National Electrical Manufacturers Association

A NEMA Fire, Life Safety, Security, and
Emergency Communication Section White Paper
NEMA BS 31003-2023

Low-Frequency Audible Signals

Published by:

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, Virginia 22209

www.nema.org

The requirements or guidelines presented in this NEMA white paper are considered technically sound at the time they are approved for publication. They are not a substitute for a product seller's or user's own judgment with respect to the particular product discussed, and NEMA does not undertake to guarantee the performance of any individual manufacturer's products by virtue of this document or guide. Thus, NEMA expressly disclaims any responsibility for damages arising from the use, application, or reliance by others on the information contained in this white paper.

© 2023 National Electrical Manufacturers Association. All rights, including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the International and Pan American copyright conventions.

Currently in preview, click buy full version

Scope

This white paper addresses the need for and development of the low-frequency audible alarm signal used in fire alarms, carbon monoxide (CO) alarms, and fire or CO alarm systems. It documents the signal's waking effectiveness for those who are hard of hearing or deaf, school-age children, and the elderly. It also summarizes the voluntary national consensus requirements for the application, installation, location, and performance for these products when employing the low-frequency audible signal.

Purpose

The purpose of this white paper is to clear up confusion in the fire alarm industry related to application of the low-frequency audible alarm signal defined in NFPA 72. It is ideally suited for installers, the fire service, building code officials, end users, fire protection engineers, and electrical engineers.

Introduction

The majority of traditional fire or CO alarm notification appliances produce an audible signal with a frequency range between 2 kHz and 4 kHz. The traditional integral sounders used in almost all smoke or CO alarms also produce a 3 kHz audible alarm signal. By contrast, the low-frequency audible alarm signal has a fundamental frequency of 520 Hz. Researchers have been testing the effectiveness of various audible alarm signals and frequencies in waking various at-risk population subgroups. Much of this research has been conducted by Dr. Dorothy Bruck and her colleague Ian Thomas at Australia's Victoria University.[1] Their findings conclude that most unimpaired adults will normally awaken quickly to a 3 kHz audible alarm signal, and the low-frequency signal is most effective at waking high-risk segments of the population, such as people with hearing loss, the elderly, school-age children, and the alcohol impaired. It is important to note that deaf persons may awaken better to tactile notification appliances or strobes.

Important Statistics

Alarms and alarm systems provide lifesaving value when occupants are awake, but their greatest benefit might be when the occupants are asleep. This is illustrated in a 2010 U.S. Fire Administration (USFA) study,[2] which reports that 50% of fire fatalities in residential buildings occur between the hours of 10:00 p.m. and 6:00 a.m., when most people are sleeping. According to a 2008 study,[3] most unimpaired adults wake up quickly to the "standard" 2-4 kHz audible fire alarm signal, even at levels well below 75 dBA. But 13% of fire fatalities in residential buildings involve children younger than 10 years old, and 44% of fire fatalities are adults between the ages of 40 and 69. Also, according to another study,[4] there are more than 34.5 million people in the U.S. who are deaf or hard of hearing.

Research on Waking Effectiveness of Audible Alarm Signals

For more than a decade, researchers have been testing the effectiveness of audible fire alarm signals at waking various at-risk population groups. The National Fire Protection Association (NFPA) Fire Protection Research Foundation (FPRF) has been instrumental in funding many of these studies. The 2008 report concludes that most unimpaired adults will wake quickly to the sounding of their smoke alarm, even at

[1] Ian Thomas and Dorothy Bruck, *Use of smoke alarms to prevent smoke and fire related deaths*, August 2015, https://www.aph.gov.au/DocumentStore.ashx?id=c665f4a1-a39c-477e-b50c-b3710030ce&subId=401510 (accessed August 29, 2022).
[2] Federal Emergency Management Agency, U.S. Fire Administration, *Civilian Fire Fatalities in Residential Buildings (2008-2010),* Topical Fire Report Series, Vol. 13, No. 1, Emmitsburg, Maryland.
[3] Ian R. Thomas and Dorothy Bruck, *Awakening of Sleeping People: A Decade of Research* (Melbourne, Australia: Centre for Environmental Safety and Risk Engineering), 2008.
[4] Ian R. Thomas and Dorothy Bruck, *Waking Effectiveness of Alarms for Adults Who Are Hard of Hearing* (Melbourne, Australia: Victoria University), National Fire Protection Association, 2007.

Currently in preview, click buy full version

© 2023 National Electrical Manufacturers Association