

# WORKPLACE SOLUTIONS

From the National Institute for Occupational Safety and Health

## Promoting Hearing Health among Fire Fighters

### Summary

Exposure to high noise levels among fire fighters is well documented and increases the risk for noise-induced hearing loss. NIOSH recommends measures to promote better hearing health through the use of quieter equipment, better work practices, hearing protection devices, and implementation of effective hearing loss prevention programs.

### Description of Exposure

More than 1.1 million fire fighters work in the United States (330,000 career fire fighters and 800,000 volunteer fire fighters) [BLS 2011; NFPA 2010].

Firefighters are exposed to many hazards as part of their job, including noise. The main sources of noise are fire sirens, alarms, communication devices, audio equipment in cabs, engine pumps, rotary and chain saws, ventilation fans, and pneumatic tools used in emergency ventilation and extrication (see Table 1). In addition, fire fighters are also exposed to chemicals and combustion by-products that may have ototoxic effects and exacerbate the onset of hearing loss [Lees 1995; Morata 2003]. Such activities often result in fire fighters being exposed to noise that exceeds occupational exposure limits [Neitzel 2012; Tubbs 1991]. Fire fighters who are repeatedly exposed to high

noise levels risk developing work-related hearing loss [Ide 2011; Kales et al. 2001; Tubbs 1991].

### Exposure Limits

The NIOSH recommended exposure limit (REL) for noise is 85 A-weighted decibels (dBA) as an 8-hour time-weighted average (TWA) using a 3-dB exchange rate (for every 3-dB increase, exposure time should be cut in half). Exposures at or above this level are considered hazardous. In addition, NIOSH recommends that exposure to continuous, intermittent, varying, or impulsive noise not exceed 140 dBA [NIOSH 1998].

Table 1. Summary of noise level measurements from fire department surveys

Job description/source	Average noise levels (dBA)	Maximum noise levels (dBA)
Driver	84–88	106–109
Jump seat	85–88	105–106
Tiller	75	97
EMS	78	100
Ventilation (sawing/blower)	87–109	110–114
Vehicle extraction (chisels/spreaders)	90–106	98–115
Fire suppression (ladders/water pumps)	89–91	84–98
Fire station (testing alarm/tools/engine)	88–101	92–116
Fire station (break room)	67	68

Sources: NIOSH 1990; NIOSH 1994; Neitzel et al. 2012

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The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for noise is 90 dBA, and the action level is 85 dBA, both as an 8-hour TWA using a 5-dB exchange rate [29 CFR 1910.95]. This means that hearing protection, administrative and engineering controls, and annual monitoring are required. The OSHA occupational noise standard also recommends that exposures to impact or impulsive noise not exceed 140 dB peak sound pressure level.

Since fire fighters in the United States commonly work 24-hours shifts with 48 hours off, noise exposure limits need to be adjusted [see Table 1-1 in NIOSH 1998 and OSHA Table G-16A in 29 CFR 1910.95]. For instance, the NIOSH REL for 24 hours would be 80.3 dBA and the OSHA Action Level would be 77.1 dBA (OSHA does not require adjustment to the PEL).

In addition, the National Fire Protection Association (NFPA) Standard on Fire Department Occupational Safety and Health (NFPA 1500) and Standard on Comprehensive Occupational Medical Programs (NFPA 1582) recommend that fire departments establish hearing conservation programs that reduce or eliminate harmful sources of noise and require hearing protection when noise exceeds 90 dBA as well as entry and periodic audiometric evaluations for all fire fighters [NFPA 2013].

## NIOSH Investigations

NIOSH conducted several Health Hazard Evaluations (HHE) [NIOSH 1982, 1988, 1990, 1991, 1994, 1995, 2008] that examined noise exposures and documented hearing loss among fire fighters (Figure 1). The first HHE examined 55 fulltime fire fighters from the Newburgh Fire Department and showed marked hearing loss in noise sensitive frequencies. Although the 8-hour TWAs were generally less than NIOSH and OSHA exposure limits, intermittent noise exposures during emergency response reached between 99–116 dBA [NIOSH 1982]. Pure tone audiometry conducted on 333 self-selected fire fighters attending an International Association of Fire Fighters convention showed 163 (49%) with normal hearing, 125 (38%) with mild to moderate hearing loss, and 45 (14%) with moderately severe to profound hearing loss [NIOSH 1991]. Audiometric results from 2 investigations (197 fire fighters at 2 fire stations serving the Memphis International Airport and 424 fire fighters at the Pittsburgh Bureau of Fire) indicated noise-induced hearing loss (NIHL) among fire fighters and a statistical correlation between hearing loss and the years of service [NIOSH 1990, 1994]. In addition to hearing loss, 35% of the Pittsburgh fire fighters reported tinnitus (ringing in the ears) [NIOSH 1994]. A study of audiometric data of 55 fire fighters at the Hamilton Fire Department tested in 1983 and again in 1989 showed a decline in their hearing ability at higher frequencies, a pattern characteristic of NIHL [NIOSH 1995].



**Figure 1.** NIOSH researcher examines noise levels generated by fire truck siren and engine.

## Other Studies

A study of 319 fire fighters in Massachusetts (average age  $39.5 \pm 6.9$  years) showed 46 (14%) fire fighters with high-frequency hearing loss compared with 5% of the general population with similar age distribution [Kales et al. 2001]. A focus group study at 2 fire departments found that although fire fighters were aware of the damaging effects of loud noise, they did not use hearing protection regularly [Hong et al. 2008]. The two fire departments had no hearing conservation programs in place, and the fire fighters viewed NIHL as an unavoidable part of the job and a smaller risk compared with other hazards. They believed HPDs interfered with their ability to communicate during emergency operations, interfered with other required safety equipment, and were generally forgotten when gearing up. Clark and Bohl [2005] examined 12,609 audiograms at two fire departments specifically selected for having rigorous hearing conservation programs and found no evidence of hearing loss among their fire fighters. A task-based study conducted at 3 fire departments found average noise levels that ranged from 82–109 dBA. The NIOSH REL of 85 dBA over an 8-hr work shift was exceeded in less than one hour for certain firefighting tasks such as the use of saws and pneumatic chisels [Neitzel et al. 2012].

## Recommendations

To prevent fire fighters from developing a hearing impairment, NIOSH recommends fire departments establish and maintain department-specific hearing loss prevention programs that include the following elements:

- Engineering and administrative controls to limit fire fighters' overall exposure to noise from equipment or in

the work environment. Fire departments should incorporate noise emission limits in their purchasing agreements for new equipment [Neitzel et al. 2012; Duffy et al. 1992; Tubbs 1991]. The “Buy Quiet” process recommended by NIOSH encourages a purchaser to compare the noise emission levels of different models of equipment and, whenever possible, buy the quieter model [Hayden 2012].

- Training about harmful noise levels from various tasks and equipment, the effects of noise exposure, and hearing loss [Duffy et al. 1992].
- Training about appropriate hearing protection devices, especially electronic devices designed specifically for fire fighters and that provide enhanced communication capabilities and block harmful noise.
- Individualized training on the proper use of hearing protection devices using commercially available fit-test systems [Murphy et al. 2011]. Fit-testing allows for easy and accurate measurement of hearing protection effectiveness just as they are being used in the field.

Although most of these recommendations are aimed at promoting hearing health among traditional structural fire fighters, they are mostly applicable to others types of fire fighting applications such as wildland fire fighting, aircraft and shipboard rescue and fire fighting, and technical rescue and hazardous materials operations.

## Acknowledgments

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## References

CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Clark WW, Bohl CD [2005]. Hearing levels of firefighters: risk of occupational noise-induced hearing loss assessed by cross-section and longitudinal data. *Ear and Hearing* 26(3):327–340.

Duffy RM, McCall P, Bass R, Tubbs RL [1992]. Fire and emergency service hearing conservation program manual. Washington, DC: International Association of Fire Fighters; Federal Emergency Management Agency, [http://www.usfa.fema.gov/downloads/pdf/publications/fa-118.pdf]

Hayden CS II, Zechmann E [2012]. Advanced tools for buying quiet Products. New York: Proceedings of the Institute for Noise Control Engineers (INCE) Conference.

Hong O, Samo D, Hulea R, Eakin B [2008]. Perception and attitudes of firefighters on noise exposure and hearing loss. *J Occup Environ Hyg* 5(3):210–215.

Ide CW [2011]. Hearing losses in wholtime firefighters occur ring early in their careers. *Occup Med (London)* 61(7):509–511.

Kales SN, Freyman RL, Hill JM, Polyhronopoulos GN, Aldrich JM, Christiani DC [2001]. Firefighters’ hearing: a comparison with population databases from the International Standards Organization. *J Occup Environ Med* 43(7):650–656.

Lees PS [1995]. Combustion products and other firefighter exposures. *Occup Med* 10(4):691–707.

Morata, TC [2003]. Chemical exposure as a risk factor for hearing loss. *J Occup Environ Med* 45(7):676–682.

Murphy WJ, Stephenson MR, Byrne DC, Witt B, Duran J [2011]. Effects of training on hearing protector attenuation. *Noise Health* 13(51):132–141.

Neitzel RL, Hong O, Quinlan P, Hulea R [2012]. Pilot task-based assessment of noise levels among firefighters. *Int J Ind Ergonomics* (June 2012):1–8.

NFPA 1500 [2013]. Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.

NFPA 1582 [2013]. Standard on comprehensive occupational medical programs for fire departments. Quincy, MA: National Fire Protection Association.

NIOSH [1982]. Health Hazard Evaluation report: Newburgh Fire Department—Newburgh, New York. By Tubbs RL; Flesch JP. NIOSH HETA No. 81–059–1045.

NIOSH [1988]. Health Hazard Evaluation report: International Association of Fire Fighters—Cincinnati, Ohio. By Tubbs RL; Mitchell S; Anderson KE. NIOSH HETA No. 84–454–1890

NIOSH [1990]. Health Hazard Evaluation report: Memphis Fire Department—Memphis, Tennessee. By Tubbs RL. NIOSH HETA No. 86–138–2017, [http://www.cdc.gov/niosh/hhe/reports/pdfs/1986-0138-2017.pdf]

NIOSH [1991]. Health Hazard Evaluation report: International Association of Fire Fighters—Anaheim, California. By Tubbs RL. NIOSH HETA No. 87–352–2097, [http://www.cdc.gov/niosh/hhe/reports/pdfs/1987-0352-2097.pdf]

NIOSH [1994]. Health Hazard Evaluation report: Pittsburgh Bureau of Fire—Pittsburgh, Pennsylvania. By Tubbs RL. NIOSH HETA No. 88–0290–2460, [http://www.cdc.gov/niosh/hhe/reports/pdfs/1988-0290-2460.pdf]

NIOSH [1995]. Health Hazard Evaluation report: Hamilton Fire Department—Hamilton, Ohio. By Tubbs RL. NIOSH HETA No. 89–0026–2495, [http://www.cdc.gov/niosh/hhe/reports/pdfs/1989-0026-2495.pdf]

NIOSH [1998]. Criteria for a recommended standard: occupational noise exposure. Revised criteria 1998. DHHS (NIOSH) Publication No. 98–126, [http://www.cdc.gov/niosh/docs/98126/]

NIOSH [2008]. Health Hazard Evaluation report: Evaluation of potential noise hazards to mechanics and 911 dispatchers at a fire department—Anchorage, Alaska. By Achutan C, Kardous CA. NIOSH HETA No. 2007–0235–3064, [http://www.cdc.gov/niosh/hhe/reports/pdfs/2007-0235-3064.pdf]

Tubbs RL [1991]. Occupational noise exposure and hearing loss in fire fighters assigned to airport fire stations. *Am Ind Hyg Assoc J* 52(9):372–378.

**DEPARTMENT OF HEALTH AND HUMAN SERVICES**  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health  
4676 Columbia Parkway  
Cincinnati, OH 45226-1998

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