

This Health Hazard Evaluation (HHE) report and any recommendations made herein are for the specific facility evaluated and may not be universally applicable. Any recommendations made are not to be considered as final statements of NIOSH policy or of any agency or individual involved. Additional HHE reports are available at <http://www.cdc.gov/niosh/hhe/reports>

**HETA 2000-0408-2825**  
**Federal Aviation Administration**  
**Burlington, Massachusetts**

---

**Randy L. Tubbs, Ph.D.**

## PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

## ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Randy L. Tubbs, Ph.D. of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by Ellen Blythe. Review and preparation for printing were performed by Penny Arthur.

Copies of this report have been sent to management representatives at FAA and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. Single copies of this report will be available for a period of three years from the date of this report. To expedite your request, include a self-addressed mailing label along with your written request to:

NIOSH Publications Office  
4676 Columbia Parkway  
Cincinnati, Ohio 45226  
800-356-4674

After this time, copies may be purchased from the National Technical Information Service (NTIS) at 5825 Port Royal Road, Springfield, Virginia 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address.

**For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.**

## Highlights of the NIOSH Health Hazard Evaluation

### Evaluation of FAA's Aviation Safety Inspectors' Noise Exposures

The FAA's New England Regional Occupational Health and Safety Office requested that NIOSH investigators conduct a noise exposure evaluation at airport ramps and repair station facilities.

#### What NIOSH Did

- # We gathered noise samples at three airports, two repair stations, and one aviation hanger
- # We watched and talked to employees as they did their jobs
- # We gave employees electronic, stereo ear muffs to try during their work

#### What NIOSH Found

- # We measured noise levels that were less than 8-hour allowable limits
- # We did see shorter noise exposures that require the use of hearing protection devices

#### What FAA Managers Can Do

- # The FAA should give hearing tests to inspectors that are required to wear hearing protection devices
- # The FAA should allow more inspectors to try the electronic ear muffs to see if they improve their working conditions and purchase them for the workers who request them
- # More noise measurements should be made at all airports and repair stations in the region

#### What the FAA Employees Can Do

- # Employees should continue to follow the practice of wearing hearing protection devices on airport ramps and posted areas in repair facilities
- # Employees should take the hearing tests offered by the FAA and give copies to their personal physician



**What To Do For More Information:**  
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513/841-4252 and ask for HETA Report # 2000-0408-2825



**Health Hazard Evaluation Report 2000-0408-2825  
Federal Aviation Administration  
Burlington, Massachusetts  
February 2001**

**Randy L. Tubbs, Ph.D.**

---

---

## **SUMMARY**

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) received a request for assistance from the Federal Aviation Administration's (FAA) New England Regional Occupational Health and Safety Office in August 2000, to evaluate noise exposures that aviation safety inspectors encounter during their employment. A previous investigation at Boston's Logan International Airport recommended that the inspectors be included in the agency's hearing conservation program. The FAA wanted to determine if other inspectors within the region should also be included in some level of a hearing conservation program.

In the week of October 23-27, 2000, a NIOSH investigator and the FAA's Occupational Health and Safety Manager visited three airports, two repair facilities at manufacturing plants, and one aviation maintenance and repair hanger to measure the aviation safety inspectors' daily noise exposures while they conducted their work activities. The survey results showed that the inspectors generally did not exceed the daily allowable noise limits specified in the evaluation criteria of this report. There was one instance where the 8-hour average noise level did exceed the NIOSH recommended limit for an inspector working on the ramp of an airport. Also, the average noise levels were sufficiently high to warrant the use of hearing protection devices, particularly while on the airport ramps. It was noted that the practice of wearing the devices was adhered to by all of the aviation safety inspectors observed in this evaluation.

The results of the noise evaluation of the FAA's aviation safety inspectors showed that the current practice of wearing hearing protection devices on the airport ramps and in posted areas of the repair facilities should be continued. Because the use of these devices is required by the agency, it is recommended that the inspectors be included in a medical surveillance program of audiometric testing to determine if the hearing protection devices are being worn properly. Recommendations are also offered to the agency on further noise surveys and on different hearing protection devices that may be better suited to their job requirements.

Keywords: SIC 9621 (Regulation and Administration of Transportation Programs), noise, aviation safety inspectors, ramp operations, hearing protection devices

# TABLE OF CONTENTS

Preface .....	ii
Acknowledgments and Availability of Report .....	ii
HHE Supplement .....	iii
Summary .....	iv
Introduction .....	1
Background .....	1
Methods .....	1
Evaluation Criteria .....	2
Results .....	3
Discussion .....	5
Conclusions .....	5
Recommendations .....	6
References .....	6

## INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from the Federal Aviation Administration (FAA) on August 22, 2000. The request came from the FAA's Federal Occupational Health and Safety Manager, who forwarded a concern about the noise levels that the agency's aviation safety inspectors encounter during their employment. The aviation safety inspectors are generally not included in the FAA's hearing conservation program and, thus, do not receive annual audiometric examinations, periodic noise monitoring, or training on the effects of occupational noise exposures and methods to reduce the risk of hearing loss.

The Flight Standards District Office (FSDO) managers in the New England Region submitted a list of 17 airports and repair facilities where the aviation safety inspectors perform their duties. From this list, NIOSH and the FAA selected five locations that were within reasonable distance from each other and typified the kinds of noise exposures the inspectors experienced in their jobs. During the week of October 22, 2000, a NIOSH investigator and FAA safety manager traveled to three airports and two repair facilities to conduct noise surveys on the aviation safety inspectors and interview them about their typical activities and noise sources. One additional aircraft maintenance and repair hanger located at one of the airports was also surveyed.

## BACKGROUND

Aviation safety inspectors, assigned to each FSDO, are responsible for inspecting aircraft, aircraft parts, and repair facilities. The inspections determine the air worthiness of aircraft by visual inspection, along with verification that parts are repaired properly and the accompanying documentation of the repairs is complete and correct. These tasks require that the inspectors visit manufacturing plants where parts are sent for repair, aviation hangers where the repairs

take place, and the ramp areas of airports where aircraft are inspected. Each inspector has several facilities that they oversee. Each location produces noise that the inspectors can encounter, including aircraft engines, auxiliary power units (APUs), pneumatic tools, machining operations, and test stands for various airplane parts.

In August 1994, the FAA's New England Region contracted with an environmental consulting firm to conduct a noise survey of inspectors assigned to the ramp at Logan International Airport in Boston, Massachusetts. Based on the findings of the sound level meter study, the consultant concluded that the FSDO inspectors' noise exposures do not exceed the Occupational Safety and Health Administration's (OSHA) regulated noise limit. However, because of the short-term, high exposures that can be found on the ramp, it was suggested that a hearing conservation program for these staff be developed. This program has since been implemented for aviation safety inspectors who work at Logan International Airport. No other inspectors in the New England Region are enrolled in this type of program. The purpose of this health hazard evaluation was to determine if inspectors assigned to other locations within the region should be included in a similar program.

## METHODS

Quest® Electronics Model Q-300 Noise Dosimeters were worn by the aviation safety inspectors while they performed the activities associated with the inspection of aircraft on airport ramps and the repair of aircraft and aircraft parts at the various repair facilities. The noise dosimeters were attached to the wearer's belt and a small remote microphone was fastened to the wearer's shirt at a point midway between the ear and the outside of the employee's shoulder. A windscreen provided by the manufacturer of the dosimeter was placed over the microphone during recordings. At the end of an inspection, the dosimeter was removed and paused to stop data collection. The information stored in the dosimeters was downloaded to a personal computer

for interpretation with QuestSuite for Windows® computer software. The dosimeters were calibrated before and after the measurement periods according to the manufacturer's instructions.

## EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),<sup>1</sup> (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),<sup>2</sup> and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).<sup>3</sup> Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized

hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 95–596, sec. 5.(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise-induced loss is caused by damage to nerve cells of the inner ear (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.<sup>4</sup> While loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are rare. In most cases, noise-induced hearing loss is insidious. Typically, it begins to develop at 4000 or 6000 hertz (Hz) (the hearing range is 20 Hz to 20000 Hz) and spreads to lower and higher frequencies. Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.<sup>5</sup>

The A-weighted decibel [dB(A)] is the preferred unit for measuring sound levels to assess worker noise exposures. The dB(A) scale is weighted to approximate the sensory response of the human ear to sound frequencies near the threshold of hearing. The decibel unit is dimensionless, and represents the logarithmic relationship of the measured sound pressure level to an arbitrary reference sound pressure (20 micropascals, the normal threshold of human hearing at a frequency of 1000 Hz). Decibel

units are used because of the very large range of sound pressure levels which are audible to the human ear. Because the dB(A) scale is logarithmic, increases of 3 dB(A), 10 dB(A), and 20 dB(A) represent a doubling, tenfold increase, and 100-fold increase of sound energy, respectively. It should be noted that noise exposures expressed in decibels cannot be averaged by taking the simple arithmetic mean.

The OSHA standard for occupational exposure to noise (29 CFR 1910.95)<sup>6</sup> specifies a maximum PEL of 90 dB(A) for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that a person may be exposed to noise levels of 95 dB(A) for no more than 4 hours, to 100 dB(A) for 2 hours, etc. Conversely, up to 16 hours exposure to 85 dB(A) is allowed by this exchange rate. The duration and sound level intensities can be combined in order to calculate a worker's daily noise dose according to the formula:

$$\text{Dose} = 100 \times (C_1/T_1 + C_2/T_2 + \dots + C_n/T_n),$$

where  $C_n$  indicates the total time of exposure at a specific noise level and  $T_n$  indicates the reference duration for that level as given in Table G-16a of the OSHA noise regulation. During any 24-hour period, a worker is allowed up to 100% of his daily noise dose. Doses greater than 100% are in excess of the OSHA PEL.

The OSHA regulation has an additional action level (AL) of 85 dB(A); an employer shall administer a continuing, effective hearing conservation program when the 8-hour time-weighted average (TWA) value exceeds the AL. The program must include monitoring, employee notification, observation, audiometric testing, hearing protectors, training, and record keeping. All of these requirements are included in 29 CFR 1910.95, paragraphs (c) through (o). Finally, the OSHA noise standard states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels.

NIOSH, in its Criteria for a Recommended Standard,<sup>7</sup> and the ACGIH,<sup>2</sup> propose exposure criteria of 85 dB(A) as a TWA for 8 hours, 5 dB less than the OSHA standard. The criteria also use a more conservative 3 dB time/intensity trading relationship in calculating exposure limits. Thus, a worker can be exposed to 85 dB(A) for 8 hours, but to no more than 88 dB(A) for 4 hours or 91 dB(A) for 2 hours. Twelve hours exposures have to be 83 dB(A) or less according to the NIOSH REL.

## RESULTS

Five locations were surveyed during the site visit in October 2000. The airport sites were the Portland International Jetport in Maine, a medium-sized commercial facility with several scheduled daily arrivals and departures; Bradley International Airport serving the Hartford, Connecticut area, a very large international airport with multiple commercial terminals; and Bedford, Massachusetts' Laurence G. Hanscom Field, a smaller general aviation airport with a few scheduled commercial shuttle flights. The repair facilities visited included an aircraft engine manufacturer and repair station in Maine, an aircraft lubrication pump manufacturer and repair station in Massachusetts, and an aircraft maintenance and repair hanger located at Bradley International Airport. At each location, an aviation safety inspector was identified by the FAA management to participate in the noise evaluation. The inspector would wear a noise dosimeter while performing the kinds of tasks he or she would normally conduct in their inspection activities.

The primary activity observed on airport ramps by the inspectors was a walk-around inspection of aircraft while they were parked at the terminal. The aircraft were powered while on the ramps by APUs and ground power units (GPUs) which produce noise. Also, other aircraft in the area would taxi to and from the terminal while the inspectors were in the vicinity. These inspectors would also spend time in the offices and baggage handling areas of the airlines. FAA inspectors at the repair facilities were required to go onto the production floor to inspect



aircraft parts and the accompanying paper work. The two facilities visited during the evaluation had many machining operations, such as metal lathes, drills, and grinders, that were involved in making original and repaired parts. There was also a test stand at the lubrication pump manufacturing facility that produced noise when every piece was checked for correct performance before being sent to the purchaser. Finally, the inspector who worked at the aircraft repair hanger was exposed to noise from power tools, paint spraying, and aircraft taxiing past the hanger.

The Quest dosimeters collect data so that one can directly compare the information with the three different noise criteria used in this survey, the OSHA PEL and AL, and the NIOSH REL. The OSHA criteria use a 90 dB(A) criterion and 5-dB exchange rate for both the PEL and AL. The difference between the two is the threshold level employed, with a 90 dB(A) threshold for the PEL and an 80 dB(A) threshold for the AL. The threshold level is the lower limit of noise values included in the calculation of the criteria; values less than the threshold are ignored by the dosimeter. The NIOSH criterion differs from OSHA in that the criterion is 85 dB(A), the threshold is 80 dB(A), and it uses a 3-dB exchange rate.

The results from the dosimeter surveys are presented in Table 1 using two different metrics. The average noise level ( $L_{AVG}$ ) represents the noise exposure for just the time when the dosimeter was on the inspector. If one assumes that the sampled activities represent the daily activities that the employee routinely performs, then the  $L_{AVG}$  will be equivalent to the 8-hr TWA. However, if the sampled activities are really the only times that the inspector is exposed to noise and the remainder of the work day is in a relatively quiet environment (less than 80 dB(A)), then the  $TWA_{(8)}$  will be lower because the criterion assumes that the non-sampled time adds nothing to the employee's dose. In no instance did the  $L_{AVG}$  noise exposures exceed the OSHA PEL criterion or the action limit. The  $L_{AVG}$  values were greater than the NIOSH REL for the aviation safety inspector who was at the Portland Jetport. Generally, the noise

exposures measured at the two airports with scheduled commercial service were greater than the repair facilities or the general aviation airport. The results measured at the general aviation airport were affected by weather in the area (fog at other airports near Bedford) that delayed incoming flights during the morning of the site visit.

The inspectors' noise exposures were variable, depending on the area where the inspector was located and the types of noise-producing equipment that were in close proximity. A comparison of a work activity time line collected by the NIOSH investigator with the real-time data collected by the noise dosimeter confirms this variability. Figure 1 shows the noise exposure of the inspector at the Portland airport and Figure 2 is the dosimeter data collected during the inspection at the lubrication pump repair facility. At the Portland airport, the inspector walked around a regional jet with an operating APU beginning at 10:15 a.m. followed immediately by an inspection of a turbo-prop aircraft that was powered by a GPU at 10:23 a.m. The inspector then entered the terminal building and the passenger area until 11:15 a.m. when the inspector returned to the ramp and an inspection of a commercial jet took place. This aircraft was powered by an APU which was exhausted through the tail section of the plane. The inspector then moved to another commercial jet at 11:25 a.m. with the APU located in the wheel well near the wings about 7 feet off of the ground. Lastly, another turbo-prop aircraft that had no ground or auxiliary power was inspected at 11:50 a.m. Each of these peaks can be clearly distinguished in Figure 1 with two of the activities exceeding a 1-min average of 100 dB(A). The noise levels for the activities of the inspector at the lubrication pump repair facility are less distinctive than at the airport. Figure 2 shows relatively quiet exposures while the inspector is in the parts repair area from 8:50 a.m. until 9:17 a.m. A general tour of the original equipment manufacturing area was done from 9:17 a.m. until 10:10 a.m., followed by a tour of the pump test room until 10:30 a.m. The remainder of the survey time was spent in a conference room in the office area of the facility. The figure shows average noise levels up to

80 dB(A) on the manufacturing floor and levels over 90 dB(A) in the pump test room. The parts repair area and conference room are quiet locations. Whenever FAA safety inspectors were on the ramp of an airport or in hearing protection areas of the repair facilities, they were wearing hearing protection devices.

## DISCUSSION

The average daily noise exposures that the FAA aviation safety inspectors encountered during this survey were below all the evaluation criteria. However, there were documented occasions where the exposure levels were great enough to warrant the usage of hearing protection devices according to the NIOSHREL.<sup>7</sup> Noise levels were consistently greater than 85 dB(A) on the airport ramps when aircraft engines and APUs were operational and in the parts' test area of the repair facility. NIOSH does recommend that hearing protection devices be worn whenever noise levels exceed this value, regardless of exposure time.<sup>7</sup> The inspectors are issued hearing protection devices by the FAA and were observed wearing the devices in the noisy environments.

It is recognized that hearing protection devices may be less effective than the protection levels that are assigned to them. The use of hearing protection devices is subject to many problems, such as discomfort, incorrect use with other safety equipment, dislodging, deterioration, and abuse.<sup>8</sup> They also perform differently in workplace settings as compared to the laboratories where the noise reduction ratings (NRR) are determined.<sup>9,10</sup> NIOSH acknowledged this problem in its original criteria document on occupational noise exposure.<sup>11</sup> The document recommended medical surveillance in the form of audiometric testing for all employees whose occupational noise exposure is controlled by personal protective equipment.

It was observed that a major component of the aviation safety inspectors' activities is communicating with pilots and ground personnel of the airlines while they are on the ramp and with

employees at the repair facilities on the manufacturing floor. This becomes more difficult when the inspectors are wearing hearing protection devices. It was observed during this survey that airplane pilots and people who were participating in the walk-through tours in the repair facilities would remove an earplug when they attempted to converse with the FAA or NIOSH individuals. As a part of this evaluation, the NIOSH investigator provided the aviation safety inspectors and the New England regional safety manager a pair of electronic, stereo ear muffs to use on the day they were monitored. The devices are volume controlled so that low-level sounds can be amplified. When the wearer is exposed to loud sounds, the amplifiers are automatically shut off in less than 2 milliseconds providing effective passive hearing protection. This kind of device seems appropriate for the work on the airport ramp where people are exposed to intermittent high levels of noise along with more moderate levels of noise exposure. The amplification helps to overcome the attenuation of the hearing protection device when the ambient levels are 80 dB(A) and below, but still offer adequate protection when the employee is exposed to the higher noise levels associated with aircraft engines and power units. One of the aviation safety inspectors commented that he was able to verify that panels on the aircraft were not loose by tapping them with his hand and hearing the response. He said that he was unable to do this with passive hearing protection devices. The inspectors were also observed to constantly wear the amplified ear muffs when talking with pilots and airline ground personnel, even when these latter individuals would remove one ear plug to carry on a conversation. These devices also left the inspector's hands free to write notes while conversing.

## CONCLUSIONS

During the week-long evaluation of FAA aviation safety inspectors, it was observed that these employees were exposed to intense noise levels for only short periods of time during their activities at airports and repair facilities. The measured noise

levels were high enough to warrant the use of hearing protection devices but were not of a sufficient length of time to be greater than the regulations or guidelines for occupational noise exposure, assuming that the activities observed in the evaluation were representative of the inspectors' noise dose over time.

The practice of wearing hearing protection devices that was observed by the NIOSH investigator is appropriate for the employees who are working on the airport ramps and posted noise areas in the repair facilities. However, it has been noted by NIOSH that whenever employees are required to wear hearing protection devices in the workplace, they should receive medical surveillance in the form of annual audiometric tests to insure that the devices are working properly and that the hearing levels of the employees are not changing.<sup>11</sup>

## RECOMMENDATIONS

The following recommendations are based on the measurements and observations made during the HHE and are offered to the FAA to help protect their employees from occupational noise-induced hearing loss.

1. Continue the agency's practice of issuing hearing protection devices to the aviation safety inspectors for use in their jobs. The use of these devices on the ramp of airports and in locations in the manufacturing and repair facilities that have been designated as hearing protection required areas is appropriate and should be enforced.
2. Because the FAA issues hearing protection devices for use by the aviation safety inspectors, a medical surveillance system consisting of annual audiometric testing should be implemented to insure that the devices are adequate and are being worn correctly by the employees. Several sources are available that outline the recommended practices of such a testing program.<sup>12,13,14,15,16</sup>

3. The FAA should consider the use of the electronic, stereo ear muffs for the aviation safety inspectors to wear while on the ramp at airports. The devices were well received by those who wore them during this evaluation. The employees were able to better converse with airline personnel while wearing the devices. It was also stated that auditory cues generated during the inspection process could be heard with the electronic devices in place, something that did not happen with passive hearing protection devices. There are several manufacturers who produce hearing protection devices of this type.

4. The FAA's Federal Occupational Health and Safety regional office should perform additional noise surveys at other airports and repair facilities that are within their jurisdiction. It is recommended that the noise dosimeter that the office has available be returned to the manufacturer or authorized representative for calibration and maintenance to insure that it is operating in a compliant fashion. Initial noise surveys of all locations should be conducted and logged. Whenever complaints or concerns about noise levels are forwarded to the health and safety office, additional spot measurements can be performed to document whether changes in employees' noise exposures have occurred.

## REFERENCES

1. NIOSH [1992]. Recommendations for occupational safety and health: compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.
2. ACGIH [2000]. 2000 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Code of Federal Regulations (CFR) [1997]. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.
4. Ward WD, Royster LH, Royster JD [2000]. Anatomy & physiology of the ear: normal and damaged hearing. Chapter 4. In: Berger EH, Royster LH, Royster JD, Driscoll DP, & Layne M, eds. The noise manual. 5th ed. Fairfax, VA: American Industrial Hygiene Association, pp 101-122.
5. Suter AH [1978]. The ability of mildly hearing-impaired individuals to discriminate speech in noise. Washington, DC: U.S. Environmental Protection Agency, Joint EPA/USAF study, EPA 550/9-78-100, AMRL-TR-78-4.
6. CFR [1992]. OSHA. 29 CFR 1910.95. Washington, DC: U.S. Government Printing Office, Federal Register.
7. NIOSH [1998]. Criteria for a recommended standard: occupational noise exposure (revised criteria 1998). Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98-126.
8. Berger EH [1980]. EARLOG monographs on hearing and hearing protection: hearing protector performance: how they work-and-what goes wrong in the real world. Indianapolis, IN: Cabot Safety Corporation, EARLOG 5.
9. Berger EH, Franks JR, Lindgren F [1996]. International review of field studies of hearing protector attenuation. In: Axelsson A, Borchgrevink H, Hamernik RP, Hellstrom P, Henderson D, Salvi RJ, eds. Scientific basis of noise-induced hearing loss. New York, NY: Thieme Medical Publishers, Inc., pp. 361-377.
10. CFR [1979]. EPA 40 CFR Part 211. Washington, DC: U.S. Government Printing Office, Federal Register.
11. NIOSH [1972]. Criteria for a recommended standard: occupational exposure to noise. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. HSM 73-11001.
12. NHCA [1987]. Occupational hearing conservationist training guidelines. Denver, CO: National Hearing Conservation Association.
13. Royster JD, Royster LH [1990]. Hearing conservation programs: Practical guidelines for success. Chelsea, MI: Lewis Publishers.
14. Suter AH [1993]. Hearing conservation manual. 3<sup>rd</sup> ed. Milwaukee, WI: Council for Accreditation in Occupational Hearing Conservation.
15. NIOSH [1996]. Preventing occupational hearing loss - A practical guide. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 96-110.
16. Royster JD [2000]. Audiometric monitoring phase of the HCP. Chapter 11. In: Berger EH, Royster LH, Royster JD, Driscoll DP, & Layne M, eds. The noise manual. 5th ed. Fairfax, VA: American Industrial Hygiene Association, pp 455-516.

Table 1

Personal Noise Dosimeter Results

FAA New England Region  
 Burlington, Massachusetts  
 HETA 2000-0408  
 October 23-27, 2000

Location	Time hh:mm	OSHA - PEL		OSHA - AL		NIOSH - REL	
		L <sub>AVG</sub>	TWA <sub>(8)</sub>	L <sub>AVG</sub>	TWA <sub>(8)</sub>	L <sub>AVG</sub>	TWA <sub>(8)</sub>
Portland,ME airport - a.m.	02:36	82.2 dB(A)	74.2 dB(A)	84.5 dB(A)	76.5 dB(A)	90.9 dB(A)	86.1 dB(A)
Portland, ME airport - p.m.	01:10	77.3 dB(A)	63.4 dB(A)	81.9 dB(A)	68.0 dB(A)	86.6 dB(A)	78.3 dB(A)
Bedford, MA airport	03:47	59.9 dB(A)	54.5 dB(A)	68.3 dB(A)	62.9 dB(A)	76.5 dB(A)	73.3 dB(A)
Bradley Int. airport	02:13	74.3 dB(A)	65.0 dB(A)	78.6 dB(A)	69.4 dB(A)	83.9 dB(A)	78.3 dB(A)
aircraft engine repair facility	00:51	59.2 dB(A)	43.1 dB(A)	79.3 dB(A)	63.2 dB(A)	81.7 dB(A)	72.1 dB(A)
lubrication pump repair facility - a.m.	02:47	70.7 dB(A)	63.1 dB(A)	75.6 dB(A)	68.0 dB(A)	81.2 dB(A)	76.7 dB(A)
lubrication pump repair facility - p.m.	01:33	43.6 dB(A)	31.8 dB(A)	52.0 dB(A)	40.2 dB(A)	67.1 dB(A)	59.9 dB(A)
Bradley Int. aircraft repair hanger	01:05	48.7 dB(A)	34.3 dB(A)	65.2 dB(A)	50.8 dB(A)	73.2 dB(A)	64.5 dB(A)

Figure 1

Portland, Maine Jetport  
HETA 2000-0408  
October 23-27, 2000

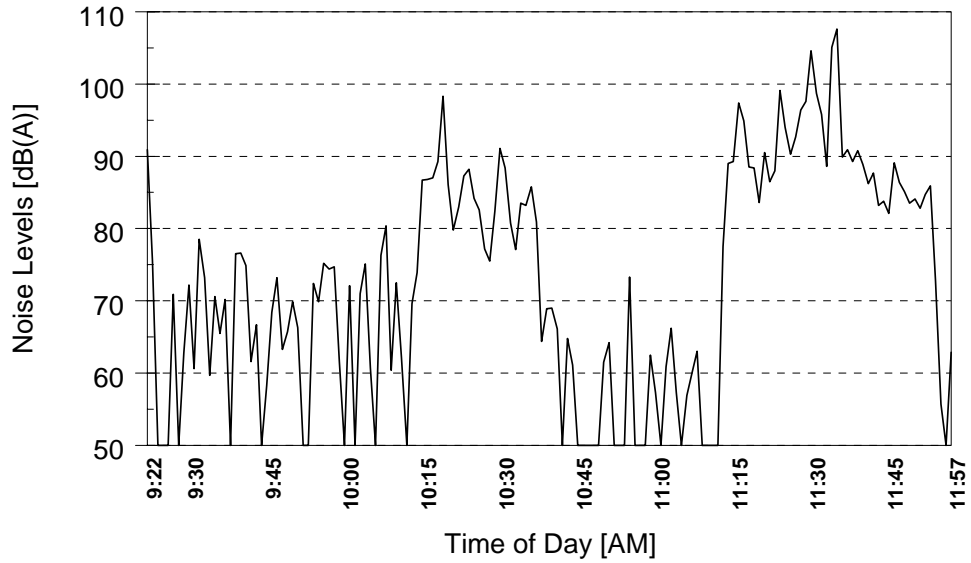
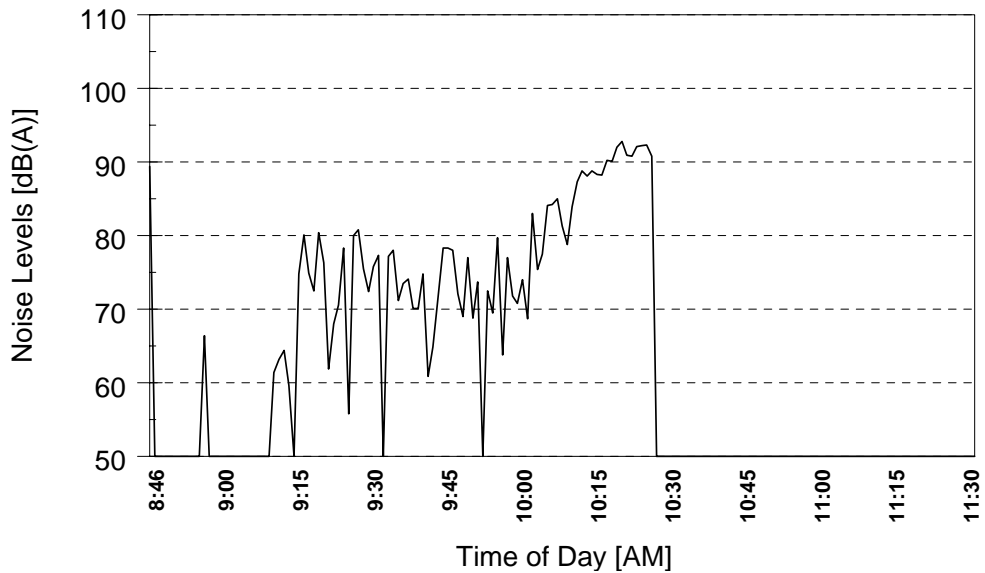


Figure 2

Aircraft Lubrication Pump Repair Facility  
HETA 2000-0408  
October 23-27, 2000



For Information on Other  
Occupational Safety and Health Concerns

Call NIOSH at:  
1-800-35-NIOSH (356-4674)  
or visit the NIOSH Web site at:  
[www.cdc.gov/niosh](http://www.cdc.gov/niosh)



! Delivering on the Nation's promise:  
Safety and health at work for all people  
through research and prevention