

**A PRACTICAL GUIDE TO EFFECTIVE HEARING CONSERVATION PROGRAMS  
IN THE WORKPLACE**

Edited by

Alice H. Suter and John R. Franks

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Public Health Service  
Centers for Disease Control  
National Institute for Occupational Safety and Health  
Division of Biomedical and Behavioral Science  
Physical Agents Effects Branch

SEPTEMBER 1990

## DISCLAIMER

Mention of the names of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health.

DHHS(NIOSH) Publication No. 90-120

## PREFACE

Hearing conservation programs can comply with the letter of the law (meaning the OSHA standard) and yet be ineffective in preventing work-related noise-induced hearing loss. Consequently, in 1988, NIOSH convened a group of hearing conservation experts to consider ways for achieving more effective hearing conservation programs. This guide sets forth the concepts and techniques which this distinguished body of experts has found to be consistent with successful hearing conservation programs. The document is not meant to be a technical treatise, but rather a practical guidebook, which should be useful to those who want to make sure that their hearing conservation programs actually are effective. It is intended for use by employers, middle management personnel, health and safety professionals, union health and safety representatives, noise-exposed employees, and other interested or affected parties concerned with hearing conservation.

NIOSH continues to support engineering controls as the most effective defense against the hazards of noise. We consider them an integral component of any effective hearing conservation program. In many instances, however, the application of engineering controls is not feasible, due to economic or practical considerations. When noise control is not feasible, or until controls can be installed, other aspects of the hearing conservation program must be emphasized. This guide discusses engineering controls only briefly, and concentrates in some detail on those factors which promote effectiveness in the non-engineering aspects of hearing conservation programs. It is our hope that the ideas contained in this guide will promote the actions needed to protect a vital human function - hearing.

Derek E. Dunn  
Chief, Bioacoustics and Occupational  
Vibration Section  
Physical Agents Effects Branch  
Division of Biomedical and  
Behavioral Science  
National Institute for Occupational  
Safety and Health



## EXECUTIVE SUMMARY

Noise is one of the most pervasive occupational health problems in America today. Approximately nine million workers are exposed on their jobs to noise levels that are potentially hazardous to their hearing. Fortunately, noise-induced hearing loss can be reduced, or often eliminated, through the successful application of occupational hearing conservation programs (HCPs).

A successful HCP benefits both the company and the affected employee. Employees are spared handicapping hearing impairments and evidence suggests that they may experience less fatigue and generally better health. Ultimately, the company benefits from reduced medical expenses and worker compensation costs. In some cases there may be improved morale and work efficiency.

The existence of a HCP (even one that complies with government standards) does not guarantee the prevention of noise-induced hearing loss. Experience with successful HCPs shows that management needs to develop and adhere to certain policies from the start. These policies cover the integration of the HCP into the company's safety and health program, designation of a key individual (a "program implementor") with ultimate responsibility for the overall conduct of the program, standard operating procedures for each phase of the program, the proper identification and use of outside services, and the purchase of appropriate equipment.

This guide, developed by those having long, varied experience in hearing conservation practices, presents some of the important attributes of successful HCPs. Concepts and action items are presented in terms of the responsibilities of three groups of personnel: those representing management, those who implement the HCPs, and the affected or noise-exposed employees. Checklists are provided in the appendices to assist in evaluating HCPs on a step-by-step basis.

The seven basic components of a HCP consist of: (1) noise exposure monitoring, (2) engineering and administrative controls, (3) audiometric evaluation, (4) use of hearing protection devices, (5) education and motivation, (6) record keeping, and (7) program evaluation.

### Noise Exposure Monitoring

As with any health hazard, it is important to characterize the hazard accurately and to identify the affected employees. Management should define the specific goals of the sound survey and make sure that operating procedures, as well as resources, are available for collecting and evaluating noise measurements. The results of the noise measurements must be reported to the HCP implementor and to the employees in an understandable format. HCP implementors need to coordinate closely with production employees to make sure that the measurements represent typical production cycles and that noise levels are adequately sampled. Program implementors should see that those who make the measurements closely follow the policies and procedures established by management, that the report explains the results clearly, and that employees are apprised of the results. Employees have the responsibility of sharing their knowledge about the production environment, the machinery, and specific operations with those who measure the noise.

### Engineering and Administrative Controls

The use of engineering controls should reduce noise exposure to the point where the

hearing hazard is significantly reduced or eliminated. It is especially important for companies to specify low noise levels when purchasing new equipment.

Management needs to identify controllable noise sources, set goals for noise control, and allocate resources to accomplish these goals. Managers should also explore potential administrative controls, such as scheduling that will minimize noise exposure, and quiet and conveniently located lunch and break areas. Program implementors must ensure that communication channels are open between management, noise control personnel, and equipment operators. The equipment operators, in turn, need to communicate their thoughts to management and those in charge of noise control, and must learn to operate and maintain their equipment to take full advantage of the noise controls.

### Audiometric Evaluation

Audiometric evaluation is crucial to the success of the HCP, since it is the only way to determine whether noise-induced hearing loss is being prevented by the prescribed hearing conservation actions. Management must allocate sufficient time and resources to the audiometric program to allow accurate testing; otherwise, the resulting audiograms will be useless. Management should also select audiometric technicians and professional consultants with demonstrated competence in relating to employees as well as in performing their duties in the audiometric program. The program implementor must monitor the audiometric program including scheduling, testing, equipment maintenance and calibration, audiogram review, feedback to the employee, and referral. Effective communication and coordination among company personnel, health services, and employees is of utmost importance. Employees need to disclose information about ear problems and prior noise exposures, or problems encountered in taking the audiometric test. They also need to follow up on any recommendations for treatment or further evaluation.

### Hearing Protection Devices

In the absence of feasible engineering or administrative controls, hearing protection devices (often referred to as hearing protectors) remain the only means of preventing hazardous noise levels from damaging one's hearing. Unless great care is taken in establishing a hearing protector program, employees will often receive very little benefit from these devices. Each employee can react differently to the use of such devices; and a successful program should respond to individual needs. The primary managerial responsibilities are: to facilitate the procurement of appropriate hearing protection devices, to demonstrate commitment to the program (e.g. by the use of these devices in appropriate situations), to provide the personnel and facilities to train employees in the use and care of hearing protection devices, and to enforce the use of hearing protectors. Program implementors need to be knowledgeable in the details of hearing protector evaluation, selection, and use, and must be able to impart this information to employees. Implementors need to encourage employees to ask questions and to help them solve any problems that may arise. Program implementors also should perform periodic on-site checks of the condition and performance of hearing protectors.

Employees must take responsibility for being fully informed about the need for hearing protection, wearing their hearing protectors correctly at all times, seeking replacements as necessary, encouraging co-workers to use these devices, and communicating problems to their supervisors.

## Education and Motivation

Education and motivation sessions are valuable for both management and employees so they will understand that a successful HCP takes commitment, communication, and cooperation. Management should set a high priority on regularly scheduled training sessions, and select articulate, knowledgeable, and enthusiastic instructors. Program implementors, or those who present the sessions, need to make their presentations short, simple, and highly relevant. They need to encourage questions and the expression of concerns, and they must make sure that all problems receive prompt attention. Employees must contribute to their own education by raising questions and concerns, and by informing program implementors when specific procedures are impractical, suggesting alternatives when possible. If HCP personnel fail to provide adequate consideration or follow-up, employees should communicate their concerns to higher levels of management.

## Record Keeping

Effective record keeping requires a committed and consistent approach. Each element of the HCP generates its own type of records (e.g., noise survey forms, audiograms, and medical histories) and much of this information needs to be integrated into the employee's health record. Management's responsibility is to provide adequate resources for efficient record processing, review, and storage in addition to training program implementors and procuring outside services if necessary. Management must ensure that confidentiality of personal data is maintained, that HCP records are available to program implementors and government inspectors, and that each employee has access to his or her own files. Program implementors must see that the information entered into the records is accurate, legible, complete, and self-explanatory. They also should ensure that records are standardized, cross-referenced, and properly maintained. Employees should take advantage of the record keeping system by inquiring about their hearing status, especially at the time of the annual audiogram.

## Program Evaluation

A thorough evaluation of all the HCP's components is necessary to determine the extent to which the HCP is really working, or if there are problems, which elements or departments are at fault. There are two basic approaches: (1) to assess the completeness and quality of the program's components, and (2) to evaluate the audiometric data. The first approach may use checklists, such as those found in Appendices A and B, and the second consists of evaluating the results of audiometric tests, both for individuals and for groups of noise-exposed employees. Management should dedicate resources for HCP evaluation (i.e., trained individuals and computer facilities). In addition, managers must be willing to acknowledge and solve problems that arise. If program implementors are not knowledgeable in the mechanics of data base analysis, the company must hire someone with these skills. Program implementors must also be committed to seeking out elusive information, and interacting with all members of the HCP team to identify and correct any deficiencies. As with many other aspects of the HCP, the employee's responsibility with respect to program evaluation is to provide feedback on the program's merits or shortcomings to the program implementor and management.





## CONTENTS

|   |     |
|---|-----|
| PREFACE.....  | iii |
| EXECUTIVE SUMMARY.....                                    | v   |
| ACKNOWLEDGMENT.....                                       | x   |
| INTRODUCTION.....   | 1   |
| VALUE OF A GOOD HEARING CONSERVATION PROGRAM.....         | 3   |
| POLICY NEEDS.....   | 6   |
| NOISE EXPOSURE MONITORING.....                            | 8   |
| ENGINEERING AND ADMINISTRATIVE CONTROLS.....              | 13  |
| AUDIOMETRIC EVALUATION.....                               | 20  |
| HEARING PROTECTION DEVICES.....                           | 27  |
| EDUCATION AND MOTIVATION.....                             | 30  |
| RECORD KEEPING.....                                       | 33  |
| PROGRAM EVALUATION.....                                   | 36  |
| APPENDIX A: OSHA NOISE STANDARD COMPLIANCE CHECKLIST..... | 38  |
| APPENDIX B: PROGRAM EVALUATION CHECKLIST.....             | 43  |
| APPENDIX C: AUDIO-VISUAL MATERIALS.....                   | 48  |
| APPENDIX D: SUGGESTED READING.....                        | 52  |
| APPENDIX E: RESOURCES.....                                | 54  |

## ACKNOWLEDGMENT

The editors would like to thank the members of the working group who spent long hours developing the philosophy and content of these guidelines. Special thanks go to those who contributed individual sections (particularly to Julia Royster who contributed several sections) and to those who thoughtfully reviewed draft versions.

### Working Group Members

\*John R. Franks, Working Group Chairman  
Bioacoustics and Occupational Vibration Section  
National Institute for Occupational Safety and Health  
4676 Columbia Parkway  
Cincinnati, Ohio 45226

Donald Gasaway  
4306 Springview  
Hearing Conservation - ASP  
San Antonio, Texas 78222

Robert Ligo  
Medical Division N 11400  
E.I. DuPont De Nemours and Co., Inc.  
Wilmington, Delaware 19898

David M. Lipscomb  
P.O. Box 1680  
8701 271st N.W., Suite 1  
Stanwood, Washington 98292

Paul L. Michael  
667 Franklin Street  
State College, Pennsylvania 16803

\*Julia D. Royster  
President, Environmental Noise  
Consultants, Inc.  
P.O. Box 144  
Cary, North Carolina 27512

\*Andrew P. Stewart  
E.L.B. and Associates, Inc.  
605 Eastowne Drive  
Chapel Hill, North Carolina 27514

\*+Alice H. Suter  
Consultant in Industrial Audiology  
and Community Noise  
818 Roeder Road, Suite 310  
Silver Spring, Maryland 20910

++Michael B. Threadgill  
General Dynamics  
P.O. Box 748, Mail Zone 1864  
Fort Worth, Texas 76101

\*Edwin H. Toothman  
Bethlehem Steel Corporation  
Room 663 Martin Tower  
Bethlehem, Pennsylvania 18016

Donald L. Wolfe  
President, Hearing Conservation  
Consultants  
West 104 Fifth Avenue  
Spokane, Washington 99204

\*Contributed sections of the guidelines  
+Currently, Research Audiologist, NIOSH

++Deceased

Reviewers

|                     |   |  |   |
|---------------------|---|--|---|
| <u>NIOSH Staff:</u> | Alexander Cohen<br>Walter M. Haag, Jr.<br>Carol J. Merry                  | Rickie R. Davis<br>Douglas L. Johnson<br>Randy L. Tubbs                    | Derek E. Dunn<br>Barry L. Lempert                       |
| <u>Extramural:</u>  | Carl D. Bohl<br>Georgia Holmes<br>Aage R. Møller<br>Henning E. von Gierke | Allan L. Cudworth<br>Martha A. Layne<br>Timothy L. Rink<br>Bradley K. Witt | Kenneth M. Eldred<br>William Melnick<br>Mark Stephenson |

We also want to thank Ms. Carol Merry for preliminary editing and coordinating initial reviews, Mr. Forest Holloway for creating many of the illustrations, Ms. Linda Carr for preparing the many drafts of the manuscript, Mr. Tyrone Eaton and Ms. Rhonda Wrenn, of Eaton and Associates, for coordinating the meeting of the hearing conservation experts and Ms. Margarete Smith for proofreading the final manuscript.

Alice H. Suter  
Research Audiologist  
Bioacoustics and Occupational  
Vibration Section  
Physical Agents Effects Branch  
Division of Biomedical and  
Behavioral Science  
National Institute for Occupational  
Safety and Health

John R. Franks  
Physical Scientist  
Bioacoustics and Occupational  
Vibration Section  
Physical Agents Effects Branch  
Division of Biomedical and  
Behavioral Science  
National Institute for Occupational  
Safety and Health



## INTRODUCTION

Noise is one of the most pervasive problems in today's occupational environment, affecting workers in manufacturing, construction, transportation, agriculture, and the military. Approximately nine million American workers are exposed to noise levels that are potentially hazardous to their hearing. The gradual progression of hearing loss due to noise may be less dramatic than an injury resulting from a workplace accident, but it is a significant and permanent handicap for the affected individual. Loss of hearing denies people sensory experiences that contribute to the quality of their lives. This tragedy is preventable.

Through comprehensive and coordinated efforts on the part of managers, interested employees, and safety and health professionals, much has been learned over the last few decades about implementing hearing conservation programs. A good hearing conservation program (HCP) has at least seven identifiable elements: noise exposure surveys, engineering controls, audiometric evaluations, worker education and training, the use of hearing protection devices, record keeping, and evaluation of overall program effectiveness. The program is usually implemented by a team, whose composition and size tend to be related to the size of the company and the number of noise-exposed employees. Members of the team may include any or all of the following: physician, nurse, audiologist, industrial hygienist, company and/or union safety representative, hearing conservation technician, and acoustical engineer.

This document summarizes the procedures involved in implementing these seven elements. They will be examined from the perspective of management, program implementors, and affected employees; and the responsibilities of each category of participants will be outlined. The management category includes all of those in the position of generating or enforcing policy and authorizing the allocation of resources. Program implementors are those who are charged by management to make the HCP work, and the employees' category includes all persons who are exposed to hazardous levels of occupational noise.

It has become clear over recent years that the level of commitment displayed by management is directly related to the overall effectiveness of the hearing conservation program. A strong commitment to a hearing conservation program can be shown by following these policies:

- 0 Strive for excellence in the program rather than just meeting minimal requirements.
- 0 Integrate the program into the overall company safety and health program.
- 0 Educate and motivate employees, so that hearing conservation practices become an integral part of their behavior on and off the job.
- 0 Designate a key person to serve as implementor/coordinator of the program.
- 0 Strive for simplification and continuity of the program's operating procedures.

- o Review the program's effectiveness regularly and make modifications when needed.

The nature and scope of the HCPs recommended in this text go beyond the minimal requirements of federal and state regulations. The objective here is not to reiterate regulatory requirements, although we urge all readers to become thoroughly familiar with the noise standards and regulations for compliance purposes. Instead, the objective is to convey some of the characteristics of good HCPs that are not necessarily found in regulations, and yet which contribute substantially to the program's success. However, to facilitate compliance with Federal regulations for occupational noise exposure, we have included an "OSHA noise standard compliance checklist" as Appendix A, and we have listed the pertinent provisions of the OSHA standard at the end of each section. In addition, for those who wish to pursue certain areas further, we have listed suggested readings at the end of each section, many of which can also be found in the expanded list of suggested readings in Appendix D. The reader's attention should also be directed to: the checklist in Appendix B, which should be helpful in evaluating HCPs that are already in place; Appendix C, which gives a listing of audiovisual materials; and Appendix E, which lists resources in both government and the private sector for those who need further assistance.

As the title states, this is a practical guide, intended to assist employers and those responsible for protecting employees' hearing to develop and maintain hearing conservation programs that actually work, and are not just perfunctory measures. This guide is not meant to be technical in nature. The reader will find no citations to the scientific literature -- only suggested readings at the end of each section. Support for the statements and recommendations made in the text are available in the scientific literature, but we believe that citations are not necessary in a practical guide such as this. The interested reader may pursue these concepts further in the suggested readings.

## VALUE OF A GOOD HEARING CONSERVATION PROGRAM

When a company has an effective hearing conservation program (HCP), everyone wins--the employers, the employees, and the safety and health professionals who implement the program. This guidebook is not about minimal programs that meet only the letter of the law, but is concerned with programs that are effective as well as efficient: those that succeed in preventing hearing loss in a practical and cost-effective manner.

### Employer Benefits

HCPs are the law in that they are required by federal and state occupational safety and health agencies. Companies that do not comply with appropriate regulations are liable for citations and fines. Most employee compensation insurance carriers also advocate HCPs, and companies that do not protect their employees from hearing loss may find their premiums increasing. Aside from the legal and economic factors, conscientious employers will want to protect their employees from an unnecessary loss of hearing. Today, there is no reason why hearing impairment needs to be the outcome of a noisy job.

A good HCP is good business. It promotes good labor relations because employees know that management is concerned, and this type of concern may translate to improved productivity and product quality. Indeed, noise itself can have an adverse effect on productivity. For complex jobs and those requiring concentration, studies show that greater efficiency is linked to lower noise levels. Also, the ease and accuracy of communication is improved as noise levels are lowered. These benefits should prove to be cost-effective for management. In addition, the conservation of hearing leads to the conservation of valuable employee resources. Studies of noisy companies that have implemented HCPs show reductions in accident rates, illnesses, and lost time. Versatility, adaptability, and promotability of employees are likely to be maintained when employees retain good hearing. Finally, morale may also benefit, which should lead to greater employee satisfaction and retention.

When the Occupational Safety and Health Administration's (OSHA) Hearing Conservation Amendment became effective in 1983, some employers were concerned about the possibility of a flood of claims for occupational hearing loss. However, no such flood has occurred, at least on a national scale. Of course, employers who take the appropriate preventive action now will greatly reduce the risk of future claims. Like other effective health and safety measures, HCPs should also extend beyond the workplace. The company that encourages employees to take their earplugs home to wear during woodworking, target practice, or other noisy off-job activities is reducing the possibility of spurious work related claims, as well as educating the employees to the need for hearing conservation in recreational settings.

Finally, the company that places a high value on safety and health maintenance should evaluate the performance of managers responsible for HCPs and reward those whose programs succeed in preventing hearing loss. An effective HCP costs money to implement, but the necessary investment will produce a beneficial return.

### Employee Benefits

The HCP's most obvious benefit to employees is that it saves their hearing and

ability to communicate. Because noise-induced hearing loss creeps up slowly, many individuals are unaware of their impairment until it is too late. Moreover, noise-induced hearing loss represents permanent damage, i.e., it cannot be restored through medical/surgical treatment. A good HCP, however, can identify hearing impairments before they become handicapping, and put an end to further deterioration. Employees who have labored for 35 or 40 years deserve to enjoy their retirement; they should be able to socialize with family and friends, and listen to music and the sounds of nature. Conserving hearing benefits employees all through life, not just in retirement, since the ability to communicate is critical in all of our interpersonal relationships. When good hearing is a prerequisite for a job an effective HCP will enable employees to sustain their hearing ability and thus qualify for jobs (perhaps higher level) that have such requirements.

A side benefit of an occupational HCP is that it can detect hearing loss that may be due to causes other than workplace noise exposure. Some individuals may suffer hearing loss as a result of impacted ear-wax, an ear infection, or possibly a more serious disease. Audiometric tests can help identify these non-noise related problems, and employees can be referred for the necessary medical attention.

Another benefit reported by employees in companies with effective HCPs is that they feel generally better, less tired and irritable. They sometimes report that they sleep better at night, and they are no longer bothered by temporary reductions in hearing ability at the end of the day, or by the tinnitus (ringing in the ears) that often accompanies the development of noise-induced hearing loss. There is also evidence that long term noise exposure may contribute to stress-related disease, especially cardiovascular disease. By reducing noise, the chances of other health impairments are consequently reduced.

Noise reduction and maintenance of hearing sensitivity can benefit safety because employees are better able to communicate, to hear alarms and warning shouts, and more subtle warning signals, such as a malfunctioning machine or the sounds of "roof-talk" in underground mines.

In summary, a good hearing conservation program is consistent with good health and good business. At a minimum, employees benefit from hearing saved. Reductions in noise exposure may also result in less fatigue and irritation, and possibly less stress-related health complaints. The company benefits from reduced worker compensation payments and medical expenses. Reduced noise exposures can be associated with improved employee morale, and, in some cases, higher production efficiency.

### Further Reading

Henderson, D. Effects of noise on hearing. Chapter 2 in A.S. Feldman and C.T. Grimes (Eds.), Hearing Conservation in Industry. Baltimore, MD: Williams & Wilkins, 1985.

Occupational Safety and Health Administration, Occupational Noise Exposure; Hearing Conservation Amendment. Federal Register, 46, Jan. 16, 1981, pp. 4078-4102 and 4105-4117.



Rossi, G. (Ed.), Noise as Public Health Problem: Proceedings of the Fourth International Congress. Milan, Italy, Centro Ricerche e Studi Amplifon, 1978.

Suter, A.H. The development of federal standards and damage risk criteria. Chapter 5 in D.M. Lipscomb (Ed.), Hearing Conservation in Industry, Schools, and the Military. Boston, MA: Little, Brown and Co., 1988.

Ward, W.D. (Ed.). Proceedings of the International Congress on Noise as Public Health Problem. EPA Report No. 550/9-73-008. U.S. Environmental Protection Agency, Washington, D.C., 1973.

Suter, A.H. Hearing Conservation. Chapter 1 in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Assoc., 1986.

## POLICY NEEDS

Company policies relating to the HCP should be carefully planned and executed to benefit the affected employee and the employer. Experience with successful HCPs shows certain policy areas that management needs to address at the beginning:

1. Program policies should be based on effective practices rather than on minimum compliance with government regulations.
2. The HCP must be a functional part of the overall company safety and health program. It should not be a stand-alone, separately-budgeted operation.
3. A key individual (program implementor) should have ultimate responsibility for the program. This person may not necessarily perform all of the functions of the HCP, but is in charge of the overall program. Experience with successful HCPs shows that a single individual often makes the crucial difference between success and failure. This person is often a nurse or an audiometric technician, but may be a safety and health officer or a supervisor. This key individual acts as the "conscience" and "champion" of the HCP. He or she focuses the attention of both management and employees on the HCP's policies and ensures that they take the necessary steps to implement them. They should also have stature in the HCP's organizational chart, with authority to make decisions, correct deficiencies, and enforce necessary actions.
4. The key individual should develop and implement HCP plans and policies for an effective program. Authority to establish hearing conservation provisions beyond those required by OSHA should be assured.
5. Employee compliance with the company's HCP policies and procedures should be mandatory.
6. HCP policies should clearly describe standard operating procedures for each phase of the program.
7. Companies may have varying needs for services which they cannot undertake with in-house staff. These can include noise surveys, employee education, audiometric testing, medical counseling, or the fitting of hearing protection devices. Outside vendors or contractors should be selected carefully so their services complement the abilities of the company staff and the in-house program elements. Vendors must understand and agree to abide by the company's HCP policies and standards of operation. On-site personnel must supervise contractors to make sure that they carry out their obligations.
8. Specific policy statements should be developed for the important elements of the program. For example, it should be company policy to require the participation of all noise-exposed employees in the audiometric program and to require the consistent and proper wearing of hearing protectors in posted areas, even if employees are only passing through these areas. These requirements should be conditions of employment. Other important policy statements should be written to cover:

- a. Monitoring of employee noise exposure levels on a regular schedule.
- b. Counseling of employees at the completion of each audiometric test, whether it is the initial, annual, retest, or termination examination.
- c. Determining the correct use of hearing protection devices by on-site equipment checks.
- d. Educating, training, and motivating employees to comply with the company's HCP provisions.
- e. Reviewing audiometric data to verify the effectiveness of the HCP.
- f. Encouraging employees to use company-provided hearing protectors for off-the-job exposure.
- g. Purchasing hearing protectors, audiometers, noise measuring equipment, and quieter machinery. This policy should address the reasons why the individual responsible for the HCP, not the purchasing department, should have final decisions about anticipated purchases.

Companies that issue clearly defined hearing conservation policies, and then adhere to these policies consistently, will have smoothly running HCPs. Employees will be fully informed and will know what is expected of them. Equipment will be appropriate, hearing protection will be used by the right people in the right places, and the program elements will be implemented in a timely fashion.

#### Further Reading

Royster, L.H., Royster, J.D., and Berger, E.H. Guidelines for developing an effective hearing conservation program. Sound and Vibration, 16(5), 22-25, 1982.

Stewart, A.P. The comprehensive hearing conservation program. Chapter 12 in D.M. Lipscomb (Ed.), Hearing Conservation in Industry, Schools, and the Military. Boston, MA: Little, Brown and Co., 1988.

## NOISE EXPOSURE MONITORING

As with any health hazard, it is of utmost importance to determine the nature of the hazard accurately, and to identify the affected employees. Those responsible for this aspect of the program must ensure that the exposures of all employees have been properly evaluated and that re-evaluations are conducted when changes in equipment or operations significantly alter the noise exposure. Readers are encouraged to consult items no. 1-11, 49, and 55 in Appendix A to ensure compliance with the noise monitoring requirements in the OSHA standard. Also, the checklist entitled "Noise Measurement" in Appendix B should be helpful in designing and evaluating a noise monitoring program.

Noise exposure monitoring is conducted for various purposes including:

1. To determine whether hazards to hearing exist.
2. To determine whether noise presents a safety hazard by interfering with speech communication or the recognition of audible warning signals.
3. To identify employees for inclusion in the HCP.
4. To classify employees' noise exposures for prioritizing noise control efforts and defining and establishing hearing protection practices.
5. To evaluate specific noise sources for noise control purposes.
6. To evaluate noise control efforts.

Various kinds of instrumentation and measurement methods may be used, depending on the type of measurements being conducted. The most common measurements are area surveys, dosimetry, and engineering surveys.

In an area survey, one measures environmental noise levels, using a sound level meter to identify work areas where employees' exposures are above or below hazardous levels, and where more thorough exposure monitoring may be needed. The result is often plotted in the form of a "noise map," showing noise level measurements for the different areas of the workplace.

Dosimetry involves the use of body-worn instruments (dosimeters) to monitor an employee's noise exposure over the work-shift. Monitoring results for one employee can also represent the exposures of other workers in the area whose noise exposures are similar.

Engineering surveys employ more sophisticated acoustical equipment in addition to sound level meters. These can include octave-band analyzers and sound level recorders which furnish information on the frequency/intensity composition of the noise being emitted by machinery or other sound sources in various modes of operation. These measurements are used to assess options for applying engineering controls.

### Management Responsibilities

Management must decide whether to contract with an external service provider or to

Measuring noise with a sound level meter (courtesy of Brüel and Kjaer Instruments).



A noise dosimeter measures and stores sound energy over time. It can be worn in the pocket, as shown, or on the belt with the microphone positioned on the shoulder.

purchase the necessary equipment and have the on-site staff trained to perform the sound survey. Because sound surveys should be performed periodically, it may be cost-effective to develop in-house expertise with the ability to schedule sound level checks (i.e., annually, whenever production machinery is added or changed, or when work processes are changed and have the potential for affecting noise levels).

Management should make sure that the individuals who monitor the noise are properly qualified to perform noise measurements, whether in-house personnel or contractors. A certified industrial hygienist can conduct most noise monitoring activities, although audiologists or technicians can do so if they have the necessary training and experience. Sound surveys for the purpose of selecting or evaluating engineering controls should involve an acoustical engineer.

Management should also ensure that operating procedures for conducting and evaluating noise measurements are available, well defined, and closely followed. These procedures should specify the scheduling of surveys, the type of measurements to be made, instrument calibration procedures, sampling criteria, methods for recording data, and procedures for reporting results.

Results of the noise measurements must be reported to the program implementor (the "key" individual discussed previously) and to employees in an understandable, uniform format. Results of area measurements or noise exposure dosimetry should be placed in each employee's hearing conservation record. In addition, a summary of the survey results should be presented during education programs for management and employees.

#### Program Implementor Responsibilities

Implementors of the HCP are responsible for making sure that the noise measurement program answers relevant questions. To obtain useful results, each sound survey must address the reason for obtaining the measurements, such as the identification of employees to be included in the HCP, or the evaluation of specific machinery for noise control purposes.

It is important that noise measurements are representative of typical production cycles. Hence, noise surveys should ensure adequate sampling of all work processes. When dosimetry is performed, make sure that employees wearing dosimeters are engaged in typical activities. Because employee cooperation and know-how is needed to obtain valid results, sound surveyors (those who measure the noise) must establish rapport with employees to benefit from their familiarity with the work environment and production process. By explaining the purpose of the measurements to employees and soliciting their help, surveyors can avoid errors, oversights, and possible mishandling of noise dosimeters by employees. Employees need to understand that realistic noise measurements are essential to plan noise control efforts and select appropriate hearing protection devices, and that they are helping themselves by helping the surveyors.

Sound surveyors should consistently follow the policies and procedures established by management with regard to the selection, maintenance, and calibration of instruments, measurement techniques, data analysis, and reporting. A good rule of thumb is to make the procedural description detailed enough so another person could reproduce the results. Comprehensive sound surveys may require additional instrumentation and greater detail than is necessary for basic surveys.

The report must present the results clearly. Results lead to recommendations, which are transformed into actions. The emphasis of the report may vary depending on the purpose of the survey (for example, OSHA compliance, documentation for worker compensation, or internal company HCP decision), so the writer should state the objectives and present the data relevant to these objectives. Because few report users will need or read every detail of the survey, it is critical to write a concise abstract for higher level management. A slightly longer summary should also be included for employees in the HCP. The body of the report should explain the calibration and measurement procedures, as well as the results, and detailed documentation (including the original data sheets) must be kept with the report in case it is needed for research, inspection by government representatives, or legal purposes.

A summary of the results of the survey should be available in the shop area hazards folder or in another convenient location. Copies of the noise maps should be readily available to the program implementor. The noise maps should be explained to the employees during their educational programs and posted for reference. If an area is labeled as requiring the use of hearing protection for all who enter, warning signs should be posted and appropriate hearing protectors should be available near the perimeter of the restricted area.

### Employee Responsibilities

Employees should assist those who make the measurements by sharing their knowledge about the work environment, the machinery in operation, and specific jobs. Employee assistance is especially critical to the success of engineering noise surveys where sound sources within a work process or piece of equipment need to be evaluated, and only the employee knows the proper operation of the equipment. Employees also need to cooperate by maintaining their normal work routine when asked to wear dosimeters, so that the results will be representative of their actual exposures.

Sound levels often increase when equipment begins to wear or fails to receive appropriate maintenance. Also, changes in equipment placement may cause unintended effects on sound levels. When employees notice such changes, they need to inform the sound surveyors or the program implementors that a change has occurred. A re-survey will be needed to evaluate the new sound levels and employee exposures whenever equipment or production changes occur.

### OSHA Requirements

Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, Subpart G, 1910.95: sections (a), (b), (c), (d), (e), (f), Appendix A, and Appendix G.

|  |
|--|
| See checklist in Appendix A of this guidebook, items no. 1-11, 50, and 56. |
|--|

### Further Reading

Earshen, J.J. Sound measurement: Instrumentation and noise descriptors. Chapter 3 in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Assoc., 1986.

Royster, L.H., Berger, E.H., and Royster, J.D. Noise surveys and data analysis. Chapter 4 in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Assoc., 1986.

**See checklist in Appendix B of this guidebook, section entitled "Noise Measurement."**



## ENGINEERING AND ADMINISTRATIVE CONTROLS

Engineering and administrative controls may be essential to achieve an effective HCP. The use of these controls should reduce noise exposure to the point where the hazard to hearing is eliminated or at least more manageable. Engineering controls are technologically feasible for most noise sources but their economic feasibility must be determined on a case-by-case basis. In some cases the application of a relatively simple noise control solution reduces the hazard to the extent that the other elements of the program, such as audiometric testing and the use of hearing protection devices, are no longer necessary. In other cases, the noise reduction process may be more complex, and must be accomplished in stages over a period of time. Even so, with each reduction of a few decibels, the hazard to hearing is reduced, communication is improved, and noise-related annoyance is reduced as well.

It is especially important that companies specify low noise levels when purchasing new equipment. Many types of previously noisy equipment are now available in noise-controlled versions, so a "buy quiet" purchase policy should not require new engineering solutions in many cases.

A summary of OSHA's requirements for engineering and administrative controls can be found in items no. 1-3 of Appendix A in this guidebook. Readers may obtain some practical guidance in the section entitled "Engineering and Administrative Controls" of Appendix B.

For hearing conservation purposes, engineering controls are defined as any modification or replacement of equipment, or related physical change at the noise source or along the transmission path (with the exception of hearing protectors) that reduces the noise level at the employee's ear.

Typical engineering controls involve:

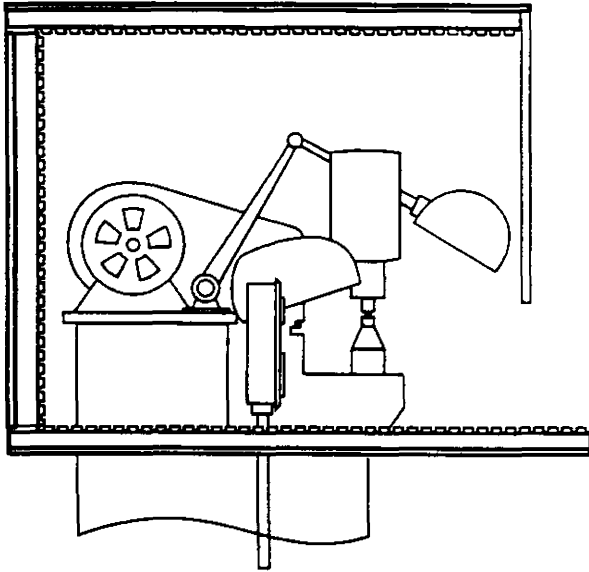
1. Reducing noise at the source.
2. Interrupting the noise path.
3. Reducing reverberation.
4. Reducing structure-borne vibration.

Common examples of the implementation of such controls are:

1. Installing a muffler.
2. Erecting acoustical enclosures and barriers.
3. Installing sound absorbing material.
4. Installing vibration mounts and providing proper lubrication.

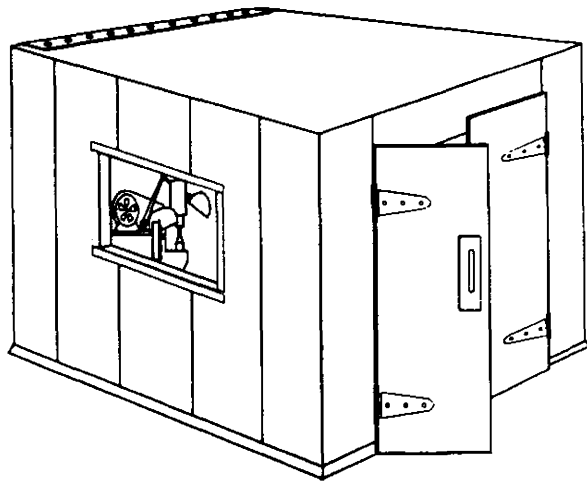
Assessing the applicability of engineering controls is a sophisticated process. First, the noise problem must be thoroughly defined. This necessitates measuring the noise levels and developing complete information on employee noise exposure and the need for noise reduction. Next, an approach to engineering control must be developed, requiring the identification of individual noise sources and an assessment of their contributions to the overall noise levels. Once identified and analyzed, the above controls can be considered. Those chosen will be influenced, to some extent, by the cost of purchasing, operating, servicing, and maintaining the control. For this reason, engineering, safety, and industrial hygiene

## Partial Enclosure

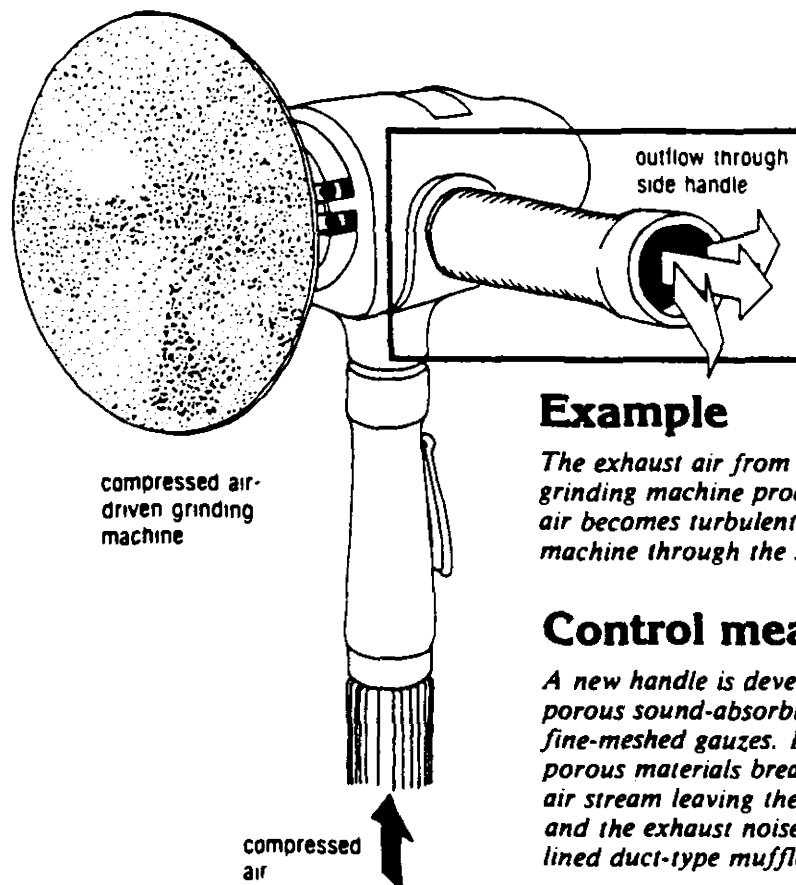


Interrupting the noise path with a partial machine enclosure (from Noise Control: A Guide for Workers and Employers, U.S. Dept. of Labor, OSHA).

## Complete Enclosure



Interrupting the noise path using a complete enclosure.

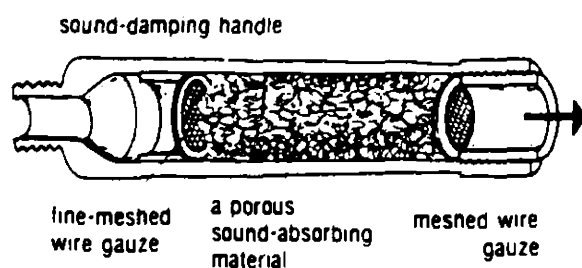


### Example

*The exhaust air from a compressed air-driven grinding machine produces a loud noise. The air becomes turbulent while leaving the machine through the side handle.*

### Control measure

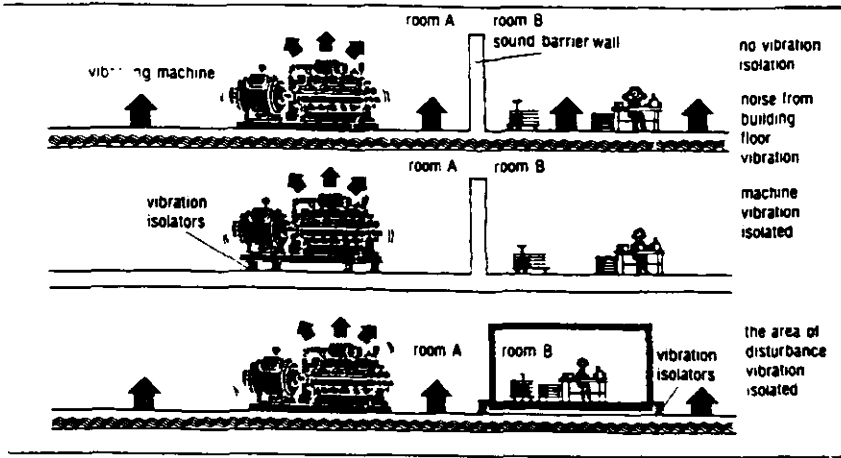
*A new handle is developed, filled with a porous sound-absorbing material between two fine-meshed gauzes. Passage through the porous materials breaks up the turbulence. The air stream leaving the handle is less disturbed, and the exhaust noise is weaker. A straight lined duct-type muffler may also be used.*



Reducing noise at the source: Installing a muffler (from Noise Control: A Guide for Workers and Employers, U.S. Dept. of Labor, OSHA).

## Example

Vibration isolation of machines can reduce the area of excessive noise as shown below. Either the machine or the working area can be isolated.

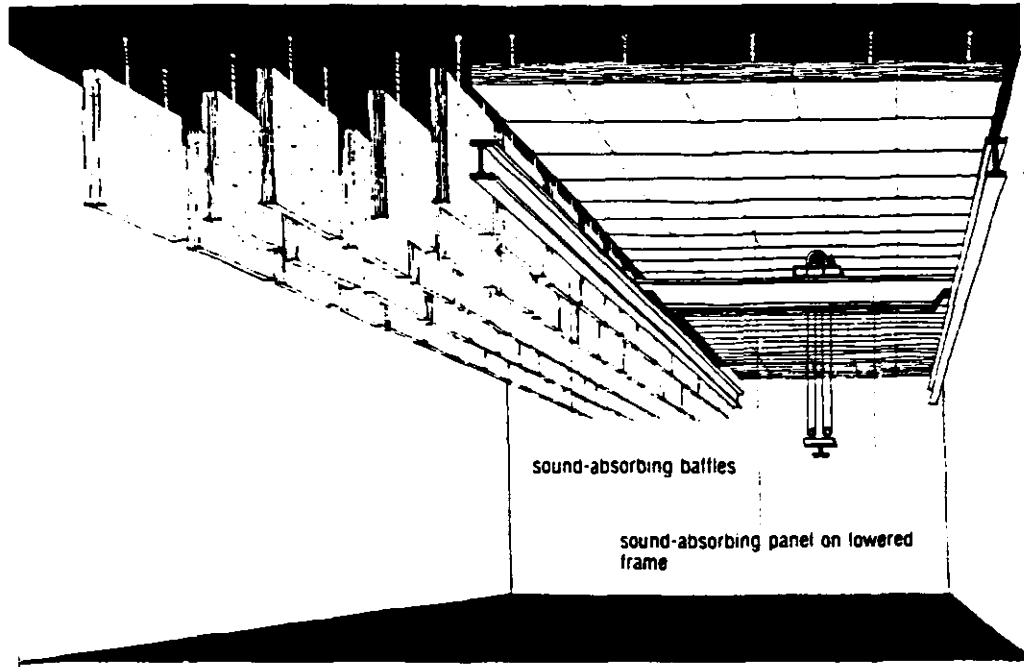


Reducing structure-borne vibration and reverberation (from *Noise Control: A Guide for Workers and Employers*, U.S. Dept. of Labor, OSHA).

## Example

A workshop with intense low frequency noise is provided with absorbants that are effective for low tones. One part of the shop contains space for hanging absorption baffles, which provide good low frequency absorption and are easily in-

stalled. A traverse leaves no room for baffles in the other part of the shop. Instead, horizontal absorbant panels are installed above the traverse, 8 inches from the ceiling, to improve the low frequency absorption.



personnel, as well as employees who operate, service, and maintain equipment, must be involved in the noise control plan. Employees who work with the equipment on a daily basis will be able to provide valuable guidance on such important matters as the positioning of monitoring indicators and panels, lubrication and servicing points, control switches, and the proper location of access doors for operation and maintenance. It also may be desirable to obtain the services of an acoustical consultant to assist in the design, implementation, installation, and evaluation of these controls.

In the design and installation of engineering noise controls, ergonomics must be considered along with optimal work efficiency. For example, work posture (sitting, standing, bending) as well as existing environmental factors (lighting, heating, and cooling) must be considered. This is especially true with employee enclosures or booths. Lighting, heating, and cooling must ensure comfort and be sufficient to prevent reduction in efficiency and work quality. Enclosures should be of adequate size and have enough window area to prevent claustrophobia. Windows should be positioned carefully to enhance proper usage by employees, and the glass may need to be tilted to prevent glare. In situations where employees will be working on or around equipment fitted with engineering controls, it is important to explain to everyone involved why the controls should not be modified, removed, or otherwise defeated.

Administrative controls, defined as changes in the work schedule or operations which reduce noise exposure, may also be used effectively. Examples include operating a noisy machine on the second or third shift when fewer people are exposed, or shifting an employee to a less noisy job once a hazardous daily noise dose has been reached. Generally, administrative controls have limited use in industry because employee contracts seldom permit shifting from one job to another. Moreover, the practice of rotating employees between quiet and noisy jobs, although it may reduce the risk of substantial hearing loss in a few workers, may actually increase the risk of small hearing losses in many workers.

A more practical administrative control is to provide for quiet areas where employees can gain relief from workplace noise. Areas used for work-breaks and lunch rooms should be located away from noise. If these areas must be near the production line, they should be acoustically treated to minimize background noise levels.

Much literature is available describing methods and procedures for noise measurement and analysis, instrumentation, engineering noise controls, performance characteristics of noise control materials, and case histories of the implementation of noise control solutions. Suggested readings are listed in Appendix D.

### Management Responsibilities

Management's primary responsibilities are to make sure that potentially controllable noise sources are identified, and that priorities for controls are set and accomplished. For this purpose, management needs to allocate the appropriate resources and engage outside services or identify capable personnel in-house. It is also management's responsibility to see that any changes of equipment or process are done only after evaluation of their impact on employee noise exposure. The purchase of quieter new equipment can be very helpful, but is usually accomplished

only with explicit specification, and occasionally some pressure on the equipment manufacturers. Sometimes the company must be willing to pay more for quieter equipment, but these expenditures should be cost-effective in the long run.

Managers may need to commit resources for in-house development of technology to control noise problems specific to their companies and processes. In some cases they may need to budget for maintenance of noise control devices to prevent deterioration of them over time. Finally, they should make sure that lunch and break areas are as quiet as reasonably possible, and that other avenues of administrative controls have been explored.

### Program Implementor Responsibilities

One of the most important responsibilities of the HCP implementor is to make sure that management is aware of the need for engineering controls and their benefits. He or she should see that the company has thoroughly assessed the full potential for using both engineering and administrative controls.

Those who implement the HCP will probably not actually execute the noise control solutions, but will provide a channel between the employees who operate the equipment, management, and the noise control specialists. It is the job of the implementor to make sure that communication lines are open, and that the equipment operators are consulted in control design. Program implementors will be responsible for making sure that employees understand the proper use of noise control devices, and for maintaining them in good condition.

### Employee Responsibilities

Because the employees who operate or maintain and repair the equipment are often the ones who know most about the processes involved, they need to express their concerns and ideas to management, the program implementor, or the engineer, so that the noise control devices will be as practical and effective as possible. Employees also have the responsibility of learning to operate their machines with the noise controls in place, of maintaining the controls properly, and of notifying the appropriate personnel when additional maintenance is needed.

### OSHA Requirements

Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, Subpart G, 1910.95: sections (a) and (b).

**See checklist in Appendix A of this guidebook, items no. 1-3.**

### Further Reading

Beranek, L.L. (Ed.). Noise and Vibration Control (Revised). New York: McGraw Hill, 1988.

Bruce, R.D. and Toothman, E.H. Engineering controls. Chapter 12 in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Assoc., 1986.

Harris, C.M. (Ed.). Handbook of Noise Control (2nd Ed.). New York: McGraw Hill, 1979. Chapters 19-31.

OSHA. Noise Control: A Guide for Workers and Employers. Pub. No. 3048. U.S. Dept. of Labor/OSHA, Office of Information. Wash. D.C. 1980.

See checklist in Appendix B of this guidebook, section entitled "Engineering and Administrative Controls."

## AUDIOMETRIC EVALUATION

Audiometric evaluation is crucial to the success of the HCP in that it is the only way to determine whether noise-induced hearing loss is being prevented. When the comparison of audiograms shows temporary threshold shift (a temporary hearing loss after noise exposure), early permanent threshold shift, or progressive noise-induced hearing loss, it is time to take swift action to halt the loss before additional deterioration occurs. Because noise-induced hearing loss occurs gradually and is not accompanied by pain, the affected employee will not notice the change until a large threshold shift has accumulated. However, the results of audiometric tests can trigger changes in the HCP more promptly, initiating protective measures and motivating employees to prevent further hearing loss.

The reader is encouraged to consult Appendix A, items no. 12-30 and 51-54, for a summary of OSHA's requirements for audiometric evaluations. The sections entitled "Monitoring Audiometry" and "Referrals" in Appendix B's checklists also should be helpful.

For maximum protection of the employees (and for that matter, the company), audiograms should be performed on the following five occasions:

1. Pre-employment.
2. Prior to initial assignment in a noisy work area.
3. Annually as long as the employee is assigned to a noisy job (a time-weighted average exposure level of 85 to 100 dBA), or twice a year for employees with time-weighted average exposures over 100 dBA.\*
4. At the time of reassignment out of a noisy job.
5. At the termination of employment.

In addition, it is suggested that employees who are not noise-exposed be given periodic audiograms as part of the company's health care program. The audiograms of these employees can be compared to those of the noise-exposed employees whenever the overall effectiveness of the HCP is evaluated. In an optimally effective program, the two employee groups will show essentially the same amount of audiometric change.

### Management Responsibilities

Managers should support the audiometric evaluation phase by allocating sufficient resources. Because the audiometric phase is sometimes the most expensive element of a HCP, it is prudent to set aside enough funds to provide for the performance of reliable hearing tests and the collection of accurate information.

Managers may opt to contract for audiometric services with an external source such as a mobile testing contractor or a local hearing clinic. Management may choose to

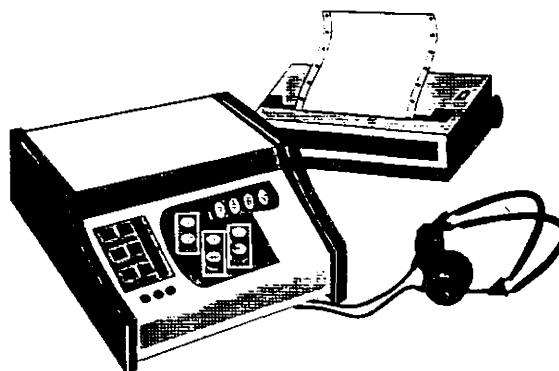
---

\*Noise-induced hearing loss can develop rapidly in workers exposed to relatively high noise levels on a daily basis. For example, the most susceptible ten percent of a population exposed to daily average noise levels of 100 dBA could be expected to develop hearing threshold shifts in excess of OSHA's criterion for standard threshold shift before the end of one year. This prediction can be made using the international standard, "Determination of Noise Exposure and Estimation of Noise-Induced Hearing Impairment" (see ISO, in Appendix D).

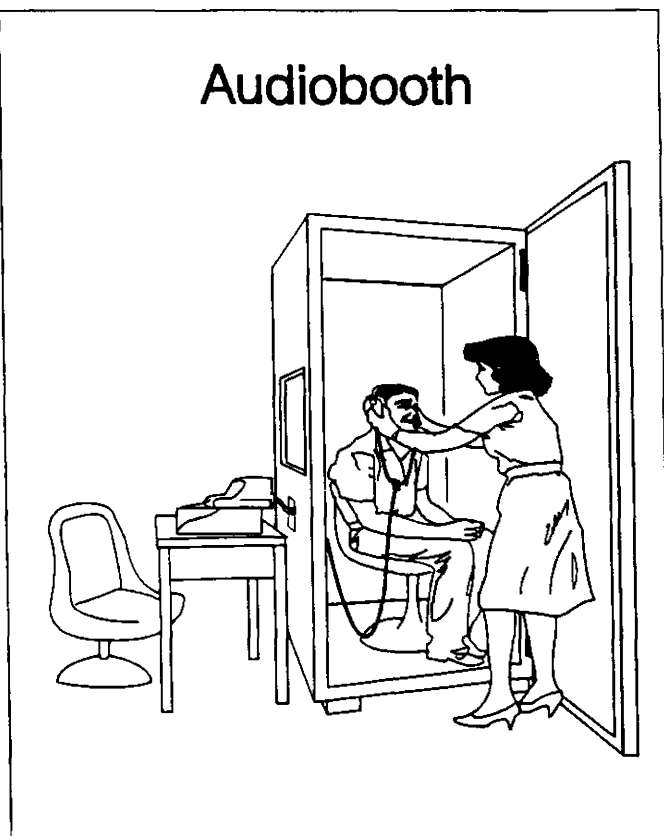


Microprocessor audiometer with separate printer.

## Audiometer System



## Audiobooth



Placing earphones for an audiometric test (from *Noise and Hearing Conservation* by G. Sevelius, MD). Reprinted with permission.

purchase audiometric equipment and train a company employee to perform audiometric testing on-site under the supervision of an audiologist or a qualified physician. The third option is to combine internal and external resources. The choice depends upon economic considerations as well as the size, policies, and geographical location of the company. If contract services are used it is critically important that management still assign responsibility for overseeing the HCP to a key on-site individual. However, whether the audiometric testing is performed internally or externally, the company will not receive the benefit of quality audiometric evaluations unless the following practices are adhered to:

1. The audiograms must be administered using properly calibrated audiometers in a sound-treated room with acceptable background sound levels during testing. Circumaural earphone enclosures (earphones inside earmuffs), which are designed to reduce external noise, should not be substituted for a sound treated room, and generally should not be used because of inherent problems with calibration and earphone placement.
2. The same type of audiometer (and preferably the same instrument) should be used from year to year. This will prevent measurement variations caused by differences among machine models/types or by the type of responses required from the person being tested.
3. The training of audiometric technicians should meet as a minimum the current requirements of the Council for Accreditation in Occupational Hearing Conservation or a similar accrediting organization.
4. All audiometric technicians should use the same testing methods for all of the company's employees.
5. All testing should be done under the supervision of an audiologist or a physician with expertise in the area of hearing assessment and protection.

Management should provide the audiometric technician with sufficient time to perform the tests thoroughly and to give noise-exposed employees proper attention. Because the audiometric session provides an ideal opportunity to motivate employees' concern for hearing conservation, technicians should have time to inform employees about their hearing status immediately after completing the audiogram and to check their hearing protection devices. When the technician is too hurried to do more than a rapid screening audiogram because of other duties, the employee correctly perceives that the exercise is performed only in response to regulatory requirements, without a sincere interest in protecting anyone's hearing. In such a situation employees often lose their motivation to participate in the HCP.

Management should also make sure that the individual who reviews the audiograms is a qualified professional with specific training and experience in the area of occupational hearing conservation. All employees, not just those with threshold shifts, should receive prompt written summaries of their current hearing status from the professional reviewer. Employees also should receive summaries of their hearing trends over time, along with recommendations for further evaluation or any extra precautions needed, such as more careful use of hearing protectors.

#### Program Implementor Responsibilities

The program implementor has important responsibilities in the audiometric testing

phase of the HCP. This individual and the person conducting audiometric testing may be the same person, but if not, the program implementor must see that the person performing the audiometric testing is well-trained and carries out the necessary functions. The individual who performs the testing needs to demonstrate enthusiasm for the program and show sincere interest in each employee while carrying out his or her duties.

The program implementor should make sure that the records include the employee's auditory history, which is the history of diseases and disorders of hearing and balance, and related factors (such as diabetes and high blood pressure), and history of exposure to noise, both on and away from the job. This information provides the professional audiogram reviewer with insight concerning probable causes for threshold shifts and enhances specific recommendations for follow-up.

Annual audiometric examinations (but not baselines) should be scheduled well into the workshift so that comparisons with baseline audiograms will reveal any early indications of hearing loss or temporary threshold shifts due to hearing protector inadequacies. In the early stages of noise-induced hearing loss, noise exposure causes temporary shifts in hearing threshold level, which, if repeated on a regular basis, become permanent. By testing toward the end of the workday, rather than before or early into the workday, these temporary threshold shifts can be identified, and steps can be taken to counteract them. Interventions at this stage thus prevent subsequent, permanent hearing loss.

Direct contact between the person performing the audiometric testing and the employee during the hearing test provides the chance to inspect the condition of the employee's hearing protector. The tester can observe whether the employee is using the device correctly, and re-evaluate the adequacy of hearing protector selection, fit, and condition. The employee should be asked whether the hearing protector is performing in a satisfactory manner. If necessary, a new protector of a different size or type can be issued and the employee instructed in the proper care and fitting of the device.

Daily calibration and listening checks of audiometer function are critical for audiogram accuracy, and the program implementor must ensure that these checks are properly documented. To measure thresholds accurately, the test room must be quiet enough to meet appropriate American National Standards Institute requirements (ANSI S3.1 1977), which is especially important for employees with normal hearing. Complete audiometer calibrations should be scheduled periodically, but the audiometer should not actually be adjusted unless it fails to meet standard tolerances. Too frequent adjustments add "see-saw" variability to the audiometric data, interfering with the interpretation of both individual and group hearing trends. To prevent another source of measurement variability, the same audiometers should be used consistently rather than switching between models, and especially between types of audiometers (manual, self-recording, and microprocessor). Failure to follow these practices jeopardizes the validity of the audiometric data and may reduce employee protection as a consequence.

Program implementors should see that the audiometric record indicates:

1. The specific purpose of the audiometric examination: for example, baseline, annual, retest, or other.
2. The specific equipment used and calibration dates.

3. The name of the tester.
4. The date and time of the test.
5. The auditory history information.
6. The hearing threshold values obtained.
7. The tester's judgment of the subject's response reliability.
8. The results of the hearing protector inspection and a record of any refitting, reissuing, or retraining.
9. The tester's comments, if any.

The program implementor must make sure that every audiogram is reviewed. The supervising professional may set up criteria for the person conducting the audiometric tests or for a computer program to bypass routine records and identify only the remaining noteworthy records for review. Routine records are those depicting normal hearing or no significant hearing decrements or improvements for a given employee. Only the professional is qualified to revise the reference "baseline" audiogram, either because of improvements in hearing or because of a persistent decline in hearing level. The reviewer should look for threshold shifts at any test frequency, not just "standard threshold shifts" as defined by OSHA\*, and for audiometric patterns indicative of medical problems. If the audiometric data indicate a degeneration of hearing, the reviewer must alert both the employee and management about these findings.

OSHA requires follow-up referrals under certain conditions (see item number 23 in Appendix A, and section (g)(8)(ii) in the OSHA noise standard). The program implementor must be familiar with these provisions, and must see that they are carried out. Sometimes medical referrals are necessary to determine the cause of a hearing loss, and medical treatment can be an important next step. Not all hearing losses are caused by noise and sometimes medical intervention can be crucial to the worker's health.

Although OSHA regulations specify required follow-up actions when a standard threshold shift is identified, follow-up for smaller shifts in hearing is recommended for optimal protection. Studies of effective HCPs show that employees with "beginning" shifts (smaller than OSHA's standard shift) get a written notification or "alert" from the professional reviewer. They also receive face-to-face counseling from on-site program implementors and, based on the reviewer's suggestions, retesting, re-evaluation of hearing protector efficiency, and extra instruction in hearing protector use. Individuals with possible medical conditions of the ear should be counseled to seek evaluation and treatment from their own physicians, or they may be referred to a company physician or a health provider covered under the company medical program. They should sign a statement that they have been counseled and have received certain recommendations.

---

\*OSHA's definition of a standard threshold shift is a change, relative to baseline, of 10 dB or more in the average hearing level at 2000, 3000, and 4000 Hz in either ear.

# Audiometric and Identification Information

Name: \_\_\_\_\_  
 Soc. Sec. #: \_\_\_\_\_  
 Birth Date: \_\_\_\_\_  
 Sex: Male Female  
 Empl No: \_\_\_\_\_  
 Job Code: \_\_\_\_\_  
 Job Descript: \_\_\_\_\_  
 Dept. No: \_\_\_\_\_

Test Date: \_\_\_\_\_  
 Test Type: \_\_\_\_\_

Time since last exposure:  
 \_\_\_ hours

Hearing Protector Used  
 Plugs \_\_\_ Muffs \_\_\_  
 Both \_\_\_ None \_\_\_  
 Unknown \_\_\_

Test Time: \_\_\_\_\_

Exposure Level \_\_\_ dBA

Hearing Protector Activity  
 Yes \_\_\_ No \_\_\_  
 Issue \_\_\_  
 Reissue \_\_\_  
 Training \_\_\_  
 Retraining \_\_\_

## Self-Reported Employee Histories

### Medical History (Y/N)

Diabetes \_\_\_\_\_  
 Ear Surgery \_\_\_\_\_  
 Head Injury \_\_\_\_\_  
 High Fever \_\_\_\_\_  
 Measles \_\_\_\_\_  
 Mumps \_\_\_\_\_  
 High Blood Pressure \_\_\_\_\_  
 Ringing in Ears \_\_\_\_\_  
 Ear Infection \_\_\_\_\_  
 Other \_\_\_\_\_

### Hobby & Military History (Y/N)

Hunting \_\_\_\_\_  
 Shooting \_\_\_\_\_  
 Racing Cars \_\_\_\_\_  
 Motorcycles \_\_\_\_\_  
 Other Loud Vehicles \_\_\_\_\_  
 Loud Music/Band \_\_\_\_\_  
 Power Tools \_\_\_\_\_  
 Military Service \_\_\_\_\_  
 Branch \_\_\_\_\_  
 Other \_\_\_\_\_

### Additional Information (Y/N)

Noisy 2nd Job \_\_\_\_\_  
 Noisy Past Job \_\_\_\_\_  
 Difficulty Hearing Right Ear \_\_\_\_\_  
 Difficulty Hearing Left Ear \_\_\_\_\_  
 Hearing Aid Right Ear \_\_\_\_\_  
 Hearing Aid Left Ear \_\_\_\_\_  
 Recent Change in Hearing \_\_\_\_\_  
 See Physician About Ears \_\_\_\_\_  
 See Prior History \_\_\_\_\_  
 Other \_\_\_\_\_

## Audiogram

### Test Frequency

| Ear   | 500 | 1000 | 2000 | 3000 | 4000 | 6000 | 8000 |
|-------|-----|------|------|------|------|------|------|
| Right |     |      |      |      |      |      |      |
| Left  |     |      |      |      |      |      |      |

Audiometer: \_\_\_\_\_  
 Exhaustive Calibration Date: \_\_\_\_\_  
 Tester Identification: \_\_\_\_\_  
 Reviewer Identification: \_\_\_\_\_

Serial Number: \_\_\_\_\_  
 Biological Calibration Date: \_\_\_\_\_  
 Test Reliability (Good, Fair, Poor) \_\_\_\_\_  
 Audiogram Classification Code \_\_\_\_\_

Comments: \_\_\_\_\_

Sample data sheet for audiogram and related employee histories.

## Employee Responsibilities

To help the professional reviewer interpret the audiogram, employees need to disclose relevant details of their noise exposure histories (on past jobs, in the military, and in hobbies and non-occupational activities).

Employees should also provide histories of ear diseases, treatment, and current ear conditions, including signs of over-exposure to noise such as tinnitus (ringing in the ear). Employees who understand that audiometric findings will be used to help conserve their hearing, not to penalize them, will respond more effectively to the audiometric listening task. Employees should let the audiometric tester know if the instructions are unclear, if tinnitus is interfering with audiometric responses, or if the audiometer produces sounds other than those described in the instructions.

Once the audiometric results have been reviewed, employees should actively cooperate with the program to protect their own hearing by following the recommendations of the professional supervisor. They should follow the employer's policies concerning the use of hearing protectors on and off the job, and should obtain any recommended medical evaluation or care.

## OSHA Requirements

Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, Subpart G, 1910.95: sections (g), (h), Appendix C, Appendix D, Appendix E, and Appendix F.

See checklist in Appendix A of this guidebook, items no. 12-30, and 52-55.

## Further Reading

Gasaway, D.C. Hearing Conservation: A Practical Manual and Guide. Englewood Cliffs, NJ: Prentice-Hall, Chapters 10, 12, and 13, 1985.

Lipscomb, D.M. Hearing testing and interpretation. Chapter 8 in D.M. Lipscomb (Ed.), Hearing Conservation in Industry, Schools, and the Military. Boston, MA: Little, Brown and Co., 1988.

Morrill, J.C. Hearing measurement. Chapter 8 in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Assoc., 1986.

Royster, J.D. Audiometric evaluation for industrial hearing conservation. Sound and Vibration, 19(5), pp. 24-29, 1985.

Wilber, L.A. Calibration of instruments used in occupational hearing conservation programs. Chapter 5 in M.H. Miller and C.A. Silverman (Eds.), Occupational Hearing Conservation. Englewood Cliffs, NJ: Prentice-Hall, 1984.

See checklist in Appendix B of this guidebook, sections entitled "Monitoring Audiometry and Record Keeping" and "Referrals."

## HEARING PROTECTION DEVICES

A hearing protection device (or "hearing protector") is anything that can be worn to reduce the level of sound entering the ear. Ear muffs, "semi-aural" devices, and ear plugs are the three principal types of devices. Each employee reacts individually to the use of these devices, and a successful HCP should be able to respond to the needs of each employee. Making sure these devices protect hearing effectively requires the coordinated effort of management, the HCP operators, and the affected employees.

OSHA's requirements for hearing protectors are summarized as items no. 31-38 and 50 in Appendix A of this document. Useful guidance can also be found in Appendix B, in the section entitled "Hearing Protection Devices."

### Management Responsibilities

Management has two roles in ensuring that hearing protection devices protect hearing effectively: facilitation and enforcement. Facilitation involves ensuring that program implementors obtain the types of devices they need. Management can do this by making sure the procurement department does not override the implementor's decisions. Management must demonstrate its commitment to a truly effective hearing protection program, not one that exists just to comply with OSHA regulations. Employee participation in the selection of hearing protectors should be encouraged. Rewards should go to employees who use them regularly and properly, and to supervisors who energetically support hearing protection policies. Management should extend its commitment to hearing protectors by requiring all personnel, including managers and visitors, to wear protectors in designated areas, and by encouraging employees to take them home to use whenever engaging in noisy activities.

Management should give program implementors the opportunity to pilot-test hearing protectors on a few employees. This will greatly facilitate decisions relating to the selection and ultimate effectiveness of these devices. HCP implementors should also be provided with resources and facilities to train employees in the use and care of hearing protectors.

Enforcing the use of hearing protectors is management's second vital role. If the use of personal safety equipment, such as hearing protectors, is clearly stated as a condition of employment, then management should be prepared to deal accordingly with those who violate the policy.

### Program Implementor Responsibilities

It is essential to the success of the program to have someone responsible for the selection of hearing protection devices and the supervision of their use. They must be able to evaluate and select appropriate devices for each employee, based on proper fit, the employee's noise exposure, hearing ability, communication needs, and other constraints imposed by job tasks or work environment. Program implementors should make available a set of devices that have been pilot-tested for effectiveness and employee acceptance. When fitting hearing protectors, attention needs to be given to each ear. Ear canals should be inspected to assure that no physical problems, such as infections or excessive ear wax, will compromise or complicate the use of hearing protectors.

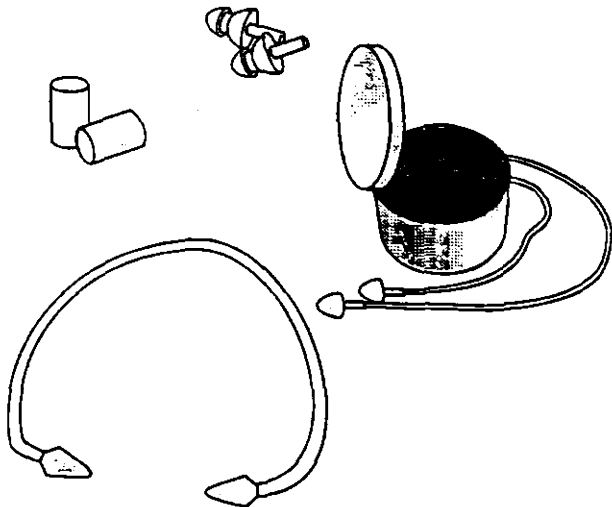
## Helmet Mounted Ear Muffs



## Ear Muffs



## Ear Plug Types



Hearing protectors, including a variety of ear plugs and a "semi-aural" device (lower left). Ear Muffs may require less individual sizing and fitting, but are heavier than ear plugs. Helmet-mounted ear muffs solve the compatibility problem between the head-band and the hard hat.



Program implementors must be able to educate employees one-on-one about the proper use and care of hearing protectors. They must be sure that each employee can demonstrate competence in fitting and using the protector, and is familiar with replacement procedures. Program implementors should also encourage employees to ask questions and to seek help in resolving problems.

Another important aspect of a successful program is to perform on-site checks of the condition of the protectors, noting misuse or wearer "modification" that would diminish effectiveness of the protectors. Program implementors should have a ready supply of replacement protectors, and be prepared to work with those employees whose negative attitudes prevent them from using these devices properly and routinely. Peer pressure in favor of protector use can be effective in helping to resolve these problems.

### Employee Responsibilities

Employees, of course, are the focus of the hearing protection program, and must make efforts to be fully informed, to obtain help when necessary, and to wear their hearing protectors correctly at all times. They need to check these devices regularly and to seek repair or replacement whenever necessary. They can also help each other by encouraging their co-workers to use hearing protectors and to seek help when they have problems.

### OSHA Requirements

Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, Subpart G, 1910.95: sections (a), (b), (i), (j), and Appendix B.

See checklist in Appendix A of this guidebook, items no. 31-38 and 51.

### Further Reading

Berger, E.H. Hearing protection devices. Chapter 10 in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Assoc., 1986.

Lempert, B.L. Compendium of hearing protection devices. Sound and Vibration, 18(5), 1984, pp. 26-39.

Royster, L.H. and Royster, J.D. Hearing protection devices. Chapter 6 in A.S. Feldman and C.T. Grimes (Eds.), Hearing Conservation in Industry. Baltimore, MD: Williams and Wilkins, 1985.

See checklist in Appendix B of this guidebook, section entitled "Hearing Protection Devices."

## EDUCATION AND MOTIVATION

To obtain active participation in the HCP by employees, and sincere and energetic support by management, it is necessary to educate and motivate both groups. Any HCP that overlooks this phase of the program will find other phases failing, because employees will not understand why it is in their best interest to cooperate, and management will fail to show the necessary commitment. Employees who understand the reasons for and the mechanics of the HCP will participate for their own benefit, rather than viewing the HCP as an imposition.

OSHA's requirements for training, education, and employee access to materials are summarized in items no. 39-44 in Appendix A, but it should be kept in mind that these are only minimal regulatory requirements. Readers should also consult the checklist in Appendix B, as well as the suggested readings at the end of this section and in Appendix D. A list of audio-visual materials is presented in Appendix C.

### Management Responsibilities

Management must emphasize the importance of the educational phase of the HCP by setting a high priority on and requiring attendance at regular hearing conservation training sessions. Training sessions should be held not only for noise-exposed employees, but also for the supervisors and managers responsible for noisy production areas. A manager should participate in each session to outline company policies and to explain the company's commitment to the HCP. The program should consist of more than films or pamphlets. It should include live presentations by articulate and knowledgeable speakers, tailored to the company's particular HCP. These presentations should be updated regularly. In addition to holding these formal programs at least annually, management should also require the inclusion of hearing conservation in regularly-scheduled safety meetings. There should be recognition of departments with excellent HCP performance (i.e., consistent and effective use of hearing protectors and reductions in the incidence of hearing threshold shifts). These accomplishments should be acknowledged through bulletin board posters, articles in the company paper, and in interactions between supervisors and employees.

Management should make sure that the HCP's staff (audiometric technicians, noise assessors, noise control experts, those who fit and issue hearing protection devices, and supervisors) have received detailed instructions in hearing conservation so that they are qualified to lead employee training sessions and comfortable about answering employees' questions. Individuals who make the main presentations in formal educational programs must be carefully selected to project genuine interest in the employees' welfare, and they must be speakers capable of gaining the employees' attention and respect.

The sessions are best structured in small groups consisting of a supervisor and the employees in that production unit. Because these individuals will have common noise exposures, they will fall under a common hearing protector policy, and they should feel comfortable enough with each other to ask questions freely and make constructive comments. Management should ensure that the questions and concerns raised during educational sessions receive thoughtful and prompt follow-up. Special educational sessions should be held for supervisors and managers of noisy departments so that they can discuss their own concerns separately.

## Program Implementor Responsibilities

Those who present the education and motivation sessions should limit the content to short, simple presentations of the most relevant facts. The focus should be on the real-life reasons for employees to protect their hearing: to preserve the ability to understand speech; to enjoy music and the sounds of nature; and to perceive sounds that may convey other critical information, such as danger or equipment malfunctions. One useful approach is to explain the audiometric results so employees can see how their own hearing threshold levels compare to those of individuals with normal hearing in their own age group. Once employees know the reasons why they need to conserve their hearing and how to monitor their audiogram results, the remainder of the program can focus on how to protect their hearing on and off the job through the effective use of hearing protection devices and good maintenance of engineering noise controls.

Presenters need to tailor education and motivation sessions to a particular group of employees and their foreman. It is important to describe the group's noise exposures, the group audiometric results, the options available to them with respect to hearing protection devices, and the engineering controls in place or planned for their department. In the separate sessions for supervisors and managers, it is appropriate to stress different points. Topics in the supervisors' sessions may include progress reports on the status of specific elements of the HCP, comparisons of group audiometric results, reports on the use of hearing protectors by department, and responses to questions or concerns expressed by employees. Materials should be updated every year. Films and pamphlets should be used only as supplementary reinforcements for the live presentations, never as the whole program.

Aside from formal educational presentations, program implementors should use every chance to remind employees and supervisors of the importance of the HCP and their active participation in it. The greatest opportunities to influence employees occur at the time of the audiometric test, when the program implementor or technician can compare the current thresholds to past results and check the fit and condition of hearing protection devices. Praise for employees with stable hearing and cautions for those with threshold shifts are effective if the comments come from a sincere and knowledgeable individual. However, in effective hearing conservation programs program implementors do not interact with employees just once a year. They ask questions and make comments on the HCP whether on the plant floor or in the halls and cafeteria - where ever contact is made. The goal is to make the HCP an ongoing concern.

## Employee Responsibilities

Employees must contribute to their own education by voicing their concerns or questions about the HCP, informing program implementors when procedures are not practical, and suggesting alternatives that would be more workable for their departments. These concerns should not have to wait until the regularly scheduled safety meetings, but should be expressed as soon as they arise. If HCP personnel fail to provide adequate consideration or follow-up, employees need to appeal to higher management until their concerns are addressed.

## OSHA Requirements

Code of Federal Regulations, Title 19, Chapter XVII, Part 1910, Subpart G, 1910.95: sections (k) and (l).

**See checklist in Appendix A of this guidebook, items no. 39-41.**

## Further Reading

Gasaway, D.C. How to successfully educate, indoctrinate, and motivate workers. Chapter 6 in D.C. Gasaway, Hearing Conservation: A Practical Manual and Guide. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1985.

Royster, L.H. and Royster, J.D. Education and motivation. Chapter 11 in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Assoc., 1986.

Sevelius, G. "Noise and Hearing Conservation." Health and Safety Publications, 2265 Westwood Blvd., Los Angeles, CA, 1984.

**See checklist in Appendix B of this guidebook, section entitled "Training and Education."**

## RECORD KEEPING

Records quite often get the least attention of any of the HCP's components. But audiometric comparisons, reports of hearing protector use, and the analysis of noise exposure measurements all involve the keeping of records. Unfortunately, records are often kept poorly because there is no organized system in place, and in many cases, those responsible for maintaining the records do not understand their value. People tend to assume that if they merely place records in a file or enter them into a computer, adequate record keeping procedures are being followed.

Many companies have found that their record keeping system was inadequate at the moment accurate information was most needed. This has often occurred during the processing of compensation claims. Problems can be avoided by implementing an effective record keeping system, in which: (1) management encourages that the system be kept active and accessible, (2) HCP implementors make sure that all of the information entered is accurate and complete, and (3) employees validate the information.

HCP records should include all items for each phase of the program: (1) noise exposure measurements, (2) plans for engineering and administrative controls, (3) audiometric evaluations, (4) provision for purchase of hearing protection devices, (5) employee education and motivation activities, and (6) program evaluations. Each phase generates its own form of records, and the information from the various records must be considered in order to evaluate the effectiveness of the HCP.

OSHA's record keeping requirements can be found in items no. 45-48 of Appendix A in this document. For more information on this subject, readers may consult the recommended readings at the end of this section, as well as the checklists in Appendix B.

### Management Responsibilities

Management should make available the facilities to store records and should provide sufficient resources to process them quickly and accurately. The forms or computer format used to gather information are the foundation of a good record keeping system. These forms should be designed so that necessary actions are triggered and then documented. If a company does not have the available resources to design a hearing conservation record keeping system compatible with the general safety and health record system, the company should turn to consultants for assistance.

Because HCP records can be complex, management should see that program implementors are fully trained in the record keeping system and its function. There should be working copies of records as well as archived copies. If an outside contractor keeps the records, a method should be established to ensure that original records are returned and entered into the company's files in a timely fashion.

Hearing conservation records are medical records and, as such, deserve the same level of integrity and confidentiality as other medical records. The company needs to make sure that these records are accessible only to program implementors, affected employees or their designated representatives, and government inspectors. Increasingly, companies maintain all of their employee health and safety records in a computer system. The use of computers supports easy access and storage of data, provides for automatic triggering of actions based on the data contained in the

records, and generates hard copies to be maintained as archives. Prudent managers will see that original copies of records pertaining to individual audiometry and noise-exposure monitoring are retained in personal medical or industrial-hygiene folders.

### Program Implementor Responsibilities

In most cases, HCP implementors will use a records system and associated forms that were developed by someone else, and must adapt their own procedures accordingly. The HCP implementor or operator must make sure that all information entered in the records is accurate, complete, legible, verifiable, and stated clearly so that the information does not need to be interpreted. If the operator discovers, while reviewing a record, that an employee's noise exposure level is not known, the measurements should be obtained and entered in the record. The same applies to other kinds of information. Also, there should be no blanks left in the form, since it is not possible to know whether a question did not apply or was overlooked. When blanks appear, they should be filled in or marked with NA for "not applicable" or INA for "information not available." Additional abbreviations should be avoided unless their meanings are clearly stated on the form in which they appear. Finally, original copies should always be available in an archive.

While management may provide the record keeping system and the necessary resources, the program implementors must ensure that the system works. The most important attributes of an effective record keeping system are standardization, maintenance, integration, and documentation. Standardization ensures commonality and consistency of data and format. Maintenance keeps records current and accurate. Integration of the recorded information allows the program implementor to assess the impact of hearing conservation on employees' hearing. Documentation of hearing conservation program elements permits analysis of long-range implications since cause-effect relationships associated with hazardous noise levels only become evident over time.

### Employee Responsibilities

Employee hearing conservation records should be available and accessible, especially at the time of regularly scheduled hearing tests. This is the ideal time for employees to check on the status of their hearing, and to pass along their comments on the HCP. Workers have a vested interest in the accuracy, validity, and accessibility of their hearing conservation and other medical records. Once they have been properly counseled, they should sign each audiogram to identify it as their own, and to signify that they are aware of any changes in hearing. They should also verify the accuracy of their medical history, any non-occupational noise exposure history, and past and current personal or work-related information.

### OSHA Requirements

Code of Federal Regulations, Title 19, Chapter XVII, Part 1910, Subpart G, 1910.95: section (m).

**See checklist in Appendix A of this guidebook, items no. 45-49.**

### Further Reading

Franks, J.R. Management of hearing conservation data with microcomputers. Chapter 9 in D.M. Lipscomb (Ed.), Hearing Conservation in Industry, Schools, and the Military. Boston, MA: Little, Brown and Co., 1988.

Gasaway, D.C. Using documentation to enhance monitoring efforts. Chapter 11 in D.C. Gasaway, Hearing Conservation: A Practical Manual and Guide. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1985.

**See checklist in Appendix B of this guidebook, section entitled "Monitoring Audiometry and Record Keeping."**

## PROGRAM EVALUATION

The primary goal of any HCP must be to reduce, and eventually to eliminate, hearing loss due to workplace noise exposure. While management may have the best intentions of implementing this goal and a company's HCP may have the appearance of being complete and complying with OSHA's requirements, the program may not achieve this goal. A thorough evaluation of the effectiveness of all of the program's components is necessary to determine the extent to which the HCP is really working.

Management and program implementors should conduct periodic program evaluations to assess compliance with federal and state regulations and to make sure hearing is being conserved. There are two basic approaches to follow in program evaluation: (1) assess the completeness and quality of the program's components, and (2) evaluate the audiometric data. The first approach can be implemented using checklists, such as those found in Appendices A and B. Appendix A can be used to assess compliance with each provision of OSHA's noise standard, and Appendix B is useful for identifying gaps in the program which could limit the program's effectiveness. Checklists such as these can serve as important tools in the evaluation process.

The second approach is to evaluate the results of audiometric tests, both for individuals and for groups of noise-exposed employees. Each individual's current test should be compared to the baseline test to see if an OSHA standard threshold shift has occurred. Previous audiograms for that individual should be inspected also and compared to each other and to the current test results to identify hearing loss progressions that may not have reached the severity of the OSHA standard threshold shift.

Audiometric data for groups of noise-exposed employees should also be evaluated using criteria other than the OSHA standard threshold shift. This usually involves statistical procedures to assess variability in population hearing levels, and usually requires computerized audiometric data. A well protected noise-exposed population will show the same hearing levels as a non-noise-exposed population, when matched for age and other factors. Different manifestations of variability can provide information on the extent to which workers are losing their hearing, and can assist in pinpointing the trouble spots in the HCP. For further information on audiometric data base analysis, readers should consult the suggested readings at the end of this section. In addition, a working group of the American National Standards Institute (ANSI S12-12) has drafted guidelines for analyzing audiometric data to evaluate HCP effectiveness.

### Management Responsibilities

Management needs to dedicate sufficient resources for a comprehensive program evaluation to the key individual (the program implementor) responsible for the HCP. Management should see that this individual is adequately trained in the conduct of HCPs and in the analysis of data, and should make sure that periodic evaluations actually take place.

Managers need to be committed to act on the outcome of the program evaluation. They must be willing to acknowledge and solve the problems which may require the



dedication of both financial resources and personnel. They must also be willing to institute and carry out disciplinary measures for non-compliance.

Another important responsibility of management is to be attentive to the comments and reactions of noise-exposed employees and to make use of their feedback during the program evaluation.

### Program Implementor Responsibilities

Program implementors must be willing to commit the time and resources needed to conduct a thorough evaluation. They need to be able to perform the mechanics of audiometric data base analysis, or they must be willing to engage the assistance of an outside contractor or consultant. They should look for early threshold shifts, and not wait until the shift becomes as severe as an OSHA standard threshold shift.

Those who perform the program evaluation must be willing to ask questions, seek out elusive information, and interact with all members of the HCP team. For example, they may need to call for audiometric retests, make sure that recommendations for treatment or evaluation have been followed, and to assure that necessary changes in hearing protection have been implemented. They must communicate their findings to management and to the affected employees.

### Employee Responsibilities

As with many other components of the HCP, the primary responsibility of employees is to provide feedback to the program implementor and to management. For effective program evaluation to take place employees need to communicate their hearing conservation problems, and explain why they are unwilling or unable to wear their hearing protectors. They need to make their needs known to higher management if they are unable to obtain replacement hearing protectors. Employees should notify the technician or audiologist if they have a problem understanding the instructions for taking the audiometric test, and report any medical problem that affects their hearing. Finally, they need to draw attention to changes in the noise levels produced by their equipment, or any malfunctioning noise control devices. Evaluation of the program, just like the conduct of the program, requires a team effort.

### Further Reading

Melnick, W. Evaluation of industrial hearing conservation programs: A review and analysis. American Industrial Hygiene Assoc. Journal, 45, pp. 459-467, 1984.

Royster, L.H. and Royster, J.D. Getting started in audiometric data base analysis. Seminars in Hearing, 9, 325-337, 1988.

Royster, J.D. and Royster, L.H. Audiometric data base analysis. Chapter 9 in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Assoc., 1986.

APPENDIX A

OSHA NOISE STANDARD COMPLIANCE CHECKLIST\*

**PURPOSE**

This checklist summarizes the OSHA noise standard. It is intended to assist companies conducting hearing conservation program evaluations to assess compliance with OSHA requirements and to determine program effectiveness. It is not intended to be used as a substitute for the OSHA Standard.

**REFERENCE**

Refer to OSHA Standard 29 CFR 1910.95(a)-(p) with accompanying appendices A-I, Occupational Noise Exposure Standard for the standard's specific requirements: Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, Subpart G. (See also 36 FR 10466 and 10518, May 29, 1971; Amended 46 FR 4078-4179, Jan. 16, 1981; Revised 48 FR 9776-9785, Mar. 8, 1983).

| NO.                             | 29 CFR 1910.95 REQUIREMENT   | STD REF NO.         | YES | NO | COMMENT |
|---------------------------------|--|---------------------|-----|----|---------|
| <b>PROTECTION AGAINST NOISE</b> |  |                     |     |    |         |
| 1                               | Must be provided when sound levels exceed time-weighted average level (TWA) 90 dBA measured with slow response                   | (a)                 |     |    |         |
| <b>CONTROLS</b>                 |  |                     |     |    |         |
| 2                               | Feasible engineering or administrative controls for employees exceeding TWA 90 dBA   | (b)(1)              |     |    |         |
| 3                               | Impulse or impact noise should not exceed 140 dB peak sound pressure level   | (b)(2)              |     |    |         |
| <b>PROGRAM</b>                  |  |                     |     |    |         |
| 4                               | Include employees whose noise exposures equal or exceed 85 dBA, 8-hr TWA (action level)  | (c)(1)and<br>(c)(2) |     |    |         |
| <b>MONITORING</b>               |  |                     |     |    |         |
| 5                               | Conduct noise monitoring when 85-dBA TWA equalled or exceeded  | (d)(1)              |     |    |         |
| 6                               | Use representative personal monitoring for highly mobile workers, significantly varying sound levels, and impulse noise exposure | (d)(1)(ii)          |     |    |         |
| 7                               | Include all continuous, intermittent, and impulsive sound levels from 80-130 dBA in measurements                                 | (d)(2)(i)           |     |    |         |
| 8                               | Calibrate equipment  | (d)(2)(ii)          |     |    |         |
| 9                               | Repeat monitoring when noise exposure increases significantly  | (d)(3)              |     |    |         |
| <b>EMPLOYEE NOTIFICATION</b>    |  |                     |     |    |         |
| 10                              | Notify employees of noise monitoring results when exposure is at or above 85 dBA TWA   | (e)                 |     |    |         |

\*Adapted from checklist supplied by ELB and Associates, Inc., Chapel Hill, NC.

---

**OSHA NOISE STANDARD COMPLIANCE CHECKLIST**

---

| <b>NO.</b>                       | <b>29 CFR 1910.95 REQUIREMENT</b>  | <b>STD REF NO.</b> | <b>YES</b> | <b>NO</b> | <b>COMMENT</b> |
|----------------------------------|--|--------------------|------------|-----------|----------------|
| <b>OBSERVATION OF MONITORING</b> |  |                    |            |           |                |
| 11                               | Employees or their reps may observe noise monitoring   | (f)                |            |           |                |
| <b>AUDIOMETRIC TEST PROGRAM</b>  |  |                    |            |           |                |
| 12                               | Audiometric testing available to employees exposed at or above 85 dBA TWA  | (g)(1)             |            |           |                |
| 13                               | Tests performed by professional or by competent technician (certification recommended)                                   | (g)(3)             |            |           |                |
| 14                               | Audiograms meet 1910.95 Appendix C requirements  | (g)(4)             |            |           |                |
| <b>BASELINE AUDIOGRAM</b>        |  |                    |            |           |                |
| 15                               | Establish within 6 months or within 1 year if using mobile van   | (g)(5)(i) and (ii) |            |           |                |
| 16                               | 14 hour-period without workplace noise before baseline (hearing protection can be substituted)                           | (g)(5)(iii)        |            |           |                |
| 17                               | Notify employees to avoid high non-occupational noise levels before baseline   | (g)(5)(iv)         |            |           |                |
| <b>ANNUAL AUDIOGRAM</b>          |  |                    |            |           |                |
| 18                               | Provide for all employees exposed at or above 85 dBA TWA   | (g)(6)             |            |           |                |
| <b>AUDIOGRAM EVALUATION</b>      |  |                    |            |           |                |
| 19                               | Compare each annual test to baseline for validity and to see if standard threshold shift (STS) exists                    | (g)(7)(i)          |            |           |                |
| 20                               | If STS, retest within 30 days (optional)   | (g)(7)(ii)         |            |           |                |
| 21                               | Audiologist, otolaryngologist, or physician reviews problem audiograms and determines need for further evaluation.       | (g)(7)(iii)        |            |           |                |
| <b>FOLLOW-UP</b>                 |  |                    |            |           |                |
| 22                               | Notify employees with STS in writing within 21 days  | (g)(8)(i)          |            |           |                |
| 23                               | Actions to be taken (unless physician determines that STS is not work-related)   | (g)(8)(ii)         |            |           |                |
|                                  | o Provide employees with hearing protectors (if not already wearing), train in care and use, and require them to be worn |                    |            |           |                |
|                                  | o Refit and retrain employees already using protectors   |                    |            |           |                |
|                                  | o Refer as necessary for clinical evaluations or additional testing  |                    |            |           |                |
|                                  | o Inform employees with non-work related ear problems of need for otologic exam  |                    |            |           |                |

---

**OSHA NOISE STANDARD COMPLIANCE CHECKLIST**

---

| <b>NO.</b>                           | <b>29 CFR 1910.95 REQUIREMENT</b>   | <b>STD REF NO.</b>   | <b>YES</b> | <b>NO</b> | <b>COMMENT</b> |
|--------------------------------------|---|----------------------|------------|-----------|----------------|
| <b>REVISION OF BASELINE</b>          |   |                      |            |           |                |
| 24                                   | Annual audiogram may become baseline as per OSHA criteria   | (g)(9)               |            |           |                |
| <b>STANDARD THRESHOLD SHIFT</b>      |   |                      |            |           |                |
| 25                                   | Definition - change relative to baseline of 10 dB or more in average hearing level at 2000, 3000, and 4000 Hz, either ear. Allowance for aging optional - Appendix F  | (g)(10)              |            |           |                |
| <b>AUDIOMETRIC TEST REQUIREMENTS</b> |   |                      |            |           |                |
| 26                                   | Each ear tested at frequencies of 500, 1000, 2000, 3000, 4000, and 6000 Hz  | (h)(1)               |            |           |                |
| 27                                   | Audiometers meet ANSI S3.6-1969   | (h)(2)               |            |           |                |
| 28                                   | Pulsed-tone and self-recording audiometers meet Appendix C requirements   | (h)(3)               |            |           |                |
| 29                                   | Test rooms meet Appendix D requirements   | (h)(4)               |            |           |                |
| 30                                   | Audiometer calibration includes: <ul style="list-style-type: none"><li>o Functional checks before each day's use</li><li>o Acoustical check annually according to Appendix E</li><li>o Exhaustive calibration every 2 years</li></ul>                       | (h)(5)               |            |           |                |
| <b>HEARING PROTECTORS</b>            |   |                      |            |           |                |
| 31                                   | Available to all employees exposed at or above 85 dBA TWA and replaced as necessary   | (i)(1)               |            |           |                |
| 32                                   | Worn by employees when: <ul style="list-style-type: none"><li>o Exposed to 90 dBA TWA or above</li><li>o Exposed to 85 dBA TWA or above when<ul style="list-style-type: none"><li>- no baseline after 6 months, or</li><li>- STS occurs</li></ul></li></ul> | (i)(2)               |            |           |                |
| 33                                   | Employees select from a variety of suitable hearing protectors  | (i)(3)               |            |           |                |
| 34                                   | Employees trained in care and use   | (i)(4)               |            |           |                |
| 35                                   | Employer ensures proper initial fitting and supervises correct use  | (i)(5)               |            |           |                |
| <b>HEARING PROTECTOR ATTENUATION</b> |   |                      |            |           |                |
| 36                                   | Evaluate attenuation for specific noise environments according to Appendix B  | (j)(1)               |            |           |                |
| 37                                   | Attenuate to at least 90 dBA, or 85 dBA if STS experienced  | (j)(2) and<br>(j)(3) |            |           |                |
| 38                                   | Re-evaluate attenuation as necessary  | (j)(4)               |            |           |                |
| <b>TRAINING PROGRAM</b>              |   |                      |            |           |                |
| 39                                   | Provide training to employees exposed to 85 dBA TWA or above  | (k)(1)               |            |           |                |

---

**OSHA NOISE STANDARD COMPLIANCE CHECKLIST**

---

| <b>NO.</b>                       | <b>29 CFR 1910.95 REQUIREMENT</b>  | <b>STD REF NO.</b> | <b>YES</b> | <b>NO</b> | <b>COMMENT</b> |
|----------------------------------|--|--------------------|------------|-----------|----------------|
| 40                               | Repeat annually and update materials   | (k)(2)             |            |           |                |
| 41                               | Training includes:   | (k)(3)             |            |           |                |
|                                  | o Effects of noise on hearing  |                    |            |           |                |
|                                  | o Purpose of hearing protectors, advantages, disadvantages, attenuation; instructions on selection, fit, use, and care |                    |            |           |                |
|                                  | o Purpose and procedures of audiometric testing  |                    |            |           |                |
| <b>ACCESS</b>                    |  |                    |            |           |                |
| 42                               | Copies of OSHA standard available to employees or their reps and posted in workplace                                   | (1)(1)             |            |           |                |
| 43                               | Information provided by OSHA available to employees  | (1)(2)             |            |           |                |
| 44                               | All records provided on request to employees, former employees, reps, and OSHA   | (m)(4)             |            |           |                |
| <b>RECORD KEEPING</b>            |  |                    |            |           |                |
| 45                               | Maintain accurate records of noise exposure measurements   | (m)(1)             |            |           |                |
| 46                               | Maintain audiometric records with the following information:   | (m)(2)             |            |           |                |
|                                  | o Employee name and job classification   |                    |            |           |                |
|                                  | o Date of audiogram  |                    |            |           |                |
|                                  | o Examiner's name  |                    |            |           |                |
|                                  | o Date of last acoustic or exhaustive calibration  |                    |            |           |                |
|                                  | o Employee's most recent noise exposure assessment   |                    |            |           |                |
|                                  | o Background noise levels in audio test rooms  |                    |            |           |                |
| 47                               | Retain all noise exposure records for at least 2 years   | (m)(3)(i)          |            |           |                |
| 48                               | Retain all audiometric test records at least for duration of employment  | (m)(3)(ii)         |            |           |                |
| 49                               | Transfer all records to successor employer   | (m)(5)             |            |           |                |
| <b>MANDATORY OSHA APPENDICES</b> |  |                    |            |           |                |
| 50                               | Noise Exposure Computation   | Appen. A           |            |           |                |
| 51                               | Methods for Estimating the Adequacy of Hearing Protector Attenuation   | Appen. B           |            |           |                |
| 52                               | Audiometric Measuring Instruments  | Appen. C           |            |           |                |
| 53                               | Audiometric Test Rooms   | Appen. D           |            |           |                |
| 54                               | Acoustic Calibration of Audiometers  | Appen. E           |            |           |                |

---

---

**OSHA NOISE STANDARD COMPLIANCE CHECKLIST**

---

| <b>NO.</b>                           | <b>29 CFR 1910.95 REQUIREMENT</b>                             | <b>STD REF NO.</b> | <b>YES</b> | <b>NO</b> | <b>COMMENT</b> |
|--------------------------------------|---|--------------------|------------|-----------|----------------|
| <b>NON-MANDATORY OSHA APPENDICES</b> |   |                    |            |           |                |
| 55                                   | Calculations and Application of Age Corrections to Audiograms | Appen. F           |            |           |                |
| 56                                   | Monitoring Noise Levels                                       | Appen. G           |            |           |                |
| 57                                   | Availability of Referenced Documents                          | Appen. H           |            |           |                |
| 58                                   | Definitions   | Appen. I           |            |           |                |

---

## APPENDIX B

### PROGRAM EVALUATION CHECKLIST\*

#### Training and Education

Failures or deficiencies in hearing conservation programs (HCPs) can often be traced to inadequacies in the training and education of noise exposed employees and those who conduct elements of the program.

1. Has training been conducted at least once a year?
2. Was the training provided by a qualified instructor?
3. Was the success of each training program evaluated?
4. Is the content revised periodically?
5. Are managers and supervisors directly involved?
6. Are posters, regulations, handouts, and employee newsletters used as supplements?
7. Are personal counseling sessions conducted for employees having problems with hearing protection devices or showing hearing threshold shifts?

#### Supervisor Involvement

Data indicate that employees who refuse to wear hearing protectors or who fail to show up for hearing tests frequently work for supervisors who are not totally committed to the HCP.

1. Have supervisors been provided with the knowledge required to supervise the use and care of hearing protectors by subordinates?
2. Do supervisors wear hearing protectors in appropriate areas?
3. Have supervisors been counseled when employees resist wearing protectors or fail to show up for hearing tests?
4. Are disciplinary actions enforced when employees repeatedly refuse to wear hearing protectors?

\*Much of this material has been adapted from D.C. Gasaway, "Evaluating and Fine-Tuning the Elements that Comprise a Program," Chapter 15 in Hearing Conservation: A Practical Manual and Guide. Prentice-Hall Inc.: Englewood Cliffs, N.J., 1985.

## Noise Measurement

For noise measurements to be useful, they need to be related to noise exposure risks or the prioritization of noise control efforts, rather than merely filed away. In addition, the results need to be communicated to the appropriate personnel, especially when follow-up actions are required.

1. Were the essential/critical noise studies performed?
2. Was the purpose of each noise study clearly stated? Have noise-exposed employees been notified of their exposures and apprised of auditory risks?
3. Are the results routinely transmitted to supervisors and other key individuals?
4. Are results entered into health/medical records of noise exposed employees?
5. Are results entered into shop folders?
6. If noise maps exist, are they used by the proper staff?
7. Are noise measurement results considered when contemplating procurement of new equipment? Modifying the facility? Relocating employees?
8. Have there been changes in areas, equipment, or processes that have altered noise exposure? Have follow-up noise measurements been conducted?
9. Are appropriate steps taken to include (or exclude) employees in the HCP whose exposures have changed significantly?

## Engineering and Administrative Controls

Controlling noise by engineering and administrative methods is often the most effective means of reducing or eliminating the hazard. In some cases engineering controls will remove requirements for other components of the program, such as audiometric testing and the use of hearing protectors.

1. Have noise control needs been prioritized?
2. Has the cost-effectiveness of various options been addressed?
3. Are employees and supervisors apprised of plans for noise control measures? Consulted on various approaches?
4. Will in-house resources or outside consultants perform the work?
5. Have employees and supervisors been counseled on the operation and maintenance of noise control devices?
6. Are noise control projects monitored to ensure timely completion?
7. Has the full potential for administrative controls been evaluated? Are noisy processes conducted during shifts with fewer employees? Do employees have sound-treated lunch or break areas?



## Monitoring Audiometry and Record Keeping

The skills of audiometric technicians, the status of the audiometer, and the quality of audiometric test records are crucial to HCP success. Useful information may be ascertained from the audiometric records as well as from those who actually administer the tests.

1. Has the audiometric technician been adequately trained, certified, and recertified as necessary?
2. Do on-the-job observations of the technicians indicate that they perform a thorough and valid audiometric test, instruct and consult the employee effectively, and keep appropriate records?
3. Are records complete?
4. Are follow-up actions documented?
5. Are hearing threshold levels reasonably consistent from test to test? If not, are the reasons for inconsistencies investigated promptly?
6. Are the annual test results compared to baseline to identify the presence of an OSHA standard threshold shift?
7. Is the annual incidence of standard threshold shift greater than a few percent? If so, are problem areas pinpointed and remedial steps taken?
8. Are audiometric trends (deteriorations) being identified, both in individuals and in groups of employees?
9. Do records show that appropriate audiometer calibration procedures have been followed?
10. Is there documentation showing that the background sound levels in the audiometer room were low enough to permit valid testing?
11. Are the results of audiometric tests being communicated to supervisors and managers as well as to employees?
12. Has corrective action been taken if the rate of no-shows for audiometric test appointments is more than about 5%?
13. Are employees incurring STS notified in writing within at least 21 days?

## Referrals

Referrals to outside sources for consultation or treatment are sometimes in order, but they can be an expensive element of the HCP, and should not be undertaken unnecessarily.

1. Are referral procedures clearly specified?
2. Have letters of agreement between the company and consulting physicians or audiologists been executed?

3. Have mechanisms been established to ensure that employees needing evaluation or treatment actually receive the service (i.e., transportation, scheduling, reminders)?
4. Are records properly transmitted to the physician or audiologist, and back to the company?
5. If medical treatment is recommended, does the employee understand the condition requiring treatment, the recommendation, and methods of obtaining such treatment?
6. Are employees being referred unnecessarily?

#### Hearing Protection Devices

When noise control measures are infeasible, or until such time as they are installed, hearing protection devices are the only way to prevent hazardous levels of noise from damaging the sensitive inner ear. Making sure that these devices are worn effectively requires continuing attention on the part of supervisors and program implementors as well as noise-exposed employees.

1. Have hearing protectors been made available to all employees whose daily average noise exposures are 85 dBA or above?
2. Are employees given a variety of protectors from which to choose?
3. Are employees fitted carefully with special attention to comfort?
4. Are employees thoroughly trained, not only initially but at least once a year?
5. Are the protectors checked regularly for wear or defects, and replaced immediately if necessary?
6. If employees use disposable hearing protectors, are replacements readily available?
7. Do employees understand the appropriate hygiene requirements?
8. Have any employees developed ear infections or irritations associated with the use of hearing protectors? Are there any employees who are unable to wear these devices because of medical conditions? Have these conditions been treated promptly?
9. Have alternative types of hearing protectors been considered when problems with current devices are experienced?
10. Do employees who incur noise-induced hearing loss receive intensive counseling?
11. Are those who fit and supervise the wearing of hearing protectors competent to deal with the many problems that can occur?

12. Do workers complain that protectors interfere with their ability to do their jobs? Do they interfere with spoken instructions or warning signals? Are these complaints followed promptly with counseling, noise control, or other measures?
13. Are employees encouraged to take their hearing protectors home if they engage in noisy non-occupational activities?
14. Are new types of protectors considered as they become available?
15. Is the effectiveness of the hearing protector program evaluated regularly?

### Administrative

Keeping organized and current on administrative matters will help the program run smoothly.

1. Have there been any changes in federal or state regulations? Have HCP policies been modified to reflect these changes?
2. Are copies of company policies and guidelines regarding the HCP available in the offices that support the various program elements? Are those who implement the program elements aware of these policies?
3. Are necessary materials and supplies being ordered with a minimum of delay?
4. Are procurement officers overriding the HCP implementor's requests for specific hearing protectors or other hearing conservation equipment? If so, have corrective steps been taken?
5. Is the performance of key personnel evaluated periodically? If such performance is found to be less than acceptable, are steps taken to correct the situation?
6. Safety: Has the failure to hear warning shouts or alarms been tied to any accidents or injuries? If so, have remedial steps been taken?

## APPENDIX C

### AUDIOVISUAL MATERIALS

The following list of films, computer software and videotapes concerned with occupational noise and hearing conservation is arranged in alphabetical order by producer or distributor. It is an updated summary of information from several sources, including E.H. Berger's Appendix II: "Annotated Listing of Noise and Hearing Conservation Films and Videotapes" in E.H. Berger, W.D. Ward, J.C. Morrill, and L.H. Royster (Eds.) Noise and Hearing Conservation Manual, 4th ed., American Industrial Hygiene Assoc., Akron, OH, 1986. This list is current as of September, 1990.

This list does not contain ratings or annotations, and the presence or absence of any film or videotape does not reflect the endorsement or judgement of the National Institute for Occupational Safety and Health.

Bilsom International, Inc. (703) 834-1070  
109 Carpenter Dr.  
Sterling, VA 22170

"Nice to Hear" film - 10 min., or slide cassettes  
"SOS" film - 14 min., or slide cassettes  
Hearing Conservation Starter Package: "SOS", posters, handouts, leader's  
guide for 50 people

BNA Communications (301) 948-0540  
9439 Key West Ave.  
Rockville, MD 20850

"Can You Hear Me?" film - 14 min.

Colorado Hearing and Speech Center (303) 322-1871  
Industrial Division  
4280 Hale Parkway  
Denver, CO 80220

"Stick It In Your Ear" film or VHS - 15 min.

Consulting Audiological Associates (312) 804-0550  
1915 N. Harlem Ave.  
Chicago, IL 60635

"Industrial Hearing Conservation  
Employee Education Program" VHS - 22 min.

Creative Media Development, Inc.  
710 S.W. Ninth Ave.  
Portland, OR 97205

(503) 223-6794

"Hear For A Lifetime" VHS, Beta, or U-matic - 16 min.

CRM Films  
2233 Faraday Ave.  
Suite F  
Carlsbad, CA 92008

(800) 421-0833

"Death Be Not Loud" film or VHS

E-A-R Division, Cabot Corporation  
7911 Zionsville Rd.  
Indianapolis, IN 46268

(317) 872-6666

"The National Hearing Quiz" film, VHS, or U-matic - 28 min.  
"Listen Up with Norm Crosby" film, VHS, or U-matic - 17 min.  
"It's Up To You" film, VHS, or U-matic - 12 min.  
"Less Than A Minute" film, VHS, or U-matic - 6 min.  
"How To Use Expandable  
Foam Earplugs" film, VHS, or U-matic - 6 min.

Educational Resources Foundation  
5534 Bush River Rd.  
Columbia, SC 29212

(800) 845-8822

"Noise? You're In Control" film, VHS, Beta, or U-matic - 14 min.

Encyclopedia Britannica Education Corp.  
310 S. Michigan Ave.  
Chicago, IL 60604

(312) 347-7000

"Ears and Hearing" film, VHS, Beta, or U-matic - 22 min.  
"Noise Pollution,  
the Environment" film, VHS, Beta, or U-matic - 16 min  
"Protecting Your Ears" film, VHS, Beta, or U-matic - 12 min

Film Fair Communications  
10621 Magnolia Blvd.  
North Hollywood, CA 91601

(213) 877-3191

"Noise and Its Effects  
on Health" film or VHS - 16 min.

Industrial Training Systems Corp.  
9 East Stow Rd.  
Marlton, NJ 08053

(609) 983-7300

"Noise Destroys" VHS - 12 min.  
"Sound Advice" VHS - 17 min.  
"Hear Today, Gone Tomorrow" VHS - 12 min.  
"Mentor/Computer Assisted  
Training" IBM-PC, 5-1/4" or 3-1/2" disks

International Film Bureau, Inc.  
332 S. Michigan Ave.  
Chicago, IL 60604

(312) 427-4545

"Listen While You Can" film - 21 min.  
"Hearing Conservation" film - 22 min.  
"Noise" film - 22 min.  
"The Noise Was Deafening" film - 21 min.  
"Protecting Your Hearing in  
a Noisy World" VHS - 14 min.

International Medifilms  
6720 N. Coldwater Canyon Ave.  
North Hollywood, CA 91606

(818) 762-6220

"Hearing, The Forgotten Sense" film - 18 min.  
"Hear: It Takes Two" film - 20 min.  
"Ear Protection and Noise" film - 12 min.

Mine Safety Appliances Co.  
P.O. Box 426  
Pittsburgh, PA 15230

(412) 967-3000

"Now Hear This! How Hearing Conservation  
Programs Can Work" VHS - 15 minutes

OSHA Office of Information  
U.S. Department of Labor  
Room N-3647  
Washington, DC 20210

(202) 523-8345

"Industrial Noise" VHS or U-matic - 10 min.

TWA Video Productions  
11500 Ambassador Dr.  
Kansas City, MO 64153

(816) 464-6880

"Sound Thinking" VHS, Beta, or U-matic - 18 min.

University of Hartford  
College of Engineering  
200 Bloomfield Ave.  
West Hartford, CT 06117  
Attn: Dr. Robert Celmer

(203) 243-4446

"Quiet Please" film - 20 min.

University of Toronto  
IMS Creative Communications  
Faculty of Medicine  
1 Kings College Circle  
Toronto, Ontario, CANADA M5S 1A8

(416) 978-6302

"Let's Hear It" film, VHS, or U-matic - 28 min.

Willson Safety Products  
P.O. Box 622  
Reading, PA 19603

(215) 376-6161

"For Good Sound Reasons" film - 15 min.

Worker's Compensation Board of British Columbia  
Hearing Conservation Unit  
Box 5350  
Vancouver, BC, CANADA V6B 5L5

(604) 276-3136

"Hearing Protection" VHS - 8 min.

## APPENDIX D

### SUGGESTED READING

- Alberti, P.W. (Ed.), Personal Hearing Protection in Industry. NY: Raven Press, 1982.
- American National Standard (draft) ANSI S12.12-198X (ASA 72-198X), "Evaluating the Effectiveness of Hearing Conservation Programs." Acoustical Society of America, N.Y. 1989.
- Bell, L. H. Fundamentals of Industrial Noise Control, Trumbull, CT: Harmony Publications, 1973.
- Beraneck, L. L. (Ed.), Noise and Vibration Control, (Revised). NY: McGraw Hill, 1988.
- Berger, E. H., Ward, W. D., Morrill, J. C., and Royster, L. H. (Eds.), Noise and Hearing Conservation Manual (4th Ed.). Akron, OH: American Industrial Hygiene Association, 1986.
- Berglund, B., Berglund, U., Karlsson, J., and Lindvall, T. (Eds.), Proceedings of the 5th International Congress on Noise as a Public Health Problem. Stockholm, Sweden, Swedish Council for Building Research, 1988.
- Feldman, A.S. and Grimes, C.T. (Eds.), Hearing Conservation in Industry. Baltimore, MD: Williams & Wilkins, 1985.
- Gasaway, D.C. Hearing Conservation: A Practical Manual and Guide, Englewood Cliffs, NJ: Prentice-Hall, 1985.
- Harris, C.M. (Ed.), Handbook of Noise Control (2nd Ed.). NY: McGraw Hill, 1979.
- Hearing Conservation News, National Hearing Conservation Assoc., 900 Des Moines St., Des Moines, IA., Quarterly.
- ISO. International Organization for Standardization. International Standard ISO 1999.2, Acoustics-Determination of Noise Exposure and Estimation of Noise-Induced Hearing Impairment. Geneva, Secretariat for ISO, TC43, SC1, 1989.
- Lempert, B.L., and Henderson, T. L. Occupational Noise and Hearing: 1968-1972, NTIS Stock No. PB 232284. Pub. No. 74-116. National Institute for Occupational Safety and Health, Cincinnati, OH, 1973.
- Lipscomb, D. M. (Ed.), Hearing Conservation in Industry, Schools, and the Military, Boston, MA: College-Hill Publications, 1988.
- Miller, M. H., and Silverman, C. A. (Eds.), Occupational Hearing Conservation, Englewood Cliffs, NJ: Prentice-Hall, 1984.
- Miller, R. K. Handbook of Industrial Noise Management, Atlanta: Fairmont Press, 1976.



NIOSH. Criteria for a Recommended Standard: Occupational Exposure to Noise. HSM 73-11001, NTIS Stock No PB 213463. National Institute for Occupational Safety and Health, Cincinnati, OH, 1972.

NIOSH. Compendium of Materials for Noise Control, NTIS Stock No. PB 298307. Pub. No. 80-116. National Institute for Occupational Safety and Health, Cincinnati, OH, 1980.

NIOSH. Industrial Noise Control Manual, Revised Ed., Pub. No. 79-117, NTIS Stock No. PB 297534. National Institute for Occupational Safety and Health, Cincinnati, OH, 1978.

Noise Control Engineering Journal, Institute of Noise Control Engineering, Poughkeepsie, NY, Bi-monthly.

OSHA. Noise Control, A Guide for Workers and Employers, Pub. No. 3048. U.S. Department of Labor/OSHA, Washington, D.C., 1980.

OSHA Noise Standard. Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, Subpart G.

OSHA. "Occupational Noise Exposure; Hearing Conservation Amendment." Fed. Reg. 46:4078-4179, Jan. 16, 1981. (For explanatory preamble)

OSHA. "Occupational Noise Exposure; Hearing Conservation Amendment; Final Rule." Fed. Reg. 48:9738-9785, Mar. 8, 1983. (For explanatory preamble)

Rossi, G. (Ed.), Noise as a Public Health Problem: Proceedings of the Fourth International Congress. Milan, Italy, Centro Ricerche e Studi Amplifon, 1983.

Royster, J.D. "Audiometric evaluation for industrial hearing conservation." Sound and Vibration, 19(5), 24-29, 1985.

Royster, J.D. and Royster, L.H. "Using audiometric data base analysis." J. Occup. Med., 28, 1055-1068, 1986.

Sevelius, G. "Noise and Hearing Conservation." Health and Safety Publications, 2265 Westwood Blvd., Los Angeles, CA, 1984.

Sound and Vibration, Acoustical Publications, Inc., Bay Village, OH, 1986.

Thumann, A. and Miller, R. K. Secrets of Noise Control. Atlanta: Fairmont Press, 1974.

Tobias, J.V., Jansen, G., and Ward, W.D. (Eds.), Proceedings of the Third International Congress on Noise as a Public Health Problem. ASHA Reports 10. The American Speech-Language-Hearing Assoc., Rockville, MD, 1980.

Ward, W.D. (Ed.), Proceedings of the International Congress on Noise as a Public Health Problem. EPA Report No. 550/9-73-008. U.S. Environmental Protection Agency, Wash., D.C., 1973.

Yerges, L. F. Sound, Noise and Vibration Control. NY: Van Nostrand Reinhold Company, 1969.

## APPENDIX E

### RESOURCES

#### Government Agencies

##### NIOSH

Division of Standards Development and  
Technology Transfer  
National Institute for Occupational  
Safety and Health  
4676 Columbia Parkway  
Cincinnati, OH 45226-1998  
1-800-35-NIOSH  
(356-4674)

Information about a wide range  
of occupational health and safety  
problems, and requests for health  
hazard evaluations

##### OSHA

Office of Information and  
Consumer Affairs  
Occupational Safety and  
Health Administration  
U.S. Department of Labor  
200 Constitution Ave. N.W.  
Washington, DC 20210  
(202)523-8151

Technical assistance with  
occupational health and safety  
problems, and for information  
about complying with OSHA  
regulations

Current lists of the On-Site  
Consultation Project Directory  
may be requested to obtain free  
consultations.

#### OSHA Regional Offices

Region I - Boston (Connecticut, Maine, Massachusetts, New Hampshire,  
Rhode Island, and Vermont)

U.S. Dept. Labor - OSHA  
133 Portland St., 1st Floor  
Boston, MA 02114  
(617) 565-7164

Region II - New York City (New Jersey, New York, and Puerto Rico)

U.S. Dept. Labor - OSHA  
201 Varick St., Room 670  
New York, NY 10014  
(212) 337-2325

Region III - Philadelphia (Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia)

U.S. Dept. Labor - OSHA  
Gateway Building, Suite 2100  
3535 Market St.  
Philadelphia, PA 19104  
(215) 596-1201

Region IV - Atlanta (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee)

U.S. Dept. Labor - OSHA  
1375 Peachtree St. N.E., Suite 587  
Atlanta, GA 30367  
(404) 347-3573

Region V - Chicago (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin)

U.S. Dept. Labor - OSHA  
32nd Floor, Room 3244  
230 So. Dearborn St.  
Chicago, IL 60604  
(312) 353-2220

Region VI - Dallas (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas)

U.S. Dept. Labor - OSHA  
525 Griffin St., Room 602  
Dallas, TX 75202  
(214) 767-4731

Region VII - Kansas City (Iowa, Kansas, Missouri, and Nebraska)

U.S. Dept. Labor - OSHA  
911 Walnut St., Room 406  
Kansas City, MO 64106  
(816) 426-5861

Region VIII - Denver (Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming)

U.S. Dept. Labor - OSHA  
Federal Bldg., Room 1576  
1961 Stout St.  
Denver, CO 80204  
(303) 844-3061

Region IX - San Francisco (American Samoa, Arizona, California, Guam, Hawaii, Nevada, Trust Territory of the Pacific Islands)

U.S. Dept. Labor - OSHA  
71 Stevenson St., 4th Floor  
San Francisco, CA 94105  
(415) 995-5672

Region X - Seattle (Alaska, Idaho, Oregon, and Washington)

U.S. Dept. Labor - OSHA  
Federal Office Bldg., Room 6003  
909 1st Ave.  
Seattle, WA 98174  
(206) 442-5930

Professional Associations

- American Industrial Hygiene Assoc.  
475 Wolf Ledges Parkway  
Akron, OH 44311-1087  
(216)762-7294  
Books and manuals on occupational subjects, list of consultants in all areas of industrial hygiene, including noise
- American Speech-Language-Hearing Assoc.  
10801 Rockville Pike  
Rockville, MD 20852  
(301)897-0135  
Information on the availability of audiologists who provide industrial audiology services
- Council for Accreditation in Occupational Hearing Conservation  
66 Morris Avenue  
Springfield, NJ 07081  
(201)379-1100  
Information on certification programs for occupational hearing conservationists (technicians), and the availability of accredited training courses
- National Council of Acoustical Consultants  
66 Morris Ave.  
Springfield, NJ 07081  
(201)379-1100  
Directory of acoustical consultants including specialists in noise control engineering
- National Hearing Conservation Association  
900 Des Moines St., Suite 200  
Des Moines, IA 50309  
(515)266-2189  
Directory of hearing conservation service providers located throughout the nation
- National Safety Council  
444 N. Michigan Ave.  
Chicago, IL 60611  
(312)527-4800  
Films and publications relating to noise control and hearing conservation, and for general safety and industrial hygiene information

