

# The Negative Effects of Occupational Noise Stress on Firefighters and Paramedics



**Locution**   
SYSTEMS INC.

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## Section 1: Introduction

Firefighters & paramedics face an alarming barrage of occupational noise. In-station noises includes piercing alert tones & loud equipment such as compressors. Outside the station, they are exposed to the noise from emergency vehicles. These sources of occupational noise pose dangers that can significantly harm the health of first responders.



Medical research shows the following general negative effects of occupational noise on first responders include:

- Heart disease
- High blood pressure
- Hearing loss
- Stroke
- Reproductive system damage (men & women)
- Decreased brain processing power
- Seizures & sudden death
- Fatal & non-fatal workplace injuries

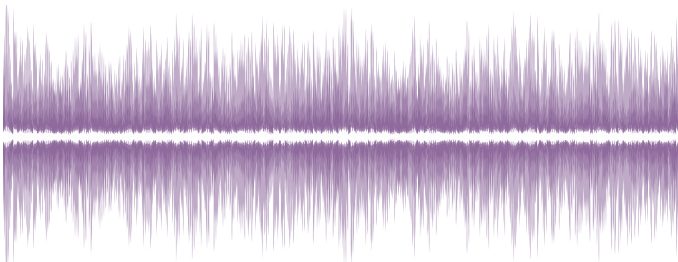
## Section 2:

# The Three Types of Occupational Noise

There are 3 types of occupational noise that can affect workers:

### Continuous Noise

Ongoing noise from a specific source



### Impulse Noise

Instantaneous sharp sounds



### Varying & Intermittent Noise

Noise that comes at unexpected times, in bursts or intervals



Alarms and tones that sound in fire stations to alert first responders of an incoming dispatch are considered **VARYING & INTERMITTENT NOISE**. Medical research shows that there are many negative physiological & psychological effects of varying, intermittent noise. **In fact, medical research has shown that varying & intermittent noise is more harmful than continuous noise.** The harmful effects to the health and safety of first responders are quite staggering. However, new fire station alerting technologies have been developed that can significantly reduce these threats to the health and safety of first responders, as well as their impact.

## Section 3:

# How Noise Stress Affects The Human Body

## 2023 New York Times Article On The Negative Effects of Noise Exposure On Humans

**Weblink:** <https://www.nytimes.com/interactive/2023/06/09/health/noise-exposure-health-impacts.html>

### Abstract Excerpt

This comprehensive article explores the negative effects of noise exposure on humans, including a detailed look at how the body reacts physiologically when exposed to noise.

1. A siren, alarm or loud noise sounds.
2. The noise enters the human body through the ears but is relayed to the stress detection center in the human brain, known as the amygdala.
3. If the amygdala is chronically triggered by noise, the reactions in the body start to produce harmful effects.
  - a. The endocrine system can overreact, causing an overload of stress chemicals to course through the body (cortisol, adrenaline).
  - b. The sympathetic nervous system also is triggered, causing the heart to race, blood pressure to skyrocket, and inflammatory cells to be produced.



### Alert



“According to the National Institute on Deafness and Other Communication Disorders, repeated exposure to sound at **85 decibels or more** can cause hearing loss.”



### Learning Points

Noise measurements on the decibel scale are logarithmic, not linear. This means that, for every 10 points of decibel level increase, the sense of loudness to the human ear DOUBLES.

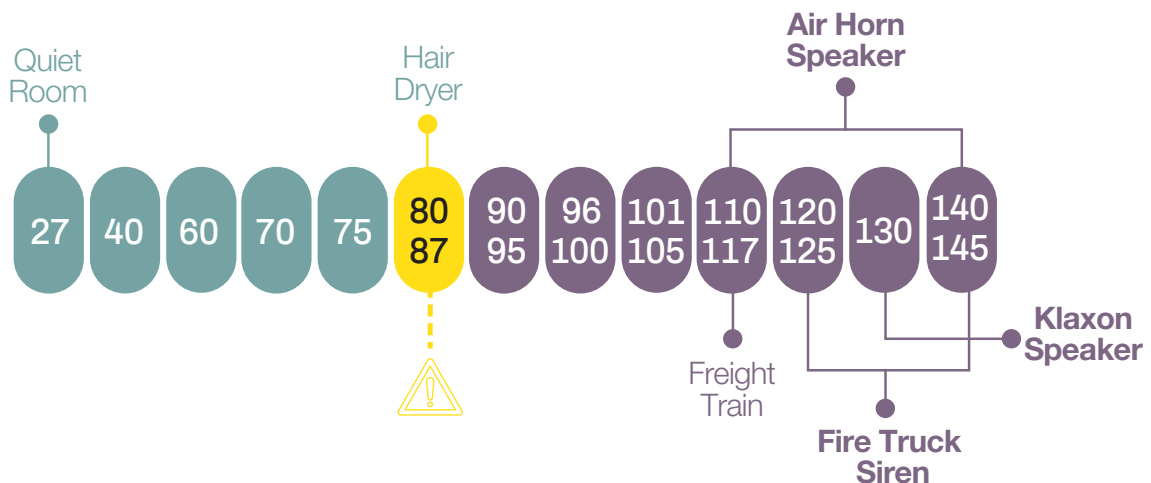
Over time, this chain reaction can lead to chronic inflammation, high blood pressure, and plaque build-up in arteries. Ultimately, this can increase the risk of heart disease, heart attacks, and stroke in first responders.

Regular exposure to sound with decibel levels above moderate levels can trigger bodily reactions that are harmful to one's health.

### Decibel Level Examples:

- Quiet room: 27 decibels
- Hair dryer: 87 decibels
- Freight train: 117 decibels
- Air horn speaker: 110 to 145.8 decibels\*
- Fire truck siren: 120-140 decibels\*
- Klaxon speaker: 130 decibels\*

\*These are common noises in the daily lives of first responders.



These decibel statistics help make it clear why hearing loss is such a problem for first responders, who can be subjected to chronic exposure to sudden, intermittent noise at high decibel levels.

## Section 4:

# Medical Research On The Negative Effects Of Noise On First Responders

**Methodology:** The medical research in this section has been gleaned from PubMed.com—the most respected medical research database in the United States. PubMed.com is managed by the U.S. National Institutes of Health. To date, there are more than 37 million medical research studies (and counting) in the PubMed.com medical research database.





## Positive Effects of Ramped Alerting Tones

### Effect of station-specific alerting and ramp-up tones on firefighters' alarm time heart rates—2016 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/27171596/>

#### Abstract Excerpt

There are a number of long-term health effects suffered by emergency responders. Some of these are influenced by psychological stress and fatigue. This study explored if stress and fatigue can be reduced by changing the method by which firefighters are alerted to emergency responses. Over several months, the method by which responders at a fire department were alerted was altered. Firefighter heart rates were measured first with standard alerting as a control (phase 1: all stations alerted simultaneously, with high-volume tones). The department then implemented station-specific (phase 2) and gradual volume ramp-up (phase 3) tone alerting, and heart rate increases were compared. The heart rate increases were then compared. The Fatigue Severity Score was used to examine firefighter fatigue, and the department administered a follow-up survey on personnel preferences. **Firefighters reported a strong preference for the “ramp-up” tones.**



#### Learning Point

Ramped fire station alert tones have been proven in medical research to reduce heart stress, by decreasing tachycardia (racing/pounding of the heart) as part of a startlement response when an alarm is sounded in the fire station.

Firefighters also were roughly evenly divided between the type of alerting they preferred:

#### All Stations Alerted:

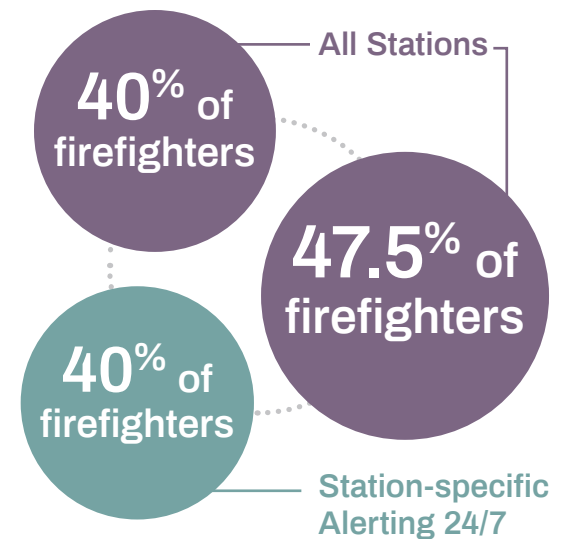
- 40% of firefighters preferred alerting all stations simultaneously 24/7
- 47.5% of firefighters wanted all stations alerted during the day

#### Station-specific Alerting 24/7:

- 40% of firefighters wanted station-specific alerting at night

Ramp-up tones were perceived as the best method to reduce stress during the day and overnight.

Small but significant decreases in the amount of tachycardic response (racing heart) to station alerting are associated with simple alterations in alerting methods. Station-specific and ramp-up tones improve perceived working conditions for emergency responders.



# Negative Effects of Occupational Noise on the HEART



## Heart rate response to alarm tones in firefighters—2021 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/33423092/>

### Abstract Excerpt

**Objective:** To examine cardiovascular responses to medical (MED) and fire (FIRE) alarm tones in firefighters.

**Methods:** Heart rate was collected throughout 24-h shifts (N = 41). Call logs were utilized post hoc to identify heart rate at the time the alarm sounded (TIMETONE), peak heart rate following the alarm (TIMEPEAK), and heart rate at the time of station departure (TIMEDEPART) for MED and FIRE calls. A 2X3 (TONE x TIME) split-plot mixed-model repeated-measures analysis of variance (ANOVA) and least significant differences tests examined the influence of tone type on heart rate, expressed as a percent of age estimated maximum. Bivariate Pearson correlations examined the relationship between body mass index (BMI) and TIMEPEAK and TIMEDEPART.

**Results:** Follow-up analyses for the significant  $2 \times 3$  repeated-measures ANOVA ( $p = 0.035$ ) indicated differences in heart rate for MED ( $p < 0.001$ ) and FIRE ( $p < 0.001$ ) where  $TIMETONE < TIMEPEAK$ ,  $TIMETONE < TIMEDEPART$ , and  $TIMEPEAK > TIMEDEPART$ . There was a non-significant simple effect of time for MED and FIRE at  $TIMETONE$  ( $p = 0.259$ ), but significant effects of tone type where  $FIRE > MED$  at  $TIMEPEAK$  ( $p < 0.001$ ) and  $TIMEDEPART$  ( $p = 0.002$ ). There was a significant small positive relationship between BMI and  $TIMEPEAK$  ( $p = 0.002$ ) and  $TIMEDEPART$  ( $p < 0.001$ ) for MED only.

**Conclusions:** Alarms increased heart rates to a greater extent in FIRE than MED calls. Higher Body Mass Index was related to greater heart rate responses in MED but was unrelated to FIRE response.



### Learning Point

Fire station alarms increased heart rates for fire calls more than med calls. This is why it's so important to deploy Locution Systems' HeartSaver alert tones, particularly for responders being deployed for fire-related calls.



### Learning Points

- Intermittent noise significantly increased diastolic blood pressure, as well as overall blood pressure.
- Intermittent noise increased heart rates for ALL groups during the task.
- **Heart rates increased significantly more in groups receiving unpredictable noise bursts.**

## The effect of intermittent noise on cardiovascular functioning during vigilance task performance—1989 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/2616702/>

### Abstract Excerpt

This study was designed to investigate the effect of intermittent noise on cardiovascular functioning during task performance. Four scenarios were measured (1 quiet period, and 3 instances of intermittent noise)—and blood pressure, heart rate, and heart rate variability were measured. Under a quiet condition and three conditions of intermittent noise, measures of blood pressure, heart rate (interbeat interval), and heart rate variability (variance, successive difference mean square, and the 0.1 Hz component of sinus arrhythmia) were obtained while subjects were occupied with a 55-min vigilance task. **Although heart rate increased in all groups during the task, it increased significantly more in groups receiving unpredictable noise bursts.**

## NIOSH Alert: Preventing Firefighter Fatalities Due To Heart Attacks and Other sudden Cardiovascular Events—2007 Research Paper

By Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health

**Weblink:** <https://www.cdc.gov/niosh/docs/2007-133/pdfs/2007-133.pdf>

### Abstract Excerpt

This firefighter safety report examines the many reasons that cause firefighter fatalities and ways to mitigate firefighter deaths, along with a lengthy list of research studies in the addendum. **Pages 4 and 5 address the occupational noise to which firefighters are exposed, which is the opposite of the typical occupational scenario.** Industrial workers typically are exposed to lower intensity noise for long periods of time, i.e. an 8-hour shift, for example. In contrast, firefighters typically are exposed to high-intensity noise for short durations of time. (Alarms, sirens, air horns, firing up diesel engines, and the roar of fires.) This sampling of medical research studies shows that the firefighter's exposure to noise, particularly chronic intermittent noise that's high intensity and of short duration, has negative health effects. This is why various fire station alerting technologies have been developed to minimize stress and the physiological and psychological effects of sudden, unexpected bursts of high-intensity sound to which more firefighters are subjected daily, weekly, and over the course of many years.

### Alert



“Firefighters are at risk of dying on the job from preventable cardiovascular conditions.”



### Learning Point

Firefighters typically are exposed to high-intensity noise for short durations of time, with detrimental effects including:

- Noise-related hearing loss
- High blood pressure
- Heart disease

## Noise Effects on the BRAIN & COGNITION



Unveiling the impact of siren noise exposure on cognitive function and mental health among firefighters—2024 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/39465335/>

### Abstract Excerpt

Firefighters reside in inherently noisy environments with sirens and emergency alarms. This noise can negatively affect the performance of firefighters and further pose a safety risk. **This study investigates the relationship between siren noise exposure and mental health disorders.** In doing so, the study focuses on cognitive function among firefighters, using a Bayesian network model for the first time. This case-control study involved 92 firefighters and was conducted in 2023. Participants were categorized into case and control groups based on their exposure levels to siren noise. Noise exposures were initially measured according to ISO 9612 standards. The questionnaires covered demographic information, scales of their depression, anxiety, and stress, the Buss-Perry aggression questionnaire, and the cognitive failure questionnaire. GeNIe academic software version 2.3 was employed for Bayesian network analysis.



### Learning Point

Firefighters exposed to siren & alarm noise are likely to have increased depression, stress, anxiety, and aggression.

The study results indicated that there's a 100% probability that heightened noise exposure increases depression by 10%; stress by 14%, anxiety by 13%, and aggression by 16%.

In addition, each variable-noise exposure affected depression, stress, anxiety, and aggression levels, and was linked to cognitive failure by 8% (depression); 28% (stress); 8% (anxiety); and 13% (aggression).

The combination of variables including noise exposure, depression, anxiety, and other mental health disorders had a 57% increase in cognitive failure. The most influence values were observed between depression and cognitive failures (0.564). The results of this study demonstrated the effect of siren noise exposure and its mental health disorders on cognitive function among firefighters. The results further highlight proper implementation of measures to mitigate these effects, and further required investigation on their effectiveness.



### Learning Point

Firefighters exposed to siren & alarm noise are likely to have increased depression, stress, anxiety, and aggression.





## Quantifying the Effect of Noise on Cognitive Processes: A Review of Psychophysiological Correlates of Workload—2022 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/36537445/>

### Abstract Excerpt

Noise is present in most work environments, including emissions from machines and devices, speech from colleagues, and traffic noise. It is generally accepted that noise below the permissible exposure limits does not pose a considerable risk for auditory effects like hearing impairments. **Yet, noise can have a direct, adverse effect on cognitive performance (non-auditory effects like workload or stress).**

In this review, literature databases were searched for peer-reviewed journal articles that deal with an at least partially irrelevant “auditory stimulation” during an ongoing “cognitive task” that is accompanied by “psychophysiological correlates” to quantify the “momentary workload.”

The spectrum of assessed types of “auditory stimulations” extended from speech stimuli (varying intelligibility), **oddball sounds (repeating short-tone sequences)**, and auditory stressors (white noise, task-irrelevant, real-life sounds). The type of “auditory stimulation” was related (speech stimuli) or unrelated (oddball, auditory stressor) to the type of primary “cognitive task.”

The types of “cognitive tasks” include speech-related tasks, fundamental psychological assessment tasks, and real-world/simulated tasks. The “psychophysiological correlates” include pupillometry and eye-tracking, recordings of brain activity (hemodynamic, potentials), cardiovascular markers, skin conductance, endocrinological markers, and behavioral markers. The prevention of negative effects on health by unexpected stressful soundscapes during mental work starts with the continuous estimation of cognitive workload triggered by auditory noise.

## Environmental noise degrades hippocampus-related learning and memory—2020 Study

**Weblink:** <https://pmc.ncbi.nlm.nih.gov/articles/PMC7797896/#:~:text=In%20this%20study%2C%20we%20showed,during%20or%20after%20noise%20exposure.>

### Abstract Excerpt

The noise pollution accompanying industrialization is a risk factor to human health. This research study found that rats exposed to a relatively low volume of sound—65 decibels—did not indicate physiological “stress status.” However, the hippocampus area of the brain (associated with learning & memory) was negatively affected. Synaptic transmission of electrical pulses in the brain was diminished.



### Learning Point

Intermittent, short-tone sequences in the workplace negatively affects workers’ cognitive processing & brain function.



### Learning Point

Lab rats exposed to low-decibel noise exposures developed diminished electrical activity in the hippocampus area of the brain—which controls memory, learning, converting short-term memories to long-term memories, and spatial navigation.

# Negative Effects On Occupational Noise On BLOOD PRESSURE



The acute effect of exposure to noise on cardiovascular parameters in young adults—2018 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/29618678/>

## Abstract Excerpt

**Objective:** In this study, an experiment was conducted to examine whether noise exposure produced acute changes in cardiovascular responses, and whether these responses differed based on psycho-acoustic parameters to noises of low to high intensity.

**Methods:** Thirty healthy subjects were enrolled. Three industrial noises were binaurally presented with a supra-aural earphone. The sound levels of noise were <55, 75, and 90 decibels. Each noise was continued for 20 min and the electrocardiogram was simultaneously recorded.

**Results:** The results showed a statistically significant increase in systolic blood pressure (SBP) at the 90-decibel sound level. These results suggest that exposure to noise, particularly high-frequency noise, negatively impacts blood pressure. The tonality and fluctuation strength of noise especially impacts systolic blood pressure.



## Learning Point

Exposure to high-decibel, high-frequency noise increases blood pressure.

## The interactive effect of chronic exposure to noise and job complexity on changes in blood pressure and job satisfaction: a longitudinal study of industrial employees—2001 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/11482631/>

### Abstract Excerpt

The hypothesis of this study was that noise exposure level and job complexity interact to affect changes in blood pressure (BP) levels and job satisfaction over 2-4 years of follow-up. **Results showed that among workers exposed to high noise, those with complex jobs showed increases in blood pressure that were more than double shown by those with simple jobs.** It was concluded that exposure to occupational noise has a greater negative impact on changes in BP and job satisfaction over time among those performing complex jobs.



### Learning Point

Workers involved in complex jobs who are exposed to high noise experience blood pressure increases that are more than double the blood pressure of workers involved in simple jobs.

# Negative Effects of Noise on SLEEP



## The effects of occupational noise on sleep: A systematic review—2023

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/37683554/>

### Abstract Excerpt

Noise exposure in the workplace is one of the most common occupational hazards, which can affect sleep in humans. The effects of occupational noise can be different than that of environmental or social noise. This study aimed to conduct a systematic review on the effects of occupational noise on various characteristics of sleep. In this study, three electronic bibliographic databases (Scopus, PubMed, and Web of Science) were systematically searched up to 14 December 2022. The search algorithm included two sets of keywords and possible combinations. The first group was keywords related to occupational noise, and the second group was keywords related to sleep. A total of 2,082 articles were identified in the initial search, and 2,034 articles were excluded based on exclusion criteria or lacking inclusion criteria. A total of 48 articles met the inclusion criteria and were selected for final review. **Among 13 articles identified as high quality, ALL studies (100%) showed that noise had a significant effect on sleep among workers in various occupations.**



### Learning Point

Occupational noise—by day or by night—negatively effects workers' sleep cycles, as well as contributing to hearing loss.

# Noise Effects on the REPRODUCTIVE SYSTEM



## Occupational Exposure to Physical and Chemical Risk Factors: A Systematic Review of Reproductive Pathophysiological Effects in Women and Men

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/36941939/>

### Abstract Excerpt

The human reproductive system can be affected by occupational exposure to many physical and chemical risk factors. This study was carried out to review the studies conducted on the effects of exposure to physical environmental hazards and chemicals on reproductive systems of females and males. In this systematic review, the databases such as “Google Scholar,” “Pub-Med,” “Scopus,” and “Web of Science” were used.

Following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA 2020), the studies included in our study were published between 2000 and 2021. In order to extract the required data, all sections of the articles were reviewed. A total of 57 studies were reviewed.



### Learning Point

Physical environment factors (noise, heat, and radiofrequency radiation) and chemical exposure risk factors had pathophysiological effects on the human reproductive system.



## Female noise exposure, shift work, and reproduction—1995 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/8520958/>

### Abstract Excerpt

In addition to having possible direct effects on the fetus, noise induces a stress reaction in the mother, possibly causing reproductive disturbances. In shift work, many physiological functions and systems that are circadian in nature can be disturbed. Study results indicate that occupational noise at the level of approximately 85 decibels for 8 hours or more on shift work—especially for women working rotating schedules—may have independent, negative effects on birth weight and length of gestation. Some forms of shift work also have been associated with early fetal loss. Moreover, some results have related noise exposure and shift work to menstrual disturbance and infertility. Although the evidence is not ample, it is prudent to consider exposure to high-level noise and shift work as risks to reproduction.



### Learning Point

Women who are exposed to 85 decibel-noise or higher for 8-hour shifts are at risk for low-birth-weight babies, miscarriage, and/or babies born prematurely.

# Negative Effects of Occupational Noise on HEARING



## Hazardous decibels: hearing health of firefighters—2007 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/17847625/>

### Abstract Excerpt

Noise-induced hearing loss ranks among the most significant occupational health problems. In the United States, more than 1 million firefighters are at risk for noise-induced hearing loss due to exposure to hazardous levels of intermittent noise from sirens, air horns, and engines of emergency vehicles and fire trucks. However, irreversible, noise-induced hearing loss is entirely preventable through both engineering controls and personal protective equipment. This article describes occupational noise exposure, hearing loss, and strategies to prevent noise-induced hearing loss among firefighters.



### Learning Point

More than a million firefighters are at risk of hearing loss due to exposure to intermittent noise from sirens, alarms, and engines of emergency vehicles and fire trucks.



## Prevalence of Hearing Loss and Perceptions of Hearing Health and Protection among Florida Firefighters—2023 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/36900832/Abstract>

### Abstract Excerpt

Firefighters are exposed to extensive hazardous noise while on the job, both during routine tasks at the station and when responding to calls. However, little is known about firefighters' occupational noise hazards. This study employed mixed methods, including focus groups, a survey, and audiometric testing, to identify sources of noise in the firefighters' work environment, determine hearing protective strategies, discern firefighters' perceptions of occupational noise exposure and impacts to their health, and quantify the prevalence of hearing loss among South Florida firefighters. A total of 6 senior officers served in an expert panel, 12 participated in focus groups, 300 completed the survey, and 214 received audiometric tests. **Most firefighters were unaware of the risk and their departments' policies, and did not participate in hearing protection practices and avoided using hearing protection devices, which they believed impede team communication and situational awareness.**



### Learning Point

Nearly 30% of this study's participants showed mild to profound hearing loss from exposure to occupational noise from sirens, alarms, air horns & vehicle noise.

Nearly 30% of participating firefighters showed mild to profound hearing loss, a prevalence that is considerably worse than expected by normal aging alone. Educating firefighters about noise-induced hearing loss early in their careers may have significant health implications for their future. These findings provide insights for developing technologies and programs to mitigate the effects of noise exposure in the firefighting population.

## 8 Summary Points

### Negative Effects of Occupational Noise—Summary—1991 Study



**Weblink:** <http://www.nonoise.org/library/suter/suter.htm>

#### Abstract Excerpt

This report focused on the effects of noise, the different types of noise, and many research studies are quoted. Highlights of research and learning points include:

1. Adverse effects of noise can be cumulative with prolonged or repeated exposure.
2. It's not easy to find research on the effects of noise because government funded studies were abruptly cancelled in 1981 and 1982.
3. Sound levels measured in decibels increase logarithmically rather than in a linear fashion, i.e., a small increase in decibels represents a large increase in sound energy.

#### Alert



White males are particularly susceptible to hearing loss from noise exposures.



### Learning Point

- Intermittent & impulse noise are more harmful than continuous noise.
- Men, particularly white males, incur more hearing loss than women from comparable noise exposures.

4. Evidence from field studies indicates that men incur more hearing loss than women from comparable noise exposures (Burns and Robinson, 1970; Berger, et al., 1978; Royster, et al. 1980)
5. Caucasians appear to be more susceptible to noise-induced hearing loss than African-Americans. (Royster, et al. 1980)
6. Intermittent noise and impulse noise are more disturbing than continuous noise.
7. Although people believe they get used to noise, physiological tests show that it's still taking a toll on the cardiovascular system (Muzet, 1983). In addition, even after 5 years of exposure to the same noise, the body still does not get used to it. (Vallet et al. 1990)
8. Key negative effects of noise include:
  - Shifts in eyesight
  - Reduced tolerance for frustration
  - Elevations in blood pressure that persist long after the initial exposure to the startling noise
  - Blood chemistry changes including increased levels of epinephrine and norepinephrine

## A risk model for occupational noise-induced hearing loss in workers—2024 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/37781851/>

### Abstract Excerpt

**Background:** Occupational hearing loss is one of the most common work-related diseases with various risk factors and considerable negative impacts on both physical and mental well-being of affected workers. Occupational noise-induced hearing loss (ONIHL) has a complex interaction with personal, environmental, and occupational factors.

**Objective:** This study aimed to develop a risk model for ONIHL in workers by identifying risk factors and their interactions.

**Methods:** The subjects were 605 males in an industrial factory in Iran. The study took place between 2022 and 2023. The sociodemographic and occupational characteristics were collected by a health technician using questionnaires and medical records. Hearing status was assessed using audiometry by a qualified audiologist. Hearing loss was analyzed by univariate logistic analysis including age, smoking, medical history, type of occupation, and some workplace hazards. The risk model was generated by logistic regression.



### Learning Point

44% of the workers in this study who were exposed to occupational noise in a factory with vibration noise, continuous noise, impulse noise, and intermittent noise developed some degree of hearing loss.



**Results:** Hearing loss in the participants was 44.13% (n = 267). In univariate logistic analysis, age (OR: 2.93, 95% CI: 1.848-4.656), smoking (OR: 1.80, 95% CI: 1.224-2.655), work experience (OR: 1.06, 95% CI: 1.016-1.107), previous exposure to noise (OR: 1.60, 95% CI: 1.112-2.312) or vibration (OR: 1.68, 95% CI: 1.150-2.475) and type of occupation (OR: 2.126, 95% CI: 1.055-4.285) were associated with an increased risk of ONIHL (P < 0.05).

**Conclusion:** It was found that vibration exposure, work experience, previous noise exposure, type of occupation as well as age and smoking significantly affected the likelihood of developing ONIHL.

# Negative Effects of Occupational Noise on INJURY RISK & WORKPLACE FATALITIES



## Injury Risk and Noise Exposure in Firefighter Training Operations—2016 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/26712895/>

### Abstract Excerpt

**Introduction:** Firefighters have high rate of injuries and illnesses, as well as exposures to high levels of noise. This study explored the relationship between noise exposure and injury among firefighters.

**Methods:** We recruited firefighters undergoing vehicle extrication and structural collapse emergency response training at a highly realistic training facility. Demographics, health status, body mass index (BMI), and history of serious injuries (i.e., injuries requiring first aid treatment, treatment in a medical clinic or office, or treatment at a hospital) were assessed at baseline, and daily activities, injury events, and near misses were assessed daily via surveys. Participants' noise exposures were monitored for one 24-hour period using noise dosimeters.



### Learning Points

- Firefighters who are exposed to occupational noise have seen increases in job-related injuries and/or “near-miss” accidents.
- Firefighters exposed to sounds exceeding 90 decibels in 30 minutes prior to an injury or near-miss were associated with increased risk.

**Results:** Of 56 subjects, 20 (36%) reported that they had ever suffered a serious injury during firefighting activities, and 9 (16%) reported a serious injury within the past year. We estimated rates of 6.6 lifetime serious injuries per 100 FTE 16.1 serious injuries per 100 FTE within the past year. Our models indicated a significant increase in injury events and near misses among those with higher BMI, and as well as a dose-response relationship between near misses/injuries and increasing noise levels. **Noise levels >90 dBA in the 30 min prior to time of injury or near miss were associated with substantially increased odds ratios for injury or near miss.** Our models further indicated that perceived job demands were significantly associated with increased risk of injury or near miss.

**Conclusion:** Our results suggest that noise exposures may need to be incorporated into injury prevention programs for firefighters to reduce injuries among this high-risk occupational group.

## Evaluating the impact of occupational noise exposure on workplace fatal and nonfatal injuries in the U.S. (2006-2020)—2024 Study

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/39332352/>

### Abstract Excerpt

**Objectives:** This study assessed the relationship between occupational noise exposure and the incidence of workplace fatal injury (FI) and nonfatal injury (NFI) in the United States from 2006 to 2020. It also examined whether distinct occupational and industrial clusters based on noise exposure characteristics demonstrated varying risks for FI and NFI.

**Methods:** An ecological study design was utilized, employing data from the U.S. Bureau of Labor Statistics for FI and NFI and demographic data, the U.S. Census Bureau for occupation/industry classification code lists, and the U.S./Canada Occupational Noise Job Exposure Matrix for noise measurements. We examined four noise metrics as predictors of FI and NFI rates: mean Time-Weighted Average (TWA), maximum TWA, standard deviation of TWA, and percentage of work shifts exceeding 85 or 90 decibels for 619 occupation-years and 591 industry-years.



### Learning Point

Workplaces with highly variable noise exposures increase the risk of fatal and non-fatal injuries in work environments.



**Results:** In addition, occupations with both higher exposure variability (IRR with FI rate: 1.49, 95% CI: 1.23-1.80; IRR with NFI rate: 1.40, 95% CI: 1.14-1.73) and higher level of sustained exposure (IRR with FI rate: 1.27, 95% CI: 1.12-1.44; IRR with NFI rate: 1.21, 95% CI: 1.05-1.39) were associated with higher rates of FI and NFI compared to occupations with low noise exposure.

**Conclusions:** The results suggest that occupational noise exposure may be an independent risk factor for workplace fatal injuries and non-fatal injuries, particularly for workplaces with highly variable noise exposures. The study highlights the importance of comprehensive occupational noise assessments.

## A mouse model of a sudden death induced by noise exposure is useful to investigate human responses to physical stress—1995

**Weblink:** <https://pubmed.ncbi.nlm.nih.gov/7591858/>

### Abstract Excerpt

This research studied the effects of noise exposure on rats. Higher harmonics and sound pressure levels induced seizures in rats that were often fatal. Just before the seizures, rats were observed to be wildly running. Restraining the animal's physical activities prevented the seizures. This study is a useful model for human sudden deaths after excessive physical workloads.



### Learning Point

Noise exposure in higher frequencies induced seizures leading to death in rats.





## Medical Research Summary

The negative effects of occupational noise on first responders harm many different parts of the human body, and systems. Intermittent, occupational noise in fire stations (piercing alarms, alert tones & loud dispatches) cause the following health problems for first responders.

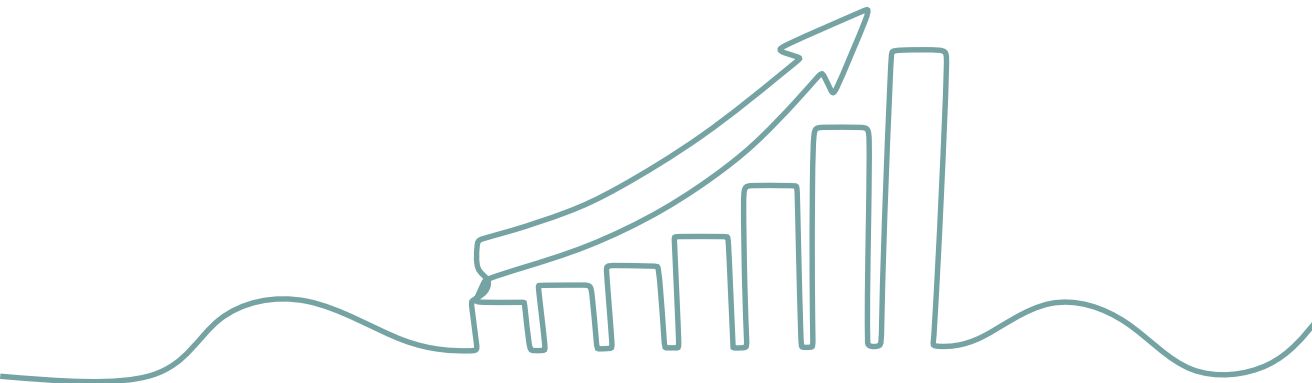
- Negative effects on the HEART
- Negative effects on the BRAIN
- Negative effects on BLOOD PRESSURE
- Negative effects on SLEEP
- Negative effects on the REPRODUCTIVE SYSTEM
- Negative effects on HEARING
- Higher risk of WORKPLACE INJURIES & FATALITIES

## Section 5:

# Fire Station Alerting Technologies That Mitigate Noise Stress For First Responders

To combat the negative health effects of sudden, loud fire station alarms & alerting tones on first responders, fire station alerting technologies have been developed to help mitigate this occupational noise.

Noise-stress-mitigating fire station alerting technologies include:



### Ramped (or Graduated) Alert Tones

Instead of loud, piercing tones that startle responders awake and into a high-stress “fight or flight” mode, ramped fire station alert tones start quietly and ramp up to the desired volume over a specific period of time. Fire-EMS departments can configure ramped station alerting tones in a variety of ways and to their preferences.

For example, a Fire-EMS department might opt to start the volume of the ramped tone at 20% of full volume and ramp up the volume in increments of 10 percent to final desired volume of 80% of full volume. The PrimeAlert Fire Station Alerting System's ramped tones functionality is highly configurable. Fire-EMS departments can have ramped alert tones configured in a variety of volume settings and speed of ramping to partial or full volume.



### HeartSaver Tones

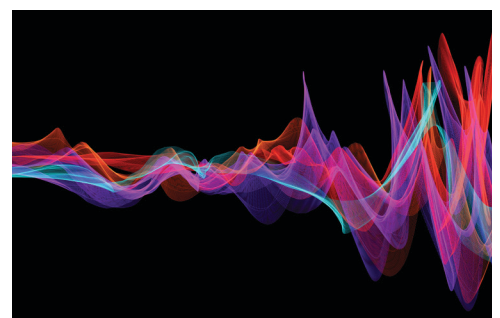
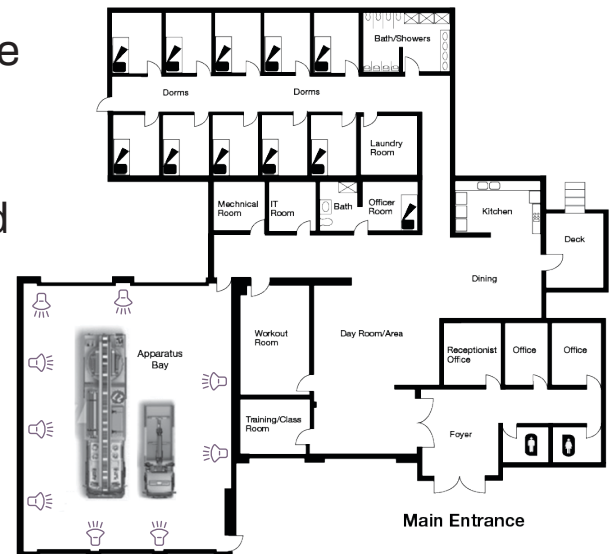
HeartSaver fire station alerting tones are special, gentle-sounding alert tones created to accomplish the alerting function without creating a startled, stress response in the body.

For example, one of Locution Systems' HeartSaver tones mimics the sound of a birdcall and gently alerts first responders who are awake and/or awakens them while minimizing a stress response. Note: Locution Systems' HeartSaver tones also can be ramped, i.e., start with a low volume & gradually ramp up in volume.

## Near-field Speaker Arrays

Another best practice for mitigating occupational noise and its negative effects on the health and safety of first responders is the use of near-field speaker arrays. Near-field speaker arrays are located in apparatus bays in place of having one speaker that blares alert tones and dispatches at high volume in the apparatus bay (producing a startlement response.) The multiple, near-field speakers can be located at intervals along the interior walls of the apparatus bay that “wash” the entire space with sound. With this speaker configuration, much less volume is required. Responders positioned anywhere in the apparatus bay can clearly hear the tone and dispatch information from the near-field speaker that’s closest to them. As a result of using a near-field speaker array, the sound in an apparatus bay is much clearer, and the volume is much lower than using a single speaker.

Fire station alerting technologies exist that can mitigate stress responses in first responders by significantly reducing exposure to sudden, loud klaxon speakers and alert tones that broadcast at high volume. Fire station alerting technologies that minimize noise stress for first responders are now considered a best practice.



For more information about Fire Station Alerting Technologies that mitigate noise stress for first responders, please contact Locution Systems.

[www.Locution.com](http://www.Locution.com)

Thank you!

