

**CALIFORNIA STATE FIRE MARSHAL
SMOKE ALARM TASK FORCE
FINAL REPORT
ANALYSIS AND RECOMMENDATIONS**

Understanding, Utilization, and Effectiveness of
Smoke Detection Technology including
Ionization, Photoelectric, and other Technologies

CAL FIRE – Office of the State Fire Marshal
August 2011

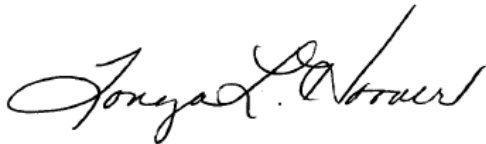


Message from the Acting State Fire Marshal

On behalf of CAL FIRE – Office of the State Fire Marshal (OSFM) I am pleased to present the Smoke Alarm Task Force final report analysis and recommendations. The extensive discussions, analysis, and expertise resulting in these recommendations were essential to the successful understanding and utilization of smoke alarm technology, and the continued efforts to protect the citizens of California. Each recommendation has sound merit and should be moved forward in a variety of methods within the framework of the OSFM.

The OSFM would like to extend a sincere gratitude to Co-Chairs: Ruben Grijalva (former State Fire Marshal and CAL FIRE Director – Retired) and Vickie Sakamoto, Division Chief, OSFM Fire and Life Safety Division; and to each of the members and organizations for their dedication and commitment to this important project. We appreciate the participants' willingness to share their time, energy, and talent; particularly during these very busy and difficult fiscal times. Through our partnerships we will continue to move fire and panic safety initiatives forward, providing a safer working environment for emergency responders and a safer environment for all those who live in and/or visit the State of California.

Sincerely,

A handwritten signature in black ink, appearing to read "Tonya L. Hoover". The signature is fluid and cursive, with a large initial "T" and "H".

TONYA L. HOOVER
Acting State Fire Marshal

Acknowledgements

This report was developed through the cumulative efforts and many hours of in-depth research and analysis. Outstanding collaborative efforts were demonstrated by the many disciplines, experts, and stakeholders participating on/with the **Smoke Alarm Task Force**. Included in those efforts are the (in alphabetical order):

Albany Fire Department
Bay Alarm Company
Boston Fire Department
BRK Brands Inc.
California Automatic Fire Alarm Association
California Building Officials
California Fire Chiefs Association
California League of Cities
California Office of the State Fire Marshal
California Professional Firefighters
California State Firefighters Association Inc.
Consultant for Codes, Standards, Legislative & Regulatory Affairs
Department of Housing and Community Development
Kidde Safety
National Electrical Manufacturers Association
National Fire Protection Association
Northern California Fire Prevention Officers Association
Palo Alto Fire Department
Southern California Fire Prevention Officers Association
Underwriters Laboratories Inc.

Smoke Alarm Task Force Members

Ruben Grijalva - Co-Chair
Vickie Sakamoto - Co-Chair

John Andres	Howard Hopper	Ken Quick
Ray Bizal	Ray Iverson	Larry Ratzlaff
Kevin Cimini	Bob Latz	Richard S. Renfro
Shane M. Clary	Jay Levy	Richard Roberts
Jim Edon	Marc McGinn	Randy Sekany
Tom Fabian	Tom McNelis	Gordon Simpkinson
Jay Flemming	Sarah Owen	Doug Williams
Gene Gant	James Palisi	Morgana Yahnke
Wendy Gifford	Jessica Power	

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Executive Summary

On January 13, 2011, CAL FIRE - Office of the State Fire Marshal convened representatives from various disciplines related to smoke alarms to form the **Smoke Alarm Task Force**. Their purpose was to address the understanding, utilization, and effectiveness of smoke detection technology including ionization and photoelectric, and other technologies, complying with current California State Fire Marshal listing standards, and used in residential occupancies as required by California regulations. The final Analysis and Recommendation Report to the California State Fire Marshal documents the understanding and utilization of smoke alarm technology through the review and examination of current/relevant studies, reports, and/or scientific data.

Stakeholders

The key stakeholders are identified in the acknowledgements; and for complete rosters of individual members and the sub-groups please see **Appendices A and B**.

Scope

The scope of the Office of the State Fire Marshal (OSFM), Smoke Alarm Task Force (SATF) project was to address the effectiveness of smoke detection technology including, but not limited to ionization and photoelectric, complying with current California State Fire Marshal (CSFM) listing standards, and used in residential occupancies as required by California statute and regulations. The task force was to review and examine current or relevant studies, reports, and scientific data (see **Appendix C**); and provide recommendations to the CSFM.

Sources of Data

The task force reviewed current research, testing, published reports, codes, standards and regulations to form a basis for observations, conclusions and recommendations; and it was agreed that referenced documents considered by the task force be limited to those directly related to United States (U.S.) codes, standards and research. These documents were to include data and observations that are applicable to modern technology, concerns and furnishings. Anecdotal data would be considered by the task force, but not

given as much weight as the technical data described above. Data from sources outside of the U.S. was not considered since the equipment and installation requirements in other countries are typically different from those adopted in the U.S.

The referenced documents the task force selected as a basis for their work are included in **Appendix C**. In many cases data and findings cited in this report include footnotes references (i.e. R-1, R-34) to specific **Appendix C** source document.

The Importance of Smoke Alarms

Smoke alarms detect and alert people to fire in its early stages, giving them the time needed to escape the dwelling or building safely. Properly operating smoke alarms can mean the difference between life and death in a fire. People must hear (or notice) the audible alarm and take appropriate action once the alarm has been initiated for a positive outcome.

Properly operating smoke alarms cut the risk of dying in reported home structure fires in half. In 2003-2006, the death rate per 100 reported home structure fires was twice as high when no working smoke alarm was present (that is, either no smoke alarm was present or an alarm was present but did not operate) compared to the rate with working smoke alarms. In fires considered large enough to activate a smoke alarm, hard-wired alarms operated 91% of the time; battery-powered smoke alarms operated 75% of the time. While this shows that hard-wired alarms have a higher success rate in operating, the fact is that both hard-wired and battery-powered smoke alarms are operating and saving lives. (R-7)

According to studies, in 1977, 22% of homes had at least one smoke alarm and in 2008, 96% had at least one smoke alarm (R-7). Also according to the report "Fire Loss in the United States, 2007", home fire deaths have decreased from 6,015 in 1978 to 2,895 in 2007. Many researchers agree that smoke alarm use has contributed to this substantial reduction. This reduction has occurred with less than 20% of homes having code specified protection (R-7).

A Consumer Product Safety Commission (CPSC) study (R-40) noted that in 30% of the fires, someone was home when smoke alarms sounded, alerting occupants in 12% of the fires and providing the only alert in 10% of the fires. (Note: In some cases, people were in the room when the fire started and therefore were aware before the alarm sounded; or noticed the smell of smoke or other cues at about the same time the alarm sounded). The level

of coverage strongly influenced the likelihood of smoke alarms sounding or alerting occupants.

When people were in homes with interconnected smoke alarms, the alarms sounded in more than half (53%) of the fires and provided the only alert in one-quarter (26%). In contrast, when people were in homes that did not have alarms on every floor smoke alarms sounded in only 4% of the fires, alerting and providing the only alert in just 2% of the fires. When the alarms did not sound, it was usually because not enough smoke reached the alarm. Clearly, when evaluating smoke alarm performance, it is necessary to consider the amount of coverage in place.

The study also noted that when someone was home, smoke alarms sounded in 41% of the fires starting on the kitchen range, providing an alert in 16% of the fires and the only alert in 13%. In actual numbers, smoke alarms provided the only alert in roughly 500,000 unreported kitchen range fires per year. This study did not collect data on the type of sensor technology used.

It is recognized that smoke alarms cannot provide sufficient escape time to all occupants as some will be impaired from hearing/recognizing the alarm signal or impaired from responding appropriately. In addition, smoke alarms are not expected to provide sufficient warning to people that are intimate with the fire. The majority of fatal victims in home fires (53%) were inside the room of the fire origin. (R-23, R-41)

Smoke Detection Technology

Since smoke alarms first went into widespread use in the late 1970's two types of smoke detection technology were predominately used:

Ionization: smoke alarms have been used in over 90% of residential installations, and are relatively inexpensive. These alarms are most effective at sensing small smoke particles associated with flaming fires.

Photoelectric: smoke alarms are slightly more expensive and are better at sensing large and lighter colored smoke particles associated with smoldering fires.

Dual smoke alarms that provide both photoelectric and ionization sensing elements in a single unit are also available. Studies show that these generally perform better than either ionization or photoelectric alarms to a wide range of smoke profiles if their individual sensors have the same

sensitivity as corresponding single-sensor units. The National Institute of Standards and Technology (NIST) research observed that dual alarms “with equivalent or higher sensitivity settings” performed better than individual alarms, but noted that in off-the-shelf models, sensor had a wider range of sensitivity settings. (R-11)

Also available are alarms that combine both carbon monoxide and smoke alarms in a single unit. These devices are listed as complying with one or more product standards.

The addition of microprocessors to smoke alarms listed as complying with Underwriters Laboratories (UL) 217 has created opportunities to enhance performance and reduce nuisance alarms. Using inputs from one or more sensors (e.g. ionization, photoelectric, carbon monoxide, temperature), these mini-computers with customized mathematical algorithms can evaluate sensor input levels or rates of change, to determine when an alarm should be generated. One such example that is available on the market today is a combination ionization/carbon monoxide smoke alarm that measures and compares levels of both smoke and carbon monoxide. If the unit senses smoke but no carbon monoxide, it reduces the sensitivity of the ionization alarm sensing threshold. This recognizes that a threatening fire in the dwelling always includes both smoke and elevated carbon monoxide concentrations. Similarly when the unit detects elevated carbon monoxide levels it increases the ionization alarm sensitivity since the elevated presence of carbon monoxide might suggest that a threatening fire is present. This is just one example of evolving technology. It should be noted that smoke detectors (UL 268) have been equipped with microprocessors for at least 15 years.

The U.S. model codes and installation standards require smoke alarms and smoke detectors to be listed in accordance with the Standard for Single- and Multiple-Station Smoke Alarms, UL 217, and the Standard for Smoke Detectors for Fire Alarm Signaling Systems, UL 268. These two product safety standards cover the construction and performance of all smoke alarms and smoke detectors regardless of the detection technology used. In order to comply with these requirements the devices must meet all applicable performance tests, including sensitivity and fire performance tests. These standards are continually under review to add or revise performance criteria. For example, recent research by UL has indicated the need for new fire performance tests that will test alarms against smoldering and flaming synthetic materials.

This report includes numerous references to smoke alarms and the UL 217 standard. Many of these references may apply to smoke detectors listed as

complying with UL 268. Instead of including reference to “smoke alarms and smoke detectors” throughout the report, it is implied that most of the references to smoke alarms also apply to smoke detectors.

For additional information on smoke detection technology and their ability to detect various types of smoke particulate see [Appendix D](#).

Furnishings and Escape Times

The purpose of home smoke alarms is to allow for occupants of the home or dwelling units to be notified of the presence of a threatening fire in order for them to escape safely. Determining if the occupants can successfully escape is embodied in the concepts of Required Safe Egress Time (RSET) and Available Safe Egress Time (ASET).

Prediction of RSET typically involves estimating the time that it would take for people to be notified that there might be a fire, the time that people would take for pre-movement activities such as alerting others, checking on family members, etc. and the time it would take for people to escape to a safe location. During the course of the evacuation, there may be other behavior, actions or inactions that extend the time for evacuations which are beyond the basic human response assumptions of National Fire Protection Association (NFPA) 72, Chapter 29 (R-10). See section titled Human Factors for additional information.

ASET is the time period between the sounding of the alarm and the onset of untenable conditions for one or more building areas. In order for escape to be a viable outcome ASET must exceed RSET.

According to the UL Fire Protection Research Foundation Smoke Characterization Project (R-19) substantial changes have occurred in the typical household since the original 1975 NIST Indiana Dunes study (R-38). Residential settings have grown increasingly larger, with more synthetic furnishings, and contain a wider variety of manufactured products. These synthetic materials tend to ignite and burn faster than materials used in the original 1975 NIST study. The combustion behavior between synthetic material and natural materials are different. Synthetic materials (e.g. polyethylene, polyester, nylon, polyurethane) generate higher heat and smoke release rates than the natural materials (e.g. wood, cotton batting).

In the NIST Indiana Dunes II study (R-35) the window of escape time in flaming fires (ASET) was 3 minutes compared to 17 minutes in the 1975 study. NIST concluded this reduction is attributable in part to faster fire

growth rates and different tenability criteria. (Note: there were also differences in ignition methodology). NIST also noted that fast detection of these types of fires is critical to allow occupants the best possible chance of escape. The average ASET time for smoldering fires in the 1975 and 2007 tests were similar.

Fire test data indicates that ionization alarms can provide 2 or more minutes of escape time than photoelectric alarms for flaming fires that can reach untenable conditions quickly. (R-35)

Unwanted Alarms

The concept of nuisance (or false) alarms has many implications. As defined in NFPA 72 a nuisance alarm is any alarm caused by mechanical failure, malfunction, improper installation, or lack of proper maintenance, or any alarm activated by a cause that cannot be determined. Requirements in the standard utilized to investigate and list smoke alarms, UL 217, include a number of tests to verify that alarms will not sound under a variety of conditions such as environmental, radio interference and line voltage surges. Smoke alarms are designed by manufacturers to attempt to reject alarm activations to unwanted sources, while remaining sensitive enough to quickly activate when smoke is detected.

In an ideal situation, smoke alarms should only sound when smoke from a threatening fire is detected. However, in some cases smoke alarms installed in close proximity to cooking appliance or kitchens may sense smoke/cooking vapors and generate an alarm signal. In this example, alarms are responding as they are designed. Such alarms are not considered to be nuisance alarms, as defined in NFPA 72 but rather are unwanted alarms. Such unwanted alarms may be good or bad depending on the situation.

If a smoke alarm activates on a rare instance where cooking produces a significant amount of smoke but no threatening fire, such as when toast is burning, this is an appropriate type of response as it alerts occupants of a problem that needs to be addressed. In this case the occupant would probably silence the alarm, air out the home, and appreciate the warning that was provided.

However, if a smoke alarm activates on a more frequent basis during normal cooking conditions, the homeowner may view the activations as annoying, and take steps to alleviate the annoying alarm signals. In many cases this would involve disabling the alarm.

Nuisance sources external to the smoke alarm are the leading cause for occupants disabling smoke alarms. "External nuisance sources can be cooking gases, steam, dust, insects, tobacco smoke, air circulated from heating equipment, and candle combustion products. Both types of smoke alarm detection technology, ionization and photoelectric, are vulnerable to external nuisance sources." (R-10)

Challenges Facing Smoke Alarms

Research and surveys have identified a number of factors that can contribute to smoke alarms not being maintained in an operable condition or not otherwise providing the desired early fire warning. These include the following:

Cooking

Cooking is the leading cause of nuisance alarms. Factors that determine the rate of nuisance alarms include the type of cooking, distance to the nuisance source, and use of a cooking exhaust fan. Ionization and photoelectric type detectors are both sensitive to cooking aerosols, but several studies have shown that when placed an equal distance from the cooking appliance, ionization type detectors have a significantly higher frequency of nuisance alarms than photoelectric type detectors. (R-10)

All smoke alarm types tested, if placed too close to a cooking source, resulted in nuisance alarms. The frequency of nuisance alarms appears to be dependent on the type of smoke alarm and the distance from the nuisance source. Regardless of the smoke alarm type, smoke alarms placed greater than 10 to 15 feet from the main cooking appliance had a reduced number of nuisance alarms. No difference was found in the smoke alarm nuisance activations for any sensor type when placed 20 feet from the cooking source. (R-18)

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. 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. (R-7)

The concept of cooking possibly contributing to the disabling of nearby smoke alarms is supported by a 2000-2002 study (R-34) of battery powered

smoke alarms installed in low income housing units. In this study both ionization and photoelectric smoke alarms with hush buttons were installed an average of eleven feet from the kitchen stove. Installing teams had been instructed to install alarms in rooms next to the kitchen, three feet away from the kitchen entrance. However, 20 % of ionization and 16% of photoelectric smoke alarms were installed in the kitchens themselves. Since this study, Chapter 29 of NFPA 72 has been revised to include new requirements in the 2010 Edition which restrict the use of ionization and photoelectric smoke alarms within 10 feet of fixed cooking appliances. At the nine-month follow-up, more than three-quarters (78%) of the ionization alarms had sounded at least once while more than half (56%) had sounded four or more times. In contrast, more than one-third (39%) of the photoelectric alarms had sounded at least once while 17% had sounded four or more times.

The study found that 20% of ionization alarms and 5% of photoelectric alarms were found to be nonfunctional within 9 months of installation, a difference that persisted at 15 months. In the 15 month follow-up, photoelectric alarms had 4 times the number of nuisance alarms due to low batteries (5% ionization, 22% photoelectric), twice as many for steam (1% ionization, 2% photoelectric), equal nuisance alarms related to fire places, and was the only type of alarm with reported nuisance alarms due to smoking. The report indicated that participants were initially instructed in alarm maintenance and provided with the operation manual and a fire safety brochure. The report did not specifically document any conclusion about the effectiveness of the hush feature. The authors suggest that installing photoelectric smoke alarms on the main floors of dwellings may increase the proportion of functioning alarms and therefore provide longer term protection, since the main source of unwanted alarms in the kitchens are usually located on the main floors. A study in Alaska in 2000 reached a similar conclusion. The researchers suggested that photoelectric alarms may be the preferred choice for dwellings with limited living space or frequent false alarms (R-34, R-3).

[Alarm Silencing](#)

Alarm silencing (hush) is an optional feature on smoke alarms that is intended to allow occupants to temporarily silence smoke alarms that are generating an unwanted alarm due to conditions that create a nuisance alarm, such as cooking. Without an alarm silencing feature, the minimum 85 decibel alarm signal will continue until the smoke clears or the user disables the unit, such as by removing the power source.

UL 217 allows smoke alarms to be provided with an automatically resettable alarm silencing means that has a fixed or variable time setting which desensitizes the alarm for a maximum of 15 minutes. Alarm silencing cannot disable the smoke alarm, and cannot reduce sensitivity to more than 4 % per foot of obscuration. Alarms must produce a distinctive audible or visible trouble signal while in the silence mode. Following the silenced period, the alarm must restore automatically to its intended operation. Silencing of one alarm of a multiple station system shall not prevent an alarm operation from the other alarms in the system.

The 2010 edition of NFPA 72 includes new requirements that allow ionization detection to be provided between 10 to 20 feet from stationary or fixed cooking appliances provided that they include an alarm-silencing means. This would appear to assume that users are aware of the existence of the alarm silencing feature, are able to activate it with the smoke alarm mounted on or near the ceiling, and that the alarm will not resound after the unit resets.

The task force could not locate research or survey results that specifically address the effectiveness of alarm silencing features to prevent the removal of batteries or the removal of the smoke alarms in household settings.

Bathrooms

The frequency of nuisance alarms from bathroom steam can be reduced if the smoke alarm is located more than 3 feet from the bathroom door. Smoke alarms that were more than 10 feet from the bathroom door had no reported nuisance alarms. The current 2010 edition of NFPA 72 specifies a 3 foot separation distance from a bathroom door. (R-10)

Batteries

Batteries play a key role in proper smoke alarm operation. Smoke alarms are usually either alternating current (AC) powered units with a non-rechargeable battery serving as the secondary power source, or units with a replaceable or non-replaceable primary battery. UL 217 requires smoke alarms with a replaceable battery used as the main source of power to provide power to the unit for at least one year in the standby condition, including novelty and weekly alarm testing, and then operate the alarm for a minimum of 4 minutes of alarm, followed by 7 days of trouble signal.

UL 217 requires smoke alarms with a non-replaceable battery serving as the main source of power to provide power to the unit for at least 10 years in the standby condition, including novelty and weekly testing, and then

operate the alarm for a minimum of 4 minutes of alarm, followed by 7 days of trouble signal.

A significant factor associated with smoke alarms not being maintained in an operable condition are units with dead batteries, or batteries that have been removed. In more than half of the reported home fires in which the smoke alarms were present but did not operate, batteries were missing or disconnected. Roughly one of every five smoke alarm failures was due to dead batteries. This poor performance is due primarily to inappropriate response of occupants to trouble and unwanted alarm signals from smoke alarms. Only 8% of the failures were due to hardwired power source problems, including disconnected smoke alarms, power outages and power shut-offs. (R-7)

When smoke alarms generate unwanted alarms, users may find the audible alarm annoying and may seek to silence the alarm. A CPSC study (R-18) indicated that when batteries were removed or disconnected from alarms, the leading reason was unwanted activations. Some alarms include a hush feature, which can be used to silence the alarm (if the smoke is not too dense) for a few minutes without disabling it. After the alarm resets, protection is still present. However, if the unwanted alarms persist or if the occupants are unaware of or unable to activate the hush feature, they may choose to disable the alarm to avoid the annoying audible alarm.

All battery powered and battery backed smoke alarms are required to produce an audible trouble signal when low battery conditions are reached. Since occupants may not have a replacement battery handy, and since they may find the trouble signal to be annoying, they may disconnect the smoke alarm until a battery can be obtained.

California regulations require installation of household fire alarm systems using smoke detectors or AC powered smoke alarms with battery backup in new construction and certain renovations, but allow selected existing installations to include a replaceable primary battery (typically 9 volts) or a non-replaceable battery with a minimum 10-year battery life.

AC powered units with battery backup will operate regardless of whether commercial power is available at the home. However low battery trouble signals may lead to the devices being disabled by the occupants. Household fire alarm systems are required to be equipped with a rechargeable battery that keeps the system and connected smoke detectors operating during a power outage.

Effective in 1999, the State of Oregon adopted requirements for all ionization battery powered smoke alarms sold in that State to have 10-year life batteries and a hush mechanism. Preliminary Oregon State Fire Marshal data available suggests a 37% decline in alarm failures due to dead or missing batteries since these requirements went into effect.

Smoke alarms with a long-life non-replaceable battery with a minimum 10-year life should not experience a low battery trouble signal for the first ten years. However, after ten years, or when the alarm chirps or does not respond to testing, the user will need to replace the smoke alarm in order to maintain protection.

User Maintenance

In order to provide protection long after the smoke alarms are installed, the units need to be periodically tested to ensure: they operate as intended; are not dirty; that replaceable batteries are switched out; and the units are replaced when they reach end of life.

Without invitation fire departments are not able to verify that occupants properly locate, test, maintain and replace smoke alarms through enforcement means. Public education efforts to install smoke alarms correctly, replace batteries annually, test and maintain smoke alarms, and replace smoke alarms when their end of life is reached can help inform occupants of the need to take action to maintain protection. A 2010 Harris Poll conducted for the NFPA (R-39) found that only one of every five households tested their smoke alarms at least once a month. More than half reported testing less than three times a year.

NFPA 72 requires that smoke alarms installed in one- and two-family dwellings to be replaced when they fail to respond to operability tests, but in no case should they remain in service longer than 10 years from the date of manufacture, unless otherwise recommended by the manufacturer's instructions; and combination smoke/carbon monoxide alarms should be replaced when the end-of-life signal activates or 10 years from the date of manufacture, whichever comes first. It also requires batteries used as a source of energy to be replaced in accordance with the manufacturer's instructions.

Data

Accurate, factual data is essential to being able to effectively evaluate the performance of smoke alarms in residential dwelling unit fires. National Fire Incident Reporting System (NFIRS) and California Fire Incident Reporting

System (CFIRS) data do not have fields that allow more useful, detailed data. In addition, the NFPA 921 Guide for Fire and Explosion Investigations does not include recommendations for investigators to gather and report on this data from the fire scene, nor do other professional fire service instruction manuals such as Kirk's Fire Investigation or other industry accepted standards.

Several key points of relevant data simply do not exist and is rather subjective given specific incidents, the conditions of the smoke alarms prior to the fire, and varying factual witness statements. NFIRS does not collect information about the specific sensor technology. Few state or local fire authorities have been routinely documenting this information in their investigations of fatal fires or fires where person(s) have been injured. A review of NFPA 921 reveals little or no standardization for examining smoke alarms or other fire protection systems or occupant warning devices as part of post fire origin and cause investigation. Further, fire service personnel are not trained to collect samples of damaged smoke alarms that will be submitted for laboratory analysis. The potential for spoliation (alteration of evidence) exists if proper packaging, storage, and chain of custody are not memorialized in a proper legal format.

NFIRS also does not collect information about the number of smoke alarms, or the proximity of occupants to the smoke alarms. This information may be included in the fire reports narrative section, by either the Fire Company Officer, and/or the Fire Investigator, and will vary by the author of the fire incident report.

It is particularly difficult to characterize smoke alarm or detector performance in NFIRS that are used in habitable single, dual, or in multi-family dwellings. A smoke alarm in the apartment of origin may be disabled, but the smoke detection system in the common areas may operate and alert residents in the rest of the building. It is unclear how such a situation would be described in NFIRS. The Fire Officer could report that the smoke alarm did not operate because the battery had been disconnected or fully removed, or the smoke detector could be documented as having operated effectively, alerting the occupants, even if an occupant in the unit of origin dies in the fire.

There is very little data about fires that are not reported to local fire departments. In their analysis, a CPSC study (R-40) noted that 97% of all home fires were not reported to the fire department. Although the vast majority of households that had fires also had smoke alarms, fire households were less likely than non-fire households to have smoke alarms on all floors, in all bedrooms, or to have interconnected alarms.

In the absence of complete data, the task force must rely on the available data, note its limitations, and attempt to obtain a reasonable working consensus on the remaining questions until such time as the data becomes available.

Human Factors

There are several human factors associated with occupant behavior and capabilities that may limit their ability to escape from a threatening fire in the dwelling even if the smoke alarms present are operating as intended.

Inappropriate Reactions to Alarm Signals

A 2004 Harris Interactive Fire Prevention Week Poll for the NFPA (R-39) asked for people's first thought when their smoke alarm last went off. Only 8% of the respondents initially thought that the sounding smoke alarm signaled a fire and they should get out. This poll did not differentiate between an alarm signal and a low battery signal, but indicates that this is a significant issue which could result in delayed evacuation in hazardous conditions. (R-7)

Additionally, even if alarms activate and notify occupants, they may be incapable of self-evacuation due to intoxication, drug influence, age, and/or disabilities. In some cases, occupants will attempt to fight the fire themselves or rescue others before calling the fire department. They may even leave the burning home and then re-enter later for some reason such as material goods, pets, or other reasons. These factors cause some additional deaths and may contribute to a delay of notification to the fire department via 9-1-1 call.

Occupant Considerations that May Limit the Ability for Response and Self-Rescue

Many human factors related to fire fatalities limit the ability of occupants to escape before untenable conditions are reached. Human factors can affect occupants' ability to react in a timely manner, escape, and react appropriately. Age, use of alcohol or drugs, disabilities, and age-related limitations (e.g. physical disabilities) are all key "factors in the risk of home fire death". (R-6)

For adults, risk increases with age, with adults over 50 years of age being at greatest risk of death when a fire is caused by smoking materials. Adults

65-74 years of age are nearly twice as likely to die as the population as a whole; 75-84 years of age are 2 ½ times as likely, and over 85 years of age, nearly four times as likely to die. Adults over 75 years of age are particularly at risk of not waking to the high pitched frequency of the majority of smoke alarms. Thirty-eight percent of fire deaths are accounted for by totaling adults older than 65 years of age and children younger than five years of age. The percentage jumps to 59% if adults over age 50 years of age are included (2003-2007 annual averages).

Physical disabilities were involved in 13% of fire deaths in total and in 32% of the deaths of those over 85 years of age.

Assessing alcohol or drug use is more difficult and these factors may overlap, but in 12% of all fire fatalities, there was possible alcohol impairment; 6% involved a possible drug or chemical impairment, which could include sleeping aids. Being unsupervised, possibly mentally disabled, or unconscious were factors of less than 5% each for the population of fire fatalities as a whole.

Other Considerations

Many individuals do not fully understand dangers posed by fires in dwelling units, the importance of maintaining operable smoke alarms, and the need to replace smoke alarms when they reach their end of life. These factors are discussed in more detail in the section on Challenges to Smoke Alarms.

California State Law, Regulations and Local Ordinances

State Law and Regulations

California law and regulations covering smoke alarm installations in residential occupancies are included in the California Health and Safety Code, 13113.7 13113.8, 13114, California Code of Regulations Title 19, California Code of Regulations Title 24, the 2010 California Building Code, the 2010 California Fire Code and the 2010 California Residential Code. The regulations covering smoke alarms in homes are almost identical to requirements in the 2009 edition of the International Residential Code, but also require the smoke alarms to be listed by the CSFM.

All smoke alarms shall be listed in accordance with UL 217 and installed in accordance with the provisions of the 2010 California Residential Code and the household fire warning equipment provisions of NFPA 72. Systems and components shall be CSFM approved and listed in accordance with the

California Code of Regulations, Title 19, Division 1 for the purpose for which they are installed.

Health and Safety Code 13113.8 requires that on and after January 1, 1986, every single-family dwelling and factory-built housing, as defined in Section 19971, which is sold shall have an operable battery-operated smoke detector.

The California Building Code, California Fire Code and California Residential Codes require new dwellings to have a single or multiple-station smoke alarm or household fire alarm system regardless of occupant load to be installed on each occupiable level and on the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms and in each room used for sleeping purposes. When more than one smoke alarm is required to be installed within an individual dwelling unit the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual unit. Smoke alarms shall receive their primary power from the building wiring provided that such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms shall emit a signal when the batteries are low. See [Appendix E](#) for the specific regulations.

Current regulations make no specific mention of the type of smoke sensing technology that can be used, but does require new installations to include AC powered units with battery backup and interconnection, in the locations specified in the California Code of Regulations Title 19, California Code of Regulations Title 24, the 2010 California Building Code, the 2010 California Fire Code, the 2010 California Residential Code, and NFPA 72. Smoke alarms installed in existing homes are not required to include primary AC power and interconnection. State regulations also do not require smoke alarms to be replaced after their 10 year rated life has been exceeded.

[California State Law and Regulations for Manufactured Homes](#)

Manufactured homes (includes mobile homes) are single-family dwellings transportable in one or more sections designed and constructed to a federally preemptive standard Health and Safety Code Section 18007. Multi-family manufactured homes are one- or two-family dwellings transportable in one or more sections built to state preemptive regulations Health and Safety Code Section 18008.7.

Unlike conventional site-built homes, special preemptive state and federal laws regulate the design, construction, alteration, sale, and maintenance of manufactured homes and multi-family manufactured homes as administered by the California Department of Housing and Community Development

(HCD), and the United States Department of Housing and Urban Development (HUD). No state, city, county or other local jurisdiction may adopt or impose any standard for the design or construction of a manufactured home or multi-family manufactured home. However, when the HUD standard for manufactured homes is silent on a subject, HCD may with HUD concurrence, adopt construction standards.

Law

- State law governing the HCD Manufactured Housing Program is found in the Health and Safety Code, Division 13, Part 2, commencing with Section 18000.
- Federal law governing manufactured housing built on or after June 15, 1976, is found in Title 42, U.S. Code, Chapter 70, Section 5401.

Regulations

- State regulations are promulgated by HCD. These regulations are contained in the California Code of Regulations, Title 25, Division I, Chapter 3, Subchapter 2, commencing with Section 4000.
- Federal regulations governing manufactured housing are located in Title 24, Code of Federal Regulations beginning with Section 3282.1. Construction standards for manufactured homes manufactured are found in Title 24, Code of Federal Regulations, Chapter XX (roman numeral), Part 3280.

Local Jurisdiction and Ordinances

A few jurisdictions in California have addressed perceived concerns with ionization smoke alarms by adopting ordinances that restrict the use of ionization and dual sensor ion/photo smoke alarms. These local ordinances are based on the concerns of local officials that alarms with ionization sensors are 4 to 5 times more likely to be disconnected due to cooking nuisance alarms, and that ionization-only alarms may not provide adequate warning of fires with an extended initial smoldering phase. A few other jurisdictions have addressed concerns by requiring that both ionization and photoelectric detection technology be required in dwelling units.

The trend of inconsistent local adoptions of more restrictive smoke alarm requirements may accelerate if no changes are made to current State requirements. The task force is also concerned that technology specific ordinances may have the unintended consequence of limiting new technology. The task force has evaluated the basis for the reasons for the development of these ordinances. This information has been considered in the proposed recommendations for statewide regulations in this report.

Research, Standards and Code Considerations

During the past several years a significant amount of research, codes and standards development work has been undertaken to address many of the issues related to smoke detection, smoke development and occupant response issues. In particular NIST, NFPA, and UL have been involved in some significant efforts as noted below. These efforts are providing the scientific basis for changes to improve occupant survivability in dwelling unit fires. Some of the more significant efforts are noted below.

National Fire Protection Association (NFPA)

During the revision cycle for the 2010 of NFPA 72 Technical Committee on Single- and Multiple-Station Alarms and Household Fire Alarm Systems (SIG-HOU)(Chapter 29) formed several Task Groups (TG) to review and evaluate the available technical information relating to the effectiveness of smoke detection technology. The TG studied both responsiveness and resistance to nuisance alarms. The full TG report, NFPA TG on Smoke Detection Follow-up Report – July 1, 2009, and the earlier TG report on smoke detection issued on February 28, 2008, are available on the NFPA website. (R-9, R-10)

The TGs concluded that neither photoelectric nor ionization detection technology offered an advantage when the type of fire was not known. Therefore, they did not recommend requiring or prohibiting any specific technology. This conclusion was based in part on a review of Available Safe Egress Times (ASET) for a variety of scenarios more conservative than stipulated in the assumptions governing NFPA 72 committee work (i.e. following an indirect path of egress). Minority opinions were also attached to the first report which listed specific points of disagreement with the majority opinion.

They also concluded the primary source of nuisance alarms was related to cooking activities. Steam from bathroom activities was also a source for nuisance alarms but to a more limited extent. Nuisance alarms caused by cooking activities occur more frequently with ionization technology than with photoelectric technology. However nuisance alarms from either technology are likely if the smoke alarm or smoke detector is placed too close to the cooking appliance.

For these reasons section 29.8.3.4(4) of the 2010 edition of NFPA 72 was revised to indicate that smoke alarms and smoke detectors are not to be installed within 10 feet from a stationary or fixed cooking appliance, unless listed for installation in close proximity to cooking appliances. In addition smoke alarms and smoke detectors installed between 10 and 20 feet from a

stationary or fixed cooking appliance must be equipped with an alarm-silencing means or use photoelectric detection. An exception to these requirements allows smoke alarms or smoke detectors that use photoelectric detection to be installed between 6 and 10 feet from any stationary or fixed cooking appliance when the kitchen or cooking area and adjacent spaces have no clear interior partitions or headers and the 10 foot area of exclusion would prohibit the placement of a smoke alarm or smoke detector required by other sections of the code. In many small living spaces, it may not be possible to place a smoke alarm 20 feet from the cooking appliance. There are several diagrams in the annex of NFPA 72 that illustrate these requirements.

The new smoke detection installation requirements in NFPA 72, Section 29.8.3.4(4) are very timely and important because in 2010 the State of California adopted NFPA 72-2010 with an effective date of January 1, 2011. However, these installation requirements have not been transcribed directly into California regulations, therefore, designers and code enforcers must have a copy of the 2010 edition of NFPA 72 available to have access to these installation requirements.

NFPA 72 has entered a revision cycle to create the 2013 edition. During the Report on Proposals meeting in January 2011 the SIG-HOU (Chapter 29) Technical Committee accepted in principle a proposal to minimize the nuisance alarm problem by applying more robust smoke detection performance test protocols. The committee amended the proposal to require that, effective January 1, 2016 all smoke alarms and smoke detectors must be listed for resistance to common nuisance sources including cooking. The Technical Committee formed a TG to develop a set of specific quantifiable and repeatable tests and performance levels.

[Underwriters Laboratories \(UL\)](#)

The UL Standards Technical Panel (STP) for UL 217 has formed a task group to investigate the feasibility of developing a performance test protocol for smoke alarms designed to be less susceptible to cooking nuisance alarms and possibly add a new dust test requirement. The task group is using the ongoing work and future full-scale testing from NIST to measure the alarm response for several cooking scenarios on an electric range/oven. One potential outcome of this research might be to use an aerosol generator to reproduce the cooking aerosol size distribution and concentrations, making the test easier to replicate reliably. This research should be completed by the fall of 2011.

In 2006, UL in conjunction with the NFPA Fire Protection Research Foundation (FPRF) undertook a fundamental investigation into combustion products generated by natural and synthetic materials common to residential settings. Resulting smoke and gases were characterized for both flaming and non-flaming (pyrolysis and smoldering) conditions. The UL- FPRF Smoke Characterization Project study (R-19) produced the following key findings:

- Synthetic materials ignite faster, burn more intensely and create greater amounts of smoke and other types of gases than natural materials.
- The response time of photoelectric and ionization smoke alarms was influenced by different smoke particle sizes and counts due to changes in the combustion mode (flaming versus non-flaming).
- Commercially available ionization smoke alarms triggered earlier than commercially available photoelectric smoke alarms for flaming and high energy non-flaming (toaster) fires.
- Photoelectric alarms triggered earlier for lower energy non-flaming fires.
- Smoke from low energy non-flaming fires was found to stratify with time.

One of the significant findings of the UL-FPRF Smoke Characterization Project was the difference in characteristics of smoke generated by polyurethane foam versus that of the materials used to assess smoke alarm performance in UL 217. The prevalence of polyurethane foam in residential upholstered furniture and mattresses are the two leading causes of fire deaths and injuries. (R-41) The noted physical difference in the generated smoke and potential subsequent impact on detection lead the UL 217 Standards Technical Panel (STP) to inaugurate a task group charged with development of flaming and smoldering polyurethane foam tests. Led by UL, the New Foam Test Task Group has completed a detailed study on how various density foams, sample sizes and ignition scenarios affect smoke build-up rate and particle size. This task group is now on the last phase of the project finalizing repeatable, consistent test protocols in preparation for submission to the technical panel.

Most recently, UL investigated smoke alarms in a modern, two-story open floor plan residence to evaluate the response rate of different smoke detection technologies and assess the benefits of having alarms in multiple locations. This data is currently being analyzed and a detailed project report will be made publically available later in 2011.

Enforcement Considerations

In contrast to commercial occupancies, building and fire officials do not typically have the authority to enter private dwelling units to perform periodic inspections to verify that smoke alarms are properly located, maintained, tested and replaced. In fact the only time they are specifically authorized to inspect the smoke alarms is during initial construction, and when permits are issued to accommodate renovations. It is therefore the responsibility of the home owner to verify that the smoke alarms are operational, and are properly located, maintained, tested and replaced as required.

California regulations require that once a home is built the smoke alarms will continue to comply with the requirements in place when the building was permitted. Furthermore, Health and Safety Code Section 13113.8 requires that an operable smoke detector (alarm) be provided when a home is sold. After final inspection and occupancy, code officials are unable to enter homes to verify that the original smoke alarm installation (or even a single smoke alarm) is present and operational.

Realtors are the only parties that have a realistic opportunity to verify the Health and Safety Code requirements are met when homes are sold. Landlords have an opportunity to verify that working smoke alarms are provided when a dwelling unit is rented, even though this is not specifically required in current California law. Some realtors and landlords utilize checklists and disclosure forms to verify that dwellings comply with specific safety criteria when they are sold or leased. These checklists may require that all smoke alarms present be operational, or may simply require that a single smoke alarm be present and operational. The checklists may or may not cover other important considerations such as expired smoke alarms, smoke alarms in improper locations, and alarms not being interconnected.

Education and Messaging

Many homeowners are not aware of the danger their families face due to fire in their home; the protection provided by smoke alarms; and how to maximize this protection. In addition they may be unaware of the need to periodically test and maintain their smoke alarms, and replace old units that have reached their useful (ten year) end of life. This lack of education or unawareness of the requirements may result in one or more of their smoke alarms not being operational. Also, education on the safety issues related to smoke alarms is not always provided to the public, building and fire officials, realtors, landlords and/or other stakeholders.

One means of assisting homeowners who are unaware of what is needed to maintain their smoke alarms in working condition is via public education efforts of the local fire and building departments. However the safety messaging provided to homeowners may only focus on items such as changing batteries periodically, or advising the proper locations of smoke alarms. It may not adequately stress other important considerations, such as not locating smoke alarms near cooking appliances and bathrooms, replacing smoke alarms more than 10 years old, advantages of interconnection, how to use alarm silencing features, and strategically locating smoke alarms throughout the home. In addition providing information so they better understand the danger that fires in modern residences pose to them and their children may put the importance of these measures in perspective and of higher priority.

Observations and Conclusions

Based on a review of the data provided, some of the more significant observations and conclusions that supported the task force recommendations are as follows:

1. Cooking is the leading cause of nuisance alarms. Ionization and photoelectric type detectors are both sensitive to cooking aerosols, and several studies have shown that ionization type detectors installed too close to a cooking appliance have a higher frequency of nuisance alarms than photoelectric type detectors.
2. Studies suggest that photoelectric and ionization smoke alarms located in proximity to kitchens are disabled by occupants due to annoying unwanted alarms, and that a higher percentage of ionization alarms are disabled. Requirements included in the 2010 edition of NFPA 72 addressed this concern, and include distinct location requirements for both alarm sensing technology used in the vicinity of cooking appliances.
3. Users may disable smoke alarms that produce frequent unwanted alarms or low battery signals. This is reflected in a study in which 54% of the smoke alarms present in reported home fires had missing or disconnected batteries. (R-7)
4. A study (R-7) showed 19% of the smoke alarms present in reported home fires had dead or discharged batteries. Most of these probably were smoke alarms with replaceable batteries that should provide a

minimum of one year of operation without battery replacement. It is likely that a much higher percentage of these smoke alarms would have been operational if they included ten year batteries.

5. Alarm silencing features are an optional feature in UL 217, and allow users the ability to silence unwanted alarm signals, as compared to removing power to the unit. However, some users may not be aware that alarm silencing (hush) features are provided, may not be able to discern product markings or be able to activate the feature due to its location on or near the ceiling. It is also not known if this feature will prevent occupants from removing batteries or the entire alarm if repeated unwanted activations occur.
6. The use of synthetic materials in modern furnishings has produced fuel packages in homes that have been shown to reduce, in some fire scenarios, available escape times from 17 minutes to 3 minutes. Fast detection of these types of fires is critical to ensure occupants have the best possible chance of escaping safely from the fire.
7. Fire test data shows that ionization alarms can provide two or more minutes of escape time than photoelectric alarms for flaming fires that can reach untenable conditions quickly. (R-35)
8. There was considerable discussion about the dangers of smoldering fires, including those with "aged" smoke that is not lifted to detectors on the ceiling because of the absence of an energetic fire plume from the smoldering source. It was recognized that some fires can smolder for an extended amount of time, and that photoelectric detection may sound an alarm sooner than ionization if the smoke reaches the alarm.
9. Dual sensor smoke alarms incorporating both ionization and photoelectric sensors may provide slightly faster responses to fast flaming and smoldering fires, and be a more desirable level of protection.
10. The task force concluded that any of the currently available listed smoke alarm technologies provide an acceptable level of protection, regardless of the sensing technology, if they are properly located, installed and maintained. However it is recognized that there are certain instances where the nature of the fire scenario in a home, or incapacitation or condition of the occupants may limit the chance of escaping safely from the fire.

11. Having a single smoke alarm in most existing homes does not provide an acceptable level of protection, especially when needed to respond to both fast burning and smoldering fires.
12. Different detection technology in use save countless lives every year, and those saved lives go unnoticed by many due to a lack of reporting by the media and a lack of knowledge by first responders. No evidence has been provided that the ability or sensitivity of any detection technology is directly related to fire deaths. Additional human factors play a role in fatal fires where smoke alarms do operate. Such human factors include cognitive and physical disabilities, intoxication, limitations due to age (young and old), and lack of pre-planning for reaction to fire alarms. Research is currently advancing the alarm reporting to better address the diversity of human response to alarms based on age and some hearing disabilities.
13. Physical disabilities, age considerations and drug and alcohol use may limit occupants' ability to respond or affect self-rescue when alarm signals sound. Public education can increase the appropriate reaction to smoke alarms, but may not be able to totally address these problems.
14. The task force is opposed to any regulations or requirements that would inhibit improvements to existing smoke alarm technology or prevent the introduction of new sensor and smoke alarm technology.
15. Smoke alarms cannot last forever and should be replaced when they fail to respond to operability tests or no longer than ten years from the date of manufacture, as described in product markings. Users may not be aware that they should replace old units at their marked end-of-life, nor is this required under current State regulations. Smoke detectors listed as complying with UL 268 are not required to be replaced after 10 years.
16. Building and fire officials can usually only enforce smoke alarm requirements when homes are first built, or in some cases when a permit is required for a significant remodel. They have no authority to enter homes at other times to verify that smoke alarms are being maintained and replaced at end of life.
17. Some realtors and landlords often include checklists and disclosure forms to verify that homes comply with specific safety and other requirements when they are sold or leased. Currently, these only include a requirement that at least one smoke alarm be installed and operational.

18. Interconnected smoke alarms increase the likelihood that occupants sleeping in a location remote from the origin of a fire will hear the smoke alarm signal and be able to escape safely in the event of a fire.
19. Educating citizens, building officials, fire officials, realtors and landlords on smoke alarm safety considerations will help them understand some key safety considerations that they may not currently know or understand. Messaging should include information on proper locations for smoke alarms, technology, end-of-life considerations, interconnection, alarm silencing, and the dangers of fires associated with modern furnishings.
20. There is a lack of data points collected regarding performance and history of smoke alarms associated with fatal residential fires. A review of NFPA 921 reveals little or no standardization of approach to examining smoke alarm effectiveness as part of post fire origin and cause investigation, so even the few data points collected are subject to individual bias and inconsistent collection. In addition CFIRS and NFIRS reporting forms do not include fields that can be used to better capture smoke alarm related data from actual fires. As a result, there remain a considerable number of unknowns in regards to the effectiveness of smoke alarms that better data could resolve.

Consensus on Recommendations

The task force worked effectively to compile this report and for the most part agreed on the content, with some exceptions. The task force agreed to ensure that any recommendations provided to the State Fire Marshal would represent a strong consensus of the voting members. Therefore the members required that each recommendation obtain a 2/3 majority vote. All recommendations received task force consensus.

Recommendations

In order to address concerns wherein occupants are more likely to be able to successfully escape in the event of a fire - the task force submits the recommendations below to be considered. While they capture the intent of the task force, we recognize that ultimate execution of each may require changes in regulations, codes, standards, and even legislation. As a result, it is expected additional work will be needed to develop enforceable language and precise definitions of terms.

Regulations and Legislation

1. The 2010 NFPA 72 requirements for smoke alarm placement in section 29.8.3.4(4) should be adopted directly into California Regulations by transcription. This should reduce the number of nuisance alarms produced due to the location of smoke alarms in proximity to cooking appliances and bathrooms. By transcribing the requirements directly into regulations it also allows building and fire officials who do not have access to a copy of NFPA 72 to better understand where smoke alarms should not be installed.
2. Legislation should be introduced to require smoke alarms in existing residential occupancies that are being sold, leased or rented to new tenants or owners to be provided with smoke alarms in accordance with current California Code of Regulations Title 24 Parts 2 and 2.5 for locations of smoke alarms. The smoke alarms should bear a manufacturer's marking confirming they are less than ten years old. Smoke alarms may be either AC powered with battery backup or be powered by a long life primary battery. Smoke detectors listed as complying with UL 268 are exempt from the long life primary battery requirement.
3. Regulations should be developed to minimize unwanted alarms that prohibit the installation of a smoke alarm with conventional ionization technology within 20 feet of a fixed cooking appliance. The effective date of such regulations should be within the next feasible rule making cycle.
4. Regulations should be adopted that require smoke alarms and smoke detectors to be replaced when they fail to respond to operability tests or no longer than ten years from the date of manufacture marked on the product. Smoke detectors listed as complying with UL 268 are not required to be replaced after 10 years.
5. Regulations should be adopted that require smoke alarms to be provided in all required locations when homes are sold, and that the alarms include a manufacturer's date of manufacture marking that is less than ten years old. Smoke detectors listed as complying with UL 268 are not required to be replaced after 10 years.
6. Regulations should be revised to require conventional ionization smoke alarms that are solely battery powered to be packaged and sold with a ten year battery and have a silence feature. This will address problems with occupants disabling smoke alarms to silence low battery signals, or

not replacing smoke alarms with dead batteries. UL 268 listed smoke detectors should be exempt from any such requirement. (The task force members understand that specific exceptions may be necessary).

Other Organizations

7. The State Fire Marshal should submit proposals to the UL 217 STP committee that are intended to reduce nuisance alarms near cooking appliances as follows:
 - Revise UL 217, Section 93 to require a point-of-sale consumer cautionary statement on the exterior of the carton on the new smoke detection location requirements within 20 feet of cooking appliances allowed by section 29.8.3.4(4) of NFPA 72-2010.
 - Revise UL 217, Section 94 installation instruction requirements to include the new smoke detection location requirements within 20 feet of cooking appliances allowed by section 29.8.3.4(4) of NFPA 72-2010. The statement should be in minimum 3/32 inch high letters on a contrasting background.
 - Revise UL 217 to require a packing sheet, separate from the installation instructions, to be placed inside the point-of-sale carton that provides a consumer cautionary statement about the new smoke detection location requirements within 20 feet of a cooking appliance allowed by section 29.8.3.4(4) of NFPA 72-2010 in order to reduce unwanted alarms. The consumer cautionary statement shall be the first thing a consumer sees when the carton is opened and the text shall be in three languages.

The State Fire Marshal should monitor the status of the above STP proposals to see if the issue is satisfactorily resolved. If within one year progress has not been made to address the concerns raised, the State Fire Marshal should consider implementing State regulations to implement the above referenced packaging requirements.

8. The State Fire Marshal should submit a recommendation to the NFPA 72 Chapter 29 Technical Committee and the NFPA Fire Protection Research Foundation to conduct a research project to determine the effectiveness of the alarm silencing (hush) feature in reducing the disablement, by occupants, of ionization smoke alarms within 20 feet of a fixed cooking appliance.
9. Monitor the ongoing development of UL 217, UL 268 and NFPA 72 in order to be aware of the latest developments and adopt more current revisions or requirements as required to address problems and

concerns. Active participation, by the Office of the State Fire Marshal as a member of the “public” and/or the committee in the proposal and comment process is highly recommended, including the current NFPA 72 code cycle (comment closing August 30, 2011).

10. Propose changes to CFIRS and NFIRS reporting forms to better capture smoke alarm related data from actual fires. In addition propose similar changes to NFPA 921, and NFPA 72 under a new appendix section formatted for damaged smoke alarm recognition. Encourage all fire suppression personnel and fire investigators, to document: sensor type, alarm location, interconnection, damage differential of the device, and victim(s) proximity to smoke alarms. This information would be included in all fire investigation reports in regards to home fires with fatalities or serious injuries. In addition, certification standards for fire investigators should be improved to include better collection of data regarding the presence and performance of smoke alarms in dwelling unit fires that involve the loss of life or serious injury to the occupant(s).
11. The State Fire Marshal should draft a letter to manufacturers urging them to provide additional consumer information on packaging, installation instructions and on a package insert that provides the following clarification:
 - Heat detectors can be used to provide additional protection in locations where smoke alarms may not be acceptable such as kitchens, furnace rooms and garages.
 - That packaging of smoke alarms should not have the word “Kitchen” displayed prominently on the packaging in a manner that may lead consumers to believe that the device should be installed in a kitchen.
 - That the installation of a smoke alarm with conventional ionization technology is not recommended within 20 feet of a fixed cooking appliance.

Additionally, the letter should urge a brochure and/or poster for display at point-of-sale which provides the information above and a graphic floor plan layout indicating the appropriate device for specific locations in the home. This letter should emphasize that while these actions would be voluntary, that such actions are in the best interest of public safety and should improve public perception of their products.

Education and Messaging

12. The State Fire Marshal should work with public safety educators and industry stakeholders to expand the scope of their safety message to cover issues likely to increase the effectiveness of smoke alarms. Messaging recommendations should be made to the NFPA Educational Messaging Advisory Committee, which is a multi-organizational committee, and other groups such as the Vision 20/20 Strategy 2 Workgroup relating to working smoke alarms. This will include messages to:

- Not locate smoke alarms near cooking appliances and bathrooms
- Replace smoke alarms more than 10 years old
- Understand and use alarm silencing features
- Understand the advantages of interconnected units
- Better understand the danger that fires in modern residences pose to residents and their children

The State Fire Marshal should encourage public safety educators to work with industry stakeholders to produce smoke alarm safety videos, public service announcements and other educational materials to assist in distribution of their messages.

13. New training programs and materials should be provided to fire officials and building officials so they better understand the key safety issues included in this report and can therefore better protect and serve the citizens in their communities. Among other things this will include messages to:

- Not locate smoke alarms near cooking appliances and bathrooms
- Replace smoke alarms more than 10 years old
- Understand the use of alarm silencing features
- Understand the advantages of interconnected units
- Understand smoke detection technology, operation and considerations
- Gain better knowledge of the danger that fires in modern residences pose to occupants

This knowledge will help them in both their code enforcement and public education efforts, and may be included in existing state fire training. Since building officials are typically responsible for the enforcement of smoke alarm installations in Group R occupancies, the State Fire Marshal should reach out to California building officials and California building official associations to provide them with support and

educational materials so they can more effectively enforce smoke alarm installation requirements, and provide safety information to the home owners after installation.

14. Outreach should be provided to landlord and realtor associations so they may better understand State regulations and safety practices related to smoke alarms. Among other things this will include messages to:
 - Ensure smoke alarms are installed in all required locations
 - If necessary, relocate smoke alarms installed near cooking appliances and bathrooms
 - Replace smoke alarms that are more than 10 years old
 - Better understand smoke alarm silencing features, interconnection and detection technologies
 - Know where to obtain State Fire Marshal approved smoke alarm safety considerations

This will increase the likelihood that older homes sold or leased to new owners/tenants will be equipped with working smoke alarms that are operational and installed in required locations.

15. The State Fire Marshal should develop an information bulletin on smoke alarm safety considerations and post in a reproducible format and distributed by landlords, realtors, retailers and other interested parties. In addition landlords and realtors should be encouraged to provide the State Fire Marshal information bulletin on smoke alarm safety considerations to the new tenants or owners. This will address problems with obsolete or inoperable units in older occupancies. It is recognized that landlords and realtors will most likely enforce these requirements as part of their standard operating procedures once the regulations are adopted and understood.

[Future Stakeholder Interactions](#)

16. Form new smoke alarm working groups to assist in the implementation of the actions the State Fire Marshal may determine to pursue as a result of this report and recommendations. Partner with key stakeholders to help achieve common public safety goals and objectives.

**CSFM Smoke Alarm Task Force
Members List**

<u>MEMBER</u>	<u>ORGANIZATION</u>	<u>EMAIL</u>
Andres, John*	Kidde Safety*	john.andres@kiddeus.com
Bizal, Ray	NFPA	rbizal@NFPA.org
Cimini, Kevin	Housing & Community Development	kcimini@hcd.ca.gov
Clary, Shane	Bay Alarm Company	Shane.Clary@bayalarm.com
Edon, Jim*	CA Automatic Fire Alarm Assn*	exsapper@gmail.com
Fabian, Tom	Underwriters Laboratories Inc.	Thomas.Fabian@us.ul.com
Fleming, Jay	Boston Fire Department (withdrew from task force 6/7/2011)	jfireeng@gmail.com
Gantt, Gene	Cal State Firefighters' Assn Inc	genegantt@comcast.net
Gifford, Wendy	Codes, Standards, Legislative & Regulatory Affairs Consultant	wendy@wendygifford.com
Grijalva, Ruben	Former CSFM	calfire@gmail.com
Hopper, Howard*	Underwriters Laboratories Inc*	Howard.D.Hopper@us.ul.com
Iverson, Ray	Nor Cal Fire Prevention Officers	riverson@ci.benicia.ca.us
Latz, Bob*	CALBO*	Bobl@csgengr.com
Levy, Jay	CA Automatic Fire Alarm Assn	jlevy@hochiki.com
McGinn, Marc	Albany Fire Department	MmcGinn@albanyca.org
McNelis, Tom	BRK Brands Inc	TMcNelis@jardensafety.com
Owen, Sarah*	National Electrical Mfrs Assn*	sarah.owen@nema.org
Palisi, James	League of Cities	jpalisi@redwoodcity.org
Power, Jessica*	Nor Cal Fire Prevention Officers*	jpower@tiburonfire.org
Quick, Ken	So Cal Fire Prevention Officers	kenneth.quick@culvercity.org
Ratzlaff, Larry	Kidde Safety	larry.ratzlaff@kiddeus.com
Renfro, Richard	CALBO	rrenfro@elkgrovecity.org
Roberts, Richard	National Electrical Mfrs Assn	Richard.roberts@systemsensor.com
Sakamoto, Vickie	CAL FIRE – OSFM	Vickie.Sakamoto@fire.ca.gov
Sekany, Randy	CA Professional Firefighters	president@siff.org
Simpkinson, Gordon*	Palo Alto Fire Department*	gordon.simpkinson@cityofpaloalto.org
Williams, Doug*	California Fire Chiefs Assn*	dwilliams@rvfire.org
Yahnke, Morgana	California Fire Chiefs Assn	myahnke@fairfield.ca.gov

*Alternates

**Smoke Alarm Task Force
Sub-Groups**

Define "Nuisance Alarms"	Statistics and Human Factors
Gene Gantt Wendy Gifford Jim Palisi Larry Ratzlaff Richard Roberts	Ray Bizal Jay Fleming Wendy Gifford Howard Hopper* Jessica Power* Gordon Simpkinson* Tom Sri
Adequate # of Alarms / Placement	The Importance of Smoke Alarm
Bob Latz* Ken Quick Richard Renfro Jim Palisi Morgana Yahnke	Ray Bizal Jay Fleming Richard Roberts Morgana Yahnke
Smoke Alarm Technology	Related Standard & Code Considerations
Shane Clary Ray Iverson Jay Levy	Tom Fabian Wendy Gifford Larry Ratzlaff Richard Roberts
California State Regulations	
Kevin Cimini Ben Ho** Kevin Reinertson** Vickie Sakamoto	

* Alternates
** OSFM Staff

Referenced Documents

The referenced documents that the task force selected to use as a basis for their work are included below. These are limited current research, testing, published reports, codes, standards and regulations. These documents are limited to current applicable subjects that are directly related to U.S. codes, standards and research.

R-1 Fatal Fires (US Fire Administration / NFDC; Topical Fire research Series, Volume 5 – Issue 1, March 2005)
<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-1%20Fatal%20Fires%20-%20US%20Fire%20Administration-%20NFDC%20-%202005.pdf>

R-2 Fatal Fires in Residential Buildings (US Fire Administration / NFDC; Topical Fire research Series, Volume 11 – Issue 2, August 2010)
[http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-2%20Fatal%20Fires%20in%20Residential%20Bldgs%20\(2010%20for%20CA\).pdf](http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-2%20Fatal%20Fires%20in%20Residential%20Bldgs%20(2010%20for%20CA).pdf)

R-3 Ionization and photoelectric smoke alarms in rural Alaskan homes (West J Med. 2000 August; 173(2): 89–92. (Thomas M Fazzini, Ron Perkins, and David Grossman August 2000)
<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-3%20Ionization%20and%20photoelectric%20smoke%20alarms%20in%20rural%20Alaskan%20homes%20-%202000%20Original%20Research.pdf>

R-4 Massachusetts Board of Fire Prevention Regulations, October 7, 2010 Minutes
<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-4%20Massachusetts%20Bd%20of%20Fire%20Prevention%20Regulations%20October%207,%202010%20Minutes.pdf>

R-5 Massachusetts Joint Building Code and Fire Code Smoke Alarm Subcommittee; Summary of conclusions and Recommendations (December 6, 2007)
<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-5%20MA%20Bldg%20Code-Fire%20Code%20Smoke%20Alarm%20Subcommitte%20Summary%20Conclusions-Recommendations.pdf>

R-6 NFPA Characteristics of Home Fire Victims – Jennifer Flynn
(March 2010)

<http://www.nfpa.org/assets/files/PDF/OS.HomeVictims.pdf>

R-7 NFPA Smoke Alarms in U.S. Home Fires - Marty Ahrens
(September 2009)

<http://www.nfpa.org/assets/files/PDF/OS.SmokeAlarms.pdf>

R-8 NFPA Smoke Alarm Presence and Performance in U.S. Home Fires -
Marty Ahrens (October 2010)

http://www.nfpa.org/assets/files//PDF/Research/Smoke_Alarm_Presence_and_Performance_in_U.S.pdf

R-9 NFPA Task Group on Smoke Detection Follow-up Report (July 2009)

<http://www.nfpa.org/assets/files//PDF/Research/FinalReportTaskGroupSmokeDetectionFollowUp.pdf>

R-10 NFPA Task Group Report – Minimum Performance Requirements for
Smoke Alarm Detection Technology (February 2008)

<http://www.nfpa.org/assets/files//PDF/Research/DetectionTechnologyTaskForce0208.pdf>

R-11 Performance of Dual Photoelectric/Ionization Smoke Alarms in Full-
Scale Fire Tests – Thomas Cleary (February 2009)

<http://fire.nist.gov/bfrlpubs/fire09/PDF/f09006.pdf>

R-12 Residential Nuisance Source Characteristics for Smoke Alarm Testing –
Thomas G. Cleary (2004)

<http://www.fire.nist.gov/bfrlpubs/fire04/art043.html>

R-13 Response-Time Comparison of Ionization and Photoelectric/Heat
Detectors (2001 AUBE Conference; J.R. Qualey III, L. Desmarais, J. Pratt;
Simplex Time Recorder Co.)

[http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-13%20Response-Time%20Comparisons%20of%20Ion%20and%20Photo-Heat%20Detectors%20\(Simplex\)AUBE%202001.pdf](http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-13%20Response-Time%20Comparisons%20of%20Ion%20and%20Photo-Heat%20Detectors%20(Simplex)AUBE%202001.pdf)

R-14 Results from a Full-Scale Smoke Alarm Sensitivity Study – Thomas
Cleary (2009) <http://www.springerlink.com/content/862642k663255617/>

R-15 Smoke Alarm Response and Tenability

(2009 AUBE Conference; Christopher L. Mealy, Andrew Wolfe, Daniel T. Gottuk; Hughes Associates, Inc. Baltimore, MD)

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-15%20Smoke%20Alarm%20Response%20and%20Tenability%20-%202009%20AUBE%20Conference.pdf>

R-16 Smoke Alarm Response and Tenability: Estimation Guidelines and Tenability Issues – Part 1 (Christopher Mealy & Daniel Gottuk) (2009)

http://www.nfpa.org/assets/files//2009%20proceedings/Smoke_Alarm_Response-Estimation_Guidelines_and_Tenability_I.pdf

R-17 Smoke Alarm Response: Estimation Guidelines and Tenability Issues – Part 2 (Christopher L. Mealy, Andrew Wolfe, Daniel T. Gottuk; Hughes Associates, Inc. Baltimore, MD)

R-18 Smoke Alarms – Pilot Study of Nuisance Alarms Associated with Cooking – Arthur Lee (March 2010)

<http://www.cpsc.gov/library/foia/foia10/os/smokealarm.pdf>

R-19 The UL/Fire Protection Research Foundation Smoke Characterization Project (April 2007)

<http://www.nfpa.org/assets/files/PDF/research/SmokeCharacterization.pdf>

R-20 Vermont Legislation (2008) – An Act relating to requiring the installation of Photoelectric-only-type smoke detectors

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-20%20Vermont%202008%20Legislative%20Bill.pdf>

R-22 City of Sebastopol 2010 CFC Adoption

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-22%20Sebastopol%20CFC%20Adoption%20chpt%209.PDF>

R-23 Performance of Home Smoke Alarms

Analysis of the Response of Several Available Technologies in Residential Fire Settings; by Bukowski, Peacock, Averill, Cleary, Bryner, Walton, Reneke and Kuligowski. (NIST Technical Note 1455-1; February 2008 Revision)

http://smokealarm.nist.gov/pdf_files/NIST_TN_1455-1_Feb2008.pdf

R-24 City of Palo Alto Ordinance No. 5104

(To adopt 2009 Edition of the International Fire Code)

<http://www.cityofpaloalto.org/civica/inc/displayblobpdf2.asp?BlobID=25766>

R-25 City of Albany Ordinance No. 2010-06

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-25%20City%20of%20Albany%20Ordinance%20No.%202010-06.pdf>

R-26 2010 NFPA 72: National Fire Alarm and Signaling Code

www.nfpa.org/72

(scroll to heading "View the document online (read only)" and click on link.

R-27 An Evaluation of Fire Detectors for Residential Placement

(Los Angeles City Fire Department, Fire Prevention Bureau, August 1981)

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-27%20An%20Evaluation%20of%20Fire%20Detectors%20for%20Residential%20Placement.pdf>

R-28 Smoke Detector Nuisance Alarms: A Field Study in a Native American Community – 1996

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-28%201996%20Smoke%20Detector%20Nuisance%20Alarms%20Field%20Study%20in%20a%20Native%20American%20Community.pdf>

R-29 When Smoke Alarms are a Nuisance (August 2001)

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-29%20When%20smoke%20alarms%20are%20a%20nuisance.pdf>

R-30 RSET/ASET, A Flawed Concept for Fire Safety Assessment

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-30%20RSET-%20ASET,%20a%20Flawed%20Concept%20for%20Fire%20Safety%20Assessment.pdf>

R-31 2009 International Residential Code (IRC) DRAFT

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-31%20DRAFT%202009%20Int%20Residential%20Code.pdf>

R-32 2010 California Residential Code (CRC)

<http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-32%202010%20CA%20Residential%20Code.pdf>

R-33 Q&A Clarifying NIST Home Smoke Alarm Study (February 2008)

http://www.nist.gov/el/fire_protection/buildings/upload/SmokeDetectors_Q-As_Feb2008.pdf

R-34 Randomized Controlled Trial of Ionization and Photoelectric Smoke Alarm Functionality (Washington Study - B A Mueller, E A Sidman, et al, 2002) <http://injuryprevention.bmj.com/content/14/2/80.full.pdf>

R-35 Performance of Home Smoke Alarms Analysis of the Response of Several Available Technologies in Residential Fire Settings (Dunes II) Richard W. Bukowski et al (January 2007) <http://www.fire.nist.gov/bfrlpubs/fire09/PDF/f09016.pdf>

R-36 - December 2007 Revision to Indiana Dunes II Study Report <http://fire.nist.gov/bfrlpubs/fire07/PDF/f07063.pdf>

R-37 January 2008 Revision to Indiana Dunes II Study Report http://www.nist.gov/el/fire_protection/buildings/upload/NIST_TN_1455-1_Feb2008.pdf

R-38 Large-Scale Laboratory Tests of Smoke Detectors (Indiana Dunes I), Richard Bukowski (1975) <http://www.fire.nist.gov/bfrlpubs/fire75/PDF/f75010.pdf>

R-39 Unwanted Fire Alarms - NFPA April 2011 (Summarizes the April 2010 NFPA Harris Poll) <http://www.nfpa.org/assets/files/PDF/OS.UnwantedAlarms.pdf>

R-40 National Sample Survey of Unreported Residential Fires, (2009) the Consumer Product Safety Commission's (CPSC's) Michael A. Greene and Craig Andres (2004-2005) [http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-40%20CPSC%20-%202004-2005%20National%20Sample%20Survey%20of%20Unreported%20Residential%20Fires%20\(2\).pdf](http://osfm.fire.ca.gov/firelifesafety/pdf/Smoke%20Alarm%20Task%20Force/R-40%20CPSC%20-%202004-2005%20National%20Sample%20Survey%20of%20Unreported%20Residential%20Fires%20(2).pdf)

R-41 Home Structure Fires, NFPA Fire Analysis and Research Division, M. Ahrens (March 2010) <http://www.nfpa.org/assets/files/pdf/os.homes.pdf>

Smoke Alarm Technology

This Appendix provides additional information on smoke detection technologies and their ability to detect various types of smoke particulate.

Ionization alarms use a small amount of americium to ionize air creating an electrical flow between electrical plates. Smoke particles interfere with the ionization process reducing the electrical current between the plates. Ionization technology is linearly sensitive to the number of particles and equally sensitive to small and large particles; it is not sensitive to the color of smoke.

Most photoelectric alarms operate by detecting light scattered by smoke particles. Because particles must reflect light to be detected; light scattering is more sensitive to lighter colored particles than darker particles and larger particles than smaller particles. Thus small, dark particles and particles too small to be seen by eye, i.e. invisible particles, are challenging to be detected by light scattering.

Some photoelectric alarms are designed to respond to smoke particles obscuring light transmission. Such alarms are also more sensitive to larger particles than smaller particles but are less susceptible to smoke particle color than scattering-based alarms. Smoke alarms of either detection technology (ionization or photoelectric) activate when the set threshold is exceeded.

The “quality” of smoke (particle size, color, and concentration) depends on the mode of combustion, the chemistry and configuration of fuel as well as the amount of fuel involved. Some smoke particles (depending on the fuel source) will aggregate over time to form larger particles. (R-19)

“Flaming combustion tends to create smaller mean particle sizes than non-flaming combustion. This is primarily due to the more efficient conversion of high molecular weight polymers to low molecular weight combustion products and ultimately CO, CO₂ and H₂O instead of organic by-products and soot.” (R-19)

Smoke formed by combustion of some materials such as polyurethane foam has been observed to increase in particle size (aggregate) with concentration/time. This may play a role in alarm response to burning upholstered furniture and mattresses when the alarm is located remote from the burning fuel. (R-19)

Ion detectors as stated within the literature work best with flaming fires or fires that produce light smoke.

Photoelectric smoke alarms are affected by particles of smoke that are suspended in the air. There are two varieties of photoelectric detectors, light obscuration and light scattering.

Detectors which operate on the light obscuration principle consist of a light source, light beam collimating system and a photosensitive detector. As the products of combustion enter the sensing chamber, the level of smoke will start to obscure the path of light from the light source to the detector. The light source is principally a pulse Infrared Red (IR) beam. When the obscuration level reaches a predetermined point, the detector will go into an alarm state. This method may also be found within projected beam detectors.

The light scattering principle is similar to the light obscuration method, with the exception that instead of the path of light going directly between the source and the detector, the light source and detector are directed to a darkened portion of the sensing chamber. When the products of combustion enter the chamber, the light from the source illuminates the particles which are within. The detector senses the reflection of light off of the particles. When this scattered light reaches a set level, the detector goes into an alarm state. The detector is usually a photodiode or a phototransistor. The light source generally has been an infrared light-emitting diode (LED). There has been a shift with some units to now use a laser beam within the detector.

Related California Law and Regulations

2010 CALIFORNIA BUILDING AND FIRE CODE, CCR, TITLE 24, PART 2 AND PART 9 SECTION 907 FIRE ALARM AND DETECTION SYSTEMS

907.2.8 Group R-1. Fire alarm systems and smoke alarms shall be installed in Group R-1 occupancies as required in Sections 907.2.8.1 through 907.2.8.3.

907.2.8.1 Manual fire alarm system. A manual fire alarm system that activates the occupant notification system in accordance with Section 907.6 shall be installed in Group R-1 occupancies.

Exceptions:

1. A manual fire alarm system is not required in buildings not more than two stories in height where all individual *sleeping units* and contiguous attic and crawl spaces to those units are separated from each other and public or common areas by at least 1-hour *fire partitions* and each individual *sleeping unit* has an *exit* directly to a *public way*, *exit court* or yard.
2. Manual fire alarm boxes are not required throughout the building when the following conditions are met:
 - 2.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2;
 - 2.2. The notification appliances will activate upon sprinkler water flow; and
 - 2.3. At least one manual fire alarm box is installed at an *approved* location.

907.2.8.2 Automatic smoke detection system. An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.6 shall be installed throughout all interior *corridors* serving *sleeping units*.

Exception: An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* and where each *sleeping unit* has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an *exit*.

907.2.8.3 Smoke alarms. Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

907.2.9 Group R-2 and R-2.1. Fire alarm systems and smoke alarms shall be installed in Group R-2 and R-2.1 occupancies as required in Section 907.2.9.1 and 907.9.3.

907.2.9.1 Manual fire alarm system. A manual fire alarm system that activates the occupant notification system in accordance with Section 907.6 shall be installed in Group R-2 occupancies where:

1. Any *dwelling unit* or *sleeping unit* is located three or more stories above the lowest *level of exit discharge*;
2. Any *dwelling unit* or *sleeping unit* is located more than one story below the highest *level of exit discharge* of *exits* serving the *dwelling unit* or *sleeping unit*; or
3. The building contains more than 16 *dwelling units* or *sleeping units*.
4. *Congregate living facilities* or *congregate residences* with more than 16 occupants.

Exceptions:

1. A fire alarm system is not required in buildings not more than two stories in height where all *dwelling units* or *sleeping units* and contiguous attic and crawl spaces are separated from each other and public or common areas by at least 1-hour *fire partitions* and each *dwelling unit* or *sleeping unit* has an *exit* directly to a *public way*, *exit court* or yard.
2. Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and the occupant notification appliances will automatically activate throughout the notification zones upon a sprinkler water flow.
3. A fire alarm system is not required in buildings that do not have interior *corridors* serving *dwelling units* and are protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, provided that *dwelling units* either have a *means of egress* door opening directly to an exterior *exit access* that leads directly to the *exits* or are served by open-ended *corridors* designed in accordance with Section 1026.6, Exception 4.

907.2.9.2 Smoke alarms. Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

907.2.9.3 Licensed Group R-2.1 occupancies. Licensed Group R-2.1 occupancies housing more than six non-ambulatory, elderly clients shall be provided with an approved manual and automatic fire alarm system.

Exceptions: Buildings housing non-ambulatory clients on the first story only and which are protected throughout by the following:

1. An approved and supervised automatic sprinkler system, as specified in Sections 903.3.1.1 or 903.3.1.2, which upon activation will initiate the fire alarm system to notify all occupants.
2. A manual fire alarm system.
3. Smoke alarms required by Section 907.2.11.

907.2.10 Group R-4. Fire alarm systems and smoke alarms shall be installed in Group R-4 occupancies as required in Sections 907.2.10.1 through 907.2.10.3.

907.2.10.1 Manual fire alarm system. A manual fire alarm system that activates the occupant notification system in accordance with Section 907.6 shall be installed in Group R-4 occupancies.

Exceptions:

1. A manual fire alarm system is not required in buildings not more than two stories in height where all individual *sleeping units* and contiguous attic and crawl spaces to those units are separated from each other and public or common areas by at least 1-hour *fire partitions* and each individual *sleeping unit* has an *exit* directly to a *public way*, *exit court* or yard.
2. Manual fire alarm boxes are not required throughout the building when the following conditions are met:
 - 2.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2;
 - 2.2. The notification appliances will activate upon sprinkler water flow; and
 - 2.3. At least one manual fire alarm box is installed at an *approved* location.
3. Manual fire alarm boxes in resident or patient sleeping areas shall not be required at *exits* where located at all nurses' control stations or other constantly attended staff locations, provided such stations are visible and continuously accessible and that travel distances required in Section 907.5.2.1 are not exceeded.

907.2.10.2 Automatic smoke detection system. An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.6 shall be installed in *corridors*, waiting areas open to *corridors* and *habitable spaces* other than *sleeping units* and kitchens.

Exceptions:

1. Smoke detection in *habitable spaces* is not required where the facility is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* and where each *sleeping unit* has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an exit.

907.2.10.3 Smoke alarms. Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

907.2.11 Single- and multiple-station smoke alarms. Listed single- and multiple-station smoke alarms complying with UL 217 shall be installed in accordance with Sections 907.2.11.1 through 907.2.11.4 and NFPA 72.

Exception: For Group R occupancies. A fire alarm system with smoke detectors located in accordance with this section may be installed in lieu of smoke alarms. Upon actuation of the detector, only those notification appliances in the dwelling unit or guest room where the detector is actuated shall activate.

907.2.11.1 Group R-1. Single- or multiple-station smoke alarms shall be installed in all of the following locations in Group R-1:

1. In sleeping areas.
2. In every room in the path of the *means of egress* from the sleeping area to the door leading from the *sleeping unit*.
3. In each story within the *sleeping unit*, including *basements*. For *sleeping units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

907.2.11.2 Groups R-2, R-2.1, R-3, R-3.1 and R-4. Single or multiple-station smoke alarms shall be installed and maintained in Groups R-2, R-2.1, R-3, R-3.1 and R-4 regardless of *occupant load* at all of the following locations:

1. On the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms.
2. In each room used for sleeping purposes.

Exception: Single- or multiple-station smoke alarms in Group I-1 shall not be required where smoke detectors are provided in the sleeping rooms as part of an automatic smoke detection system.

3. In each story within a *dwelling unit*, including *basements* but not including crawl spaces and uninhabitable attics. In *dwellings* or *dwelling units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

4. In a Group R-3.1 occupancy, in addition to the above, smoke alarms shall be provided throughout the habitable areas of the *dwelling unit* except *kitchens*.

907.2.11.2.1 Group I-4 Occupancies. Large family day-care homes shall be equipped with State Fire Marshal approved and listed single station residential type smoke alarms.

907.2.11.2.2 Group R-3.1. In all facilities housing a bedridden client, smoke alarms shall receive their primary power from the building wiring when such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms shall be electrically interconnected so as to cause all smoke alarms to sound a distinctive alarm signal upon actuation of any single smoke alarm. Such alarm signal shall be audible throughout the facility at a minimal level of 15 db above ambient noise level. These devices need not be interconnected to any other fire alarm device, have a control panel, or be electrically supervised or provided with emergency power.

907.2.11.3 Interconnection. Where more than one smoke alarm is required to be installed within an individual *dwelling unit* or *sleeping unit* in Group R-1, R-2, R-3, R-3.1 or R-4, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

907.2.11.4 Power source. In new construction and in newly classified Group R-3.1 occupancies, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery back-up shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

Exception: Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system.

907.2.11.5 Existing Group R-3 Occupancies. See the California Residential Code or Chapter 46 of the California Fire Code.

2010 CALIFORNIA FIRE CODE, CCR, TITLE 24, PART 9 SECTION 4603 – FIRE SAFETY REQUIREMENTS FOR EXISTING BUILDINGS

4603.6.5 Group R-1.A fire alarm system and smoke alarms shall be installed in existing Group R-1 occupancies in accordance with Sections 4603.6.5.1 through 4603.6.5.2.1.

4603.6.5.1 Group R-1 hotel and motel manual fire alarm system. A manual fire alarm system that activates the occupant notification system in accordance with Section 907.6 shall be installed in existing Group R-1 hotels and motels more than three stories or with more than 20 *sleeping units*.

Exceptions:

1. Buildings less than two stories in height where all *sleeping units*, attics and crawl spaces are separated by 1-hour fire-resistance-rated construction and each *sleeping unit* has direct access to a *public way*, *exit court* or yard.
2. Manual fire alarm boxes are not required throughout the building when the following conditions are met:
 - 2.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2;
 - 2.2. The notification appliances will activate upon sprinkler water flow; and
 - 2.3. At least one manual fire alarm box is installed at an *approved* location.

4603.6.5.1.1 Group R-1 hotel and motel automatic smoke detection system. An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.6 shall be installed in existing Group R-1 hotels and motels throughout all interior *corridors* serving sleeping rooms not equipped with an *approved*, supervised sprinkler system installed in accordance with Section 903.

Exception: An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* and where each sleeping unit has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an *exit*.

4603.6.5.2 Group R-1 boarding and rooming houses manual fire alarm system. A manual fire alarm system that activates the occupant notification system in accordance with Section 907.6 shall be installed in existing Group R-1 boarding and rooming houses.

Exception: Buildings less than two stories in height where all *sleeping units*, attics and crawl spaces are separated by 1-hour fire-resistance-rated construction and each *sleeping unit* has direct access to a *public way*, *exit court* or yard.

4603.6.5.2.1 Group R-1 boarding and rooming houses automatic smoke detection system. An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.6 shall be installed in existing Group R-1 boarding and rooming houses throughout all interior *corridors* serving *sleeping units* not equipped with an *approved*, supervised sprinkler system installed in accordance with Section 903.

Exception: Buildings equipped with single-station smoke alarms meeting or exceeding the requirements of Section 907.2.11.1 and where the fire alarm system includes at least one manual fire alarm box per floor arranged to initiate the alarm.

4603.6.6 Group R-2. An automatic or manual fire alarm system that activates the occupant notification system in accordance with Section 907.6 shall be installed in existing Group R-2 occupancies more than three stories in height or with more than 16 *dwelling* or *sleeping units*.

Exceptions:

1. Where each living unit is separated from other contiguous living units by *fire barriers* having a *fire-resistance rating* of not less than 0.75 hour, and where each living unit has either its own independent *exit* or its own independent stairway or ramp discharging at grade.
2. A separate fire alarm system is not required in buildings that are equipped throughout with an *approved* supervised *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and having a local alarm to notify all occupants.
3. A fire alarm system is not required in buildings that do not have interior *corridors* serving *dwelling units* and are protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, provided that *dwelling units* either have a *means of egress* door opening directly to an exterior *exit access* that leads directly to the *exits* or are served by open-ended *corridors* designed in accordance with Section 1023.6, Exception 4.

4603.6.7 Group R-4. An automatic or manual fire alarm system that activates the occupant notification system in accordance with Section 907.6 shall be installed in existing Group R-4 residential care/assisted living facilities in accordance with Section 907.2.10.

Exceptions:

1. Where there are interconnected smoke alarms meeting the requirements of Section 907.2.11 and there is at least one manual fire alarm box per floor arranged to continuously sound the smoke alarms.
2. Other manually activated, continuously sounding alarms *approved* by the *fire code official*.

4603.6.8 Existing Group R 1 and Group R 2 High-rise. Notwithstanding the provisions of Section 3412.23 of the California Building Code, every existing high-rise building used for the housing of a Group R-1 or Group R-2 Occupancies shall have installed therein a fire alarm system conforming to this subsection.

4603.6.8.1 General. Every apartment house and every hotel shall have installed therein an automatic or manually operated fire alarm system. Such fire alarm systems shall be so designed that all occupants of the building may be warned simultaneously.

4603.6.8.2 Installation. The installation of all fire alarm equipment shall be in accordance with this Code.

4603.6.9 Existing high-rise buildings.

4603.6.9.1 Fire alarm system. Every existing high-rise building shall be provided with an approved fire alarm system. In department stores, retail sales stores and similar occupancies where the general public is admitted, such systems shall be of a type capable of alerting staff and employees. In office buildings and all other high-rise buildings, such systems shall be of a type capable of alerting all occupants simultaneously.

Exceptions:

1. In areas of public assemblage, the type and location of audible appliances shall be as determined by the enforcing agency.
2. When acceptable to the enforcing agency, the occupant voice notification system required by California Building Code Section 3412.21 may be used in lieu of the fire alarm system.

4603.6.9.2 Existing systems. Existing fire alarm systems, when acceptable to the enforcing agency, shall be deemed as conforming to the provisions of these regulations.

4603.6.9.3 Annunciation. When a new fire alarm system is installed, it shall be connected to an annunciator panel installed in a location approved by the enforcing agency. For purposes of annunciation, zoning shall be in accordance with Section 907.7.3.1.

4603.6.9.4 Monitoring. Shall be in accordance with section 907.7.5.

4603.6.9.5 Systems Interconnection. When an automatic fire detection system or automatic extinguishing system is installed, activation of such system shall cause the sounding of the fire alarm notification appliances at locations designated by the enforcing agency.

4603.6.9.6 Manual fire alarm boxes. A manual fire alarm box shall be provided in the locations designated by the enforcing agency. Such locations shall be where boxes are readily accessible and visible and in normal paths of daily travel by occupants of the building.

4603.6.9.7 Emergency voice/alarm communication system. An approved emergency voice/alarm communication system shall be provided in every existing high-rise building which exceeds 150 feet (45720 mm) in height measured in the manner set forth in Section 403 of the California Building Code. Such system shall provide communication from a location available to and designated by the enforcing agency to not less than all public areas.

The emergency voice/alarm communication system may be combined with a fire alarm system provide the combined system has been approved and listed by the State Fire Marshal. The sounding of a fire alarm signal in any given area or floor shall not prohibit voice communication to other areas of floors. Combination systems shall be designed to permit voice transmission to override the fire alarm signal, but the fire alarm signal shall not terminate in less than three minutes.

4603.6.9.8 Fire department system. When it is determined by test that portable fire department communication equipment is ineffective, a communication system acceptable to the enforcing agency shall be installed within the building to permit emergency communication between fire-suppression personnel.

4603.6.9.9 Smoke control systems. Existing air-circulation systems shall be provided with an override switch in a location approved by the enforcing agency which will allow for the manual control of shutdown of the systems.

Exception: Systems which serve only a single floor, or portion thereof, without any penetration by ducts or other means into adjacent floors.

4603.6.9.10 Elevator recall smoke detection. Smoke detection for emergency operation of elevators shall be provided in accordance with Section 907.4.3.

4603.7 Single- and multiple-station smoke alarms. Single and multiple-station smoke alarms shall be installed in existing Group R occupancies and in *dwellings* not classified as Group R occupancies in accordance with Sections 4603.7.1 through 4603.7.3.

4603.7.1 Where required. Existing Group R and Group I-1 occupancies and *dwellings* not classified as Group R occupancies not already provided with single-station smoke alarms shall be provided with single-station smoke alarms. Installation shall be in accordance with Section 907.2.11, except as provided in Sections 4603.7.2 and 4603.7.3.

Exception: See Section 4603.7.5.

4603.7.2 Interconnection. Where more than one smoke alarm is required to be installed within an individual *dwelling* or *sleeping unit*, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

Exceptions:

1. Interconnection is not required in buildings that are not undergoing *alterations*, repairs or construction of any kind.
2. Smoke alarms in existing areas are not required to be interconnected where *alterations* or repairs do not result in the removal of interior wall or ceiling finishes exposing the structure, unless there is an attic, crawl space or *basement* available which could provide access for interconnection without the removal of interior finishes.
3. *Work_involving the exterior surfaces of dwellings, such as the replacement of roofing or siding, or the addition or replacement of windows or doors, or the addition of a porch or deck, are exempt from the requirements of this section.*
4. *Installation, alteration or repairs of plumbing or mechanical systems are exempt from the requirements of this section.*

4603.7.3 Power source. Single-station smoke alarms shall receive their primary power from the building wiring provided that such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery backup shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

Exceptions:

1. Smoke alarms are permitted to be solely battery operated in existing buildings where no construction is taking place.
2. Smoke alarms are permitted to be solely battery operated in buildings that are not served from a commercial power source.
3. Smoke alarms are permitted to be solely battery operated in existing areas of buildings undergoing *alterations* or repairs that do not result in the removal of interior walls or ceiling finishes exposing the structure, unless there is an attic, crawl space or *basement* available which could provide access for building wiring without the removal of interior finishes.
4. *Work_involving the exterior surfaces of dwellings, such as the replacement of roofing or siding, or the addition or replacement of windows or doors, or the addition of a porch or deck, are exempt from the requirements of this section.*
5. *Installation, alteration or repairs of plumbing or mechanical systems are exempt from the requirements of this section.*

4603.7.4 Group R-3.1. *In all facilities housing a bedridden client, smoke alarms shall receive their primary power from the building wiring when such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms shall be electrically interconnected so as to cause all smoke alarms to sound a distinctive alarm signal upon actuation of any single smoke alarm. Such alarm signal shall be audible throughout the facility at a minimal level of 15 db above ambient noise level. These devices need not be interconnected to any other fire alarm device, have a control panel, or be electrically supervised or provided with emergency power.*

4603.7.5 Additional provisions for existing Group R-3 occupancies.

4603.7.5.1 *Existing Buildings housing Group R-3 Occupancies established prior to the effective date of these regulations may have their use continued if they conform or are made to conform to provisions of these regulations to the extent that reasonable and adequate life safety against the hazards of fire, panic and explosion is substantially provided. Additional means of egress, the installation of automatic sprinkler systems, automatic fire alarm system or other life safety measures, may be required to provide reasonable and adequate safety.*

Note: *It is the intent of this sections that every existing occupancy need not mandatorily conform with the requirements for new construction. Reasonable judgment in the application of requirements must be exercised by the enforcing agency.*

4603.7.5.2 *For purposes of clarification, Health and Safety Code section 13113.7 is repeated.*

(a) Except as otherwise provided in this section, a smoke detector, approved and listed by the State Fire Marshal pursuant to Section 13114, shall be installed, in accordance with the manufacturer's instructions in each dwelling intended for human occupancy within the earliest applicable time period as follows:

(1) For all dwelling units intended for human occupancy, upon the owner's application on or after January 1, 1985, for a permit for alterations, repairs, or additions, exceeding one thousand dollars (\$1,000).

(2) For all other dwelling units intended for human occupancy on or after January 1, 1987.

However, if any local rule, regulation, or ordinance, adopted prior to the compliance dates specified in paragraphs (1) and (2) requires installation in a dwelling unit intended for human occupancy of smoke detector, which receive their power from the electrical system of the building and requires compliance with the local rule, regulation, or ordinance at a date subsequent to the dates specified in this section, the compliance date specified in the rule, regulation, or ordinance shall, but only with respect to the dwelling units specified in this section, take precedence over the dates specified in this section.

The State Fire Marshal may adopt regulations exempting dwellings intended for human occupancy with fire sprinkler systems from the provisions of this section, if he or she determines that a smoke detector is not reasonably necessary for fire safety in the occupancy.

Unless prohibited by local rules, regulations, or ordinances, a battery-operated smoke detector which otherwise meets the standards adopted pursuant to Section 13114 for smoke detectors, satisfies the requirements of this section.

(b) "Dwelling units intended for human occupancy," as used in this section, includes a duplex, lodging house, apartment complex, hotel, motel, condominium, stock cooperative, time-share project, or dwelling unit of a multiple-unit dwelling complex. For the purpose of this part, "dwelling units intended for human occupancy" does not include manufactured homes as defined in Section 18007, mobilehomes as defined in Section 18008, and commercial coaches as defined in 18001.8.

(c) The owner of each dwelling unit subject to this section shall supply and install smoke detectors required by this section in the locations and in the manner set forth in the manufacturer's instructions, as approved by the State Fire Marshal's regulations. In the case of apartment complexes and other multiple-dwelling complexes, a smoke detector shall be installed in the common stairwells. All fire alarm warning systems supplemental to the smoke detector shall also be listed by the State Fire Marshal.

(d) A high rise structure, as defined in subdivision (b) of Section 13210 and regulated by Chapter 3 (commencing with Section 13210), and which is used for purposes other than as dwelling units intended for human occupancy, is exempt from the requirements of this section.

(e) The owner shall be responsible for testing and maintaining detectors in hotels, motels, lodging houses, and common stairwells of apartment complexes and other multiple dwelling complexes.

An owner or the owner's agent may enter any dwelling unit, efficiency dwelling unit, guest room, and suite owned by the owner for the purpose of installing, repairing, testing, and maintaining single station smoke detectors required by this section. Except in cases of emergency, the owner or owner's agent shall give the tenants of each such unit, room, or suite reasonable notice in writing of the intention to enter and shall enter only during normal business hours. Twenty-four hours shall be presumed to be reasonable notice in absence of evidence to the contrary.

The smoke detector shall be operable at the time that the tenant takes possession. The apartment complex tenant shall be responsible for notifying the manager or owner if the tenant becomes aware of an inoperable smoke detector within his or her unit. The owner or authorized agent shall correct any reported deficiencies in the smoke detector and shall not be in violation of this section for a deficient smoke detector when he or she has not received notice of the deficiency.

(f) A violation of this section is an infraction punishable by a maximum fine of two hundred dollars (\$200) for each offense.

(g) This section shall not affect any rights which the parties may have under any other provision of law because of the presence or absence of a smoke detector.

(h) This section shall not apply to the installation of smoke detectors in single-family dwellings or factory-built housing which is regulated by Section 13113.8, as added by Assembly Bill No. 2285 of the 1983-84 Regular Session.

4603.7.5.3 For purposes of clarification, Health and Safety Code section 13113.8 is repeated.

(a) On and after January 1, 1986, every single-family dwelling and factory-built housing, as defined in Section 19971, which is sold shall have an operable smoke detector. The detector shall be approved and listed by the State Fire Marshal and installed in accordance with the State Fire Marshal's regulations. Unless prohibited by local rules, regulations, or ordinances, a battery-operated smoke detector shall be deemed to satisfy the requirements of this section.

(b) On and after January 1, 1986, the transferor of any real property containing a single-family dwelling, as described in subdivision (a), whether the transfer is made by sale, exchange, or real property sales contract, as defined in Section 2985 of the Civil Code, shall deliver to the transferee a written statement indicating that the transferor is in compliance with this section. The disclosure statement shall be either included in the receipt for deposit in a real estate transaction, an addendum attached thereto, or a separate document.

(c) The transferor shall deliver the statement referred to in subdivision (b) as soon as practicable before the transfer of title in the case of a sale or exchange, or prior to execution of the contract where the transfer is by a real property sales contract, as defined in Section 2985 or purposes of this subdivision, "delivery" means delivery in person or by mail to the transferee or transferor, or to any person authorized to act for him or her in the transaction, or to additional transferees who have requested delivery from the transferor in writing. Delivery to the spouse of a transferee or transferor shall be deemed delivery to a transferee or transferor, unless the contract states otherwise.

(d) This section does not apply to any of the following:

(1) Transfers which are required to be preceded by the furnishing to a prospective transferee of a copy of a public report pursuant to Section 11018.1 of the Business and Professions Code.

(2) Transfers pursuant to court order, including, but not limited to, transfers ordered by a probate court in the administration of an estate, transfers pursuant to a writ of execution, transfers by a trustee in bankruptcy, transfers by eminent domain, or transfers resulting from a decree for specific performance.

(3) Transfers to a mortgagee by a mortgagor in default, transfers to a beneficiary of a deed of trust by a trustor in default, transfers by any foreclosure sale after default, transfers by any foreclosure sale after default in an obligation secured by a mortgage, or transfers by a sale under a power of sale after a default in an obligation secured by a deed of trust or secured by any other instrument containing a power of sale.

(4) Transfers by a fiduciary in the course of the administration of a decedent's estate, guardianship, conservatorship, or trust.

(5) Transfers from one co-owner to one or more co-owners.

(6) Transfers made to a spouse, or to a person or persons in the lineal line of consanguinity of one or more of the transferors.

(7) Transfers between spouses resulting from a decree of dissolution of a marriage, from a decree of legal separation, or from a property settlement agreement incidental to either of those decrees.

(8) Transfers by the Controller in the course of administering the Unclaimed Property Law provided for in Chapter 7 (commencing with Section 1500) of Title 10 of Part 3 of the Code of Civil Procedure.

(9) Transfers under the provisions of Chapter 7 (commencing with Section 3691) or Chapter 8 (commencing with Section 3771) of Part 6 of Division 1 of the Revenue and Taxation Code.

(e) No liability shall arise, nor any action be brought or maintained against, any agent of any party to a transfer of title, including any person or entity acting in the capacity of an escrow, for any error, inaccuracy, or omission relating to the disclosure required to be made by a transferor pursuant to this section.

However, this subdivision does not apply to a licensee, as defined in Section 10011 of the Business and Professions Code, where the licensee participates in the making of the disclosure required to be made pursuant to this section with actual knowledge of the falsity of the disclosure.

(f) Except as otherwise provided in this section, this section shall not be deemed to create or imply a duty upon a licensee, as defined in Section 10011 of the Business and Professions Code, or upon any agent of any party to a transfer of title, including any person or entity acting in the capacity of an escrow, to monitor or ensure compliance with this section.

(g) No transfer of title shall be invalidated on the basis of a failure to comply with this section, and the exclusive remedy for the failure to comply with this section is an award of actual damages not to exceed one hundred dollars (\$100), exclusive of any court costs and attorney's fees.

(h) Local ordinances requiring smoke detectors in single-family dwellings may be enacted or amended. However, the ordinances shall satisfy the minimum requirements of this section.

(i) For the purposes of this section, "single-family dwelling" does not include a manufactured home as defined in Section 18007, a mobile home as defined in Section 18008, or a commercial coach as defined in Section 18001.8.

(j) This section shall not apply to the installation of smoke detectors in dwellings intended for human occupancy, as defined in and regulated by Section 13113.7 of the Health and Safety Code, as added by Senate Bill No. 1448 in the 1983-84 Regular Session.

2010 CALIFORNIA RESIDENTIAL CODE, CCR, TITLE 24, PART 2.5 SECTION R314 – SMOKE ALARMS

R314.1 Smoke detection and notification. All smoke alarms shall be listed in accordance with UL 217 and installed in accordance with the provisions of this code and the household fire warning *equipment* provisions of NFPA 72. *Systems and components shall be California State Fire Marshal listed and approved in accordance with California Code of Regulations, Title 19, Division 1 for the purpose for which they are installed.*

R314.2 Smoke detection systems. Household fire alarm systems installed in accordance with NFPA 72 that include smoke alarms', or a combination of smoke detector and audible notification device installed as required by this section for smoke alarms, shall be permitted. The household fire alarm system shall provide the same level of smoke detection and alarm as required by this section for smoke alarms. Where a household fire warning system is installed using a combination of smoke detector and audible notification device(s), it shall become a permanent fixture of the occupancy and owned by the homeowner. The system shall be monitored by an *approved* supervising station and be maintained in accordance with NFPA 72.

Exception: Where smoke alarms are provided meeting the requirements of Section R314.4.

R314.3 Location. Smoke alarms shall be installed in the following locations:

1. In each sleeping room.
2. Outside each separate sleeping area in the immediate vicinity of the bedrooms.
3. On each additional story of the *dwelling*, including *basements* and habitable attics but not including crawl spaces and uninhabitable *attics*. In *dwellings* or *dwelling units* with split levels and without an intervening door between the adjacent

levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

When more than one smoke alarm is required to be installed within an individual *dwelling* unit the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual unit.

R314.3.1 Alterations, repairs and additions. When *alterations*, repairs or *additions* requiring a *permit* occur, or when one or more sleeping rooms are added or created in existing *dwellings*, the individual *dwelling unit* shall be equipped with smoke alarms located as required for new *dwellings*.

Exceptions: See Section R314.6.

R314.4 Power source. *Smoke alarms shall receive their primary power from the building wiring provided that such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery backup shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.*

Exceptions:

1. *Smoke alarms are permitted to be solely battery operated in existing buildings where no construction is taking place.*
2. *Smoke alarms are permitted to be solely battery operated in buildings that are not served from a commercial power source.*
3. *Smoke alarms are permitted to be solely battery operated in existing areas of buildings undergoing alterations or repairs that do not result in the removal of interior walls or ceiling finishes exposing the structure, unless there is an attic, crawl space or basement available which could provide access for building wiring without the removal of interior finishes.*
4. *Work_involving the exterior surfaces of dwellings, such as the replacement of roofing or siding, or the addition or replacement of windows or doors, or the addition of a porch or deck, are exempt from the requirements of this section.*
5. *Installation, alteration or repairs of plumbing or mechanical systems are exempt from the requirements of this section.*

R314.5 Interconnection. *Where more than one smoke alarm is required to be installed within an individual dwelling or sleeping unit, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.*

Exceptions:

1. *Interconnection is not required in buildings that are not undergoing alterations, repairs or construction of any kind.*
2. *Smoke alarms in existing areas are not required to be interconnected where alterations or repairs do not result in the removal of interior wall or ceiling finishes exposing the structure, unless there is an attic, crawl space or basement available which could provide access for interconnection without the removal of interior finishes.*
3. *Work_involving the exterior surfaces of dwellings, such as the replacement of roofing or siding, or the addition or replacement of windows or doors, or the addition of a porch or deck, are exempt from the requirements of this section.*
4. *Installation, alteration or repairs of plumbing or mechanical systems are exempt from the requirements of this section.*

R314.6 Existing Group R-3 occupancies.

R314.6.1 *Existing buildings housing Group R-3 occupancies established prior to the effective date of these regulations may have their use continued if they conform or are made to conform to provisions of these regulations to the extent that reasonable and adequate life safety against the hazards of fire, panic and explosion is substantially provided. Additional means of egress, the installation of automatic sprinkler systems, automatic fire alarm system or other life safety measures may be required to provide reasonable and adequate safety.*

Note: *It is the intent of this section that every existing occupancy need not mandatorily conform with the requirements for new construction. Reasonable judgment in the application of requirements must be exercised by the enforcing agency.*

R314.6.2 *For purposes of clarification, Health and Safety Code Section 13113.7 is repeated.*

(a) Except as otherwise provided in this section, a smoke detector, approved and listed by the State Fire Marshal pursuant to Section 13114, shall be installed, in accordance with the manufacturer's instructions in each dwelling intended for human occupancy within the earliest applicable time period as follows:

(1) For all dwelling units intended for human occupancy, upon the owner's application on or after January 1, 1985, for a permit for alterations, repairs, or additions, exceeding one thousand dollars (\$1,000).

(2) For all other dwelling units intended for human occupancy on or after January 1, 1987.

However, if any local rule, regulation, or ordinance, adopted prior to the compliance dates specified in paragraphs (1) and (2) requires installation in a dwelling unit intended for human occupancy of smoke detector, which receive their power from the electrical system of the building and requires compliance with the local rule, regulation, or ordinance at a date subsequent to the dates specified in this section, the compliance date specified in the rule, regulation, or ordinance shall, but only with respect to the dwelling units specified in this section, take precedence over the dates specified in this section.

The State Fire Marshal may adopt regulations exempting dwellings intended for human occupancy with fire sprinkler systems from the provisions of this section, if he or she determines that a smoke detector is not reasonably necessary for fire safety in the occupancy.

Unless prohibited by local rules, regulations, or ordinances, a battery-operated smoke detector which otherwise meets the standards adopted pursuant to Section 13114 for smoke detectors, satisfies the requirements of this section.

(b) "Dwelling units intended for human occupancy," as used in this section, includes a duplex, lodging house, apartment complex, hotel, motel, condominium, stock cooperative, time-share project, or dwelling unit of a multiple-unit dwelling complex. For the purpose of this part, "dwelling units intended for human occupancy" does not include manufactured homes as defined in Section 18007, mobilehomes as defined in Section 18008, and commercial coaches as defined in 18001.8.

(c) The owner of each dwelling unit subject to this section shall supply and install smoke detectors required by this section in the locations and in the manner set forth in the manufacturer's instructions, as approved by the State Fire Marshal's regulations. In the case of apartment complexes and other multiple-dwelling complexes, a smoke detector shall be installed in the common stairwells. All fire alarm warning systems supplemental to the smoke detector shall also be listed by the State Fire Marshal.

(d) A high rise structure, as defined in subdivision (b) of Section 13210 and regulated by Chapter 3 (commencing with Section 13210), and which is used for purposes other than as dwelling units intended for human occupancy, is exempt from the requirements of this section.

(e) The owner shall be responsible for testing and maintaining detectors in hotels, motels, lodging houses, and common stairwells of apartment complexes and other multiple dwelling complexes.

An owner or the owner's agent may enter any dwelling unit, efficiency dwelling unit, guest room, and suite owned by the owner for the purpose of installing, repairing, testing, and maintaining single station smoke detectors required by this section. Except in cases of emergency, the owner or owner's agent shall give the tenants of each such unit, room, or suite reasonable notice in writing of the intention to enter and shall enter only during normal business hours. Twenty-four hours shall be presumed to be reasonable notice in absence of evidence to the contrary.

The smoke detector shall be operable at the time that the tenant takes possession. The apartment complex tenant shall be responsible for notifying the manager or owner if the tenant becomes aware of an inoperable smoke detector within his or her unit. The owner or authorized agent shall correct any reported deficiencies in the smoke detector and shall not be in violation of this section for a deficient smoke detector when he or she has not received notice of the deficiency.

(f) A violation of this section is an infraction punishable by a maximum fine of two hundred dollars (\$200) for each offense.

(g) This section shall not affect any rights which the parties may have under any other provision of law because of the presence or absence of a smoke detector.

(h) This section shall not apply to the installation of smoke detectors in single-family dwellings or factory-built housing which is regulated by Section 13113.8, as added by Assembly Bill No. 2285 of the 1983-84 Regular Session.

R314.6.3 For purposes of clarification, Health and Safety Code Section 13113.8 is repeated.

(a) On and after January 1, 1986, every single-family dwelling and factory-built housing, as defined in Section 19971, which is sold shall have an operable smoke detector. The detector shall be approved and listed by the State Fire Marshal and installed in accordance with the State Fire Marshal's regulations. Unless prohibited by local rules, regulations, or ordinances, a battery-operated smoke detector shall be deemed to satisfy the requirements of this section.

(b) On and after January 1, 1986, the transferor of any real property containing a single-family dwelling, as described in subdivision (a), whether the transfer is made by sale, exchange, or real property sales contract, as defined in Section 2985 of the Civil Code, shall deliver to the transferee a written statement indicating that the transferor is in compliance with this section. The disclosure statement shall be either included in the receipt for deposit in a real estate transaction, an addendum attached thereto, or a separate document.

(c) The transferor shall deliver the statement referred to in subdivision (b) as soon as practicable before the transfer of title in the case of a sale or exchange, or prior to execution of the contract where the transfer is by a real property sales contract, as defined in Section 2985 or purposes of this subdivision, "delivery" means delivery in person or by mail to the transferee or transferor, or to any person authorized to act for him or her in the transaction, or to additional transferees who have requested delivery from the transferor in writing. Delivery to the spouse of a transferee or transferor shall be deemed delivery to a transferee or transferor, unless the contract states otherwise.

(d) This section does not apply to any of the following:

(1) Transfers which are required to be preceded by the furnishing to a prospective transferee of a copy of a public report pursuant to Section 11018.1 of the Business and Professions Code.

(2) Transfers pursuant to court order, including, but not limited to, transfers ordered by a probate court in the administration of an estate, transfers pursuant to a writ of execution, transfers by a trustee in bankruptcy, transfers by eminent domain, or transfers resulting from a decree for specific performance.

(3) Transfers to a mortgagee by a mortgagor in default, transfers to a beneficiary of a deed of trust by a trustor in default, transfers by any foreclosure sale after default, transfers by any foreclosure sale after default in an obligation secured by a mortgage, or transfers by a sale under a power of sale after a default in an obligation secured by a deed of trust or secured by any other instrument containing a power of sale.

(4) Transfers by a fiduciary in the course of the administration of a decedent's estate, guardianship, conservatorship, or trust.

(5) Transfers from one co-owner to one or more co-owners.

(6) Transfers made to a spouse, or to a person or persons in the lineal line of consanguinity of one or more of the transferors.

(7) Transfers between spouses resulting from a decree of dissolution of a marriage, from a decree of legal separation, or from a property settlement agreement incidental to either of those decrees.

(8) Transfers by the Controller in the course of administering the Unclaimed Property Law provided for in Chapter 7 (commencing with Section 1500) of Title 10 of Part 3 of the Code of Civil Procedure.

(9) Transfers under the provisions of Chapter 7 (commencing with Section 3691) or Chapter 8 (commencing with Section 3771) of Part 6 of Division 1 of the Revenue and Taxation Code.

(e) No liability shall arise, nor any action be brought or maintained against, any agent of any party to a transfer of title, including any person or entity acting in the capacity of an escrow, for any error, inaccuracy, or omission relating to the disclosure required to be made by a transferor pursuant to this section.

However, this subdivision does not apply to a licensee, as defined in Section 10011 of the Business and Professions Code, where the licensee participates in the making of the disclosure required to be made pursuant to this section with actual knowledge of the falsity of the disclosure.

(f) Except as otherwise provided in this section, this section shall not be deemed to create or imply a duty upon a licensee, as defined in Section 10011 of the Business and Professions Code, or upon any agent of any party to a transfer of title, including any person or entity acting in the capacity of an escrow, to monitor or ensure compliance with this section.

(g) No transfer of title shall be invalidated on the basis of a failure to comply with this section, and the exclusive remedy for the failure to comply with this section is an award of actual damages not to exceed one hundred dollars (\$100), exclusive of any court costs and attorney's fees.

(h) Local ordinances requiring smoke detectors in single-family dwellings may be enacted or amended. However, the ordinances shall satisfy the minimum requirements of this section.

(i) For the purposes of this section, "single-family dwelling" does not include a manufactured home as defined in Section 18007, a mobile home as defined in Section 18008, or a commercial coach as defined in Section 18001.8.

(j) This section shall not apply to the installation of smoke detectors in dwellings intended for human occupancy, as defined in and regulated by Section 13113.7 of the Health and Safety Code, as added by Senate Bill No. 1448 in the 1983-84 Regular Session.

ADOPTED REFERENCE STANDARDS:

NFPA 72–2010 EDITION – NATIONAL FIRE ALARM CODE AS AMENDED BY THE CALIFORNIA STATE FIRE MARSHAL

Amended Sections as follows:

10.3.1 Equipment constructed and installed in conformity with this Code shall be listed for the purpose for which it is used. *Fire alarm Systems and components shall be California State Fire Marshal approved and listed in accordance with California Code of Regulations, Title 19, Division 1.*

10.3.3 All devices and appliances that receive their power from the initiating device circuit or signaling line circuit of a control unit shall be *California State Fire Marshal* listed for use with the control unit.

10.6.1 *Where approved by the authority having jurisdiction*, ECS priority signals when evaluated by stakeholders through risk analysis in accordance with 24.4.2.2 shall be permitted to take precedence over all other signals.

14.4.7.1 Testing. Household fire alarm systems shall be tested *in accordance with the manufacturer's published instructions* according to the methods of Table 14.4.2.2.

17.15 Fire Extinguisher Monitoring Device. A fire extinguisher monitoring device shall indicate those conditions for a specific fire extinguisher required by *California Code of Regulations, Title 19, Division 1, Chapter 1, Section 574.2 (c)* and *California Fire Code* to a fire alarm control unit.

23.4.2.2(4) Where the vertically run conductors are contained in a 2-hour rated cable assembly, or enclosed (installed) in a 2-hour rated enclosure or a listed circuit integrity (C.I.) cable, which meets or exceeds a 2-hour fire resistive rating.

23.8.5.1.2 Where connected to a supervising station, fire alarm systems employing automatic fire detectors or waterflow detection devices shall include a manual fire alarm box to initiate a signal to the supervising station.

Exception: Fire alarm systems dedicated to elevator recall control, supervisory service *and fire sprinkler monitoring*.

23.8.5.4.1 Systems equipped with alarm verification features shall be permitted under the following conditions:

(1) The alarm verification feature is not initially enabled unless conditions or occupant activities that are expected to cause nuisance alarms are anticipated in the area that is protected by the smoke detectors. Enabling of the alarm verification feature shall be protected by password or limited access.

(2) A smoke detector that is continuously subjected to a smoke concentration above alarm threshold does not delay the system functions of Sections 10.6 through 10.13, 23.8.1.1, or 21.2.1 by more than 30 seconds.

(3) Actuation of an alarm-initiating device other than a smoke detector causes the system functions of 4.4.3, 6.8.1.1, or 6.16.2.1 without additional delay.

(4) The current status of the alarm verification feature is shown on the record of completion (*see Figure 4.5.2.1, item 10*).

(5) *Operation of a patient room smoke detector in I-2 and R-2.1 Occupancies shall not include an alarm verification feature.*

29.3.1 All devices, combinations of devices, and equipment to be installed in conformity with this chapter shall be approved or listed *by the California State Fire Marshal* for the purposes for which they are intended.

29.5.2.1.1* Smoke and Heat Alarms. Unless exempted by applicable laws, codes, or standards, smoke or heat alarms used to provide a fire-warning function, and when two or more alarms are installed within a dwelling unit, suite of rooms, or similar area, shall be arranged so that the operation of any smoke or heat alarm causes all alarms within these locations to sound.

29.7.2.1 *The alarm verification feature shall not be used for household fire warning equipment.*

29.7.5.7.1 *The alarm verification feature shall not be used for household fire warning equipment.*

UL 217–2006 EDITION – SINGLE AND MULTIPLE STATION SMOKE ALARMS
WITH REVISIONS THROUGH MAY 2007

UL 268–2006 – SMOKE DETECTORS FOR FIRE PROTECTIVE SIGNALING SYSTEMS
WITH REVISIONS THROUGH JANUARY 1999

Manufactured Housing
Smoke Alarm Requirements
Federal Preemptive Standards

Code of Federal Regulations
Title 24 – Housing and Urban Development
Part 3280 – Manufactured Home Construction and Safety Standards

§ 3280.208. Smoke alarm requirements.

(a) Labeling. Each smoke alarm required under paragraph (b) of this section must conform with the requirements of UL 217, Single and Multiple Station Smoke Alarms, dated January 4, 1999 (incorporated by reference, see § 3280.4), or UL 268,

Smoke Detectors for Fire Protective Signaling Systems, dated January 4, 1999 (incorporated by reference, see § 3280.4), and must bear a label to evidence conformance.

(b) Required smoke alarm locations. (1) At least one smoke alarm must be installed in each of the following locations:

(i) To protect both the living area and kitchen space. Manufacturers are encouraged to locate the alarm in the living area remote from the kitchen and cooking appliances. A smoke alarm located within 20 feet horizontally of a cooking appliance must incorporate a temporary silencing feature or be of a photoelectric type.

(ii) In each room designed for sleeping.

(iii) On the ceiling of the upper level near the top or above each stairway, other than a basement stairway, in any multistory home completed in accordance with this part or part 3282 of this chapter. The alarm must be located so that smoke rising in the stairway cannot be prevented from reaching the alarm by an intervening door or obstruction.

(2) For each home designed to be placed over a basement, the manufacturer must provide a smoke alarm for the basement and must install at the factory an electrical junction box for the installation of this smoke alarm and for its interconnection to other smoke alarms required by this section. The instructions for installers and information for homeowners required in paragraph (f) of this section must clearly indicate that a smoke alarm should be installed and is to be located on the basement ceiling near the stairway.

(3) A smoke alarm required under this section must not be placed in a location that impairs its effectiveness or in any of the following locations:

(i) Within 3 feet horizontally from any discharge grille when a home is equipped or designed for future installation of a roof-mounted evaporative cooler or other equipment discharging conditioned air through a ceiling grille into the living space; and

(ii) In any location or environment that is prohibited by the terms of its listing, except as permitted by this section.

(c) Mounting requirements. (1) Except in rooms with peaked sloping or shed sloping ceilings with a slope of more than 1.5/12 or as permitted pursuant to paragraph (e) of this section, smoke alarms must be mounted either:

(i) On the ceiling at least 4 inches from each wall; or

(ii) On a wall with the top of the alarm not less than 4 inches below the ceiling, and not farther from the ceiling than 12 inches or the distance from the ceiling specified in the smoke alarm manufacturer's listing and instructions, whichever is less.

(2) Except as permitted pursuant to paragraph (e) of this section, in rooms with peaked sloping ceilings with a slope of more than 1.5/12, smoke alarms must be mounted on the ceiling within 3 feet, measured horizontally, from the peak of the ceiling; at least 4 inches, measured vertically, below the peak of the ceiling; and at least 4 inches from any projecting structural element.

(3) Except as permitted pursuant to paragraph (e) of this section, in rooms with shed sloping ceilings with a slope of more than 1.5/12, smoke alarms must be mounted on the ceiling within 3 feet, measured horizontally, of the high side of the ceiling, and not closer than 4 inches from any adjoining wall surface and from any projecting structural element.

(d) Connection to power source. (1) Each smoke alarm must be powered from:

(i) The electrical system of the home as the primary power source and a battery as a secondary power source; or

(ii) A battery rated for a 10-year life, provided the smoke alarm is listed for use with a 10-year battery.

(2) Each smoke alarm whose primary power source is the home electrical system must be mounted on an electrical outlet box and connected by a permanent wiring method to a general electrical circuit. More than one smoke alarm is permitted to be placed on the same electrical circuit. The wiring circuit for the alarm must not include any switches between the over-current protective device and the alarm, and must not be protected by a ground fault circuit interrupter.

(3) Smoke alarms required under this section must be interconnected such that the activation of any one smoke alarm causes the alarm to be triggered in all required smoke alarms in the home.

(e) Visible and tactile notification appliances. (1) In addition to the smoke alarms required pursuant to this section, the manufacturer must provide visible and listed tactile notification appliances if these appliances are ordered by the purchaser or retailer before the home enters the first stage of production. These appliances are required to operate from the primary power source, but are not required to operate from a secondary power source.

(2) A visible notification appliance in a room designed for sleeping must have a minimum rating of 177 candela, except that when the visible notification appliance is wall-mounted or suspended more than 24 inches below the ceiling, a minimum rating of 110 candela is permitted.

(3) A visible notification appliance in an area other than a room designed for sleeping must have a minimum rating of 15 candela.

(f) Testing and maintenance. (1) Each required smoke alarm installed at the factory must be operationally tested, after conducting the dielectric test specified in § 3280.810(a), in accordance with the alarm manufacturer's instructions. A smoke alarm that does not function as designed during the test and is not fixed so that it functions properly in the next retest must be replaced. Any replacement smoke alarm must be successfully tested in accordance with this paragraph.

(2) Home manufacturers must provide specific written instructions for installers on how to inspect and test the operation of smoke alarms during installation of the home. These instructions must indicate that any smoke alarm that does not meet the inspection or testing requirements needs to be replaced and retested.

(3) Home manufacturers must provide the homeowner with the alarm manufacturer's information describing the operation, method and frequency of testing, and proper maintenance of the smoke alarm. This information must be provided in same manner and location as the consumer manual required by § 3282.207 of this chapter, but does not have to be incorporated into the consumer manual. No dealer, distributor, construction contractor, or other person shall interfere with the distribution of this information