



RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

PROJECT SUMMARY

Review of Audible Alarm Signal Waking Effectiveness

12 April 2019

Background: Smoke alarm and signaling systems are a proven strategy for reduction of fire fatalities in the general population. However, studies have shown that at risk populations such as the elderly, school age children, alcohol impaired, and those that are hard of hearing do not fully benefit from conventional smoke alarm systems, particularly during sleeping hours. Research has been conducted to develop performance requirements to optimize the waking effectiveness for alarm and signaling systems to meet the needs of these at risk groups. This includes previous research from the Research Foundation on the waking effectiveness of alarms¹ as well as other research.

The Foundation study involved several tasks including a risk assessment to estimate the potential impact in lives saved of changes in waking effectiveness of smoke alarms for older adults, quantifying the human behavior aspects of the problem, developing benchmark performance criteria for alarm and signaling systems, and reviewing new and promising technologies that address the performance criteria. One of the main findings of this work is that the 520 Hz square wave T-3 sound was the most effective signal to awaken hard of hearing participants. Other studies have shown the same results for children and other at risk populations.

Performance requirements for a sound pressure level of 85 dBA at 10 feet from the device for single and multiple-station smoke alarms appear in multiple codes and standards, including UL 217, Standard for Smoke Alarms. This is in contrast to the requirement for UL 268, *Smoke Detectors for Fire Alarm Systems*, listed smoke detectors, which is to emit 75 dBA at the pillow. The 85 dBA specification requires significantly more power, which makes the 520 Hz square wave signal a particular challenge for alarms operating on a battery/battery backup.

There is a need to review all existing data on this topic to clarify the sound pressure level(s) used in previous research and the background and technical basis for the required sound pressure levels in the codes and standards to determine the impact of a reduction in the sound pressure level when using a 520 Hz square wave signal.

¹ Bruck, Dorothy and Thomas, Ian. *Optimizing Fire Alarm Notification for High Risk Groups Research Project*. Fire Protection Research Foundation, Quincy, MA. 2007.

Research Goal: Assess the data on waking effectiveness to determine an acceptable reduction in the required sound pressure for sounders using a 520 Hz square wave signal that still provides superior waking effectiveness compared to high frequency sounders.

Project Tasks: This project involves the following tasks:

Task 1: Carry out a literature review of the relevant information on this topic including:

- The history of the required locations for smoke detection in dwellings and hotel guest rooms and the associated technical basis in both NFPA 72, *National Fire Alarm and Signaling Code*, and the model codes.
- The history and associated technical basis for the required sound pressure levels in the relevant codes and standards, including UL 217, UL 268, and UL 464, *Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories*.
- Research on waking effectiveness of smoke alarms for at risk groups.
- Research on the impact of the sound pressure level as well as the duration of the alarm tone on waking.

Develop an interim report of the findings from Task 1 that includes a timeline of the changes in the codes/standards along with the research on the topic.

Task 2: Using the effectiveness of traditional 3 kHz sounders as a baseline for performance (as well as conditions from the foundational literature), analyze the literature found in Task 1 to determine if sounders using a 520 Hz square wave signal can be reduced below the 85 dBA at 10 ft requirement and still provide superior waking effectiveness. If more research is needed, please identify the knowledge gaps.

Task 3: Based on the findings, develop recommendations for any changes to performance requirements or for future research.

Implementation: This research program will be conducted under the auspices of the Research Foundation in accordance with Foundation Policies and will be guided by a Project Technical Panel who will provide input to the project, recommend contractor selection, review periodic reports of progress and research results, and review the final project report.

Schedule: The final report will be published in August 2019.

About us:

About the Fire Protection Research Foundation

The [Fire Protection Research Foundation](#) plans, manages, and communicates research on a broad range of fire



safety issues in collaboration with scientists and laboratories around the world. The Foundation is an affiliate of NFPA.

About the National Fire Protection Association (NFPA)

Founded in 1896, NFPA is a global, nonprofit organization devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. The association delivers information and knowledge through more than 300 consensus codes and standards, research, training, education, outreach and advocacy; and by partnering with others who share an interest in furthering the NFPA mission. [All NFPA codes and standards can be viewed online for free.](#) NFPA's [membership](#) totals more than 65,000 individuals around the world.

