# UNWANTED FIRE ALARMS

## April 2011

NFPA

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**Abstract**
Unwanted fire alarms are a problem for the fire service, businesses, and the public.  In 2009, fire departments went to 16 false alarms for every 10 fires, and 45 false alarms for every 10 structure fires.  In 2009, almost half (45%) of false alarm responses were to unintentional activations, one-third (32%) were due to system malfunctions, 8%  resulted from malicious or mischievous false alarms, and 15% were due to other false alarms.  The ratio of smoke alarm activations to actual fires is even higher in surveys of the public than it is in fire department responses.

This report contains two sections.  The first, by Marty Ahrens, summarizes NFPA estimates of fire department responses to false alarms some findings from other studies about causes of fire alarm activations and false alarms, and policies to address them.  The second, by Ben Evarts, provides a detailed overview of fire department responses to false alarms in 2003, the most recent year the detailed data were available.

Many unwanted fire alarms could be prevented by improving procedures, training, and enforcement throughout the process.  An interdisciplinary approach is needed to address the problem.

Keywords:  false alarm, fire alarm, alarm verification, nuisance alarm, alarm system, smoke alarm, smoke detector, fire department

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Unwanted fire alarms are a problem for the fire service, businesses, and the public. NFPA estimates that in 2009, U.S. fire departments responded to an estimated total of 2,177,000 false alarms. These calls include false calls to 911 as well as automatic alarms and are not limited to false calls relating to structure fires. During 2009, false alarm responses included

- 979,500, (45% of false alarms) calls due to unintentional activations,
- 698,000 (32%) due to system malfunctions,
- 183,000 (8%) malicious or mischievous false alarms and;
- 316,500 (15%) other false alarms, including bomb scares and unclassified false alarms.

In 2009, fire departments went to 16 false alarms for every 10 fires, and 45 false alarms for every 10 structure fires.

Responses due to unintentional activations have generally been increasing since 1990. System malfunctions were generally increasing from 1990 to 1999 and have been trending downward since then. Malicious or mischievous false alarms have been falling over the past 20 years.

These unnecessary responses pose a severe burden for local fire departments in terms of personnel, fuel use, equipment wear and tear, risk of injury, and in extreme cases, even death. In their analysis of firefighter fatalities in 2009, Fahy, LeBlanc, and Molis report that 29 firefighter fatalities had resulted from false calls over the past 10 years.

This report contains two sections. The first, by Marty Ahrens, summarizes NFPA estimates of fire department responses to false alarms, some findings from other studies about causes of fire alarm activations and false alarms, and possible policies to address them. The second, by Ben Evarts, provides a detailed overview of fire department responses to false alarms in 2003.

The U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) now collects data on all types of fire department responses. Due to the size of the file, 2003 was the last year that the national file included non-fire responses such as false alarms. Evarts used the 2003 NFIRS data and NFPA survey results to provide more detailed estimates about the type of unwanted alarm and the occupancies in which they occurred. Note that NFIRS does not distinguish single-station smoke alarms from smoke detectors that are part of a system. The term "smoke detectors" in NFIRS is used to capture incidents with both technologies.

In 2003, false alarms due to malfunctions and false alarms due to unintentional activations together accounted for three-quarters of all false alarm responses. Unintentional smoke detector activations caused one in five (19%) alarms from these two categories.

When malfunctions and unintentional activations were grouped by the equipment involved, smoke detection activations accounted for almost one-third (31%) of these unwanted false alarms. Fire alarms system activations led to almost the same

percentage (30%). Carbon monoxide detection, heat detection, sprinklers, and other extinguishing equipment were involved in a much smaller share of the unwanted alarms.

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. Fifty-five percent of these activations occurred in residential properties, including

- one-quarter (27%) in one- or two-family homes,
- 18% in apartments or other multi-family dwellings, and
- 10% in other residential properties.

Smoke detector activations may include 911 calls about sounding smoke alarms as well as automatic alarms.

The requirements for smoke detection in residential dwelling units are very different from those in commercial properties. The purpose of fire-warning equipment for residential occupancies is to "provide a reliable means to notify the occupants …", according to Section 29.2 of the 2010 edition of NFPA 72, *National Fire Alarm and Signaling Code.* Fire department notification by household fire alarm systems is not a priority of the code. Common areas of multi-family housing, hotels, dormitories and similar residential properties would be protected by commercial fire alarm systems.

The ratio of smoke alarm activations to actual fires is even higher in surveys of the public than it is in fire department responses. Dubivsky's and Bukowski's 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. Among the causes cited for false alarms in these facilities were: smoking (in groups); dust; humidity; high air velocity; defective; 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 increased the systems' sensitivity.

In a 2010 Harris poll done for the NFPA, 96% of surveyed households said they had at least one smoke alarm. In roughly half (52%) of all homes with at least one smoke alarm, a smoke alarm was installed in the kitchen, despite the fact that smoke alarms should generally not be installed in kitchens because of the potential for nuisance alarms.

Forty-three percent of those with smoke alarms said that at least one had sounded in the past year. Among those with activations, cooking was cited as a factor by roughly three out of four households. Eight percent with activations said the alarm chirped to indicate a low battery.

When respondents in the same survey had to select only one answer, none mentioned a real fire as a cause of the activation. When those with activations were asked a series of yes or no questions,

- 5% agreed that that the activation alerted them to a real fire,
- 15% said the alarm sounded in response to a fire they already knew about,
- *Twenty-two percent said it warned them of something that could have become a fire.*
- 43% said it sounded after they knew food was burning.
- Almost two-thirds (63%) agreed that the activations were due to normal

conditions associated with cooking, smoking, steam or other normal household conditions.

- Twelve percent said it went off for no apparent reason.

There is a continuum of fire alarm activations and response across five scenarios. The first, malfunctioning alarms with no hazards and no obvious trigger, are probably the most annoying to all parties. The second, nuisance activations in response to predictable environmental stimuli such as cooking fumes, shower steam, and construction activities, are also disruptive. However, the pattern is understood.

The third scenario, a warning of pre-fire conditions, is often overlooked in discussions of fire detection. Smoke detectors or other fire alarms can alert occupants to a situation that is on the verge of becoming a fire but is very easily remedied. These warnings are useful. It would be inappropriate to call them false or nuisance alarms, but they would generally not be considered fires either.

Malfunctioning alarms and nuisance activations are clearly undesirable. A warning of pre-fire conditions is very useful, but a fire department response is not needed.

In the fourth scenario, the alarm sounds when a fire is very small. With an early discovery, the occupant is often able to extinguish the fire prior to fire department arrival. However, there is a risk of fire spread if the occupants cannot quickly put the fire out.

Because not all spaces in a building are in the same proximity to the detection unit and some types of fires are detected earlier by some types of sensors than others, there is no obvious way to distinguish in advance

between this type of fire and the last category of a more serious fire. In these cases, a prompt fire department response is essential.

NFPA 72 currently allows supervising stations to verify alarm signals from household fire alarm systems before notifying the fire service if such verification will not delay reporting by more than 90 seconds and the authority having jurisdiction agrees. Proposals have been made to expand this verification practice to non-residential occupancies. Such verification can reduce the costs and risks associated with unnecessary response. When the automatic alarm is signaling a real fire, a delayed response can allow the fire to grow unchecked for a longer period of time.

Peter J Finley's 2001 paper for the USFA's Executive Fire Officer Program (EFOP), *Residential Fire Alarm Systems: the Verification and Response Dilemma*, surveyed departments protecting populations of 47,000 to 67,000 and residents of his community, Vineland, New Jersey, who had experienced fire department responses to false alarms in their homes. Among the departments that responded to his survey, on average, one in five (19%) fire-related responses was made because of automatic fire alarm activations.

Among these departments,
- 9% of automatic fire alarm activations were residential fire alarm system activations.
- System malfunctions caused almost one-third (31%) of the residential fire activations.
- Only 3% were actual fires.

Most of the fire departments did not consider unintentional activations to be false alarms. Three-quarters (78%) of the

departments did not permit verification of residential fire alarms prior to responding. However, almost nine out of ten (88%) would modify the response if dispatch is informed that the alarm may be false.

One-quarter of the departments issue citations or violation notices and almost one-third (31%) use fines or penalties when necessary. Eighty percent of the departments who issue fines permit at least three false alarms in a year before issuing the fines.

Of the Vineland, New Jersey residents who had experienced fire department responses to automatic false alarms:
- 84% of the surveyed residents said they tried to stop the fire department from responding.
- Half (52%) said they would still want the fire department to check.
- Two-thirds (69%) would still want the fire department to check if they came with just one engine and no lights or sirens.
- Three-quarters (76%) did not want children who were home alone to be able to cancel the fire department response.

Dell'Orfano reported that increased 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.

In his March 2007 *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. Seventy percent of the 244 total fire alarms in 2002-2006 were false. These alarms could be divided into four causes: 1) user error, 2) work done without notification, 3) system malfunction, and 4) damage to the system. Increased training, improved procedures and communication, investigation in to false alarm causes, and passing false alarm fines to tenants or contractors who caused them led to a 50% drop in fire alarms from 2003-2006.

Several studies provided details on the causes of unwanted false alarms, including improper placement, testing without communication, lack of maintenance, construction, etc. Many unwanted fire alarms could be prevented by improving procedures, training, and enforcement throughout the process. Unwanted fire alarms are a problem for both the fire service and the public. An interdisciplinary approach is needed to address this problem.

# Unwanted Fire Alarms:
## A Problem for the Fire Service and the Public, By Marty Ahrens

## Introduction

Smoke and other fire detection equipment can detect a fire in its earliest stages and alert occupants to a developing fire. When fire detection systems are monitored, the fire department can be alerted to an alarm activation and start to respond before anyone on site reports the incident. For most systems, the alarm at the premises is designed to go off at the same time the signal is sent to the supervising station – before the call is made to the fire department.

Unfortunately, many smoke alarm or fire detection activations do not signal a true emergency. This can result in a dangerous sense of complacency among occupants and unnecessary strain and risk to fire departments who respond to these incidents. A United Kingdom study interviewed adults and children about the risks, benefits, and problems associated with smoke alarms.[1] Some children reported that smoke alarms activated any time someone was cooking. Equipment activations were not viewed as emergencies. An eight-year-old said, "When the smoke alarm goes off, I have to turn up the television." Many of us have been in public buildings when the fire alarm has gone off and been essentially told "Don't worry about it."

### About the Data

The fire department response estimates in this analysis were derived directly from NFPA's annual fire department experience survey for Figures 1-3. Estimates by specific type of false alarm were derived from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) and the NFPA survey together. Readers should be aware of a few points about the NFIRS coding system.

1. NFIRS does not use the same language or definitions as NFPA 72.
2. NFIRS does not collect data on how the fire department was notified. These false alarms include both automatic alarms and calls from people who may have heard an operating smoke alarm.
3. With this data, we cannot distinguish monitored smoke detection systems from smoke alarms. It is very likely that the data on smoke detectors also include smoke alarms. Some of the unspecified alarm systems may also be smoke detection systems.

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[1] H. Roberts, K. Curtis, K. Liabo, D.Rowland, C. DiGuiseppi, and I. Roberts. "Putting Public Health Evidence into Practice: Increasing the Prevalence of Working Smoke Alarms in Disadvantaged Inner City Housing, *J. Epidemiol. Community Health,* 2004:48:280-285, online at http://jech.bmj.com/cgi/reprint/58/4/280.

To help understand the nature of the problem, this paper explores statistics about fire department responses to false alarms, survey data describing the public experience with fires, smoke alarms, and smoke alarm or detector activations, and highlights key findings from three papers done for Executive Officer Program at the National Fire Academy. Possible strategies to address the problem are also discussed.

## Size of the Problem: Fire Department Responses

Michael Karter noted that in 2009, U.S. fire departments responded to an estimated 2,177,000 false alarms. Figure 1 shows that these included 979,500 (45%) unintentional calls, 698,000 (32%) system malfunctions, 183,000 (8%) malicious or mischievous false calls, and 316,500 other or unclassified false calls, including bomb scares.[2] These calls include false calls to 911 as well as automatic alarms and are not limited to false calls of structure fires.

**Figure 1. Fire Department Responses in 2009 to False Alarms, by Type of False Alarm**
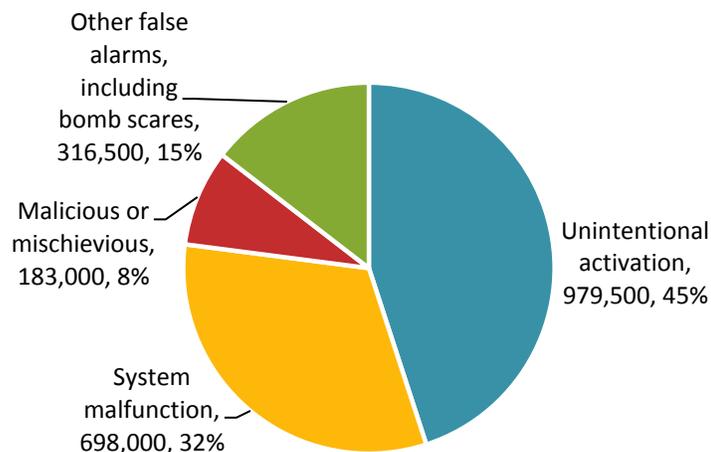


The term "unintentional call" includes incidents in which an interior device is tripped accidentally, in which a monitored system is tested without prior fire department notification, and situations in which the equipment is activated by normal environmental stimuli, such as normal cooking or high heat.

It is important to remember that the false alarm data we have is based on the situation fire departments found when they arrived, not the method of alarm. Someone might call 911 to report a fire alarm sounding believing it was an actual fire. It might later be found to be a system malfunction. These statistics also omit good intent calls when someone mistakes steam or smoke from a barbecue or a tar kettle for a hostile fire.

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[2] M. Karter. *False Alarm Activity in the U.S. 2009.* Quincy, MA: National Fire Protection Association, (2010).

In their analysis of firefighter fatalities in 2009, Fahy, LeBlanc, and Molis report that 29 firefighter deaths had resulted from false calls over the past 10 years.[3]

Karter also reported on the trends in reported false alarms.  Figure 2 shows the trends seen in types of false alarms reported to the fire departments.  Over the past 20 years, unintentional calls have been increasing while malicious or mischievous calls have been falling.  System malfunctions peaked in 1999 and have been heading downward since.

**Figure 2. Trends in Fire Department Responses to False Alarms, by Type of False Alarm:  1990-2009**
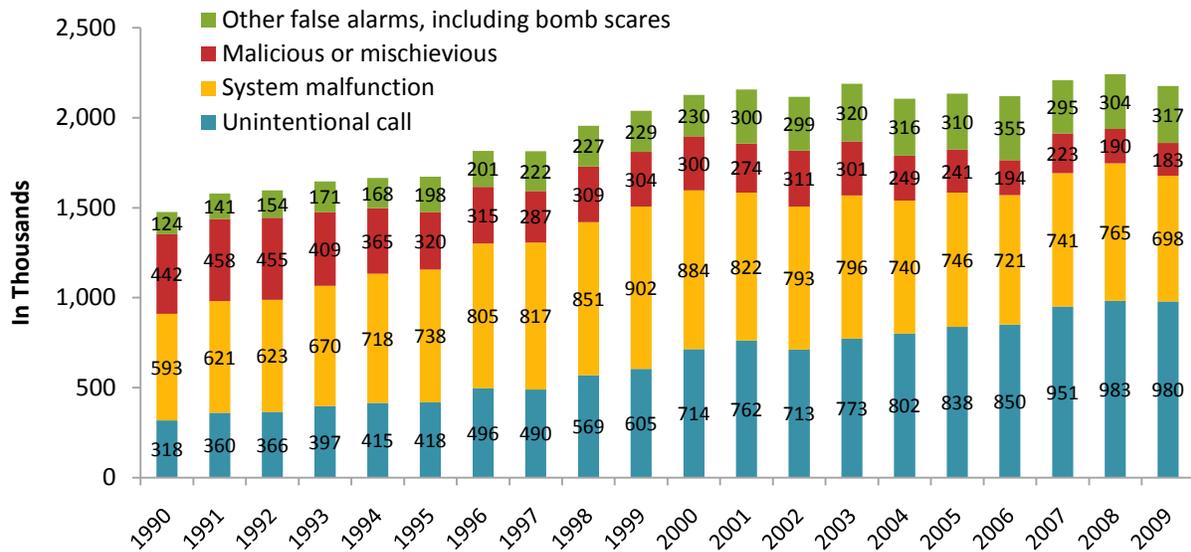
Figure 3 shows that the ratio of false alarms of all types (not just automatic fire detection) to reported fires and reported structure fires has roughly doubled over 20 years.  In 2009, fire departments went to 16 false alarms for every 10 fires, and 45 false alarms for every 10 structure fires.

The data about fire department responses to false alarms shown in Figures 1 to 3 was collected by NFPA's annual fire department experience survey.  The U.S. Fire Administration's (USFA's) National Fire Incident Reporting System collects detailed information about aggregated fire department responses.  Different states have different reporting requirements.  National estimates with more detail were obtained from NFIRS data that had been scaled up by a ratio obtained by dividing estimates from the survey by the totals in NFIRS.  Due to the increasing size of the NFIRS file, the last year the complete non-fire file was released was 2003.

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[3] [3] R. Fahy, P. LeBlanc, and J. Molis. *Firefighter Fatalities in the United States -- 2009.*  Quincy, MA:  National Fire Protection Association, (2010).

**Figure 3.**
**Ratio of Reported False Alarms to Structure Fires and All Fires: 1990-2009**
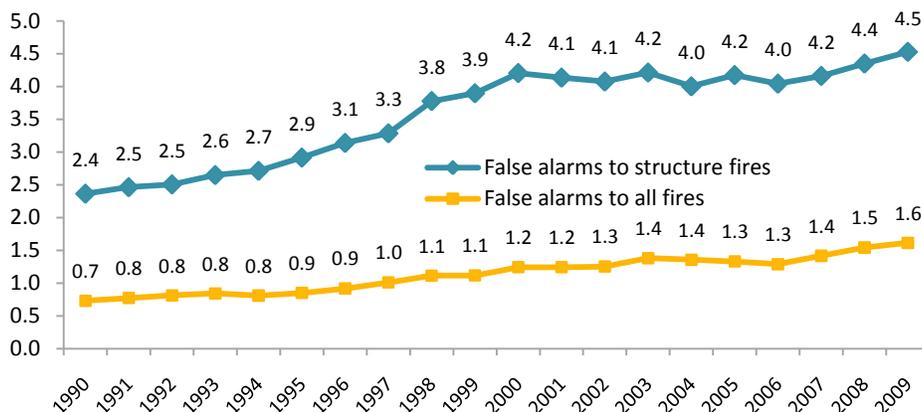


Ben Evarts analyzed false alarm from that year. Table 1 of his analysis shows the estimated number of false alarms by specific incident type. Figure 4 shows the percentage breakdown of fire department responses to false fire alarms due to malfunctions or unintentional activations by specific incident type. One in five (19%) of the malfunctioning or unintentional false alarms from fire protection equipment was due to an unintentional smoke detector activation. (Some of these may be 911 calls in response to smoke alarm activations rather than smoke detection system activations.) Several incident types lack detail.

**Figure 4. Fire Department Responses in 2003 to False Alarms from Malfunctioning or Unintentional Activation of Fire Protection Equipment, by Incident Type**
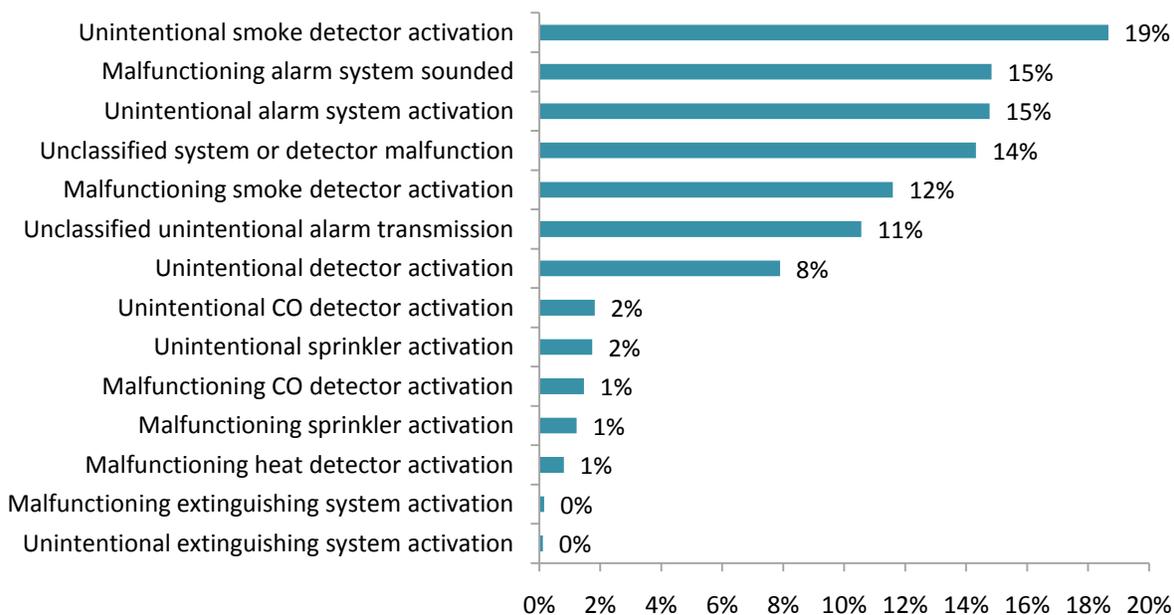


In Figure 5, the incident types are grouped by the type of equipment that malfunctions or was unintentionally activated and led ultimately to an unwanted fire department response. Smoke

detection activations accounted for almost one-third of these unwanted false alarms. Fire alarms system activations led to almost the same percentage. Carbon monoxide detection, heat detection, sprinklers, and other extinguishing equipment were involved in a much smaller share of the unwanted alarms. While NFIRS incident type 734 captures heat detector activations due to malfunctions, NFIRS incident type code 744 -- "Detector activation (no fire), unintentional. A result of a proper system response to environmental stimuli such as high heat conditions." – is not restricted to heat detectors.

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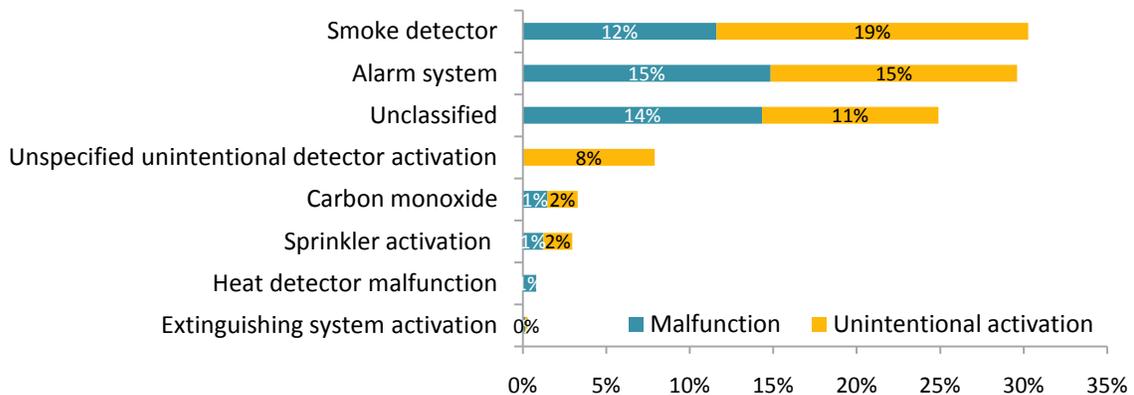


Tables 2-8 show the property use where each of the false alarms occurred for eight categories of system malfunctions or unintentional calls. While residential properties accounted for the largest share of false alarms of any single occupancy group, non-residential properties accounted for more than half of false alarm responses in all categories shown except unintentional smoke detector activations. Fifty-five percent of these activations occurred in residential properties, including 27% in one- or two-family homes, 18% in apartments or other multi-family dwellings, and 10% in other residential properties. These smoke detector activations may include 911 calls about sounding smoke alarms. Figure 6 shows the frequency of different type of false alarms for non-residential properties, one- or two-family homes, and other residential properties.

**Figure 6. Fire Department Responses in 2003 to False Alarms by Property Use for Selected Incident Types**
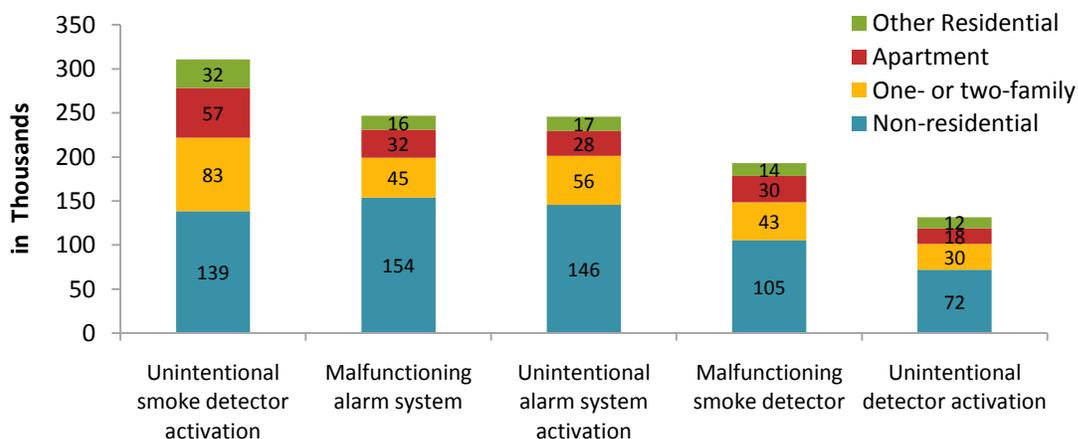
The requirements for smoke detection in residential dwelling units are very different from those in commercial properties. The purpose of fire-warning equipment for residential occupancies is to "provide a reliable means to notify the occupants …" according to Section 29.2 of the 2010 edition of NFPA 72, *National Fire Alarm and Signaling Code.* Fire department notification by household fire alarm systems is not a priority of the code. Common areas of multi-family housing, hotels, dormitories and similar residential properties would be protected by commercial fire alarm systems.

## Size of the Problem:  Unwanted Alarms and the Public

The ratio of smoke alarm or smoke detector activations to actual fires is even higher in surveys of the public than it is in fire department responses. A 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.[4] Among the causes cited for false alarms in these facilities were: smoking (in groups); dust; humidity; high air velocity; defective;  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 the 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.

In a 2010 poll done for the NFPA,[5] 96% of surveyed households said they had at least one smoke alarm. In roughly one of every four households, all the smoke alarms were interconnected. For these discussions, the term "smoke alarms" would also include smoke detectors that are part of a household system. *In roughly half (52%) of all homes with at least one smoke alarm, a smoke alarm was installed in the kitchen.* Smoke alarms should generally not be installed in kitchens because of the potential for nuisance alarms.

Forty-three percent of those with smoke alarms said that at least one had sounded in the past year. Figure 7 shows that cooking was cited as a factor in these activations by roughly three out of four households. None of the respondents indicated that a fire caused the activation. For this question, they could only select one answer.

Additional information was sought about what was happening when the alarm sounded. Respondents were asked to answer yes or no to a series of questions about the last time the smoke alarm went off. The results show some inconsistency. Although no one cited fire as a reason for the activations in the previous question, Figure 8 shows that 5% agreed that that the activation alerted them to a real fire while 15% said the alarm sounded in response to a fire they already knew about and 43% said the alarm sounded after they already knew that food was burning.

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[4]  P. Dubivsky and R. Bukowski. *False Alarm Study of Smoke Detectors in Department of Veterans Affairs Medical Centers (VMACS),* Gaithersburg, MD, U.S. Department of Commerce, National Institute of Technology, online at http://fire.nist.gov/bfrlpubs/fire89/PDF/f89012.pdf.
[5] Harris Poll National Quorum.  National Fire Protection Association -- Smoke Alarms.  September 8-12, 2010

**Figure 7. Reasons Given for Smoke Alarm Activations in Past Year**

| Reason | Percent |
|--------|---------|
| Cooking | 73% |
| Low battery chirp | 8% |
| Unclassified | 5% |
| Woodstove or fireplace | 4% |
| Lost power or power surge | 3% |
| Steam | 2% |
| No apparent cause | 2% |
| Malfunction or defective | 1% |
| Don't know | 2% |
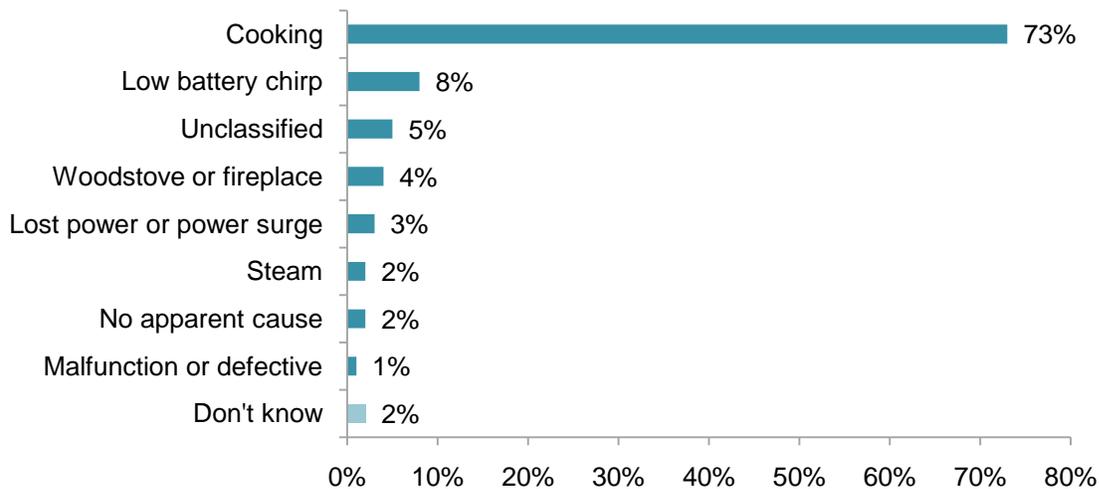
Almost two thirds reported that the activations were due to non-hazardous situations associated with cooking, smoking, steam or other normal household conditions. Twenty-two percent said it warned them of something that could have become a fire. Twelve percent said it went off for no apparent reason.

**Figure 8. The Last Time a Smoke Alarm Sounded, It...**

| | Percent |
|--|---------|
| Went off because of normal cooking, smoking,… | 63% |
| Sounded after they knew food was burning | 43% |
| Warned them of something that could have… | 22% |
| Alerted them to a fire they already knew about | 15% |
| Went off for no apparent reason | 12% |
| Alerted them to a real fire | 5% |
| Sounded due to an unclassified reason | 9% |
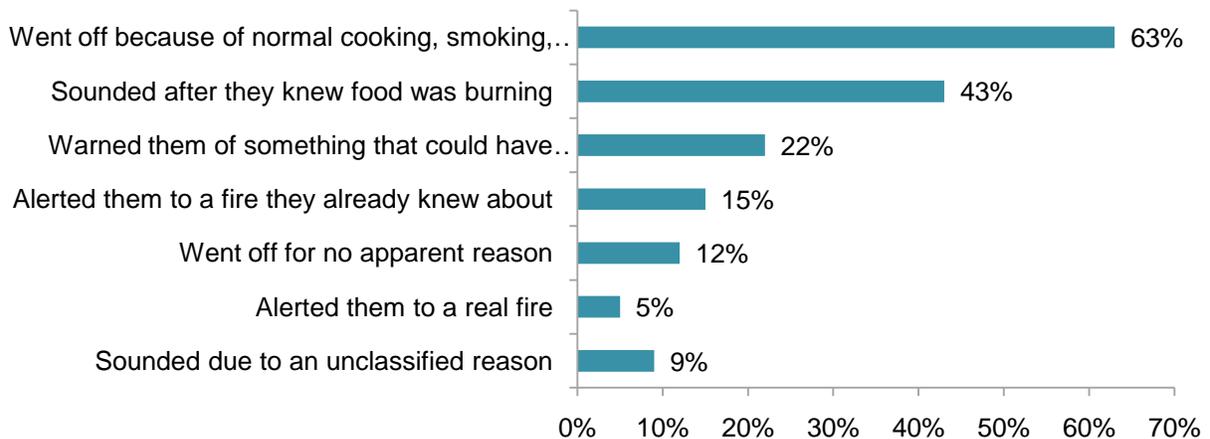
In a 2004 survey conducted for the NFPA, 40% of the respondents with smoke alarms reported that one had sounded at least once in the past twelve months.[6] Sixty-nine percent reported activations due to cooking activities, 13% were due to battery problems, including the low-battery chirping, 5% were due to steam (frequently from a shower), and 4% of the activations were due to smoke alarm tests. All respondents who reported that an alarm had sounded were asked for their first thought after they heard it:

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[6] 2004 Fire Prevention Week Survey conducted for National Fire Protection Association by Harris Interactive Market Research, pp. 11-14.

- 24% said that food had burned;
- 11% thought about how to turn off the smoke alarm;
- 11% were unconcerned because they knew what caused it to sound;
- 8% investigated;
- O*nly 8% thought there was a fire and they should get out;*
- 7% recognized the low battery signal;
- 7% were annoyed at what they assumed to be a nuisance alarm;
- 3% noted that the smoke alarm works;
- 3% thought they should have used the exhaust fan; and
- 2% didn't recognize it as a smoke alarm and wondered what it was.

Some of the nuisance activations, particularly from cooking, fall into a gray area. A sounding smoke alarm may remind a cook who has left the kitchen area of food on the stove requiring immediate attention. While not yet a fire, the potential exists if corrective action is not taken. If such action is taken, the situation can often be quickly resolved without fire department involvement.

It may be helpful to think about what we want detection equipment to do and what type of response would be desirable under what circumstances. Did the activation or could the activation have provided a useful warning to the occupants? Is evacuation warranted? Should the fire department respond?

The early warning is useful when the activation alerted to a real fire or warned of something that could have become a fire. While it may be annoying to have an alarm sounding when everyone already knows about a fire, it is easy to imagine situations where the warning would have been more useful.

How much evacuation is warranted? Are too many people affected? Section 9.6.10.4 of NFPA 101, Life Safety Code, states that for smoke alarms inside the private areas of residential occupancies, "The alarms shall sound only within an individual dwelling unit, suite or rooms or similar area and shall not actuate the building fire alarm system, unless otherwise permitted by the authority having jurisdiction…" Many are starting to consider smoke alarms to be akin to the boy who cried wolf. Sometimes people are dealing in the process of dealing with the activation source when the alarm sounds. When people learn that they evacuated because the alarm sounded under normal conditions or without apparent reason, they may be less likely to evacuate in the future. Similarly, many of us who advise people to leave when the smoke alarm goes off would not ourselves evacuate without investigating to see if we could handle the situation ourselves.

My single-station smoke alarm went off once when I had turned on the wrong burner to heat hot water for tea. I was grateful for the warning. The problem was resolved when I went back downstairs and turned off the burner. We never left the house and certainly would not have wanted the fire department to come. If I had been in a building with all alarms interconnected, I could have disrupted the evenings of a lot of people. People routinely handle very small fires quickly and effectively. The lid is put on the flaming grease pan. The cigarette smoldering on

the carpet is stamped out, leaving only a small burn mark. In some cases, the incident has been fully dealt with before the detection equipment operates.

In 2004-2005, the Consumer Product Safety Commission (CPSC) conducted a telephone survey to estimate the total number of residential fires experienced by U.S. households, including fires that were not attended by fire departments.[7] They estimate that U.S. households experienced 7.4 million fires per year, including 7.2 million that were unattended. The same study found that greater coverage and interconnectedness increased the likelihood of smoke alarms operating, of alerting occupants, and of being the only alert. In homes that had interconnected smoke alarms, the alarms sounded in 53% of the fires and provided the only alert in 26%. These findings reinforce the importance of the early warning while showing that 97% of home fires were handled without fire department assistance. Most fires resulted in no flame damage or damage to only the item first ignited. Not surprisingly, the fire department was more likely to have attended fires that spread.

Figure 9 illustrates the continuum of fire detection activations and response. The first category, a malfunctioning alarm with no hazard and no obvious trigger, is probably the most annoying to all parties. If alarms regularly go off for no obvious reason, most people will assume that any sounding alarm is false. Nuisance activations in response to predictable environmental stimuli such as cooking fumes and shower steam are also disruptive. However, the pattern is understood. An alarm that sounds around dinner time may well be dismissed. An alarm in the middle of the night would be considered unusual and would probably be taken more seriously.

**Figure 9. Fire Detection Activations and Desired Response: A Continuum**
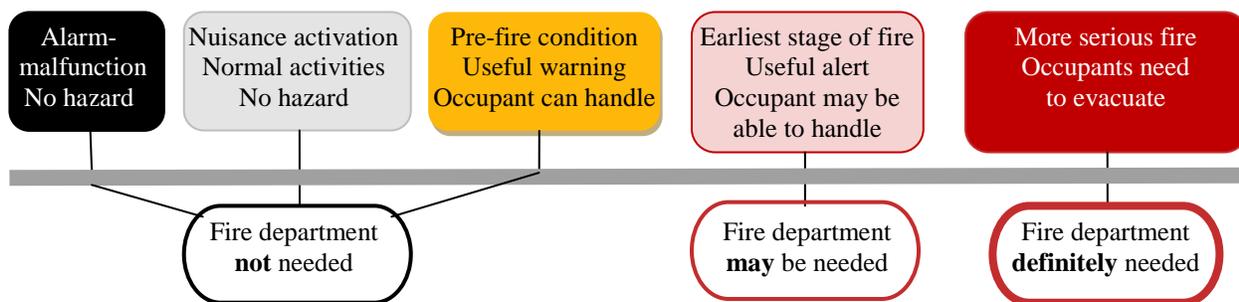


The third category, the alert to pre-fire conditions I experienced, is often overlooked in discussions of fire detection. Smoke or fire alarms can alert occupants to a situation that is on the verge of becoming a fire but is very easily remedied. These incidents would not be called false or nuisance alarms, but they would generally not be considered fires either. (A purist might say tiny amounts of products of combustion are being produced.) Green and Anders noted that both reported and unreported home fires fell from the survey done in 1984 to the latest one in 2004-2005. It is possible that more widespread use of smoke alarms has prevented situations from developing into something that would be identified as an actual fire. This is consistent with the 22% of households that had a smoke alarm operate in the previous year in the survey done

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[7] Michael A. Greene and Craig Andres. *2004-2005 National Sample Survey of Unreported Residential Fires.* U.S. Consumer Product Safety Commission, July 2009,

for NFPA who reported that the alarm alerted them to something that could have become a fire. These alerts are highly desirable but a fire department response is unnecessary.

In the fourth category, events have progressed enough to produce a recognizable fire. With an early warning from the system, the occupant is often able to extinguish the fire prior to fire department arrival. In some cases, the fire is already out when the fire department arrives and has never spread beyond the object of origin. However, there is a risk of fire spread if the occupants cannot quickly put the fire out. Because not all spaces in a building are in the same proximity to the detection unit and some types of fires are detected earlier by some types of sensors than others, there is no obvious way to distinguish in advance between this type of fire and the last category of a more serious fire. In these cases, a prompt fire department response is essential.

Section 29.7.8.2 of NFPA 72, *National Fire Alarm and Signaling Code* allows supervising stations to verify alarm signals from household fire alarm systems before notifying the fire service if such verification will not delay reporting by more than 90 seconds and the authority having jurisdiction agrees. Issues related to verification will be discussed in the next section.

## Efforts to Reduce Responses to Unwanted Automatic Fire Alarms

As discussed earlier, false alarms strain fire department resources. Any emergency response has the potential to result in injury. Firefighters who are on one call are not available to answer another. Volunteer firefighters can grow resentful at being called out for no reason. Three papers done for USFA's Executive Fire Officer Program were reviewed to help provide background for this discussion.

- Peter J. Finley, Vineland, New Jersey Fire Department. *Residential Fire Alarm Systems: the Verification and Response Dilemma*, 2001, online at www.usfa.dhs.gov/pdf/efop/tr_02pf.pdf;

- Eugene R. Reece, Jr., Appleton, Wisconsin Fire Department. *Reducing Risks from False Fire Alarms,* 2008, online at www.usfa.dhs.gov/pdf/efop/efo42669.pdf;

- . Michael E. Dell'Orfano. South Metro Fire Rescue Authority, Centennial, Colorado. *Analysis of False Alarms in Commercial Occupancies for South Metro Fire Rescue Authority,* 2010, online at www.usfa.dhs.gov/pdf/efop/efo44787.pdf.

In 1998, the Vineland, New Jersey City Council ruled to ban verification of residential fire alarms before fire department notification and to immediately alert the fire department of any unscheduled activations in 1998. Fire-related calls jumped 21% from 1998 to 1999. Half of the fire responses in 1999 and 2000 were to automatic fire alarm system activations. About one-third of these system activities were in one-or two-family homes.

Finley conducted research to determine if the ban should be overturned. He noted that within the combination department, some saw this as a career vs. volunteer issue. If verification was not allowed, the department would need to hire more full-time firefighters. As part of his study, he surveyed fire departments of comparable size and people in his own community who had unwanted residential alarms.

He sent surveys to 203 departments protecting populations of 47,000 to 67,000 and received 67 usable responses. His findings are summarized in the text box on the next page. On average, one in five (19%) fire-related responses was made because of an automatic fire alarm activation. Nine percent of automatic fire alarm activations were residential fire alarm system activations. The extent of the problem varied considerably. Responses indicated that automatic fire alarm activations accounted for up to two-thirds (68%) of fire-related responses or as little as zero percent. The range for residential activations was 0-60%. He discovered that system malfunctions caused almost one-third (31%) of the residential fire activations. Only 3% were actual fires. Most of the fire departments did not consider unintentional activations to be false alarms.

Three-quarters (78%) of the departments did not permit verification of residential fire alarms prior to responding. However, almost nine out of ten (88%) would modify the response if dispatch was informed that the alarm might be false. Almost two-thirds (64%) of the departments provided education about detector placement, maintenance and related issues if false alarms were becoming a problem. One-quarter of the departments issue citations or violation notices and almost one-third (31%) use fines or penalties when necessary. Eighty percent of the departments who issue fines permit at least three false alarms in a year before issuing the fines; 43% permitted three false alarms per year. This was the most common threshold

Finley also obtained survey data from 53 Vineland, New Jersey households that had experienced residential fire alarm system activations and fire department responses. Eighty-four percent said they tried to stop the fire department from responding. However, half (52%) said they would still want the fire department to check while two-thirds (69%) would still want the fire department to check if they came with just one engine and no lights or sirens. Three-quarters (76%) did not want children who were home alone to be able to cancel the fire department response.

Insurance issues were also addressed in Finley's paper. He noted that homeowners generally get a discount on their property insurance if they have a monitored fire alarm system. Fire department verification or response procedures do not affect the discount. However, ISO required at least two engines and one ladder or truck to all structural incidents. Sending a lesser response could affect the homeowner's discount.

**Reece also collected data about false alarms.**
In his paper, Reece included a July 10, 2008 memo from Chief Neil Cameron stating that in 2007, the average false alarm in Appleton, Wisconsin used roughly 90 minutes of unit time and 25 minutes of staff time. Reece also referenced an article by Wayne Moore that noted the detector protection and cleaning is necessary when hot work is done. Moore also stressed the training of technicians who maintain the system.

**Finley's Results from 67 Fire Departments
Protecting Populations of 47,000-67,000**

*19% of fire-related responses were for automatic fire alarm activations, with a range of 0-68%*

> *9% of automatic fire alarm activations were residential fire alarm system activations, with a range of 0-60%.*

*Causes of residential fire alarm activations*
- System malfunctions accounted for 31%,
- Smoke from cooking or burnt food caused 27%,
- Other unintentional activation accounted for 24%,
- Steam from a shower triggered 4%;
- Smoke from fireplaces, candles, etc. also activated 4%, and
- Actual fires caused only 3% of the residential fire alarm activations.

*Most did not consider unintentional activations to be false alarms.*
- 89% of the fire departments did not consider smoke from cooking or burnt food to be a false alarm, and
- 70% did not consider smoke from candles or a fireplace a false alarm.

*Policies, procedures, and perspectives on verification of residential fire alarm activations*
- 78% do not permit verification prior to response
- 62% felt greater liability was associated with untrained civilians deciding an alarm was a system problem than in responding
- 93% felt that fire alarms are intended to protect life and property
- 65% respond to automatic alarms at emergency speed with lights and sirens
- 88% modify response when dispatch gets additional info that alarm may be false, with 57% of the 88% cancelling all but the first due engine

*Handling repeat false alarms*
- 64% of respondents educate about detector placement, maintenance, and related issues if false alarms are becoming a problem.
  - 25% give citations or violation notices.
  - 31% issue fines or penalties.
    - 80% of 31% who issue fines or penalties permit 3 or more alarms in a year before fines are issued.

**Finley's Results from 53 Surveys Completed by Households with False Alarm Responses**
- 84% tried to stop the fire department response;
- 64% said the fire department did not provide a tangible service when they came;
- 52% still want the fire department to check;
- 69% want the fire department to check if they would come with just one engine and no lights or sirens; and
- 76% don't want children home alone to be able to cancel a response.

Reece also cited findings from "Result Minneapolis" by Minneapolis Fire Department showing the ten leading cause of 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

Minneapolis identified top 10 buildings for alarms and focused on an educational approach fires.

Reece also surveyed fire departments about their experience and policies about false fire alarms. Twenty-four of the 100 fire departments he surveyed responded to a question listing five possible causes of false alarm. The ranks 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

**Increased inspections by South Metro Fire Rescue Authority led to a decrease in false alarm responses to top offenders.**
Dell'Orfano reported 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. He found a small positive correlation between the age of the building and the frequency of false alarms.

## A Property Management Company's Approach

In his March 2007 *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. 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 if 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, 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.

## Summary

Table A summarizes some of the findings from these works and discussions with NFPA staff. The first three entries, plan design, plan review, and system installation, can affect future systems. Are the people performing these functions knowledgeable about the requirements? Section 29.8.3.4 of NFPA 72 has installation requirements that prevent the placement of smoke alarms in locations where normal cooking smoke, steam, etc. would likely activate a detector.

Several sources indicated that some alarms occur during testing or maintenance. Frequent reminders about the importance of communication can help.

When fires start, there is usually a development phase. Some thought might be given to expanding the principle of limited initial notification in apartment and hotel dwelling units to other settings. Local pre-alerts before the alarm signal is transmitted may be appropriate for some properties to alert occupants that a situation is developing that could become a fire.

Construction or hot work was identified as a cause of some alarms. It is likely that people planning such work often neglect permits and fail to consider the possibility of false alarms. Greater education could be helpful for both property owners and trades people. Penalties for repeat false alarms can help convince property owners that they need to take an active role in solving the problem.

**Table A.  Minimizing the Toll of False Automatic Fire Alarms:
Possible Points of Intervention**

| Aspect | | | | |
|---|---|---|---|---|
| **Plan design** | Qualifications of designer | | | |
| **Plan review** | Qualifications of reviewer | | | |
| **System installation** | Qualifications of installers | | | |
| **System inspection and maintenance** | Communication with FD and property owner | Qualifications of inspectors | | |
| **In apartments or hotels, dwelling unit or suite detection sounds only in unit (NFPA 101, 9.6.2.10.4 )** | | | | |
| **Possible pre-alert in occupant space before external signal transmitted** | Would probably require changes in technology and code | | | |
| **Educate about hot work and alarms** | | | | |
| **Alarm verification** | Occupied vs. unoccupied premises | Motivation and competence of verifier | Risk from unchecked fire | Is the property sprinklered? |
| **Discretion to downgrade response** | | | | |
| **Investigate and communicate false alarm cause** | Help property owners and managers prevent the alarms | | | |
| **Target frequent properties** | | | | |
| **Penalties for repeat false calls** | | | | |

Is pre-response verification desirable?  Most in the fire safety community have been trying to convince the public to call the fire department when they think something is wrong.  Individuals who fear repercussions may be unwilling to admit to a fire.  Teenagers, people from repressive cultures, older adults who want to stay in their homes and others may not want to admit something was wrong or that they did something that started a fire.  Or they may themselves assume it is a false alarm.  Although the alarm was not transmitted automatically to the fire department, a staff member silenced the alarm in the 1997 Harveys Lake, Pennsylvania board and care fire that killed 10 people.  Downgrading, but not cancelling, a report may be an option.

Fire department efforts to investigate false alarms and communicate with fire alarm companies and property managers or owners could help prevent future false alarms.  In many communities, a relatively small number of properties account for a disproportionate share of their false alarms.  Minneapolis could identify their top 10 properties for false alarms.  Other communities probably know who their biggest problems are.  Some departments that levy fines for repeated false alarms will waive the fines if the funds are spent to repair the system.  Penalties for repeat false alarms can provide incentives for corrective actions.  Kitteringham explained the many-faceted approach used by one-property management firm.  Municipal fines helped the firm get cooperation from tenants and contractors.  Smaller operations may not have the resources or expertise to easily address the problems on their own.

Other questions remain.  Finley noted ISO requirements.  Most career fire departments strive to meet the response time requirements of NFPA 1710.  Will verification allow for a fully ready response in time?  Is there agreement about what is a fire?

I firmly believe that the early warning from smoke alarms or detectors is critical.  But if neither the public nor the fire department really believes that the alarm means there is a fire, the benefit is much less.  We require people and companies to spend money to install this equipment.  Many false alarms can be prevented by ensuring that:
- Only qualified individuals are engaged in plan design, plan review and system installation,
- Property owners and system maintenance people are in regular communication with the fire department about testing, and
- Hot work is done with permits and consideration of detection equipment.

Fire departments that help building owners find and address the causes of false alarms and allow penalties for false alarms to be waived if comparable funds are spent to upgrade problem fire alarm systems are likely to end up with more properties with better systems, fewer responses to false alarms, and less frustration all around.

# False Alarms by Incident Type and Occupancy, By Ben Evarts

**Table 1.**
**Fire Department Responses to False Alarms, by Specific Incident Type – 2003**

| Incident Type | Number of Incidents | Percent of Incidents |
|---|---|---|
| False alarm or false call, other | 388,400 | (18%) |
| | | |
| Malicious, mischievous false alarms | 127,800 | (6%) |
| *Malicious, mischievous false call, other* | *48,100* | *(2%)* |
| *Municipal alarm system, malicious false alarm* | *21,700* | *(1%)* |
| *Direct tie to FD, malicious false alarm* | *5,500* | *(0%)* |
| *Telephone, malicious false alarm* | *9,300* | *(0%)* |
| *Central station, malicious false alarm* | *22,600* | *(1%)* |
| *Local alarm system, malicious false alarm* | *20,600* | *(1%)* |
| | | |
| Bomb scare - no bomb | 9,100 | (0%) |
| | | |
| System or detector malfunction | 739,300 | (34%) |
| *System malfunction, other* | *238,400* | *(11%)* |
| *Sprinkler activation due to malfunction* | *20,400* | *(1%)* |
| *Extinguishing system activation due to malfunction* | *2,700* | *(0%)* |
| *Smoke detector activation due to malfunction* | *193,000* | *(9%)* |
| *Heat detector activation due to malfunction* | *13,400* | *(1%)* |
| *Alarm system sounded due to malfunction* | *246,900* | *(11%)* |
| *CO detector activation due to malfunction* | *24,400* | *(1%)* |
| | | |
| Unintentional system/detector operation (no fire) | 924,800 | (42%) |
| *Unintentional transmission of alarm, other* | *175,800* | *(8%)* |
| *Sprinkler activation, no fire - unintentional* | *28,900* | *(1%)* |
| *Extinguishing system activation* | *2,000* | *(0%)* |
| *Smoke detector activation, no fire - unintentional* | *310,600* | *(14%)* |
| *Detector activation, no fire - unintentional* | *131,400* | *(6%)* |
| *Alarm system activation, no fire - unintentional* | *245,800* | *(11%)* |
| *Carbon monoxide detector activation, no CO* | *30,200* | *(1%)* |
| | | |
| Biological hazard, malicious false report | 100 | (0%) |
| | | |
| Total | 2,189,500 | (100%) |

Source: NFIRS and NFPA Survey

**Table 2.**
**False Alarms Caused by System Malfunction or Unintentional Operation**
**by Property Use – 2003**

| Property Use | Number of Incidents | Percent of Incidents |
|---|---|---|
| Residential | 735,900 | (44%) |
| *One-or-two-family dwelling* | *382,700* | *(23%)* |
| *Apartment or multi-family dwelling* | *226,900* | *(14%)* |
| *Hotel or motel* | *60,300* | *(4%)* |
| *Other residential property* | *66,000* | *(4%)* |
| | | |
| Mercantile, business | 301,500 | (18%) |
| *Office, bank or mail facility* | *133,400* | *(8%)* |
| *Unclassified or unknown-type mercantile or business* | *38,800* | *(2%)* |
| *Department store or unclassified general retail* | *36,700* | *(2%)* |
| *Grocery or convenience store* | *27,100* | *(2%)* |
| *Other mercantile or business property* | *65,500* | *(4%)* |
| | | |
| Educational | 171,900 | (10%) |
| *Preschool through grade 12* | *129,500* | *(8%)* |
| *Other educational property* | *42,400* | *(3%)* |
| | | |
| Assembly | 162,500 | (10%) |
| *Eating or drinking places* | *52,100* | *(3%)* |
| *Place of worship or funeral property* | *38,800* | *(2%)* |
| *Other assembly* | *71,600* | *(4%)* |
| | | |
| Health care, detention & correction | 145,300 | (9%) |
| *Nursing home or residential board and care facility* | *48,300* | *(3%)* |
| *Hospital or hospice* | *40,600* | *(2%)* |
| *Other health care, or detention property* | *56,300* | *(3%)* |
| | | |
| Manufacturing, processing | 47,400 | (3%) |
| | | |
| Storage | 42,500 | (3%) |
| *Warehouse, residential or self-storage* | *28,100* | *(2%)* |
| *Other storage property* | *14,400* | *(1%)* |
| | | |
| Industrial, utility, defense, agriculture, mining | 15,900 | (1%) |
| | | |
| Outside or special property | 11,900 | (1%) |
| | | |
| Unclassified property | 29,500 | (2%) |
| | | |
| Total | 1,664,200 | (100%) |

Source: NFIRS and NFPA Survey

**Table 3.**
**Smoke Detector Activations due to Malfunction**
**by Property Use– 2003**

| Property Use | Number of Incidents | Percent of Incidents |
|---|---|---|
| Residential | 87,500 | (45%) |
| *One-or-two-family dwelling* | *43,100* | *(22%)* |
| *Apartment or multi-family dwelling* | *30,200* | *(16%)* |
| *Hotel or motel* | *6,100* | *(3%)* |
| *Dormitory, fraternity, sorority or barracks* | *3,600* | *(2%)* |
| *Other residential properties* | *4,600* | *(2%)* |
| | | |
| Mercantile, business | 32,500 | (17%) |
| *Office, bank or mail facility* | *14,900* | *(8%)* |
| *Department store or unclassified general retail* | *4,000* | *(2%)* |
| *Unclassified or unknown-type mercantile or business* | *3,100* | *(2%)* |
| *Other mercantile or business properties* | *10,600* | *(5%)* |
| | | |
| Educational | 24,400 | (13%) |
| *Preschool through grade 12* | *18,100* | *(9%)* |
| *Other educational properties* | *6,200* | *(3%)* |
| | | |
| Health care, detention & correction | 20,100 | (10%) |
| *Nursing home or residential board and care facility* | *6,500* | *(3%)* |
| *Hospital or hospice* | *5,700* | *(3%)* |
| *Clinic or doctor's office* | *3,000* | *(2%)* |
| *Other health care or detention property* | *4,900* | *(3%)* |
| | | |
| Assembly | 18,800 | (10%) |
| *Place of worship or funeral property* | *5,500* | *(3%)* |
| *Eating or drinking places* | *5,200* | *(3%)* |
| *Other assembly property* | *8,100* | *(4%)* |
| | | |
| Manufacturing or processing | 2,900 | (2%) |
| | | |
| Storage | 2,600 | (1%) |
| | | |
| Industrial, utility, defense, agriculture, mining | 1,700 | (1%) |
| | | |
| Outside or special property | 500 | (0%) |
| | | |
| Unclassified properties | 1,900 | (1%) |
| | | |
| Total | 193,000 | (100%) |

Source: NFIRS and NFPA Survey

**Table 4.**
**Heat Detector Activations due to Malfunction**
**by Property Use– 2003**

| Property Use | Number of Incidents | Percent of Incidents |
|---|---|---|
| Residential | 3,900 | (29%) |
| *One-or-two-family dwelling* | *1,400* | *(10%)* |
| *Apartment or multi-family dwelling* | *1,300* | *(9%)* |
| *Hotel or motel* | *800* | *(6%)* |
| *Dormitory, fraternity, sorority or barracks* | *300* | *(3%)* |
| *Other residential property* | *100* | *(1%)* |
| | | |
| Assembly | 2,500 | (18%) |
| *Eating or drinking places* | *900* | *(7%)* |
| *Place of worship or funeral property* | *500* | *(4%)* |
| *Club* | *300* | *(3%)* |
| *Library, museum, courthouse or other public property* | *200* | *(2%)* |
| *Other assembly property* | *400* | *(3%)* |
| | | |
| Mercantile, business | 2,200 | (16%) |
| *Office, bank or mail facility* | *900* | *(7%)* |
| *Grocery or convenience store* | *300* | *(2%)* |
| *Unclassified or unknown-type mercantile or business* | *300* | *(2%)* |
| *Laundry, dry cleaning, professional supplies or services* | *200* | *(2%)* |
| *Department store or unclassified general retail* | *200* | *(2%)* |
| *Other mercantile or business property* | *300* | *(2%)* |
| | | |
| Educational | 2,000 | (15%) |
| *Preschool through grade 12* | *1,600* | *(12%)* |
| *Other educational property* | *400* | *(3%)* |
| | | |
| Health care, detention & correction | 1,300 | (10%) |
| *Nursing home or residential board and care facility* | *600* | *(4%)* |
| *Mental retardation or substance abuse* | *300* | *(3%)* |
| *Hospital or hospice* | *200* | *(2%)* |
| *Other health care or detention property* | *200* | *(1%)* |
| | | |
| Storage | 500 | (4%) |
| | | |
| Manufacturing, processing | 400 | (3%) |
| | | |
| Industrial, utility, defense, agriculture, mining | 300 | (3%) |
| | | |
| Outside or special property | 200 | (2%) |
| | | |
| Unclassified property | 100 | (1%) |
| | | |
| Total | 13,400 | (100%) |

Source: NFIRS and NFPA Survey

**Table 5.**
**Alarm System Activations due to Malfunction**
**by Property Use– 2003**

| Property Use | Number of Incidents | Percent of Incidents |
|---|---|---|
| Residential | 92,800 | (38%) |
| *One-or-two-family dwelling* | *45,000* | *(18%)* |
| *Apartment or multi-family dwelling* | *31,700* | *(13%)* |
| *Hotel or motel* | *7,900* | *(3%)* |
| *Dormitory, fraternity, sorority or barracks* | *3,800* | *(2%)* |
| *Other residential property* | *4,400* | *(2%)* |
| | | |
| Mercantile, business | 51,400 | (21%) |
| *Office, bank or mail facility* | *23,400* | *(9%)* |
| *Department store or unclassified general retail* | *6,400* | *(3%)* |
| *Unclassified or unknown-type mercantile or business* | *5,400* | *(2%)* |
| *Grocery or convenience store* | *4,000* | *(2%)* |
| *Other mercantile or business property* | *12,200* | *(5%)* |
| | | |
| Educational | 27,500 | (11%) |
| *Preschool through grade 12* | *21,800* | *(9%)* |
| *Other educational property* | *5,700* | *(2%)* |
| | | |
| Assembly | 25,100 | (10%) |
| *Eating or drinking places* | *7,500* | *(3%)* |
| *Place of worship or funeral property* | *7,000* | *(3%)* |
| *Other assembly property* | *10,600* | *(4%)* |
| | | |
| Health care, detention & correction | 21,700 | (9%) |
| *Nursing home or residential board and care facility* | *7,000* | *(3%)* |
| *Hospital or hospice* | *5,900* | *(2%)* |
| *Other health care or detention property* | *8,900* | *(4%)* |
| | | |
| Manufacturing, processing | 10,000 | (4%) |
| | | |
| Storage | 7,700 | (3%) |
| *Warehouse, residential or self-storage* | *5,100* | *(2%)* |
| *Other storage property* | *2,600* | *(1%)* |
| | | |
| Industrial, utility, defense, agriculture, mining | 3,500 | (1%) |
| | | |
| Outside or special property | 1,000 | (0%) |
| | | |
| Unclassified or other property | 6,200 | (3%) |
| | | |
| Total | 246,900 | (100%) |

Source: NFIRS and NFPA Survey

**Table 6.**
**Smoke Detector Activation (No Fire), Unintentional, Includes Proper System Response
to Environmental Stimuli such as Non-Hostile Smoke
by Property Use– 2003**

| Property Use | Number of Incidents | Percent of Incidents |
|---|---|---|
| Residential | 172,100 | (55%) |
| *One-or-two-family dwelling* | *83,200* | *(27%)* |
| *Apartment or multi-family dwelling* | *56,600* | *(18%)* |
| *Hotel or motel* | *15,800* | *(5%)* |
| *Dormitory, fraternity, sorority or barracks* | *6,400* | *(2%)* |
| *Other residential property* | *10,100* | *(3%)* |
| | | |
| Mercantile, business | 39,600 | (13%) |
| *Office, bank or mail facility* | *18,100* | *(6%)* |
| *Department store or unclassified general retail* | *4,800* | *(2%)* |
| *Grocery or convenience store* | *4,700* | *(2%)* |
| *Other mercantile or business property* | *12,100* | *(4%)* |
| | | |
| Assembly | 28,700 | (9%) |
| *Eating or drinking places* | *9,900* | *(3%)* |
| *Place of worship or funeral property* | *6,000* | *(2%)* |
| *Other assembly property* | *12,800* | *(4%)* |
| | | |
| Educational | 27,600 | (9%) |
| *Preschool through grade 12* | *19,800* | *(6%)* |
| *Other educational property* | *7,800* | *(3%)* |
| | | |
| Health care, detention & correction | 27,400 | (9%) |
| *Nursing home or residential board and care facility* | *9,800* | *(3%)* |
| *Hospital or hospice* | *7,000* | *(2%)* |
| *Mental retardation or substance abuse* | *4,900* | *(2%)* |
| *Other health care or detention property* | *5,700* | *(2%)* |
| | | |
| Storage | 2,700 | (1%) |
| | | |
| Manufacturing, processing | 2,700 | (1%) |
| | | |
| Industrial, utility, defense, agriculture, mining | 1,700 | (1%) |
| | | |
| Outside or special property | 1,200 | (0%) |
| | | |
| Unclassified property use | 7,000 | (2%) |
| | | |
| Total | 310,600 | (100%) |

Source: NFIRS and NFPA Survey

**Table 7.**
**Detector Activation (No Fire), Unintentional a Result of Proper System Response
to Environmental Stimuli such as High Heat Conditions
by Property Use– 2003**

| Property Use | Number of Incidents | Percent of Incidents |
|---|---|---|
| Residential | 59,700 | (45%) |
| *One-or-two-family dwelling* | *29,600* | *(23%)* |
| *Apartment or multi-family dwelling* | *17,700* | *(13%)* |
| *Hotel or motel* | *5,300* | *(4%)* |
| *Residential Boarding and Care* | *2,800* | *(2%)* |
| *Other residential property* | *4,300* | *(3%)* |
| | | |
| Mercantile, business | 21,100 | (16%) |
| *Office, bank or mail facility* | *8,400* | *(6%)* |
| *Unclassified or unknown-type mercantile or business* | *2,500* | *(2%)* |
| *Department store or unclassified general retail* | *2,500* | *(2%)* |
| *Grocery or convenience store* | *2,400* | *(2%)* |
| *Other mercantile or business property* | *5,200* | *(4%)* |
| | | |
| Educational | 14,800 | (11%) |
| *21 - Preschool through grade 12* | *11,000* | *(8%)* |
| *Other educational property* | *3,800* | *(3%)* |
| | | |
| Health care, detention & correction | 14,500 | (11%) |
| *Hospital or hospice* | *5,200* | *(4%)* |
| *Nursing home or residential board and care facility* | *4,800* | *(4%)* |
| *Clinic or doctor's office* | *2,100* | *(2%)* |
| *Other health care or detention property* | *2,500* | *(2%)* |
| | | |
| Assembly | 13,400 | (10%) |
| *Eating or drinking places* | *4,500* | *(3%)* |
| *Place of worship or funeral property* | *3,300* | *(3%)* |
| *Other assembly property* | *5,600* | *(4%)* |
| | | |
| Manufacturing, processing | 2,600 | (2%) |
| | | |
| Storage | 2,200 | (2%) |
| | | |
| Industrial, utility, defense, agriculture, mining | 1,300 | (1%) |
| | | |
| Outside or special property | 600 | (0%) |
| | | |
| Unclassified property | 1,300 | (1%) |
| | | |
| Total | 131,400 | (100%) |

Source: NFIRS and NFPA Survey

**Table 8.**
**Alarm System Activations (No Fire), Unintentional**
**by Property Use– 2003**

| Property Use | Number of Incidents | Percent of Incidents |
|---|---|---|
| Residential | 100,400 | (41%) |
| *One-or-two-family dwelling* | *55,800* | *(23%)* |
| *Apartment or multi-family dwelling* | *28,000* | *(11%)* |
| *Hotel or motel* | *6,900* | *(3%)* |
| *Other residential property* | *9,600* | *(4%)* |
| | | |
| Mercantile, business | 43,100 | (18%) |
| *Office, bank or mail facility* | *16,400* | *(7%)* |
| *Unclassified or unknown-type mercantile or business* | *6,600* | *(3%)* |
| *Department store or unclassified general retail* | *5,900* | *(2%)* |
| *Grocery or convenience store* | *4,300* | *(2%)* |
| *Other mercantile or business property* | *9,900* | *(4%)* |
| | | |
| Educational | 29,000 | (12%) |
| *Preschool through grade 12* | *22,400* | *(9%)* |
| *Other educational property* | *6,600* | *(3%)* |
| | | |
| Assembly | 25,900 | (11%) |
| *Eating or drinking places* | *7,900* | *(3%)* |
| *Place of worship or funeral property* | *6,100* | *(2%)* |
| *Other assembly property* | *11,900* | *(5%)* |
| | | |
| Health care, detention & correction | 24,100 | (10%) |
| *Nursing home or residential board and care facility* | *8,400* | *(3%)* |
| *Hospital or hospice* | *6,200* | *(3%)* |
| *Clinic or doctor's office* | *3,800* | *(2%)* |
| *Mental retardation or substance abuse* | *3,700* | *(2%)* |
| *Other health care or detention property* | *2,000* | *(1%)* |
| | | |
| Manufacturing, processing | 9,300 | (4%) |
| | | |
| Storage | 5,900 | (2%) |
| *Warehouse, residential or self-storage* | *3,700* | *(2%)* |
| *Other storage property* | *2,100* | *(1%)* |
| | | |
| Outside or special property | 2,100 | (1%) |
| | | |
| Industrial, utility, defense, agriculture, mining | 2,000 | (1%) |
| | | |
| Unclassified property | 4,200 | (2%) |
| | | |
| Total | 245,800 | (100%) |

Source: NFIRS and NFPA Survey

## Appendix A.
## How National Estimates Statistics Are Calculated

The statistics in this analysis are estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual survey of U.S. fire departments. NFIRS is a voluntary system by which participating fire departments report detailed factors about the fires to which they respond. Roughly two-thirds of U.S. fire departments participate, although not all of these departments provide data every year. Fires reported to federal or state fire departments or industrial fire brigades are not included in these estimates.

NFIRS provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. NFIRS also captures information on the extent of flame spread, and automatic detection and suppression equipment. For more information about NFIRS visit http://www.nfirs.fema.gov/. Copies of the paper forms may be downloaded from http://www.nfirs.fema.gov/documentation/design/NFIRS_Paper_Forms_2008.pdf.

NFIRS has a wide variety of data elements and code choices. The NFIRS database contains coded information. Many code choices describe several conditions. These cannot be broken down further. For example, area of origin code 83 captures fires starting in vehicle engine areas, running gear areas or wheel areas. It is impossible to tell the portion of each from the coded data.

**Methodology may change slightly from year to year.**
NFPA is continually examining its methodology to provide the best possible answers to specific questions, methodological and definitional changes can occur. *Earlier editions of the same report may have used different methodologies to produce the same analysis, meaning that the estimates are not directly comparable from year to year.*

**NFPA's fire department experience survey provides estimates of the big picture.**
Each year, NFPA conducts an annual survey of fire departments which enables us to capture a summary of fire department experience on a larger scale. Surveys are sent to all municipal departments protecting populations of 50,000 or more and a random sample, stratified by community size, of the smaller departments. Typically, a total of roughly 3,000 surveys are returned, representing about one of every ten U.S. municipal fire departments and about one third of the U.S. population.

The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities have fewer people protected per department and are less likely to respond to the survey. A larger number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city

departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them.  Most respond, resulting in excellent precision for their part of the final estimate.

The survey includes the following information:  (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined in NFIRS; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; 3) the number and nature of non-fire incidents; and (4) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results.  The results of the survey are published in the annual report *Fire Loss in the United States*.  To download a free copy of the report, visit http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf.

**Projecting NFIRS to National Estimates**
As noted, NFIRS is a voluntary system.  Different states and jurisdictions have different reporting requirements and practices.  Participation rates in NFIRS are not necessarily uniform across regions and community sizes, both factors correlated with frequency and severity of fires.  This means NFIRS may be susceptible to systematic biases.  No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems.  But there is enough reason for concern so that a second database -- the NFPA survey -- is needed to project NFIRS to national estimates and to project different parts of NFIRS separately.  This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

Scaling ratios are obtained by comparing NFPA's projected totals of residential structure fires, non-residential structure fires, vehicle fires, and outside and other fires, and associated civilian deaths, civilian injuries, and direct property damage with comparable totals in NFIRS.  Estimates of specific fire problems and circumstances are obtained by multiplying the NFIRS data by the scaling ratios.  Reports for incidents in which mutual aid was given are excluded from NFPA's analyses.

Analysts at the NFPA, the USFA and the Consumer Product Safety Commission developed the specific basic analytical rules used for this procedure.  "The National Estimates Approach to U.S. Fire Statistics," by John R. Hall, Jr. and Beatrice Harwood, provides a more detailed explanation of national estimates.  A copy of the article is available online at http://www.nfpa.org/osds or through NFPA's One-Stop Data Shop.

Version 5.0 of NFIRS, first introduced in 1999, used a different coding structure for many data elements, added some property use codes, and dropped others.  The essentials of the approach described by Hall and Harwood are still used, but some modifications have been necessary to accommodate the changes in NFIRS 5.0.

Figure A.1 shows the percentage of fires originally collected in the NFIRS 5.0 system. Each year's release version of NFIRS data also includes data collected in older versions of NFIRS that were converted to NFIRS 5.0 codes.

**Figure A.1. Fires Originally Collected in NFIRS 5.0 by Year**
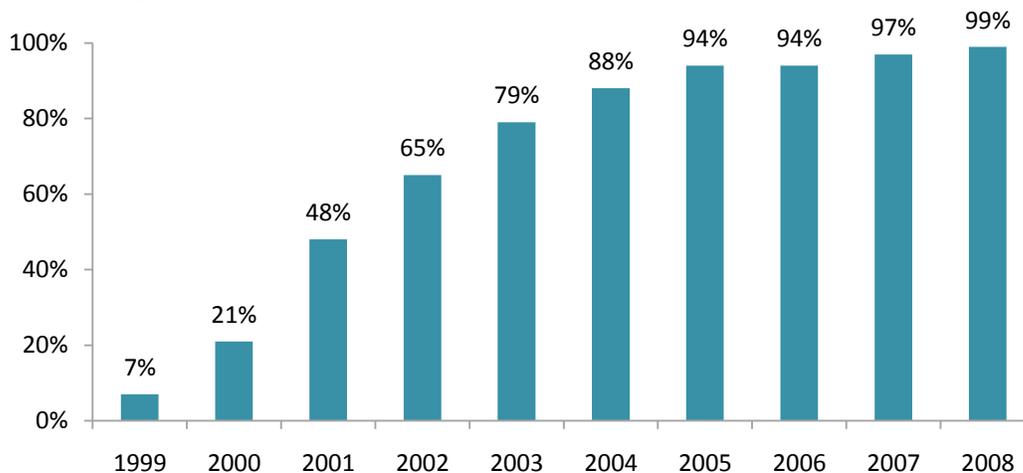


From 1999 data on, analyses are based on scaling ratios using only data originally collected in NFIRS 5.0:

$$\frac{\text{NFPA survey projections}}{\text{NFIRS totals (Version 5.0)}}$$

For 1999 to 2001, the same rules may be applied, but estimates for these years in this form will be less reliable due to the smaller amount of data originally collected in NFIRS 5.0; they should be viewed with extreme caution.

NFIRS 5.0 introduced six categories of confined structure fires, including:
- cooking fires confined to the cooking vessel,
- confined chimney or flue fires,
- confined incinerator fire,
- confined fuel burner or boiler fire or delayed ignition,
- confined commercial compactor fire, and
- trash or rubbish fires in a structure with no flame damage to the structure or its contents.

Although causal and other detailed information is typically not required for these incidents, it is provided in some cases. Some analyses, particularly those that examine cooking equipment, heating equipment, fires caused by smoking materials, and fires started by playing with fire, may examine the confined fires in greater detail. Because the confined fire incident types describe certain scenarios, the distribution of unknown data differs from that of all fires. Consequently, allocation of unknowns must be done separately.

Some analyses of structure fires show only non-confined fires.  In these tables, percentages shown are of non-confined structure fires rather than all structure fires.  This approach has the advantage of showing the frequency of specific factors in fire causes, but the disadvantage of possibly overstating the percentage of factors that are seldom seen in the confined fire incident types and of understating the factors specifically associated with the confined fire incident types.

Other analyses include entries for confined fire incident types in the causal tables and show percentages based on total structure fires.  In these cases, the confined fire incident type is treated as a general causal factor.