to NFIRS.

Karter., M. J., & Molis, J. L. (2011). *U.S. Firefighter Injuries- 2010.* Quincy, MA: National Fire Protection Association.

The NFPA survey also collects data on firefighter injuries. This annual series of reports provides estimates of the number of firefighter injuries occurring in the line of duty by type of duty. More detailed information is provided on fireground injuries. Estimates are also provided on exposures to infectious diseases and injuries resulting from vehicle collisions.

Kinsey, K. (2012, March 14). E-mail "unwanted alarms, etc.". Austin, Texas: Austin Fire Department.

Karyl Kinsey, an analyst with the Austin Fire Department, provided the research team with narratives of fire department reports to 2011 incidents in which the dispatch problem type was a fire alarm and the NFIRS incident types were either false alarms, steam or other gas mistaken for smoke, or dispatched and cancelled en route. The spread sheet contained incident number, dispatched call type, incident type property use, the number of 2011 fire alarm incidents at the address, the number of 2011 incidents with alarm company information, automatic alarm evidence for incident expressed as number of indicators, call processing time decile, an indicator of whether the CAD notes say "Alarm co", and an indicator of alarm company callback phone number, and the narrative. Multiple activations at the same address were common.

Kirkland, Washington Fire Department. (n.d.). *Information Bulleting: Fire Alarm Response Procedures*. Retrieved April 17, 2012, from http://www.kirklandwa.gov/Assets/Fire+and+Building/Fire+PDFs/Information+Bulletin$!3a+Fire+Alarm+Response+Procedure.pdf

The Kirkland, Washington Fire Department outlined steps for the public in event of a fire alarm. All alarms should be treated as emergencies until safety is verified. Alarm systems should not be silenced or reset until the fire department evaluates the situation. They note that most fire alarm systems have an alarm silencing provision that disables the audible signal and will not reactivate in a real fire. A reset alarm will sound in a fire situation, but may not retain information about the activation. When an alarm is reset, responding firefighters have to check the whole building, not just one zone. Premature resetting can make it difficult to identify an issue that might have caused a false alarm.

Kitteringham, G. (2007, March/April). Nuisance Alarms. *NFPA Journal* .

Kitteringham described the approach used by the Brookfield Properties management group in addressing the false alarm problem in three multi-towered commercial high-rise buildings in Calgary, Alberta, Canada. During this period, the Calgary Fire Department proposed fines when properties had three or more false alarms. From 2002-2006, the three properties had experienced 244 fire alarms. Seventy percent were false. Legitimate alarms accounted for only 21% of the alarms. It was unknown whether the remainder were legitimate or false. False alarms were divided into four categories:

1) User error;
2) Work done without notification;
3) System malfunction; and
4) Damage to the system.

They expanded training on the fire alarm system for building personnel. Building personnel were trained to ask contractors for details about hot work, dust, painting, equipment

movement, or other activities that might trigger an alarm. When work was done on the fire alarm system, the security personnel, building engineers and contractors would have daily meetings. Training sheets explained how to manage the panels, take one point off-line when work was being done, etc. Procedures were tightened to ensure that contractors worked *with* building staff rather than bypassing them. When false alarms occurred, the fines were passed on to the tenants and/or contractors who caused them.

An internal reporting process to inform senior management about alarm frequency, cause of the alarms and necessary corrective action was instituted. All alarms are reported an investigated. Training and system changes are documented. Potential impacts of any change on other parts of the system are considered. In 2003, the properties experienced 60 alarms. In 2006, after these procedures had been instituted, only 30 alarms occurred. The author noticed that the 2006 total also saw a decrease in legitimate alarms. He also noted that any large, complicated system will occasionally have a component fail.

Mankiewicz, D. (2004, June). UL Certified Fire alarm Systems in Sterling Heights: The Reason and History. Sterling Heights, MI, PowerPoint presentation.

In his 2004 PowerPoint presentation, Don Mankiewic z, Assistant Fire Marshal for Sterling Heights, Michigan, reported that the Sterling Heights Fire Department responded to more than 540 false alarms in 2002 and more than 530 such incidents in 2003. They began requiring UL certification for new, modified and problematic systems. At the time of the presentation, the city had 10 certificated fire alarm systems with about a dozen more in process. The presentation contained results from three properties that had been certificated for a year. Three properties showed substantial drops in false alarms, with one retail establishment dropping from 17 false alarms to zero; false alarms at an office building fell from 12 to three, and nursing home false alarms dropped from 10 to seven.

Menasha, WI Fire Department. (2003, January). *Fire Alarm Procedures.* Retrieved May 10, 2012, from http://www.town-menasha.com/fireweb/Documents/SOG2008/(SOG)%201525%20Fire%20Alarm%20Procedures.pdf

This document provides the standard operating guidelines for firefighters responding to activated fire alarms in terms of response and procedures at the scene. The latter involves size up, having contact made with the building representative, procedures at the fire alarm panel, completing a false alarm notification form, and information transfer.

National Burglar & FIre Alarm Association and False Alarm Reduction Association. (2001). *Model FIre Alarm Ordinance: A Joint Document of NBFAA/FARA.*

This document discusses procedures and language to implement a model fire alarm ordinance to address false alarms that summon fire departments. Beginning with and advisory board of stakeholders. Under ordinance provisions, alarm systems are registered with and responsible party and fire alarm company contact information is provided to the fire department, systems are certified by the fire department, inspected and tested al teat annually and maintained according to codes and manufacturer specifications. Fire departments are encouraged to use software for tracking and enforcement. Definitions, recommended procedures, and a proposed fee formula are provided.

National Fire Protection Association. (2012). *2012 Annual Revision Cycle Cocle Report on Comments: NFPA 72.* Retrieved April 26, 2012, from http://www.nfpa.org/Assets/files/AboutTheCodes/72/72-A2012-ROC.pdf.

NFPA's code development cycle issues reports each year on the proposals received (ROP) and reports on the comments (ROC) received on the previous year's proposals. Technical or Correlating Committee action on the proposals and comments are documented in the respective reports. The report also includes comments and actions on the proposals made by the IAFC to address the problem of unwanted alarms.

National Fire Protection Association. (2012). *NFPA 1, Fire Code, 2012 Edition.* Quincy, MA: National Fire Protection Association.

According to the document scope, relevant portions of NFPA 1® cover "the inspection of permanent and temporary buildings, processes, equipment, systems, and other fire and related life safety situations,… the review of construction plans, drawings, and specifications for life safety systems, fire protection systems, access, water supplies, processes, hazardous materials, and other fire and life safety issues…,existing occupancies and conditions, the design and construction of new buildings, remodeling of existing buildings, and additions to existing buildings and the design, alteration, modification, construction, maintenance, and testing of fire protection systems and equipment."

The document references the provisions of NFPA 72 in Section 13.7.4 in its section on automatic fire detectors. In addition, Section 13.7.5 1 states that "Fire alarm systems that have produced five or more nuisance alarms in a 365-day period shall be classified as chronic nuisance alarm prone systems. The AHJ shall be authorized to require central station service be provided for chronic nuisance alarm prone systems… The system owner shall replace required fire alarm systems that cannot be serviced or repaired to eliminate system impairments or chronic nuisance alarms."

National Fire Protection Association. (2010). *NFPA 72, National Fire Alarm and Signaling Code, 2010 Edition.* Quincy, MA: National Fire Protection Association.

According to the document scope, NFPA 72® "covers the application, installation, location, performance, inspection, testing, and maintenance of fire alarm systems, supervising station alarm systems, public emergency alarm reporting systems, fire warning equipment and emergency communications systems (ECS), and their components." The document is updated through NFPA's codes and standards process, and like all NFPA codes, its provisions are not binding unless adopted by the authority having jurisdiction. It currently contains provisions allowing verification of residential automatic fire alarms if the AHJ permits, as well as a number of approaches that can minimize unwanted fire alarms.

The AHJ plays a critical role in plans review and inspections. NFPA 72 gives the AHJ considerable authority and discretion. Section 10.18.1.1 states that "The AHJ shall be notified prior to installation or alteration of equipment or wiring." While NFPA 72 explains how systems should be installed other codes such as NFPA 1, *Uniform Fire Code,* and NFPA 101, *Life Safety Code,* provide occupancy-specific requirements. The AHJ should encourage fire alarm system designers to involve the AHJ in the planning stages. The AHJ can set local requirements for permits, licensure, training or certification requirements for system designers, installers, and service personnel. AHJs can require detailed specifications, drawings and calculations. After installation, the AHJ can require a preliminary record of completion and as-built drawings. The latter should be made available for inspection and testing. NFPA 72 also provides guidance for AHJ system installation checks and visual inspections. The document also requires that affected parties be notified before testing to prevent unnecessary response. The AHJ should ensure that testing and documentation are completed. The AHJ can require written statements of compliance and verification of compliant installation with third party certification.

Once the fire alarm system has been commissioned, the building owner is responsible for inspection, testing and maintenance (ITM). This responsibility may be delegated, in writing, to qualified staff or to a service provider. NFPA 72 provides requirements for maintenance, testing and inspection procedures, frequency, and documentation and requirements that defects or malfunctions be corrected or the owner notified within 24 hours.

When system modifications go beyond a simple repair or replacement in kind, the planning and design requirements are the same as for a new system. The extent of reacceptance testing depends on the extent of the modifications.

National Fire Protection Association. (2012). *NFPA 101, Life Safety Code ®, 2012 Edition.* Quincy, MA: National Fire Protection Association.

According to the document scope, relevant portions of NFPA 101® cover" protective features and systems, building services, operating features, maintenance activities, and other provisions in recognition of the fact that achieving an acceptable degree of life safety depends on additional safeguards to provide adequate egress time or protection for people exposed to fire."

NFPA. (2010). *NFPA 1221: Standard for the Installation, Maintenance and Use of Emergency Services Communication Systems.* Quincy, MA: National Fire Protection Association.

According to the document scope, NFPA1221 covers "the installation, performance, operation, and maintenance of public emergency services communications systems and facilities." Call handling time requirements are specified in this document.

Oxnard, California Fire and Rescue. (2008, May). *False Alarm Mitigation, FDP #37.* Retrieved April 25, 2012, from http://www.oxnardfire.org/Uploads/FirePrevention/FDP37FalseAlarmMitigation.pdf

In an effort to reduce the number of false alarms, the Oxnard, California Fire Department described procedures used to determine responsibility and provide documentation for cost recovery. The number of responding apparatus may be reduced for alarms initiated by fire detection or suppression systems when the property has a history of false alarms and there is no supporting evidence of a fire. False alarms are divided into two categories, accidental and preventable. Owners, property managers are billed for three or more alarms in a year. Contractors are billed for each false alarm during testing, maintenance, installation, etc. The Monitoring Company is billed for three or more alarms from properties they monitor. Billing is considered a tool, and special circumstances can be addressed.

Pannell, D. C. (2005). *The Impact of False Fire Alarm Responses in Memphis.* Emmitsburg, MD: National Fire Academy Executive Fire Officer Paper.

Pannell's study collected information and developed formulas to quantify the cost of false fire alarm responses. Measures include fuel use based on mileage, depreciation based on vehicle original cost and age of vehicle, staffing costs based on time spent. He also had a discussion of false alarm definition and provided his own. A false automatic alarm was one "that elicits emergency fire response which was not caused by heat, smoke, fire, other emergency condition."

Presnack, T. (2009). Third Party Verification of Fire Alarms. *PowerPoint presentation* . Underwriters Laboaratories.

Presnack's presentation described how UL certification verifies code compliance, provides accountability, ensures proper signal dispatch, ensures that systems are repaired, proper testing and maintenance are performed, and through these activities, reduces false alarms. They ensure compliance by reviewing system documentation, signal processing, and testing and maintenance records, and auditing installations.

Presnak, T. e. (2012, June 19). UL Alarm Data e-mail.

In most communities that require fire alarm certification, the requirements apply first to new construction. Some jurisdictions require certification when occupancies change, renovations or additions are done, or when the fire alarm equipment is changed. Some require certification for

specific occupancy groups. Properties that have more than a certain number of unwanted alarms over a specified period may be required to get the system certificated. False alarm fees may be waived if the system is certificated. The program is designed to be customizable for each community.

Reece, E. R. (2008). *Reducing Risks from False Alarms in Appleton, Wisconsin.* Emmitsburg, MD: National Fire Academy Exectuve Fire Officer Program.

Reece, E.R. In fiscal year 2007, Appleton, Wisconsin Fire Department responded to 423 activated alarms, including 53 carbon monoxide alarms, which were false alarms. Excluding medical calls, false alarms accounted for one-third of their total calls. False CO calls were considered less of an issue because the standard response was a single engine in non-emergency mode. A July 10, 2008 memo from Appleton Chief Neil Cameron noted that 90 minutes of unit time and 250 minutes of staff time was used at an average false alarm.

Roberts, R. (2012, March 6). E-Mail: False alarm definitions fromthe California Smoke Alarm Task Force.

Roberts was a member of the California Smoke Alarm Task Force. Their deliberations included an extended discussion of categories of unwanted alarms. These were not included in the Task Force report. After learning of this project, Roberts shared the Task Force definitions.

Sampson, R. (2011). *False Burglar Alarms.* Center for Problem-Oriented Policing, Inc.

U.S. police departments responded to roughly 36 million alarm activations, usually burglar alarm activations, in 2002. These responses cost approximately $1.8 billion. False alarms accounted for 94-98% of the activations. When an alarm activates, the monitoring company, which may be in another state, calls the owner. If no contact is made or the wrong code is given, the company calls the police. Security systems installation and marketing are profit-making businesses

The leading causes of false burglar alarms are user errors, such as wrong keypad codes, pets, open doors or windows when activating alarms, and inadequate employee training about how to enter alarmed properties; defective or inappropriate equipment; and improper installation. Because commercial properties tend to have more complex systems and more people involved, the rate of false alarms is higher than at residential properties."Chronic false alarm activations are often due to inadequate employee training or inferior systems that have not been upgraded." (p. 9)

Costs associated with false burglar alarms include: personnel and costs associated with dispatch and call-taking, back-up personnel and equipment, alarm analysis, permitting, billing, notifications, and education programs; facilities and equipment for managing false alarms; publication production costs; time that could have been spent on other things; and delay or displacement of response to other calls because resources were already in use. Noise is also a problem. Some companies offer free monitoring for a few months, while insurance companies offer premium discounts. The author noted that residential burglary rates are highest in low-income areas, yet burglar alarms are more

common in affluent areas. False alarms can lead to more police response to areas with lower crime rates. There is little to suggest that burglar alarms help police catch burglars. Taxpayers are in effect subsidizing the alarm industry by paying for police responses, particularly when no fees are charged fro the first three false alarms per year.

The author lists stakeholders who should be included when addressing false alarms. In addition to alarm owners, security and alarm companies, building managers, the author suggested including local government finance officials and community members who do not have alarms.

The author concluded that verified response, which requires alarm companies to respond to the scene or have visual information indicating a crime has occurred before contacting the police, is the most effective strategy to reduce false burglar alarms. Fees should be charged for *all* false holdup, duress and panic alarms and that police will only respond to holdup, duress or panic alarms from buildings.

Alarm permits with escalating fines for false alarms and cost-based recovery fees have substantial administrative costs and low collection rates. Administrative costs for permits and fines can be reduced by charging the companies directly, but cooperation from the companies is required. Outsourcing permit, fine and fee administration can help manage, but not solve, the false alarm problem. Alarm companies may be required to make two calls to owners with activations before contacting police. This works better when owners have several call numbers. Alarm companies covering multiple jurisdictions can have difficulty determining which policies are used where, and some may worry about liability if they don't call police immediately. Accepting dispatch cancellations from the alarm company reduced time spent, but does not reduce number of calls or dispatched responses. Alerting alarm companies to false alarm abusers requires police staff time and alarm company cooperation. This approach is most effective if alarm companies, as well as alarm owners, are penalized.

Withholding police response for chronic sites or sites without a permit can be combined with a modified verified response is an option when police have quick access to database and owners are informed of the intent to suspend. Recordkeeping is critical.

Publishing alarm companies' false alarm rates can motivate alarm companies to improve performance, particularly with advance notice allowing companies to take corrective action prior to publication. Record-keeping is essential. Verified response may be required for companies with high false alarm rates.

Classes for alarm users can reduce human errors. These work best when taught at the premises by the installers or monitoring company. If police lead classes, they need expertise in alarm systems and false alarm causes. Should the public sector educate about a private product?

The call priority for automatic alarms can be lowered. This assumes sufficient resources to respond, but does nothing to address causes or reduce calls to dispatchers.

The author does not recommend providing a high-priority response to unverified burglar alarm calls. This in effect gives police full responsibility for all automatic alarm activations.

Schmit, S. A. (2012, June 20). UL Alarm Data e-mail thread. Northbrook, IL.

Stephen Schmit explained that the cost of certification is incurred by the alarm service company (ASC), not the AHJ. Each alarm service company or company location pays a one-time fee to obtain a UL listing and the right to issue UL Certificates As part of the process, installation, service, maintenance, monitoring, and where applicable, runner services), are thoroughly evaluated. To maintain their listing, the ASCs pay an annual fee and are audited at least once a year by UL staff. The audit uses records review, property examination, interviews, and surprise service tests. Noncompliance issues are considered either isolated or systemic. Both must be corrected within 30 days at the property in question. Systemic issues require a root cause analysis and corrective action plan for the future. Additional site visits are conducted when necessary.

Toone, J. B. (2008). *Evaluating the Relationship between Unnecessary Utilization of Grandview Fire Department Resources and its Resulting Impact on Community Risk.* Emmitsburg, MD: National Fire Academy Executive Fire Officer Program.

Toone noted that fire alarm responses had increased 16% over the previous three years while the population had decreased 2%. From 2005 to 2007, the Grandview Fire department responded to a total of 801 automatic fire alarms. Only one, or 0.1% of the responses due to automatic alarms, was a working fire. Grandview had a false burglar and fire alarm ordinance with fines for repeat alarms and permission for police to terminate response to repeat offenders. Because software did not link police department records of alarm permits to the fire department dispatch, the fire department dispatch would not see a non-response indicator.

Looking at both unwanted fire alarms and unnecessary EMS, 24% of the fire department calls were considered unnecessary. He also estimated the number of simultaneous calls. The author noted that staffing and resources would not have changed with 24% fewer runs. Poor morale was likely the greatest risk from unwanted alarms.

Township of Cumru, PA Fire Department. (2008, March 12). *Emergency Operations: Fire Alarm Procedures Standard Operating Guidelines Secition 15.24.* Retrieved April 17, 2012, from http://www.cumrutownship.com/images/FireAlarmProcedures.pdf.

The Cumru Fire Department provides detailed standard operating guidelines for false alarm procedures. In the absence of confirming information to an activated fire alarm, only the first apparatus responds in emergency mode. If no emergency exists upon arrival, they are to confirm key holder contact, and check and document alarm system status. The system can be silenced while the premises are inspected to find the device that activated, but the panel should NOT be reset. If no cause can be found, the system can remain in silence mode until the emergency contact resets it. The first unit on scene should remain to advise the emergency contact. If the contact does not come, the information should be relayed to occupants.

Tualatin Valley Fire & Rescue. (2010). *Tualatin Valley Fire & Rescue now requires monitoring companies to attempt verification of all fire alarm signals.* Retrieved April 24, 2012, from http://www.etnews.org/docs/TVFR_Alarm_Verification.pdf.

This document explains the procedures covered in TVF&R Fire Code Ordinance that requires alarm companies to attempt verification of automatic fire alarms prior to transmission. If contact is made confirming that no emergency exists, the alarm shall not be transmitted to the PSAP. The ordinance gives the alarm company 90 seconds to initiate contact in addition to the 90 seconds allowed for signal retransmission in NFPA 72. The FAQs explain the rationale. From 2003to 2007, they responded to more than 10,000 automatic commercial fire alarms, but only two were working fires. One in ten emergency calls is a false alarm. Only 15% of false alarms occur at a property that already one in the same suggesting that penalties are not enough. Maintenance can help, but human-caused unintentional alarms from burnt food, welding, etc. are not addressed by maintenance. On-site signals will still operate. The response to automatic fire alarms of one unit travelling without lights or sirens be delayed 90 seconds. However, six to eight units are dispatched to verified emergencies.

Tualatin Valley Fire and Rescue. (n.d.). *TVF&R's Response to Automatic Alarms*. Retrieved May 24, 2012, from http://www.tvfr.com/HomePageDocs/FalseAlarmsQA.pdf.

This document provides additional explanations of their policy on automatic commercial fire alarm verification noting that if a residential alarm operates, the alarm company calls the house to see if is actually a false alarm triggered by something like burnt toast. The note that cost savings due to fuel, maintenance, etc. are small, but the real value is in not tying up crews in the event of a true emergency. Reducing the growth of call volume can potentially reduce the need to increase staffing and other resources.

U.S. Fire Administration National Fire Data Center. (2008). *National Fire Incident Reporting Sytem 5.0 Complete Reference Guide.* Emmitsburg, MD.

This is the coding manual for the National Fire Incident Reporting System. It provides instructions and an expanded data dictionary for every coded field in the system. Note that departments who only use computer drop-down menus of the code choices may see abbreviated definitions. For more information about NFIRS, see www.nfirs.fema.gov.

University of Washington Environmental Health and Safety. (2009, May 18). *Focus Sheet: False Fire Alarms*. Retrieved April 17, 2012, from www.ehs.washington.edu/fsofire/focusfalsealarms.pdf

The University of Washington Seattle Campus had 161 false fire alarms in 2008. They were required to devise and implement procedures to reduce false alarms. Roughly one in five false alarms were due to construction projects, with dust, steam and other particles the common culprits. University recommendations called for pre-construction meetings to discuss false alarm prevention procedures, including temporary fire partitions and dust barriers; consultation with the fire protection engineer about removal, bagging or disabling fire alarm devices; fire watch requirements in case fire alarm components are temporarily disabled; any project-related

false alarms that occur and how to prevent them, and steps for contractual "final clean" and removal of detector covers after the fire alarm system is approved by the fire department.

Upson, R., & Notarianni, K. (2010). *Quantitative Evaluation of Fire and EMS.* Quincy, MA: Fire Protection Research Association.

This study evaluated fire emergency and EMS mobilization times so as to provide empirical validation of benchmarks in NFPA 1221 and NFPA 1710. It analyzed data from a number of career or mostly career fire departments on fire vs. EMS response, daytime vs. nighttime response, crew proficiency in a baseline turnout exercise, and the potential effects of station layout on turnout response. Recorded call handling and turnout times were analyzed.