

Regulation & Law

Product Safety

CPSC Report Calls for More Research On Deficiencies in Smoke Alarm Audibility

Current models of smoke detectors do not reliably awaken children under 16 years of age or senior citizens, who are hard of hearing, according to a Consumer Product Safety Commission report released Jan. 11, and the CPSC staff recommended conducting more research on possible technical solutions for these deficiencies.

According to the report, "A Review of the Sound Effectiveness of Smoke Alarms," in 2003, the CPSC initiated a project to review the audibility effectiveness of residential smoke alarms for the older population. The scope of the project was broadened to address recent concerns that children may not wake to the sound of a smoke alarm. The CPSC staff estimates that in 1999 there were 337,300 unintentional residential structure fires resulting in 2,390 civilian deaths, 14,550 civilian injuries, and \$4.24 billion in property losses. The National Fire Protection Association (NFPA) reports that, during the 24-year period from 1977 to 2001, home fires and home fire deaths dropped 49 percent and 47 percent, respectively, excluding events from September 11, 2001. In 2001, four of every five fire deaths occurred in home structure fires, excluding 9/11, according to NFPA.

Population Growing Older

An estimated 35 million people in the United States were 65 years old or older in 2000, or almost 13 percent of the population. In 2010, the "baby boom" generation will begin to turn 65. As more of the baby boomers become 65 and older, the number of people over the age of 65 is expected to double by the year 2030, growing to 70 million. The number of people over the age of 65 will have increased to 20 percent of the population, or one in five people in the United States, by 2030.

The NFPA reports for 1999 that the fire death rate for people over 65 is 25.3 fire deaths per million, or more than twice the national average. The fire death rate increases for older age groups. For example, for those over the age of 75, the fire death rate (32.9 fire deaths per million) is about three times the national average.

The NFPA also reports for 1999 that preschool children (under age 5) accounted for a disproportionate number of fire deaths in homes. Preschool children had a fire death rate of 19.9 fire deaths per million, or roughly twice the national average (10.5). The number of fire deaths involving preschool children has been on the decline. NFPA attributes the declining number of fire deaths to the CPSC regulation requiring child-resistant cigarette lighters, which became effective in 1994. NFPA reported that, if this trend continues, preschool children may no longer be a high-risk age group.

Conclusions Presented

The CPSC report presents a literature review of the sound effectiveness of residential smoke alarms in waking sleeping children and in producing audible signals suitable for older adults. Among the conclusions presented in the report are:

Current smoke alarms are effective in waking most adults with normal hearing who are

not under the influence of drugs, alcohol, or sleep deprivation. Current smoke alarms do not reliably wake people under the influence of drugs, alcohol, or sleep deprivation. Current smoke alarms may not reliably notify or alert seniors with hearing loss.

The fire death rate for older adults is higher than the national average. This may be attributed to many factors--reduced mobility and awareness, loss of hearing, etc. Various home configurations and locations of smoke alarms can limit the transmission of sound throughout the house. Interconnected smoke alarms can provide earlier warning of smoke and fire. The addition of interconnected smoke alarms inside bedrooms may provide improved warning of smoke and fire where bedroom doors are closed.

Research Recommendations

The report said that alternative warning systems and sounds warrant further exploration to account for as many home configurations and occupant needs as possible. Additional research is needed to better understand what potential deficiencies exist regarding the audibility of smoke alarms. The CPSC staff said it believes the following areas of research need to be explored to help determine possible technical solutions and/or develop public education campaigns:

Changing the Smoke Alarm Frequency: This area involves examining possible technical solutions to lowering the smoke alarm frequency below 2 kHz or implementing a high-low frequency combination. The study would examine commercial alarms that produce alarms in the lower frequencies and determine if they can be incorporated into residential smoke alarm designs. If an alternate frequency or alarm sound is determined to be successful at alerting the older population, the same frequency or alarm should be tested for effectiveness on other age groups. Preferably, the "new" smoke alarm with the improved alarming should also be powered from only a battery to address homes that do not have hardwired smoke alarms. The study would have adults and seniors listen to the lower frequency (or possibly modulated) signal to determine effectiveness of attention getting and perceived urgency.

Training Approach vs. Sleep-Induced Incapacity: Studies have shown that children are difficult to wake with the sound of a smoke alarm. It has also been shown that children have longer periods of deeper sleep than adults. The objective of this study would be to determine whether children could be awakened by an alarm through training. This study would determine if children sleep through an alarm due to a sleep induced incapacity to perceive sounds or a lack of training and motivation to respond to a sound that they can hear but just do not recognize or care about. The study would train a group of children to recognize their home alarm's sound. A valued awards system would be used to help motivate them in responding to the alarm sound during the night. The children would be trained to the alarm sound during waking hours so that the alarm sound becomes salient and be reminded that they will be rewarded if they hear the sound. The subjects will not be forewarned of when the actual night test would occur. Preferably, the actual alarm testing at night should occur when the subjects are in the slow-wave sleep. Following training, the subjects would be exposed to the smoke alarm sound when asleep. The study will help determine if their sleep suppresses their capability to hear the smoke alarm sound or if highly motivated training is an effective method of overcoming their sleep.

Exploration of Alternative Cues: If the problem is a physiologically induced perceptual impairment, can another cue, besides an electronic tone, reliably wake children? Possibilities include flashing strobe lights, a voice, musical sounds, or environmentally meaningful static noises like crackling leaves (similar to wood burning) or rushing water. The study would select a number of cues that may differ substantially from normal smoke alarms to provide a possible alternative. Preferably, the testing should occur at night when the subjects are in the slow-wave sleep. If the subjects respond to a specific cue,

the same cue should be repeated with different aged children to determine the reliability of awakening.

Smoke Alarm Sound Uniqueness: If children or adults cannot identify a smoke alarm sound when they are awake, it would be assumed that they would have a lower probability of recognizing the sound when they are asleep. The study would examine the present smoke alarm pattern and tone (at a lower sound level) to determine if it is similar to other daily sounds. The study would have children and adults listen to various alarms, tones, and other daily sounds to determine if the smoke alarm sound is identifiable and unique. Other daily sounds can be microwave beeping, open car door with keys in the ignition, car horn, security alarms, other alarms, doorbell, etc.

Improving the Detection of Smoke Alarms: The study would examine possible technical solutions in increasing the detection of smoke without increasing nuisance alarms. Possible technical solutions may require different or combination sensors. The sensor(s) may help better discriminate actual smoke from other false inputs such as aerosols, steam, and normal cooking. The combination or alternative sensors may be able to detect smoke sooner, allowing more escape time for the occupants. The alternative or combination sensors would be tested to determine if they perform better than present ionization and photoelectric smoke alarms.

Determining the Effectiveness of Various Alerting Cues Sounding Simultaneously in a Residential Home: The study would examine the effectiveness of different alarm cues sounding simultaneously. The study would examine the present smoke alarm pattern with alternative alarm sounds in the home to determine if the alternative alarm sounds are still recognizable. The study would test and record multiple alarm sounds in the home to determine if the alternative (such as voice) or the present smoke alarm sound is still identifiable and unique.

Copies of the report, "A Review of the Sound Effectiveness of Smoke Alarms," is available on the CPSC Web site at <http://www.cpsc.gov/library/foia/foia05/os/alarm1.pdf>. 