Industry Guide 15

A Guide to Developing and Maintaining an Effective Hearing Conservation Program

Occupational Safety and Health Division
N.C. Department of Labor
1101 Mail Service Center
Raleigh, NC 27699-1101

Cherie Berry
Commissioner of Labor

N.C. Department of Labor
Occupational Safety and Health Program

Cherie Berry
Commissioner of Labor
OSHA State Plan Designee

Allen McNeely
Deputy Commissioner for Safety and Health

Kevin Beauregard
Assistant Deputy Commissioner for Safety and Health

Susan Haritos
Reviewer

Acknowledgments

This edition of *A Guide to Developing and Maintaining an Effective Hearing Conservation Program* is based largely on the work of Julia Doswell Royster, Ph.D., CCC-A/SLP, retired, and Larry H. Royster, Ph.D., retired. Dr. Royster wrote the original North Carolina OSHA noise guidelines and Noise Compliance Plan. Numerous publications have reported the research of both authors (see References in this publication). Each author is recognized as an expert in the areas of noise control and hearing conservation. Most of the illustrations for this publication were prepared by the E-A-R Division of Aearo Co. The Aearo Co. has granted permission for the use of the illustrations in this industry guide. The information in this guide was updated in 2012.

This guide is intended to be consistent with all existing OSHA and NCDOL standards. If an area is considered by the reader to be inconsistent with a standard, then the appropriate state or federal standard should be followed.

To obtain additional copies of this guide, or if you have questions about North Carolina occupational safety and health standards or rules, please contact:

N.C. Department of Labor
Education, Training and Technical Assistance Bureau
1101 Mail Service Center
Raleigh, NC 27699-1101

Phone: (919) 807-2875 or 1-800-NC-LABOR (1-800-625-2267)

Additional sources of information are listed on the inside back cover of this guide.

The projected cost of the NCDOL OSH program for federal fiscal year 2011–2012 is $17,841,216. Federal funding provides approximately 31 percent ($5,501,500) of this total.

Revised 3/13

Contents

Foreword

The ear is a delicate organ. Serious damage to the ears can leave a person partially or completely deaf. Sudden extreme loud noise or prolonged loud noise may cause permanent injury to the hearing. Workers in very noisy industries may be affected over time if hearing protection programs are not initiated and followed.

Employers must be aware of workplace hazards facing their employees and take appropriate action to minimize or eliminate exposure to these hazards. *A Guide to Developing and Maintaining an Effective Hearing Conservation Program* describes a program that employers can implement to protect their employees' hearing ability.

In North Carolina, the N.C. Department of Labor enforces the federal Occupational Safety and Health Act. NCDOL offers many educational programs to the public and produces publications to help inform people about their rights and responsibilities regarding occupational safety and health.

When reading this guide, please remember the mission of the N.C. Department of Labor is greater than just regulatory enforcement. An equally important goal is to help citizens find ways to create safe workplaces. This booklet, like the other educational materials produced by the N.C. Department of Labor, can help.

Cherie Berry
Commissioner of Labor

Introduction

This publication describes a program that employers can implement to protect their employees' hearing ability. The writers intended to take the reader beyond the minimum provisions of OSHA requirements. They did not intend to create a guide to the OSHA occupational noise exposure standard. If at any point the OSHA standard and information here should appear to conflict, the standard must be considered controlling. Therefore, the reader should be acquainted with the OSHA standard.

The occupational noise exposure standard is included in the North Carolina OSHA Standards for General Industry. Contact the Education, Training and Technical Assistance Bureau, Occupational Safety and Health Division, N.C. Department of Labor, for a copy of the standards and for assistance in interpreting them. (See the inside back cover of this publication for the address and telephone number.)

The occupational noise exposure standard is at 29 CFR 1910.95. It would be best if the reader is familiar with the content of the standard before reading this guide.

1

Effective Hearing Conservation Programs (HCPs): Benefits and Strategies

The purpose of industrial hearing conservation programs (HCPs) is to prevent employees from developing noise-induced hearing loss on the job. After occupational hearing loss was recognized as a health problem, the Occupational Safety and Health Administration (OSHA) promulgated regulations that specified minimum requirements for employers to meet. However, simply complying with the OSHA regulations does not guarantee that a program will be effective in preventing occupational hearing loss, as many unsuccessful HCPs demonstrate.

If the employer runs an ineffective HCP, there is no payback for the time and resources invested. An ineffective HCP is only an exercise in regulatory compliance. However, the goal of preventing occupational hearing loss can be achieved if the employer applies a few basic principles in organizing the HCP. Our experience with industries across the country indicates that there is no correlation between the amount of money spent on the HCP and its effectiveness. However, if management ensures that the HCP has the desired characteristics described in this guide, the program will succeed.

A Look at HCPs Nationwide

During 1980–84 the authors of this publication received a grant through N.C. State University from the E-A-R Division of Cabot Corp. to conduct on-site interviews with HCP personnel nationwide to describe the use of hearing protection devices (HPDs) in 218 industries of all types. In addition to the structured questionnaire results about HPDs, comments from those interviewed and observations provided insights about common mistakes in HCP implementation and organization. Some frequent causes of HCP ineffectiveness are shown in Table 1.

Table 1

Frequent Causes of HCP Ineffectiveness

- Inadequate communication and coordination among: (1) plant personnel involved in the HCP and (2) on-site personnel and corporate headquarters
- Insufficient or erroneous information used to make HCP decisions
- No meaningful training for HPD fitters and reissuers
- Inadequate or inappropriate selection of HPDs in stock and over-reliance on noise reduction ratings in choosing HPDs
- Failure to fit and train each HPD wearer individually
- Over-reliance on contractors to provide HCP services
- Failure to use the audiometric monitoring results to educate and motivate employees
- Failure to use audiometric data to evaluate the effectiveness of the HCP

By avoiding pitfalls such as those shown in Table 1 and by following the tips in this booklet, the employer can develop an effective HCP. The policies and procedures outlined in this publication have proved useful in HCPs in a variety of industries around the United States and will probably apply to most production facilities. Nevertheless, because it is impossible to specify HCP guidelines to cover every situation, the hearing conservationist has to use common sense in evaluating whether particular pieces of advice are workable for each plant's HCP. Local personnel can judge best how to tailor the guidelines for their facility to achieve the goal: prevention of occupational hearing loss.

Benefits of the HCP to the Employee

Preventing hearing loss on the job is the primary employee benefit of the HCP, but just why is this important? Hearing loss from any cause reduces the quality of life for the affected individual. Hearing impairment interferes with normal communication, and communication is a significant part of life. For many jobs we need adequate hearing to qualify to be hired or promoted, so hearing loss decreases our employment potential. On the job we need good communication ability to give and receive instructions, use the telephone, and detect machinery sounds and warning signals. Off the job our interpersonal communication with family and friends puts pleasure in our lives and gives us a feeling of being involved with others in recreational situations and at home. We also need our hearing to enjoy music and the quiet sounds of nature. For all of those reasons and more, good hearing is invaluable.

The HCP also provides a health screening benefit for employees, since nonoccupational hearing losses and potentially treatable ear diseases are often detected through the annual audiograms.

Benefits of the HCP to the Employer

The employer benefits directly by implementing an effective HCP that maintains employees' good hearing, since workers will remain more productive if their communication abilities are not impaired. Employees with good hearing are also more versatile and can be promoted to jobs where communication (especially by telephone) is even more important. Effective HCPs can reduce accident rates and promote work efficiency, as well as reduce the stress and fatigue related to noise exposure.

The HCP is one aspect of the employer's overall policy toward worker health and safety practices, and employee relations are better and job turnover is lower for companies that pay attention to the working environment. Maintaining a safe and healthy workplace contributes to the company's prestige and image as a desirable employer.

An effective HCP also lessens monetary losses from workers' compensation claims and insurance premiums. Further, the effective HCP is cost-effective in that while compliance with OSHA and other governmental regulations is achieved, loss prevention and productivity gains are also realized.

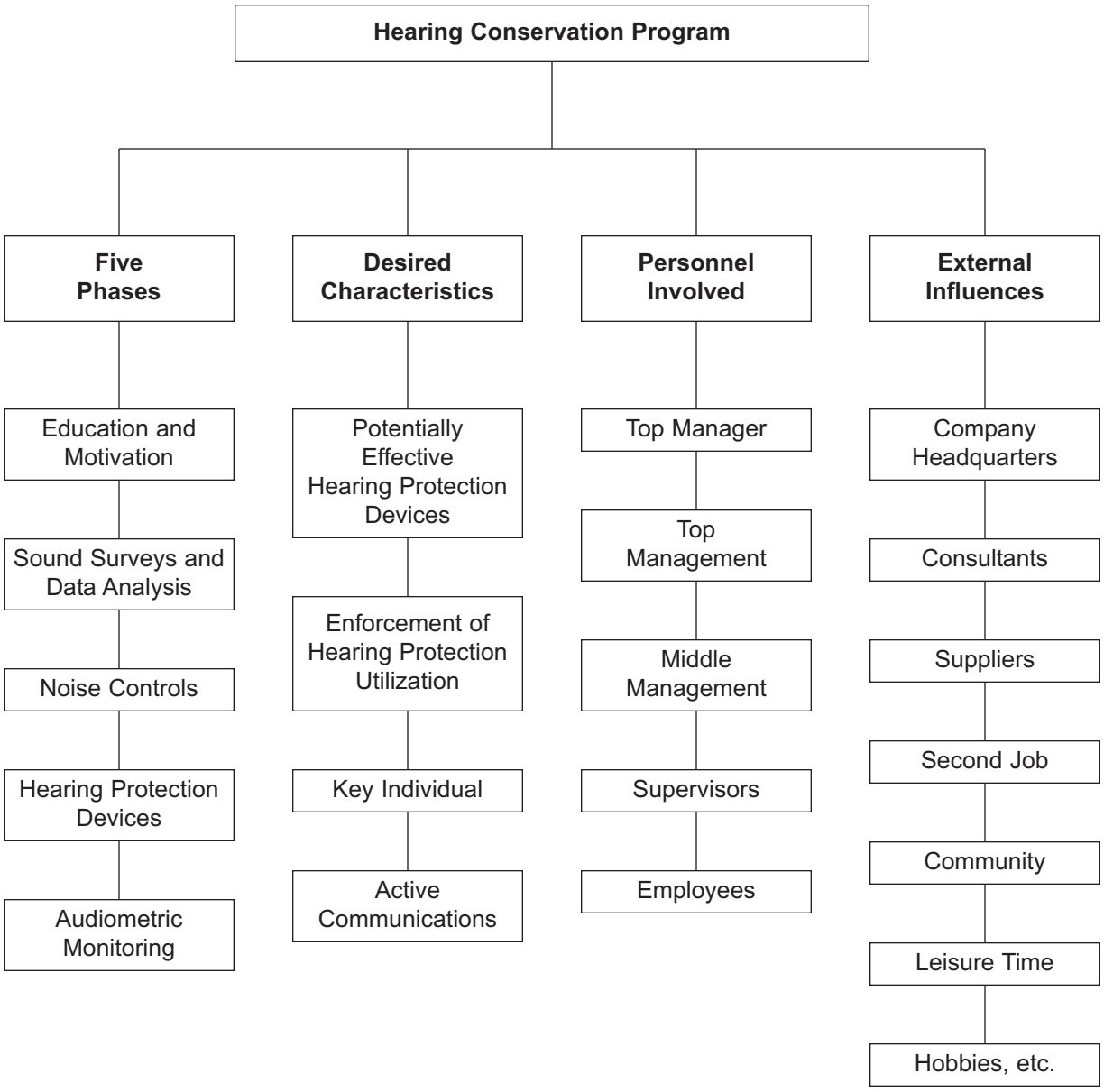
2

Organizing Your HCP: Five Phases Under a Key Individual

Figure 1 presents an outline of the major aspects of an HCP. The five phases of the program are shown in the first column. The second column lists characteristics that differentiate effective HCPs from unsuccessful programs. The third column indicates various company personnel who are important to HCP success. The fourth column lists influences external to the company that may also affect the HCP. Each of these aspects is discussed below, and additional information is available. (See References, items 1 and 2.)

Figure 1

Hearing Conservation Program (HCP) Phases, Desired Characteristics, Personnel Involved, and External Influences That Affect HCP Function



Five Related Phases

The phases of every HCP are education, sound exposure surveys, engineering and/or administrative noise controls, hearing protection, and audiometric evaluations. The relative emphasis placed on the phases may vary according to the needs of the particular production facility, but each one is essential for an effective program.

The Education and Motivation Phase

The *education and motivation phase is the most important* because HCP personnel and employees will not actively participate in hearing conservation unless they understand its purpose, how they will benefit directly from the program, and know that compliance with the company's safety and health requirements is a *condition of employment*. Without meaningful education to motivate individual actions, the HCP will fail. Educational efforts must begin even before sound surveys and engineering controls are carried out to obtain representative exposure results and to develop employee acceptance of machine modifications. Likewise, the success of the hearing protection and audiometric phases depends on teaching employees how to understand and take care of their hearing. In effective HCPs the educational phase is continuous—not just an annual presentation—as HCP personnel take daily opportunities to remind others about conserving their hearing.

The Sound Survey and Data Analysis Phase

The sound survey phase involves determining the degree of hazardous noise exposure for workers so that appropriate HCP policies can be established to protect them. For example, the choices of hearing protectors available to employees may be limited to the most effective devices for departments with very high noise exposures. In addition, sound surveys can identify the dominant noise sources in each area of the plant and determine where engineering controls can significantly reduce employee exposures.

The Noise Controls Phase

The noise controls phase attempts to reduce employees' noise exposures to nonhazardous levels with engineering and administrative controls. Engineering controls involve modification of the noise *source* (such as by fitting mufflers to air exhaust nozzles), the noise *path* (such as by placing sound-absorbent enclosures around equipment), or the *receiver* (such as by constructing an enclosure around the employee's work station). Administrative noise controls include changes in employees' work schedules or task assignments to reduce noise exposures by limiting exposure time. The ultimate goal is to *eliminate* employee exposures to harmful noise. However, significant *reductions* in exposure are very important because it is much easier to achieve effective protection for employees using hearing protection devices if the exposures are lower rather than higher. Application of retrofit noise controls to existing machinery may be effective. But when the employer purchases new equipment, an excellent opportunity exists to demand reduced sound level output as part of the specifications required of the equipment manufacturer. In addition, regular maintenance programs for equipment and for its noise control modifications help keep noise levels down as well as extend the life of the machinery.

The Hearing Protection Devices Phase

The hearing protection devices phase of the HCP provides hearing protection devices (HPDs) for employees and training in how to wear them as long as hazardous noise levels exist in the workplace. Because feasible engineering noise controls have not been developed for many types of industrial equipment, HPDs are the best current option for preventing noise-induced hearing loss in these situations.

The Audiometric Evaluations Phase

The audiometric evaluations phase of the HCP ties together the whole program. Each exposed employee receives an annual hearing check to monitor hearing status and detect any hearing change. If the HCP is working, employees' audiometric results will not show changes associated with on-the-job noise-induced hearing damage. If suspicious hearing changes are found, the audiometric technician and the audiologist who reviews the record can counsel the employee to wear HPDs more carefully, assess whether more effective HPDs are needed, and motivate the individual to be more careful in protecting his or her hearing both on and off the job. Sometimes nonoccupational causes of hearing change may be identified, such as gunfire or hobby noise exposure or medical problems.

Characteristics of Effective HCPs

HPDs—Effective and Enforced

The importance of HPD policies to HCP success is underscored by the first two desired characteristics of effective HCPs: *strict enforcement* of HPD utilization (actual enforcement, not just a paper policy) and the availability of HPDs that are *potentially effective* for the work environment. Potentially effective HPDs are devices that are practical and comfortable enough for employees to wear them consistently and provide adequate sound attenuation.

The Key Individual

The most important strategy for making the five phases of the HCP function together effectively is to unite them under the supervision of one *key individual*. In smaller companies where one person may actually carry out all facets of the HCP, lack of coordination is not usually a problem. However, as company size increases, different types of staff become involved in the HCP: safety personnel, medical personnel, engineers, industrial hygienists, tool crib supervisors and production supervisors. With personnel from varying disciplines carrying out different aspects of the program, it becomes very difficult to coordinate their efforts unless one key individual is overseeing the entire HCP. The choice of who this person should be is critical to the success of the program. *The primary qualification for the key individual is genuine interest in the company's HCP.* Nonetheless, selecting the key individual does not minimize the crucial importance of the line supervisor to the success of the HCP.

Since extra training is easy to obtain through brief courses such as those approved by the Council for Accreditation in Occupational Hearing Conservation (CAOHC) (see Resources, item 2), the background of the key individual is less important than his or her enthusiasm and ability to relate to people. The key individuals we have observed know everyone by name and are equally friendly with production employees and managers. The key individual is approachable and is always sincerely interested in comments or complaints that can help to improve the HCP. This individual does not stay in an office, running the HCP on paper by mandate, but spends time on the production floors to interact with employees and observe how problems can be prevented or solved.

Active Communications

The key individual maintains communication among all company personnel involved in the HCP by passing information both up and down the hierarchy. The primary HCP team members meet together regularly to update each other on the progress of the program. Once people with different tasks understand how their own parts contribute to the overall outcome of the program, they will respond to feedback about their performance by cooperating to prevent hearing loss. The key individual can achieve this active communication and cooperation if management provides him or her with the authority to make HCP decisions and the resource allocations to act on decisions once they are made.

Personnel Involved in the HCP

The success of the HCP depends on everyone from the top manager to the most recently hired trainee; each has an important role. For management, the role is largely to support the HCP and enforce its policies as one facet of the company's overall health and safety program. For middle management and supervisors, the role is more direct: these staff members are part of the primary HCP team, which carries out the five phases. Their duties include monitoring noise exposures, maintaining engineering controls, participating in educational efforts, fitting HPDs and reissuing HPD replacements, supervising daily HPD utilization, performing the audiometric evaluations, and giving feedback to employees about their hearing results. The role of employees is to participate actively in the program and to make suggestions as to how to improve HCP operation. However, for employee participation to succeed, the HCP team must be receptive to comments and respond to employee input.

External Influences on the HCP

If local HCP decisions are limited by policies mandated by corporate headquarters, the key individual may need top management's assistance in obtaining exceptions to the corporate rules to meet local needs. The key individual also must keep control over any services provided by outside contractors (such as sound surveys or audiograms). When contractors are used, it is more difficult to integrate their services cohesively into the overall HCP, but it is critical to do so. If in-plant personnel do not follow through by using the information provided by the contractors, then the contracted elements of the program lose effectiveness.

Finally, employees' hearing is affected by off-the-job activities such as recreational target shooting or use of power tools in farming or woodworking. The HCP cannot save workers' hearing through protection on the job unless employees are educated to protect their ears during *off-the-job* noise exposures. The wise employer encourages employees to take HPDs home for use in nonoccupational noisy situations. Meaningful educational programs focus on the importance of good hearing for enjoyment of social and recreational activities, so the employee will appreciate the employer's concern for hearing conservation in all parts of life.

Organization Makes the Difference

Most HCPs make at least some efforts in each of the five phases, but most programs remain ineffective because they are fragmented and incomplete. When HCP personnel lack adequate training to carry out their duties, have no direct supervision to coordinate their efforts, and are not evaluated on their performance, the HCP fails. By putting an interested and capable person in charge of all five phases, then authorizing this *key individual* to make decisions and take actions to improve the program, management will be rewarded by a cost-effective, successful HCP.

Checklist for HCP Development

- ☐ All five HCP phases have been implemented.
- ☐ There is a key individual in charge of the HCP team.
- ☐ HPDs are potentially effective in actual use.
- ☐ HPD utilization is enforced.
- ☐ There is active communication among the HCP team members and personnel at all levels.

3

Education and Motivation

Education and motivation are critical to helping employees actively participate in the HCP and generating the sincere support of the program by management. Regular educational and motivational activities related to hearing conservation develop interest in the program and keep the importance of the HCP in mind throughout the year. Any HCP that attempts to skip over this phase of the program will find other phases failing because personnel do not understand why it is in their own best interest to cooperate in the HCP and take advantage of its benefits. For more details about education and motivation, see References, items 3 and 4.

Education Paves the Way for Other Phases

When sound surveys are planned to determine whether an HCP needs to be established, limited educational efforts must come first to notify supervisors and employees about the purpose of the sound surveys and to explain that their assistance is important for obtaining accurate sound measurements. Employees will be much more cooperative if they are informed in advance of what will be happening and why.

If a noise problem is identified during sound surveys, then a more formal educational program needs to be given before the noise control, hearing protection and audiometric evaluation phases of the HCP are initiated. This start-up program would present the results of the sound surveys, explain the risks of noise-induced hearing loss, and introduce the HCP policies established for various areas or departments of the plant.

Making Education a Priority

Management must emphasize the importance of the educational phase by scheduling regular training sessions and requiring attendance. Educational sessions should be held not only for employees who are regularly over-exposed to noise, but also for employees who occasionally enter the HPD-required areas of the plant and for the supervisors and managers responsible for production areas with hazardous noise. When a company's HCP is being introduced, a manager should participate in each educational session to outline company policies and demonstrate the company's commitment to the HCP. In an established HCP, a manager should participate in educational sessions to the degree practical to reinforce the company's priority on the HCP.

Developing Adequate Personnel Resources

Management must ensure that the primary HCP team members (the key individual, audiometric technicians, HPD fitters and issuers, and supervisors) have received sufficient education about hearing conservation. Then they will be qualified and comfortable carrying out their HCP responsibilities, as well as leading employee training sessions and answering employees' questions. The success of the program depends on this team.

Organizing Sessions for Best Results

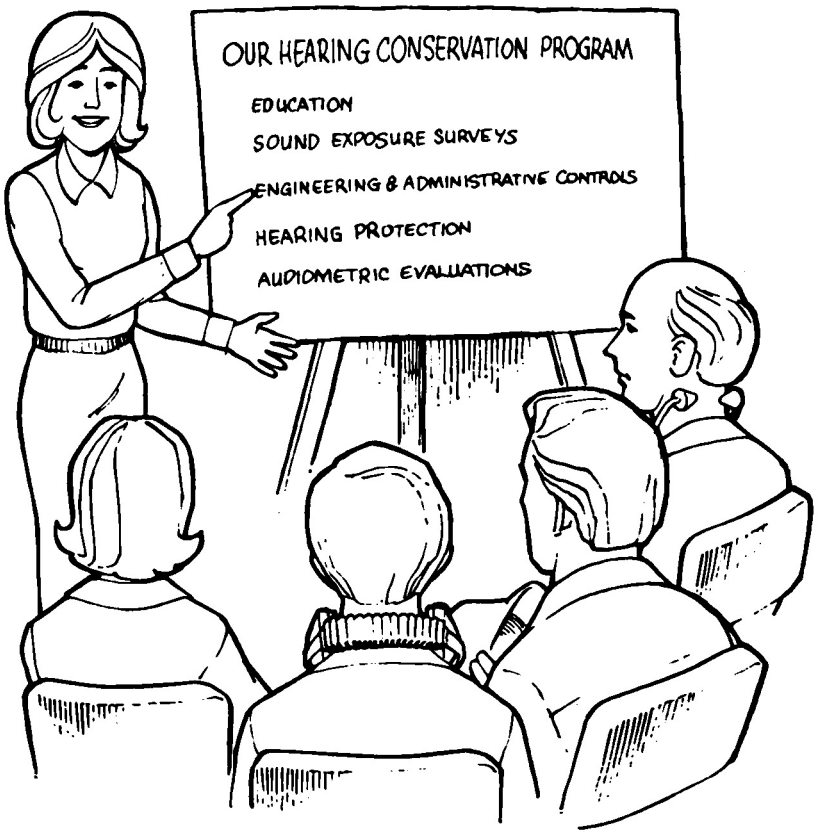
The educational sessions work best in small groups consisting of the presenters plus the supervisor and employees in a production unit. These individuals will typically have common noise exposures, will fall under a common HPD policy, and will feel comfortable enough with each other to ask questions freely. Management must also ensure that employee questions and concerns raised during educational sessions receive thoughtful and prompt follow-up. Separate sessions should be held for supervisors of noisy departments and their managers, so that they can discuss company policy concerns prior to meeting with employees. These groups need more detailed information to prepare for questions employees may later ask during educational sessions or when back in their departments.

A Relevant Approach to Education

To hold employees' interest, the personnel who make the main presentations in formal educational programs must be selected to project genuine interest in employees' welfare, and the program content must be updated every year.

Keep it:

- Short
- Simple
- Meaningful
- Motivating



The annual educational program covers practical aspects of all five phases of the company's HCP and gives employees a chance to ask questions.

Educators should limit the content to a brief, simple presentation of the most relevant facts for employees. The focus should be on the real-life reasons of why it is to the advantage of employees to protect their hearing to maintain their quality of life: to preserve speech understanding ability in both work settings and social environments, to enjoy music, and to perceive auditory warnings and signals such as car engine noises that indicate malfunctions.

Information to help employees understand how their audiogram results compare to expected age-effect hearing loss will increase the motivational benefit of the audiometric phase. Once employees are familiar with their audiogram results and know the reasons why they need to preserve their hearing, the remainder of the program can focus on how to protect their hearing on and off the job. Employees protect themselves by the effective use of HPDs and engineering noise controls, plus administrative controls including good general maintenance of production equipment. The educational program should stress how the HCP benefits employees by protecting their hearing at work and detecting hearing changes that result from medical conditions and nonoccupational noise exposures. A sample educational outline is shown as Table 2.

Table 2

Suggested Educational Program Content

How noise damages our hearing

Consequences of hearing loss in everyday life
- Diminished ability to understand speech
- Social isolation from friends and family
- Interference with work and leisure activities

Noise exposures that are hazardous
- Off the job (gunfire; power tools)
- On the job (sound survey results for plant)

Engineering and/or administrative noise controls implemented or planned

HPD choices for the employees' department
- Using them correctly
- Caring for and replacing them
- Solving common HPD problems or complaints

Audiometric evaluations—purpose and procedures
- Understand your own audiogram results
- Hearing changes may mean inadequate protection
- Nonoccupational hearing loss may be detected

Ways to protect your hearing on and off the job
- Wear HPDs correctly and consistently
- Avoid unnecessary noise exposures
- Use engineering and administrative noise controls

The company's HCP policies
- The importance of the HCP to management
- HCP participation as a condition of employment

Questions and answers

Final motivation
- The HCP as a benefit for employees
- Participation is to employees' own advantage

Tailoring the Presentation to the Audience

Presenters need to make the educational program's content specific to the particular group of employees attending with their supervisor. Presenters should mention the employees' specific noise exposures, the HPD options available, and the engineering controls in place or planned for their department. For the separate sessions for supervisors and managers, greater details and different emphases are appropriate to address the concerns of these personnel. Such sessions may present a progress report on the status of the HCP, review of the company's legal obligations for regulatory compliance, comparisons of audiometric and HPD utilization indicators by department, and answers for questions that employees may ask. Films and pamphlets should be used only as supplementary reinforcements for live presentations, never as the whole program. Verbal presentations and audiovisual aids should be changed annually.

Taking Advantage of Motivational Opportunities

Aside from formal educational presentations, HCP personnel should use every chance to remind employees and supervisors of the importance of the HCP and their active participation in it, especially concerning hearing protection. The greatest opportunity to influence employees occurs at audiogram time, when the current hearing results can be compared to past results and the fit and condition of HPDs can be checked. Praise for employees with stable hearing and cautions for those with threshold shifts can be effective if the comments come from a sincere individual. The personnel who really make HCPs come alive do not wait for this once-a-year chance to interact with employees. They tour the plant floor making comments and talking to workers in the halls and cafeteria. HCP personnel need to emphasize hearing conservation as an *ongoing* effort. This can be achieved through safety meetings, rewards for departments with excellent HCP performance, bulletin board posters, articles in the company paper, and daily interactions with employees. The goal is to emphasize the HCP continually as part of the company climate.

People with noise-induced hearing loss usually find it hard to understand the high-pitched voices of children and women. By protecting your hearing, you can prevent noise damage from affecting your family life.

Questions and Suggestions

Employees need time during educational sessions, safety meetings, and their daily work to voice their concerns or questions. They need the opportunity to inform HCP personnel when certain HPDs or engineering controls are not practical and to suggest alternatives that would be more workable for their departments. If HCP personnel do not provide adequate follow-up or consideration, employees need to be able and encouraged to go up the management line until their concerns are addressed.

Checklist for Education and Motivation

- ☐ Team members receive education about hearing loss and hearing conservation to understand the goals and policies of the HCP.
- ☐ HCP team members receive training in how to carry out their functions (especially concerning HPD fitting and utilization).
- ☐ Employees annually attend updated educational programs that focus on why and how to protect their own hearing on and off the job.
- ☐ HCP personnel keep the program in employees' minds through informal reminders at least quarterly.
- ☐ Management backs up the HCP by personal example (wearing HPDs), policy enforcement, and participation in educational programs.
- ☐ Employees are evaluated on their HCP participation during the company's annual personnel reviews.

4

Sound Surveys

The noise measurement data obtained through sound surveys are needed to determine the degree of exposure hazard and to make decisions about how to protect employees. Different instruments and measurement methods may be used depending on the type of survey being conducted.

Types of Surveys and Instrumentation

In *basic sound surveys* a sound level meter is used to identify work areas that clearly do not have a noise problem and areas that *do have* potentially hazardous noise environments. The basic survey determines the departments where employees may need to be included in the HCP due to their daily noise exposures (a combination of the noise levels with their corresponding durations). In *detailed sound surveys*, it is preferable to use a personal noise dosimeter to estimate the worker's daily noise dose and equivalent OSHA time-weighted average (TWA) noise exposure. Obtaining detailed information by use of a sound level meter can be more difficult because of worker mobility and differences in the sound levels. (For additional information on conducting a detailed sound survey with a sound level meter, see References, item 5.) In *engineering sound surveys* instruments such as sound level meters, octave-band analyzers, and recorders may be used to measure the noise levels produced by machinery in various modes of operation in order to assess the potential for applying engineering controls.

Surveys should be conducted on a recurrent basis: annually, or more often if it is suspected that the employees' TWAs may have changed significantly. Thus, it is often cost-effective to purchase the instrumentation and have an on-site staff member trained to perform sound level and exposure measurements. With in-house expertise, the company can check sound levels whenever production machinery is changed without bringing in an external consultant. In addition, company personnel can evaluate simple noise control options without having to hire a consultant.

Ways Sound Survey Results Are Used

The results of sound surveys are needed for many reasons:

- To designate those areas of the plant where hazardous noise levels exist
- To identify the employees to be included in the HCP
- To classify employee noise exposures to define HPD policies and rank areas for noise control efforts
- To determine whether noise levels present a safety hazard in terms of interference with speech communication and warning signal detection
- To evaluate noise sources for noise control purposes
- To document noise levels and employee exposures for legal purposes such as workers' compensation

Keeping Surveys in Perspective

It is important to define the goals of the sound surveys and limit their scope to obtaining the information needed to guide decisions. It is not necessary to perform extremely detailed surveys to decide how best to protect employees. In many instances adequate data can be obtained with only a sound level meter and a stopwatch. The time and money devoted to exposure monitoring should be just sufficient to make appropriate HCP decisions. The bulk of resource allocations should go to the phases of the program that actually *provide protection* for employees (education, noise controls, hearing protection and audiometric evaluations).

The sound survey should result in a noise map of the production facility. A noise map is a floor plan with areas of the plant designated according to whether area workers are included in the HCP and according to which HPD utilization policy applies to the area: voluntary or required use, with free or restricted HPD choice. (See Table 3.) Estimates of daily noise exposures for representative employees in various jobs are also needed, particularly for jobs in which workers are exposed to noise that varies in level. A suggested guideline for classifying HCP policies according to the established TWAs is shown in Table 3.

Table 3

Suggested TWA Ranges for Classifying Plant Areas and Corresponding HCP Policies for Area Employees

TWA, dB(A)	Workers in the HCP	HPD Utilization	HPD Selection Options
84 or below	no	voluntary	free choice
85–89	yes	optional*	free choice
90–94	yes	required	free choice
95–99	yes	required	limited choice
100 or above	yes	required	very limited choice

*HPD utilization will be required:

1. For any individual who shows a significant change in hearing
2. For all employees if audiometric data base analysis results or group hearing trends indicate inadequate protection

Planning and Coordinating With Production Personnel

HCP personnel must plan the sound surveys to obtain information needed to answer relevant questions about protecting employees. If external contractors perform the surveys, the key individual must define the information desired and familiarize the contractors with the environment, employee work schedules and production variations. Following this procedure ensures that the desired information will be obtained.

The sound surveyor must coordinate scheduling with production personnel to capture representative production cycles. Supervisors can predict when noise levels will be higher or lower, when certain pieces of equipment will be in operation, and when downtime for repairs or maintenance will be scheduled. Production schedules and machinery function do not always follow predictions. Thus, surveyors must be flexible and return as needed to obtain the desired data for all typical work activities. By coordinating with supervisors to minimize interference with production, the surveyors will enhance supervisors' cooperation and willingness to share information.

Employee cooperation and knowledge are needed to obtain valid survey results. Therefore, sound surveyors must establish rapport with workers to benefit from their familiarity with the production environment and machinery. Experienced operators can often identify dominant sound sources, predict time periods of relatively higher or lower sound levels, and describe the effects of different operation modes on sound levels. If surveyors explain the purpose of the survey to workers and solicit their help in planning the measurements to be made, they can avoid errors and oversights and reduce the prospect of resentful or suspicious workers sabotaging the results or damaging the instrumentation.

Data Collection

In making measurements and documenting results, the surveyors must consistently follow accepted practices for instrument selection and calibration, measurement techniques, sampling strategy, methodology description and documentation, and data recording. Detailed guidelines for data collection are available. (See References, item 5.) The American National Standards Institute (ANSI) also publishes relevant standards. (See Resources, item 1.) During data collection, the surveyor must record in detail the measurement locations and times and the procedures followed. A good rule of thumb is to make the survey description detailed enough that another person could follow it to replicate the results (provided the noise environment has not changed). It is very useful to record C-weighted as well as A-weighted sound levels for purposes of estimating HPD adequacy and considering engineering controls. (For more information about C-weighted and A-weighted sound levels, see References, item 12.)

Employee Participation Is Essential

Employees can assist the sound surveyors in obtaining representative results by sharing their knowledge about the production environment, the machinery in operation and worker tasks. Employee assistance is critical in operating machinery for detailed engineering sound surveys intended to evaluate sound sources within a unit of machinery. Employees should

continue their normal activities when wearing dosimeters for individual worker exposure monitoring to ensure that the results will be representative.

A noise dosimeter takes into account the variations in sound levels over time and predicts the employee's daily noise dose, which can be converted to the TWA.

Employees should be asked to notify HCP personnel when the sound environment creates a possible safety hazard due to communication difficulty or when changes in sound levels call for a resurvey. Sound levels may increase significantly when equipment begins to wear, and changes in equipment placement or processes may have unintended effects on sound levels. When employees notice such changes, they need to inform the sound surveyors that a resurvey is needed to evaluate the sound levels and corresponding employee exposures.

Report Preparation

The report written after completing the sound survey must present the results clearly. The writer should state the survey objectives and present data relevant to these objectives. Because few report users will need or read the full details of the survey, it is critical to include a concise abstract or administrative review section. A slightly longer summary should be included for the primary HCP team.

The body of the report must summarize the calibration and measurement procedures to support the validity of the conclusions. Detailed documentation must be kept with the report to substantiate the procedures if they are ever questioned. Although the report will contain neatly organized tables of data, the *original* data recording sheets and instrument calibration sheets should be preserved for potential legal purposes. Keep in mind that all sound survey reports may be used as legal documents if the company ever becomes involved in a workers' compensation or other suit related to the noise environment.

Communicating Exposure Results

The written abstract of sound survey results should be given to managers and department supervisors, and the longer summary should be given to the HCP team members. The updated noise map of the plant should be explained to employees during their educational programs and posted for employees to refer to. In areas where hearing protectors are required for all who enter, warning signs should be posted. Employee TWA estimates must be transcribed onto the audiometric records for individual employees to aid the audiogram reviewer in interpreting whether hearing trends are caused by on-the-job noise exposure.

Checklist for Sound Surveys

- ☐ Representative TWAs have been determined for all noise-exposed job classifications.
- ☐ A noise map of the plant has been posted to show:
  1. areas where employees are included in the HCP
  2. areas where HPD utilization is required.
- ☐ Employees have been told the typical noise exposures for their departments during educational sessions.
- ☐ HCP team members and department supervisors have summaries of sound survey results.
- ☐ Employee TWAs are listed on their individual audiometric records.

5

Engineering and Administrative Noise Controls

Engineering Controls

If real-world noise sources such as production equipment, fans and air compressors that overexpose employees can be quieted so that their contribution to the employees' daily TWA is no longer important, and if the cost of controlling the sources is less than the cost of not controlling them, then the noise problems should be controlled. However, real-world situations are seldom clear-cut. Making management and engineering decisions concerning the anticipated effectiveness and cost of noise control options is often a challenge to all parties involved (managers, equipment manufacturers, OSHA personnel and consultants).

For example, consider a situation where a long-term financial benefit would result (increased production and lower cost per unit produced) if known noise control solutions for a piece of production equipment were installed. It is also known that installing noise controls would lower the employees' TWA by at least 5 dB(A). However, the capital to carry out the modifications is not available. Therefore, in this situation the monetary constraints would delay known noise control options in favor of the utilization of hearing protection until the company is financially able to make the necessary equipment modifications. Management should recognize that failure to make the changes as soon as practical would reduce the company's ability to compete in the free market.

What is management's responsibility with respect to the engineering and administrative noise control phase of the HCP? For any plant site, management has the responsibility to identify the dominant noise sources in all production areas and determine if practical noise control options are available and if the cost of noise controls is justified. It is not adequate for management to say, prior to conducting the engineering noise control survey, that production equipment A is the noise problem and no solution exists. It might be that uncontrolled air exhaust or an improperly installed hydraulic valve, both problems that are often easily controlled, are the only major noise sources creating the overexposure for the operators of the equipment. Whereas identifying the dominant noise sources in a production area is typically easy to do, determining the reasonableness of the anticipated cost is more difficult.

Identifying Dominant Noise Sources

During the basic or detailed sound survey, the surveyor should have identified the obvious dominant noise sources in the room. This information is now used as the starting point for the engineering noise survey, which will determine the contribution of each dominant source to employee noise exposures.

Using a sound level meter, the surveyor can measure the sound levels at the employee's workstation as individual pieces of equipment in the production area are run separately to determine their relative contributions. In some circumstances it is not practical to run individual pieces of equipment (due to continuous equipment operation or equipment interdependence). Then it will be necessary to conduct the survey during the yearly maintenance period or to make measurements at times when, due to equipment failure or temporary equipment shutdowns, one or more of the production units is not operating. Once the noise levels at the employees' work stations are known with different units in operation, then the effective contribution of each piece of equipment can be easily determined. For more information, see References, item 5.

Contributing Equipment Noise Sources

Once the dominant noise sources have been defined, the next step is to determine the significant contributing noise sources within each piece of equipment. Typically this survey involves a team consisting of equipment operators, a mechanic, and a sound surveyor. As far as the machinery design will allow, individual components of the equipment are operated and the noise levels at the employee's workstation are recorded for each operating condition. The ideal situation occurs when one component of the equipment is found to be the only significant sound source and a readily available, inexpensive noise control solution exists.

One Example

In a production room the measured TWA of stamping machine operators was 93 dB(A), and TWAs of 88 dB(A) were measured for employees in another area of the room who were packing the product. (Note that the level of the noise in the room was constant and roughly equal to the predicted OSHA TWA.) For employees working in both areas, noise exposures were below 80 dB(A) when the stamping machines were not running but the heating, ventilating and air conditioning (HVAC) system was in operation. Therefore, it was concluded that the dominant noise sources in this production room were the stamping machines.

The next step was to operate one stamping machine while the remaining machines were not running. Due to production constraints, this required the sound testing to be carried out between second and first shifts. The survey team consisted of the company's chief mechanic and the sound surveyor.

The stamping machine could be run without any product being stamped, and the air supply used to assist in the removal of the product could also be turned off. Therefore the test sequence followed involved running the stamping unit with the air supply turned off and without product (condition 1), then with the air supply on but without product (condition 2), and finally turning out product with the air on (condition 3). For condition 1 the measured sound level at the employee's work station was less than 80 dB(A). When the air was turned on (condition 2), the sound level increased to 90 dB(A). Finally, for condition 3 the sound level increased by 0.5 dB(A) to 90.5 dB(A). Note that if the addition of the product (condition 3) had contributed as much to the measured noise level as did the air supply (condition 2), then the increase in level for condition 3 would have been 3 dB(A). Because the increase was only 0.5 dB(A), it was concluded that the contribution from running product was at least 10 dB less than the contribution of the basic machine components plus the air noise.

Many common noise problems, such as air exhaust noise, are simple to control with commercially available mufflers.

After identifying the air exhaust system of the stamping machines as the room's major contributing noise source, management had the information to determine the feasibility of controlling the noise to reduce employees' exposures. Since the measured sound level at the operator's work station was 90.5 dB(A) with only one stamping machine running, and the workstation level increased to 93 dB(A) with all units in operation, then the increase of 2.5 dB(A) was due to the contribution of the remaining stamping machines. In other words, noise controls needed to be applied not only to the operator's own machine, but also to all other surrounding units, to reduce the noise level at the employee's work station to below 85 dB(A).

In this case a solution was both economically and technically feasible. For expenditure of less than $15 per stamping machine, management was able to completely eliminate the noise hazard to below OSHA requirements. Without the engineering noise control survey, however, management would not have had the information necessary to make the appropriate decision.

Feasibility Considerations

When conducting the engineering noise control surveys, several pieces of production equipment are commonly found to be dominant noise sources, contributing about equally to the employee's daily TWA. Each of these dominant noise sources may have included several equally contributing component noise sources. Even when feasible solutions are known for some of the contributing sources, the existence of multiple sources may make it possible to conclude that controlling the employee's noise exposure cannot be economically justified. However, the pieces of production equipment that are the dominant sound sources and their internal contributing noise sources must first be identified. Otherwise, management will not have the necessary technical information to accompany other information (such as effects on production and cost) upon which to base appropriate decisions concerning controlling the noise through engineering means.

Administrative Controls

The most common interpretation of the term "administrative controls" includes the use of changes in employees' work schedules and job tasks to reduce the noise exposures for individuals. Many people consider the purchase of quieter new equipment to be an engineering noise control. However, such "buy quiet" efforts are more of a managerial decision than an engineering effort, since the purchaser transfers the responsibility for engineering out the noise to the equipment manufacturer. To distinguish the application of retrofit noise controls in the local plant from "buy quiet" programs, the purchase of quieter new equipment is interpreted here as an administrative noise control. Also considered here to be an administrative noise control is management's establishment of regular maintenance programs to keep noise levels down by ensuring that both machinery and its noise control features are kept in good condition. No matter which term the reader chooses to apply to these noise control strategies—engineering controls or administrative controls—the goal is the same: to reduce employees' noise exposures.

Controlling Employee Work Schedules

Work schedules may be modified to limit, or control, the employees' noise exposures. In a few special situations the use of administrative controls has not only significantly reduced employees' TWAs but also increased productivity by sharing a very demanding task between two individuals. In one instance the operator [TWA of 89 dB(A)] and oiler [TWA less than 80 dB(A)] for a large dragline operation, who typically worked 12-hour daily shifts, were both retrained and allowed to change work positions every three hours. Although the oiler's salary had to be increased, the resulting increase in productivity offset the cost of higher pay for the oiler, and both employees benefited from reduction of their TWAs to less than 85 dB(A).

However, caution is advised in using administrative options when they involve exposing a previously unexposed population [TWAs less than 85 dB(A)] to potentially damaging noise levels to reduce the TWAs for a population that is already noise-exposed. In general it is not good safety practice to increase the percentage of the workforce exposed to a known hazard.

Maintaining an Acceptable Maintenance Program

To prevent the noise produced by existing equipment (newly purchased or modified by engineering controls) from increasing significantly, a regularly scheduled equipment maintenance program should be in place. It is common to control a noise problem by engineering means only to return months later and find that the installed noise mufflers, equipment enclosures and vibration isolators have failed to maintain the controlled level of noise due to either sabotage, inap-

propriate equipment utilization or inadequate maintenance. Management has the responsibility to ensure that equipment that has been controlled for noise output is properly serviced and utilized to maintain the controlled level of noise. Management typically does not realize that equipment that has been controlled for noise output must become a part of a regular noise control equipment maintenance program. Company engineers and noise control consultants estimate that 2-4 percent of the cost of noise control will have to be spent yearly in maintaining the level of noise reduction originally achieved. It is important to require the active participation of all involved parties (such as equipment operators, supervisors, and mechanics) in maintaining the production equipment in a satisfactory condition. Management directives and the regularly scheduled company education program best achieve this goal.

Planning for Noise Control Purposes

A very effective use of administrative controls involves long-term planning (less than five years to start of implementation) for a significantly quieter work environment. It should be obvious to all by now, after more than 35 years of OSHA, that in a high percentage of noisy production environments there is no quick solution to the noise problem.

In these instances one solution is the purchase of new equipment, or remodeling of existing equipment or facilities, with sufficient guarantees of a noise-free or significantly reduced noise environment (TWA reduced by 10 dB(A) or more). Notice that earlier a significant reduction in the noise environment was defined as 5 dB(A). However, due to the problem of estimating noise environments for new production facilities, a planned reduction of 10 dB(A) should guarantee at least a 5 dB(A) reduction after equipment installation.

Noise Limits for Equipment Purchases and Modifications

A second effective use of administrative controls is *enforced* equipment noise specifications for purchasing new equipment or modifying existing equipment. *Notice that we emphasize "enforced" because the clear tendency in industry is for management to establish noise specifications that are regularly passed over by purchasing agents for less expensive alternatives, regardless of the cost differential.*

Solving Noise Control Problems Using In-House Personnel

The preceding discussions of noise controls have been aimed primarily at defining the more obvious noise problems. Once these problems have been defined, then management must decide the route to take in achieving an engineering solution if appropriate. For the simpler noise problems, in-house solutions are normally more cost effective.

To solve the minor noise problems in house it is necessary to: (1) identify the individual who will find and implement the solution and (2) give the individual the necessary flexibility and authority. The experiences of industrial personnel clearly show in-house staff do not need professional training to solve simple noise problems. Nurses, audiometric technicians and safety directors who have received the most elementary training in noise control concepts have been successful at solving such problems. Together with the lead mechanic, they have controlled air exhaust noise by installing commercially available mufflers. They have controlled HVAC fan system noise by purchasing and installing in-line commercially available noise attenuators. They have controlled motor noise resulting from improper vibration isolation by installing appropriate commercially available mechanical isolators.

Company personnel should not believe that without the results of the noise control survey, a noise problem cannot be solved without expensive outside consulting services. For the more difficult noise problems, however, some type of outside consultation is almost always necessary. Private firms specialized in noise abatement offer consultation services. Additionally, consultation is available through the Consultative Services Bureau, Occupational Safety and Health Division, N.C. Department of Labor. (See the inside back cover of this publication for the address and telephone number.)

Sources of Information

For immediate information concerning possible noise control options, management has several possible sources including the resource staff of the N.C. Department of Labor, trade associations, insurance carriers, and extension departments at the local technical college or university. In addition to these sources, there are chapters and articles, plus several relatively easy-to-read textbooks (see References, items 6–10) and one free journal that publishes an annual summary of all the manufacturers of noise and vibration control products (see Resources, item 3).

Purchasing quiet equipment to replace old machines or to outfit a new facility can eliminate the noise exposure hazard.

Checklist for Noise Controls

- ☐ Engineering noise control survey completed.
- ☐ Dominant production noise sources identified.
- ☐ Contributing equipment noise sources identified.
- ☐ Equipment noise purchase specifications exist.
- ☐ Noise control maintenance program exists.
- ☐ HCP education phase includes engineering controls.
- ☐ New facility planning includes noise control.
- ☐ Solution of simple noise problems documented.

6

Hearing Protection Devices

Hearing protection devices (HPDs) are the first line of defense against noise in environments where engineering and administrative controls have not reduced employee exposures to safe levels. HPDs *can prevent* significant hearing loss, but only if their utilization is carefully implemented and supervised. Employees will not achieve adequate protection if various HPDs are simply placed onto the tool crib shelf, with the choice of style and size left up to the employee.

For more information about hearing protection, see References, items 4 and 11–12, and Resources, item 4.

Organizing the HPD Phase for Success

HPD effectiveness cannot be achieved without the enthusiastic and diligent efforts of those who select, fit, issue and reissue the protectors. Management must choose capable and interested personnel to handle the HPD phase. Those selected should be provided with the knowledge they need to do a good job. Working with the employee in selecting optimal HPDs and training the employee to wear and care for HPDs are much more complicated tasks than dispensing safety glasses, for example. Therefore, those responsible for HPDs need detailed education from the HCP supervisor, from attending a CAOHC course, or from materials and workshops sometimes provided by HPD manufacturers and associations concerned with hearing conservation.

HPDs will not protect employees unless their proper utilization is absolutely enforced as a condition of employment. Many companies have written disciplinary rules for failure to wear HPDs, but they are never implemented. For the HCP to be effective, management must set the same priority on HPD utilization as on the use of all safety equipment and then back it up with action: the employee either wears HPDs in required areas or goes home.

Types of HPDs

Earplugs

The most popular HPDs are earplugs, which are inserted into the ear canal to provide a seal against the canal walls. *Foam* or *"rolldown"* earplugs are rolled between the fingers to compress them for proper fit. They can be made from polyvinyl chloride or polyurethane. *Premolded* earplugs are made of flexible vinyl materials and come in different sizes. *Formable* earplugs are made of malleable materials such as cotton/wax or silicone putty and spun fiberglass that can be manipulated to conform to the shape of the wearer's ear canals. *Custom molded* earplugs are made from impressions of the individual employee's ear canal.

Earmuffs

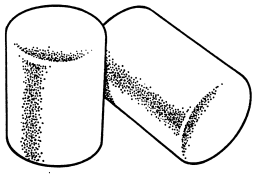
Sometimes called circumaural HPDs, earmuffs enclose the entire external ears inside rigid cups. The inside of the cup is filled with acoustic foam, and the perimeter of the cup is fitted with a cushion that seals against the head around the ear by force of the headband. In most industrial environments earmuffs are less popular than earplugs, but they can provide reliable protection. Glasses, facial hair, long hair or facial movements such as chewing may reduce the protective value of earmuffs.

Banded Earplugs or Semi-Aurals

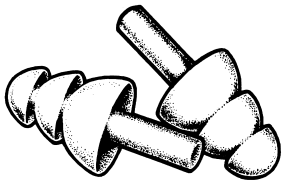
These HPDs are small stoppers that seal against the entrance to the ear canal by force of a band worn under the chin or behind the neck. The typically provide less protection than earplugs or earmuffs. They are most suitable for short-term use, as they are less comfortable than other HPDs for all-day wear.

Helmets or Hard Hats

While not used in most occupational settings, helmets with built-in or hard hats with attached hearing protection are available. Occupations and activities where the use is more common include logging and tree felling, recreational sports, and the military.

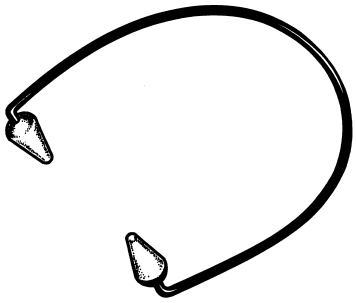


Foam earlplugs expand to fit ear canals at differecnt sizes and shapes.



Premolded earplugs may come in from one to five sizes to fit different ear canals.

Earmuffs cover the ear to block out noise.



Semi-aural HPDs or canal caps are convenient for brief periods of noise exposures.

Hearing Protector Attenuation

All HPDs attenuate noise by creating a seal that prevents sound from entering the ear. Earplugs mainly seal against the wall of the ear canal, while semi-aurals seal against the entrance to the ear canal or its outer edge, and earmuffs seal against the head all around the external ear. In each case the amount of sound reduction achieved depends largely on the completeness of the seal—any air leaks will allow some sound to bypass the HPD.

The maximum achievable attenuation is limited by the bone-conducted sound that results when sound vibrates the skull. However, bone-conducted sound transmission is not important for industrial environments compared to the effect of whether the HPD is fitted properly and used correctly. In practice, when employees do not receive adequate protection from their HPDs, it is because they do not achieve an *adequate seal*. This may happen because the HPD *does not fit properly* (the HPD is the wrong size or design for the individual) or *is not used correctly* by the employee (due to inadequate training or carelessness).

The Noise Reduction Rating (NRR)

HPD manufacturers publish attenuation data for their products based on idealistic laboratory measurements. The NRR shown on the label of the HPD package is intended to give a single-number rating of the laboratory attenuation across a range of frequencies. The NRR is subtracted from the employee's noise exposure to indicate the maximum exposure reduction that could be attained if the employee had similar physical characteristics as the laboratory subjects and could wear the product in the same way as the laboratory subjects.

The NRR is designed to be subtracted from the C-weighted sound pressure level to give the A-weighted level under the HPD:

[Noise level, dB(C)] – [NRR] = [estimated exposure, dB(A)]

If only A-weighted exposure is known, then a correction factor of 7 dB must be subtracted from the NRR:

[Noise level, dB(A)] – [NRR – 7] = [estimated exposure, dB(A)]

The 7-dB correction factor is needed with A-weighted levels because the dB(A) value gives no indication of whether the energy in the noise environment is predominately low-frequency or high-frequency, and HPDs provide less protection at lower frequencies. Most dosimeters predict only noise dose or equivalent TWA values based on A-weighted sound pressure levels. However, if the sound surveyor measures both dB(A) and dB(C) levels with a sound level meter, then the average "C minus A" difference for the noise environment can be used as the correction factor in place of 7 dB. In high-speed textile spinning, for example, "C minus A" differences ranging from 2 to –1 dB have been measured.

When noise exposures indicate the need for double hearing protection (e.g., earmuffs and earplugs), only a 5 dB reduction can be taken for the second protection. (For more information about this and other attenuation formulas, see References, item 12, and Resources, item 9.)

Real-World Attenuation

Although the NRR is a readily available number that appears as if it should allow the HPD selector to decide whether a protector is adequate, it is flawed by the laboratory test conditions used to obtain it. Real-world users do not achieve the amount of attenuation indicated by the NRR. In general, HCP personnel can count on properly trained and motivated HPD wearers receiving about 50 percent of the NRR value in attenuation. Very motivated users can achieve better results. (See References, item 12).

The NRR cannot even be used to rank the real-world effectiveness of HPDs. Studies in which employees were pulled off the job to have their actual HPD attenuation measured have shown that the attenuation achieved with different HPDs gave a different rank from their NRRs. Products that are more "goof-proof" (foam earplugs and earmuffs) provided higher real-world attenuation than other HPDs (see References, item 12).

Because the NRR is not a realistic indicator of the attenuation that wearers achieve, HCP personnel should not use the NRR as a significant criterion for evaluating HPDs. Comfort, convenience and compatibility with the working environment ultimately determine the protection an employee will receive from a hearing protector, since the effective attenuation of an unworn HPD is zero.

Purchasing Appropriate HPDs

It is essential to select and keep in stock a sufficient choice of HPDs appropriate to the work environment and the wearers' needs. Generally an adequate selection would include three types of earplugs, two styles of earmuffs and one semi-aural device.

The best HPD is the one the employee will wear consistently and correctly!

The choice of HPDs should be made by the HCP personnel based on characteristics of the work environment and real-world HPD performance as well as the preferences of the employees. The purchasing department must not be allowed to overrule the HPD selection. Management should give HCP personnel the authority to obtain the HPDs they feel are best for the company's workforce. The factors that should be considered in choosing HPDs the company will stock are discussed in the following paragraphs.

Real-World Attenuation

Because most employees have noise exposures below a TWA of 95 dB(A), they only need 10 dB of real-world attenuation. Most HPDs can provide this much protection, if properly fitted and correctly worn. Higher employee TWAs require more careful HPD selection, and only the protectors with the best real-world attenuation (earmuffs or foam earplugs) are recommended for TWAs of 100 dB(A) or above.

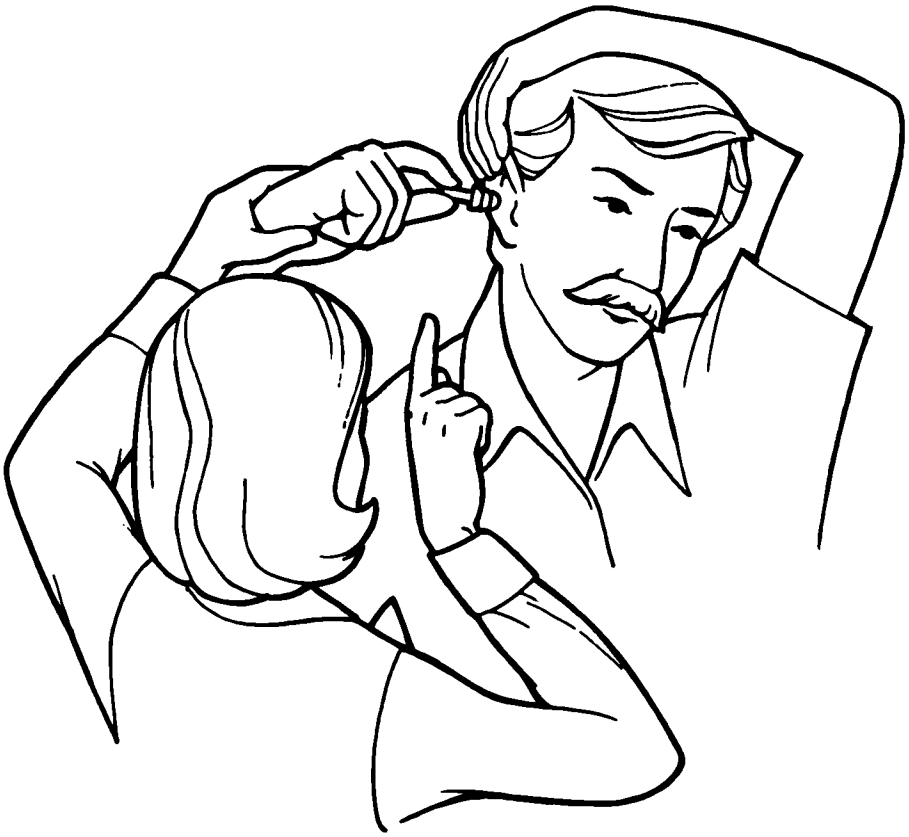
Comfort

Employees will not wear uncomfortable HPDs, so the goal of fitting is to find the most comfortable HPD that gives adequate protection for the environment. Because no single HPD suits all wearers, several choices should be available. The employee should be allowed to select his or her preferred HPD as long as the issuer confirms that the fit is adequate for the required attenuation.

Convenience

Employee acceptance of HPDs depends on practical factors such as:

- Ease of correct positioning considering physical limitations of the wearer (such as finger size or strength, arthritis)
- Speed and ease of HPD removal and repositioning
- Simplicity of carrying or storing during work breaks
- Compatibility with other safety gear (masks, hard hats)
- Suitability for job tasks (crawling in tight spaces, strenuous physical activity, repetitive head movements)
- Practicality in the physical environment (for example, considering heat, dirt, chemicals)



Each employee needs to be shown how to insert earplugs or wear earmuffs properly to achieve a good seal and adequate protection.

Communication Needs

Select an HPD that will allow the employee to communicate as required in the workplace noise environment. For normal-hearing employees, this is usually not a problem since HPDs improve speech discrimination in noise above 90 dB(A) by reducing distortion in the ear from high sound levels. However, for workers with preexisting hearing loss, HPDs often make communication more difficult by reducing speech-sound information to below their hearing thresholds. Hearing-impaired employees who must receive detailed face-to-face instructions may prefer earmuffs so that they can lift up the earmuff cup to hear speech, or plugs with minimal attenuation may improve reception of speech as well as auditory warning signals. Hearing-impaired employees may also benefit from HPDs that exhibit flat attenuation across the frequency spectrum. These HPDs provide less reduction than regular HPDs of the high-frequency sounds that are affected most by hearing loss.

Employee Input

HCP personnel need to solicit employee opinions about various HPD products. This can be done by conducting wearer evaluation trials, by asking for employee feedback in safety meetings and in the break room or cafeteria, and by questioning individuals when HPDs are reissued or when the annual audiogram is administered. HCP personnel should be aware of new HPDs that might be suitable additions to or replacements for the HPD choices currently carried in stock. When employees ask about products they have seen, if practical, the HPD issuer should investigate these options.

Maximizing the Effectiveness of HPDs in Actual Use

The attention paid by the HPD issuer to the following factors will determine how much real-world protection employees receive from their HPDs.

Correct Fit

HPDs offer little or no protection if they do not form a seal to block out sound. All HPDs must initially be fitted by a trained issuer. Earplugs must be fitted separately in each ear, as an individual's two ear canals may differ in size or shape. Because none of the "universal-fit" plugs can actually fit every individual, even one-size earplugs, including foam earplugs, must be checked for proper fit in both left and right ears. Pamphlets about selecting and fitting HPDs are available from National Hearing Conservation Association (see Resources, item 5).

Good HCPs always stock premolded plugs in a full range of sizes to suit extra small and extra large ear canals. Before inserting an earplug into the employee's ear, the fitter must visually check the ear canal for excess wax or obvious abnormal conditions that would require fitting to be delayed until the problem is corrected. The fit of earmuffs also must be checked for each wearer to make sure that the earmuff cushion seals against the head all around the ear, and that the outer ear (pinna) can fit inside the cup (the cushion must not rest on the pinna).

There is no such thing as a "universal-fit" HPD!

Training Users

Each HPD wearer must receive specific instructions on how to wear and care for the HPD issued. To ensure that the employee can insert or place the HPD correctly, the fitter should watch while the individual user demonstrates how to put on the HPD correctly. If the employee's initial attempt is inadequate, the fitter should reinstruct and have the worker practice in the fitter's presence until proper placement is achieved. Employees must be convinced that they will not receive adequate protection unless they correctly wear and maintain their HPDs. The employee needs to know the signs of HPD deterioration that indicate it is time to get a replacement. Each year the employee should be asked to bring his or her HPDs to the audiometric evaluation so that the fitter can inspect them for wear, reevaluate the fit, and check that the employee can still place them correctly.

Responding to Wearer Questions and Complaints

HPD issuers must be open to employee concerns. Issuers should seek answers to employees' questions and work individually with employees who find it difficult to wear HPDs because of discomfort or the inability to communicate adequately while wearing them.

Controlling the HPD Replacement Process

HPD reissuers need to maintain strict control of replacements so that employees are reissued only the style and size of HPD indicated on the fitting record. Employees who wish to change HPD type or size must return to the fitter for refitting.

Replacing HPDs Regularly

New HPDs should be routinely issued to each wearer on a schedule appropriate for the type of HPD being worn. An aggressive replacement procedure will prevent employees from retaining HPDs that have lost their effectiveness. At the same time HCP personnel can detect altered HPDs and reeducate the employees who made alterations. Some key individuals periodically set up an HPD replacement station at the plant exit during shift changes as an extra reminder.

Monitoring HPD Utilization

Front-line supervisors and production department heads need to perform regular checks to ensure that employees are properly wearing their HPDs. Employees who do not cooperate with the mandatory HPD utilization policy must receive reeducation and meaningful disciplinary actions, eventually culminating in dismissal for repeated offenses. At the same time, consistent HPD users should be rewarded for their performance through recognition for departments with good utilization records and by praise for individual wearers.

Motivating Employees to Wear HPDs Effectively

Ultimately, the employee who wears the HPDs is personally responsible for achieving and maintaining protection from noise through the proper use of HPDs. However, the employer must educate and motivate the employee to take this active part in the HCP. The key individual and other HCP team members should strongly consider employees' input when selecting the HPDs to be stocked, as well as when finding a suitable protector for an individual. Employees need clear, understandable information to help them appreciate that they will be protected from developing hearing loss only if they consistently and correctly wear HPDs that are fitted properly.

Identifying Satisfactory HPDs

The employee and the fitter need to work together to select a product that will be comfortable and convenient enough for the worker to wear it consistently. The employee who has received proper education will understand that some initial discomfort is expected during the breaking-in period when getting used to HPDs. If the employee still encounters significant discomfort or interference with job tasks after one to two weeks of wearing a new HPD, then the wearer should return to the fitter to request another type.

Wearing HPDs Correctly and Consistently

Ultimately employees must accept the responsibility to reduce their noise exposure by faithfully and properly wearing HPDs both on and off the job. Intermittent or incorrect HPD use will not prevent the development of noise-induced hearing loss. The department supervisors can ensure that all employees in HPD-required areas are wearing HPDs, and the HPD fitters can spot-check in each department for actual correctness of HPD fit and placement. Annually, at audiogram time, each employee should be retrained in proper HPD fitting, use and care.

Caring for and Replacing HPDs

Employees need specific instructions as to how to wash their HPDs, store them in cases or safe places to prevent damage, inspect them for signs of wear and tear, and seek replacements when deterioration occurs. Employees must be taught that achieving good protection depends on keeping the HPDs in good condition. Worn-out or intentionally altered HPDs will not provide adequate attenuation.

Demonstrating Management Support

Managers must demonstrate support for HPD utilization and emphasize its importance by:

- Wearing HPDs each time they enter an area with either a voluntary or mandatory HPD wearing policy (no matter for how brief a time the managers are in the area)
- Establishing a policy of mandatory HPD utilization
- Making HPD utilization enforcement part of the basis for performance ratings of the front-line supervisors and production department heads
- Providing a mechanism for regularly praising or rewarding employees who wear HPDs correctly and consistently
- Rating the performance of all personnel responsible for any aspects of HPD utilization enforcement, fitting, issuing and replacement
- Directing that HPDs be made available to employees for off-the-job noise exposures so that hearing will be protected around the clock
- Purchasing equipment to allow HPD issuers to monitor the field performance of HPDs as actually used by individuals
- Scheduling regular meetings among the HPD fitters and issuers, the reissuers, and the supervisors who enforce utilization on a daily basis

Shooting is one of the most common causes of off-the-job noise-induced hearing loss, but hearing protectors are very effective against gunfire noise.

Checklist for Hearing Protection

- ☐ HPD utilization in required areas is strictly and consistently enforced.
- ☐ Comfort, practicality and real-world attenuation—not the NRR—are the primary criteria for selecting which HPDs will be stocked.
- ☐ Each employee is individually fitted with HPDs and trained in their proper use and care.
- ☐ Fit is checked for all types of HPDs, including earmuffs and single-size earplugs.
- ☐ A minimum of two earplugs (one in multiple sizes) and one earmuff are available for selection, but preferably three plugs, two muffs and one semiaural.
- ☐ HPDs are replaced on a regular basis.
- ☐ HPD reissuers distribute only the type of HPD fitted to each employee; to change types or sizes the employee must return to the fitter.
- ☐ Each employee's HPDs are rechecked during the audiometric evaluation for condition, fit and correct placement.
- ☐ Employees are given HPDs to take home for use during off-the-job noise exposures.

7

Audiometric Monitoring

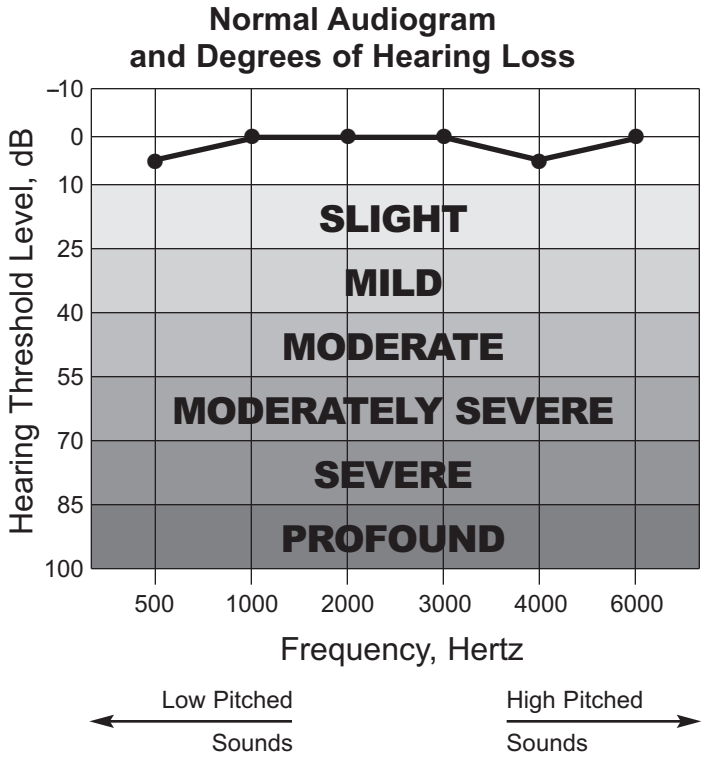
The audiometric monitoring phase of the HCP ties together all the other phases by indicating whether the program's goal is being achieved: prevention of on-the-job hearing loss. If the HCP is not effective, the result will be seen as worsening hearing thresholds for employees, as well as a higher percentage of the noise-exposed population showing an OSHA standard threshold shift (STS). One consequence is an increase in the company's potential liability for compensable occupational hearing loss.

When audiograms detect temporary threshold shift, early permanent threshold shift or progressive noise-induced hearing loss, the HCP personnel are alerted to take swift actions to halt the loss before the employee's hearing shows a significant deterioration. Because noise-induced hearing loss typically occurs so gradually, the affected individual may not notice the slow change until a large threshold shift has accumulated. Audiometric monitoring can identify individuals who are inadequately protected so that they can be retrained or given better HPDs and extra motivational attention to prevent further loss.

However, audiometric evaluations cannot provide reliable data to guide intervention unless they are conducted under adequate quality standards and the results are appropriately evaluated and meaningfully communicated to the employee. For more details about the audiometric phase, see References, items 13 and 14.

Management Support Needed for Quality

Managers must support the audiometric evaluations phase by funding quality services. Because audiometry requires a substantial investment of money and personnel time, it is cost-effective to allocate enough resources to ensure that the desired benefits are obtained from audiometric monitoring. Otherwise, the money is simply wasted on deficient services that do not serve their intended purpose of alerting HCP personnel to take actions that will prevent hearing loss.



The audiogram shows hearing thresholds for tones at different pitches or frequencies. Normal thresholds fall within the *unshaded* area of the chart. If noise-induced hearing loss begins to develop, the thresholds for the higher frequencies (3,000–6,000 Hz) will start to fall into the shaded areas.

In-House Versus Contracted Services

Managers may choose to contract for employee audiograms to be performed by an external source (a mobile testing contractor or a local clinic). Alternately, management may purchase audiometric equipment and train internal personnel to perform audiograms under the supervision of an audiologist or qualified physician. The choice depends on factors including the company's philosophy about safety and health, as well as its size and geographical location. Our experience indicates that the audiometric phase will be much more effective in motivating employees if their audiograms are performed and discussed with them by in-plant HCP personnel. If external services are used, it is critical that management assign responsibility to the on-site key individual for making sure that quality services are obtained and for using the audiometric results to motivate employees.

Well-Qualified Personnel to Perform Audiograms

The audiometric technicians should hold current CAOHC certification as occupational hearing conservationists. Additionally, all technicians should use consistent testing methods under the supervision of an audiologist or qualified physician.

Adequate Time Allowed to Complete Evaluations

If the audiogram session is to achieve its potential for motivating the employee about hearing conservation, there must be adequate time for that purpose. The technician needs sufficient time to obtain auditory history information, inspect HPD condition and fit, properly instruct the employee, carefully administer the audiogram, briefly explain the results to the employee, and document the findings. When the technician is too hurried to do more than give a rapid screening audiogram and herd the employee out the door, the worker correctly perceives that the testing is performed only for OSHA compliance without any sincere interest in protecting hearing. In this case the employee will usually lose motivation to participate in the HCP.

Obtaining All Needed Information

The OSHA regulations do not require measurement of hearing thresholds at 8,000 Hz or the documentation of auditory history information (details about the employee's off-the-job noise exposures, medical conditions affecting hearing, the presence of ringing in the ears, and other associated information). However, the wise employer will include both of these features in employees' audiometric evaluations because they allow the reviewer to interpret the audiogram results with more confidence and may eliminate a number of costly medical referrals. The 8,000 Hz thresholds assist the reviewer in distinguishing between age-related hearing change and noise-induced hearing change. The auditory history information assists the reviewer in deciding whether observed hearing change is probably related to on-the-job noise exposures, or whether off-the-job causes may have contributed.

Regular Schedule of Audiometric Monitoring

For maximum protection of the company and employees, audiograms should be performed at pre-employment or prior to initial assignment to a noisy work area. Thereafter, audiograms should be performed annually for as long as the employee is assigned to a noisy job (or twice a year during the first two years of exposure for workers with TWAs over 100 dB(A)). The company should also perform an audiogram when the employee is reassigned out of a noisy job and at the termination of employment.

Many companies have found it is desirable to give audiograms, as a health screening benefit, every one to three years to employees without on-the-job noise exposure. Annual audiometric results for nonexposed employees also serve as a control group when using audiometric data base analysis to evaluate the HCP's effectiveness, as discussed in the final section of this publication.

Careful Choice of a Professional Reviewer

Management should ensure that the program supervisor who reviews employees' audiograms is a well-qualified professional with specific training and experience in the area of industrial hearing conservation. Such a choice will benefit the employer as well as the employees, as an experienced audiologist or physician is less likely to mistake nonoccupational loss as being job-related.

Feedback and Follow-up

The audiometric session is the greatest opportunity to motivate employees concerning hearing conservation. Management should allow an extra two minutes for the audiometric technician to give the employee simple, brief remarks about his or her hearing status immediately after the audiogram is completed to praise the worker or warn that better HPD utilization is needed. All employees (not just those with threshold shifts) should receive written feedback from the professional reviewer. When the reviewer points out potentially noise-induced hearing changes, company personnel need to take decisive follow-up actions. These actions include individual counseling, refitting and retraining for HPD utilization, encouraging the employee to wear HPDs during off-the-job noise exposures, and more careful supervision of on the job HPD use. When the reviewer indicates that the shifts appear unrelated to noise exposure, the employee should be urged to seek otological/audiological evaluation and treatment. If audiograms are filed and forgotten rather than used to guide follow-up actions, then the audiometric phase simply documents hearing loss as opposed to helping prevent it.

Quality Control Responsibilities of Audiometric Technicians

The accuracy and usefulness of the audiogram results depend on the care and attentiveness of the audiometric technicians.

Maintaining Test Equipment and Environment

Audiogram accuracy depends on the audiometric technicians performing and documenting daily calibration checks and self-listening checks of audiometer function. If an electro-acoustic blockhead device is used to check calibration of audiometer output levels, the technician must still listen through the earphones for signal distortion or erratic responses that the device cannot detect. A log of biological and/or electro-acoustic output checks and listening checks of audiometer function should be maintained.

To measure thresholds accurately for employees with 0-dB hearing levels and to ensure that company audiograms are acceptable for legal purposes (such as workers' compensation claims), the test room must be quiet enough to meet ANSI standard S3.1-1999 (R2008), "Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms." That standard requires lower background levels than the OSHA Hearing Conservation Amendment. The technician should periodically check and document background levels.

Acoustic and exhaustive audiometer calibrations should be scheduled regularly, but calibration services should not be allowed to adjust the audiometer unless it fails to meet calibration tolerances. Unnecessary annual adjustments typically add seesaw variability to the audiometric data, interfering with the interpretation of both individual and group hearing trends. If audiometer adjustments must be made because tolerances are exceeded, the calibration company must be required to provide both preadjustment and post-adjustment measurements so that the size and direction of changes will be documented.

Another source of measurement variability can be prevented by using the same audiometers consistently. Technicians should not switch back and forth between types of audiometers (manual, self-recording and microprocessor audiometers).

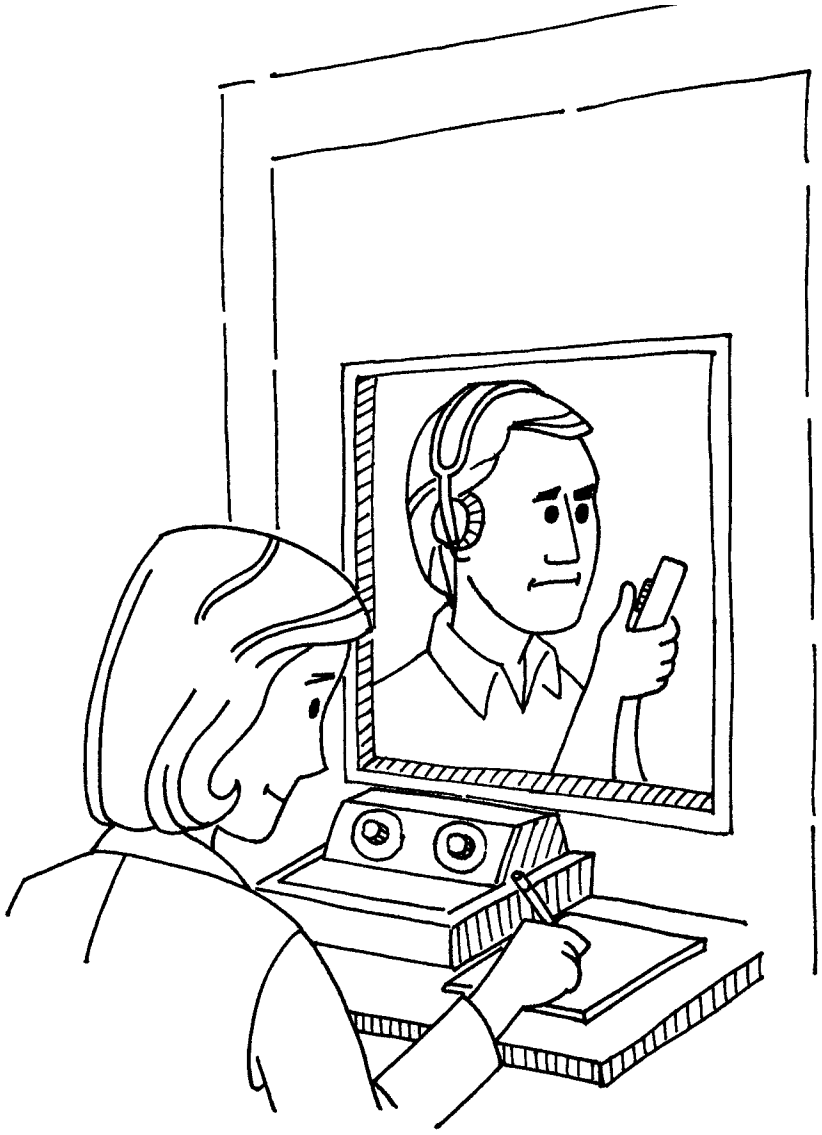
Using Consistent Instructions and Testing Methods

All audiometric technicians should use the same standardized testing method under the supervision of an audiologist or qualified physician. If technicians do not place the earphones carefully to line up the earphone speakers with the employee's ear canals, then the measured thresholds may be in error; therefore, never allow employees to place the earphones themselves. When technicians differ in their response instructions to employees or their signal presentation and threshold recording methods, the excess variability in threshold measurements interferes with interpretation of hearing trends. It is very important to instruct employees to listen carefully and respond to the faintest tones they can just barely detect—rather than waiting until tones are loud and clear before responding. (The wording of the instructions can be adjusted to whatever vocabulary seems most meaningful to the employees, but this concept of listening for faint tones must be communicated.) Because hearing thresholds may improve over time, the audiometric technician must try to measure the best thresholds for the employee, not just duplicate the results of the last test.

Maintaining Complete Records

The audiometric record should indicate the specific equipment used, calibration date, the name of the technician, the date and time of the test, and the threshold values obtained. The technician's judgment of the subject's response reliabili-

ty, the HPD inspection results and refitting or reissuing record, the employee's TWA, and the technician's comments should also be recorded. The professional reviewer's recommendations and documentation that follow-up actions were carried out should be documented too.



Annual audiometric evaluations monitor the employee's hearing thresholds. If noise-related hearing changes are detected, counseling and HPD retraining may help achieve better protection.

Scheduling Audiograms

The audiometric evaluations should be scheduled in close coordination with production supervisors in order not to disrupt production more than necessary. If supervisors' needs are ignored, the supervisors will be less likely to fulfill their HCP responsibility of monitoring HPD utilization. To minimize the disruptive effect on departments and to ensure that employees who are transferred among departments do not accidentally miss their annual audiograms, it is often useful to schedule audiograms in the employee's birth month. Participation in annual audiometric evaluations should be a condition of employment, not a choice.

The baseline audiogram should be administered when the employee has not been exposed to noise for the preceding 14 hours. However, annual audiograms should be administered during the workshift, not before it, so that the results will detect any temporary threshold shifts in hearing that may be occurring in employees who are not adequately protected.

Using the Audiogram Session to Best Advantage

The annual audiogram is often the only predictable time during the year when the individual employees have the opportunity for a one-to-one conversation about hearing conservation and their own hearing status. This time is the best chance to motivate workers to protect their hearing. Whether the technicians are external (contract) personnel or internal (staff members), they absolutely must demonstrate enthusiasm for hearing conservation and sincere interest while performing audiograms and giving feedback to employees.

Auditory History Information

The OSHA regulations do not require maintenance of auditory history information (documentation of the employee's past noise exposures in the military and in previous jobs, the employee's off-the-job noise exposures such as gunfire or use of power tools, and the employee's ear-related medical history). However, it is in the employer's best interest to record these data for better interpretation of the employee's audiometric results and for protection against future hearing loss compensation claims. Updated history information allows the professional reviewer to make recommendations with more insight and confidence concerning probable causes for threshold shifts. In addition, the history questions remind the employee that off-the-job factors influence hearing status.

Checking HPDs at Time of Audiogram

As previously discussed in the HPD section, the audiometric technician should check the condition and fit of the employee's HPDs, change them if needed, and reinstruct the wearer.

Immediate Feedback About Hearing Trends

The professional who supervises the audiometric technician can provide guidelines for the technician's comments about employees' hearing as soon as they step out of the audiometric booth. That is when they are most interested in their hearing and most receptive to suggestions. If hearing thresholds have remained stable, praise the employee for a job well done. If thresholds appear to be worsening, advise the employee of the need to determine the causes of the hearing change. For example, the causes might be medical problems or inadequate use of HPDs on or off the job. Note that the professional reviewer will provide more detailed written feedback about the hearing changes.

Following Up on Audiometric Results

Every audiometric record must be reviewed to classify the hearing trends and determine whether other actions are needed.

Careful Audiogram Review

The supervising professional may set up procedures for the technician to follow when reviewing routine records (those with normal hearing and no shifts or improvements) and when preparing employee feedback notices. Alternately, the company may find it easier to have the professional review the routine records as well as the problem audiograms. The reviewer needs to look for significant improvement threshold shifts at any test frequency (not just OSHA standard threshold shifts) and look at audiogram patterns indicative of possible otological pathology. Significant shifts would include a change of 15 dB at any frequency that is confirmed as being persistent on a retest, or a change of 20 dB (whether confirmed or not).

Prompt Meaningful Feedback

All employees need feedback not just those with OSHA STS!

The reviewer (or technicians under professional supervision) should provide each employee written feedback describing the worker's hearing status in terms of three aspects:

1. Comparison to the expected age-effect hearing levels for the worker's age/sex/race group and the hearing ability needed for unimpaired communication

2. A description of the amount of change seen in the current audiogram compared to past results and the designated reference baseline

3. Recommendations, including praise for stable hearing, warnings to use HPDs more carefully on and off the job if hearing changes are observed, and suggestions to seek medical attention or further audiological evaluation

Taking Appropriate Follow-Up Actions

Audiograms don't prevent hearing loss but feedback and follow-up can!

OSHA regulations specify required follow-up actions for OSHA STS (a change of 10 dB in the average thresholds at 2,000, 3,000 and 4,000 Hz in either ear after optional corrections for aging). But in effective HCPs, aggressive follow-up for beginning hearing shifts will prevent losses from progressing into OSHA STSs. In an excellent HCP, the employee with beginning shifts will receive a written warning from the professional reviewer and face-to-face counseling from on-site HCP personnel based on the reviewer's comments. Similarly, there should be reevaluation of HPD adequacy, retraining in HPD placement and extra supervision in on-the-job HPD utilization for such an employee. A retest audiogram may be given to see if the shifts persist or disappear. Individuals with potential medical ear conditions will be counseled by the employer to seek medical evaluation and treatment or possibly be sent for treatment at company expense.

Immediate feedback about the audiogram results can motivate the employee to protect hearing on and off the job.

Educating Employees to Take Responsibility

As employees become familiar with the audiometric evaluation process, understand their audiogram results, and learn how their everyday habits in HPD utilization can affect their hearing trends, they will be encouraged to take the lead in protecting their own hearing on and off the job. No matter how much effort the employer puts into the HCP, it is impossible to inspect whether each employee is wearing HPDs adequately each day. Eventually the individual worker must accept responsibility for following through with good hearing protection habits. The best tool the hearing conservationist has to motivate individuals about protecting their hearing is to counsel them about their audiogram results.

Checklist for Audiometric Evaluations

- ☐ Audiometers are in good operating condition.
- ☐ Audiometer calibration is not adjusted unless it is out of tolerances, and both pre-adjustment and post-adjustment readings are permanently recorded.
- ☐ Audiometric technicians use consistent testing methods under professional supervision.
- ☐ Technicians instruct employees to listen carefully and respond to the faintest tones they can detect.
- ☐ Employees' auditory history information is updated annually and provided to the audiogram reviewer.
- ☐ Employees receive immediate feedback from the audiometric technician about audiogram results as related to HPD use.
- ☐ Employees receive written feedback from the audiogram reviewer about:
  - hearing status compared to normal for age
  - hearing change over time
  - recommendations for better protection on and off the job, or for medical examination or treatment if appropriate.
- ☐ The audiogram reviewer looks for significant shifts at any frequency, not just for OSHA STSs.
- ☐ Audiogram reviewers revise employees' reference baseline thresholds for threshold improvement as well as for persistent worsening.
- ☐ HCP personnel follow through with counseling and HPD retraining for employees with hearing change.

8

Making Sure That the HCP Works

The Team Approach

Now that you have reviewed all five phases of HCPs, take another look at Figure 1 on page 3 and consider the importance of teamwork in achieving the goal of preventing hearing loss on the job. No single phase of the HCP can work effectively in isolation from the others. Many people are involved: supervisors, tool crib clerks, safety officers, audiometric technicians, nurses, personnel directors, industrial hygienists, engineers, audiologists and physicians. No single discipline can claim superior ability to run the HCP: the program depends on the cooperation of many people, under the leadership of the key individual. The key individual can be anyone with the interpersonal skills and managerial know-how to coordinate the contributions of these diverse personnel toward preventing hearing loss. The key individual is the catalyst who makes the HCP work by maintaining communication among the team members to achieve a unified HCP.

Documentation and Recordkeeping

When the OSHA inspector visits, the only way the company can demonstrate that the HCP is satisfactory is through adequate documentation of the five phases. Some people actually refer to recordkeeping as a sixth phase, but recordkeeping is an integral part of each phase, not a separate activity. For example, the audiometric phase depends on cumulative records to show hearing changes over time. It also depends on records of auditory history information, employee noise exposure, and HPD fitting and reissuing to evaluate whether threshold shifts may be work-related. In addition to the legal documentation it provides, good recordkeeping is helpful in monitoring the program and sharing information among HCP team members. The key individual should assign responsibility to HCP team members for maintaining the records associated with their duties and should ensure that the records are accessible. A list of the needed records is shown as Table 4, and further details are provided in References, items 15–16.

Recording Hearing Loss on the OSHA 300 Form

Occupational hearing loss is recorded on the OSHA Form 300 either as an occupational illness (for gradual hearing loss) or as an occupational injury (for sudden traumatic hearing loss). When hearing loss is gradual and an STS or "standard threshold shift" (as defined in 29 CFR 1910.95) is determined and the hearing threshold is above 25 dB when averaged across 2,000, 3,000 and 4,000 Hz, the loss is recorded under the hearing loss column on the 300 form. When hearing loss occurs due to a sudden traumatic event (such as a burst eardrum from an explosion), the loss is recorded as an injury.

Table 4

Documentation Guidelines for the HCP

A. Records Specified in OSHA's Hearing Conservation Amendment

1. Noise exposure measurements:
   - Detailed survey report must include complete list of instruments used in survey, calibration, measurement positions, tables of sound level measurements and TWA calculations

   List departments or employees with TWAs of 85 dB(A) or over
   - For OSHA retain two years or until new sound survey
   - Keep indefinitely for workers' compensation purposes
2. Documentation of engineering/administrative noise controls:
   - results of engineering sound surveys
   - installations completed and noise reduction achieved
   - regular maintenance of machinery and controls
3. Documentation of annual educational programs, including:
   - content of presentation
   - names of presenters
   - list of employees who attended
4. Documentation of hearing protection phase of HCP:
   - date of initial HPD fitting of each employee
   - brand and size of HPD fitted (in each ear if appropriate)
   - employee's signature for training in HPD use and care
   - documentation of employer's supervision of correct HPD use such as walk-through checks of utilization
   - NRR and TWA calculations showing HPD adequacy
5. Employee's audiometric records, including:
   - name, age, job classification and TWA exposure
   - date of audiogram and name of audiometric technician
   - audiometer model, serial number and date of its last calibration
     - Retain for duration of employment for OSHA
     - Keep indefinitely for workers' compensation
6. Supporting records for audiometric phase of HCP:
   - technician's certification credentials
   - audiometer make, model and serial number
   - audiometer acoustic and exhaustive calibration records
   - biological calibration check records of audiometer
   - background sound levels in audiometric test room
7. Documentation of audiogram review and follow-up actions:
   - review of each audiogram by professional or technician
   - credentials of audiologist or physician reviewer
   - reviewer's follow-up recommendations
   - documentation that the employer did recommended follow-up
   - documentation of employee's written notification of STS
   - employee's signature indicating OSHA STS follow-up
   - documentation of HPD utilization enforcement after STS

B. Additional Records Employer Should Keep for the HCP

1. Audiometric phase:
   - auditory history information for each employee in HCP
   - annual history updates
   - annual otoscopic checks
   - pre-employment or pre-exposure audiograms
   - termination audiograms
2. Hearing protection phase:
   - dates of HPD reissuing, brand and size reissued
   - annual documentation at audiogram time that:
     - employee's HPD is correct size, in good condition
     - employee can demonstrate proper use of the HPD
   - list of HPDs the employer allows to be used in work environments with different TWA ranges, considering real-world attenuation (must derate the NRR)
3. Sound exposure monitoring:
   - noise map of the facility, showing:
     - areas where HPDs are optional
       [TWAs below 90 dB(A)]
     - HPD-required areas
       [TWAs = 90 dB(A) or higher]
     - areas where only certain HPDs are acceptable
       [TWAs = 95 dB(A) or higher]

Assessing Your HCP

The most basic form of program assessment is to use the checklists provided in this booklet to see whether all the bases have been covered. Have all the tasks been accomplished? For example, the key individual might discover that a group of employees did not attend an educational program or missed their annual audiograms. Just as important is whether the more subjective guidelines have been met. For instance, has the key individual made a point to get feedback from the HDP reissuers and employees concerning the practicality of the new earplug?

The checklist approach is fine as far as it goes, but it does not assess the effectiveness of the program, just its completeness. To evaluate whether hearing loss is really being prevented, a different approach is needed.

Audiometric Data Base Analysis (ADBA)

The audiometric results for the noise-exposed employees provide the only objective indication of whether the HCP is succeeding in preventing occupational hearing loss. Reviewing the audiometric records for employees one at a time detects hearing changes for individuals, but it does not provide an overall picture of how well the group of workers is being protected. In contrast, analysis of group audiometric data can show the trends for departments and the whole plant.

The ANSI S12 Working Group 12 (S12/WG12) for Evaluation of Hearing Conservation Programs has developed simple procedures that the employer can apply to the audiometric data for a group of exposed employees to assess whether they are being adequately protected. The advantage of audiometric data base analysis (ADBA) procedures is that problems in the HCP can be detected early, before individual workers develop significant permanent hearing loss. If the results show that the HCP is ineffective, the employer can improve program practices to prevent additional hearing loss from developing.

Audiograms do not prevent hearing loss but using ADBA results can!

The ANSI S12/WG12 issued its recommendations for procedures to use in evaluating the effectiveness of HCPs in draft ANSI S12.13-1991, "Evaluating the Effectiveness of Hearing Conservation Programs." This document was later changed to a technical report, ANSI S12.13 TR-2002 and was reaffirmed by ANSI in January 2011. The general guidelines and two of the recommended ADBA procedures are summarized below, and detailed discussions are available. See References, items 17–19.

Audiometric Variability as an Indicator

The procedures recommended for audiometric data base analysis are based on the year-to-year variability in audiometric thresholds. If you look at the audiogram results for a person from one year to the next, thresholds at some frequencies may be a little better while thresholds at other frequencies may be a bit worse. Variability in audiometric threshold measurements comes from three main sources:

1. Normal fluctuations in the responsiveness of the person being tested (unavoidable variability)
2. Inconsistencies in the equipment and testing methods used to administer the audiogram (avoidable measurement error)
3. True threshold changes due to temporary or permanent hearing loss if employees receive inadequate protection from noise (what the HCP is trying to prevent)

ADBA looks at the total variability in employees' hearing threshold measurements. If the variability in the HCP is in the same low range that is achieved in low-noise-exposed or nonexposed industrial groups, then the HCP is judged to be successful in avoiding measurement error and in preventing hearing loss. However, if variability is too high, then the hearing conservationist must determine whether the cause is a problem with the audiometric testing procedures or a real indication of developing hearing loss resulting from inadequate protection. Until the variability is reduced, the HCP is judged ineffective, because unreliable audiometric results may not be capable of identifying actual hearing loss in individuals.

Recommended Guidelines

Two variability procedures recommended by the ANSI S12/WG12 are based on counting the percentage of employees whose hearing shows changes of 15 dB or more between two sequential (consecutive) annual audiograms, such as from Test 1 to Test 2, or from Test 2 to Test 3. Threshold changes are counted both toward better hearing and toward worse hearing to yield values for these two ADBA procedures:

1. Percent Worse Sequential (%Ws): the percentage of employees who show a worsening of 15 dB or more in thresholds for at least one test frequency (500 Hz through 6,000 Hz) in either ear between two sequential audiograms
2. Percent Better or Worse Sequential (%BWs): the percentage of employees who show either an improvement or a worsening of 15 dB or more in thresholds for at least one test frequency (500 Hz through 6,000 Hz) in either ear between two sequential audiograms.

   Based on applying these procedures to the audiometric data for over 20 industrial HCPs, the ANSI S12/WG12 has defined ranges of values that indicate the HCP's quality as acceptable, marginal, or unacceptable. These ranges are shown in Table 5. The ranges are slightly different for the first four years of audiometric testing (sequential test comparisons 1–2, 2–3, and 3–4) than for later years of testing. Note that before the procedures are applied, the population must be restricted to a group of workers who all have the same number of audiograms (ideally, six or more).

Advantages and Benefits of ADBA

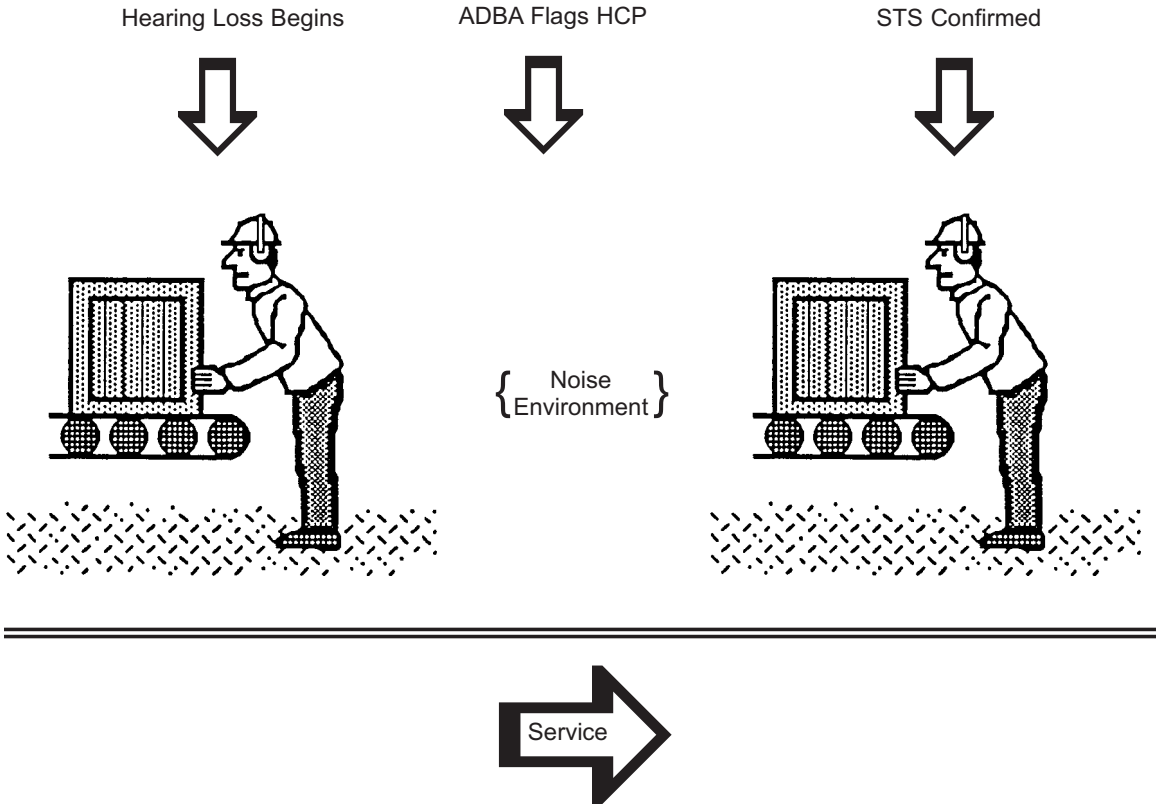
By using the variability procedures to evaluate the audiometric data, HCP personnel can detect problems in the HCP quickly—within one or two years—then act to correct the deficiencies before many employees develop significant permanent hearing changes. In other words, the analysis helps HCP personnel to prevent hearing loss, as illustrated in Figure 2.

Simple bar graphs of ADBA results provide useful feedback for the supervisors and employees in different departments to show how better HPD utilization produces lower variability (see References, item 17). These concrete results can be effective in motivating employees. The key individual can use ADBA procedures to guide policy decisions. If HCP personnel are unsure whether a particular HPD provides adequate protection, the ADBA results for employees wearing different HPDs can be compared. Similar department comparisons can show whether required HPD utilization is needed to protect employees in a low-noise department (see References, item 19).

Figure 2

Using ADBA

When the company uses audiometric data base analysis (ADBA), problems in the HCP can be detected before employees develop significant permanent hearing threshold shifts.



Finally, ADBA findings give objective evidence to demonstrate for management when the budget allocations for the HCP need to be increased or redistributed to improve protection in departments with poorer performance. After HCP changes have been implemented, ADBA results show management the associated gains, less hearing loss and reduced potential liability for workers' compensation claims.

Table 5

Criterion Ranges for Rating HCP Performance (from ANSI S12.13 TR-2002)

Recommended percentage values for the %Ws and %BWs ADBA Procedures (Sequential Test Comparisons and No Age Corrections)

HCP Rating	Over First Four Test Comparisons (1–1, 2–3, and 3–4)	Over Later Test Comparisons (5–6, 6–7, 7–8, etc.)	
	%Ws	%Ws	%Bws
Acceptable	<20	<17	<26
Marginal	20 to 30	17 to 27	26 to 40
Unacceptable	>30	>27	>40

Checklist for HCP Evaluation

There is a key individual overseeing all five phases of the HCP.

- ☐ HCP team members check that all tasks are accomplished and documented.
- ☐ HPDs are potentially effective in actual use.
- ☐ HPD utilization is enforced.
- ☐ Active communication is maintained among HCP team members and all personnel up and down the company hierarchy.
- ☐ Management holds personnel accountable for their HCP performance and gives praise or criticism as appropriate.
- ☐ Audiometric data base analysis is used to evaluate the HCP's effectiveness in preventing on-the-job hearing loss.

References

1. Royster, L.H., Royster, J.D., and Berger, E.H. Guidelines for Developing an Effective Hearing Conservation Program. *Sound and Vibration,* Volume 16(5), pages 22–25, 1982.
2. Royster, L.H., and Royster, J.D. An Overview of Effective Hearing Conservation Programs. *Sound and Vibration,* Volume 19(2), pages 20–23, 1985.
3. Royster, L.H., and Royster, J.D. Education and Motivation. In E.H. Berger, L.H. Royster, J.D. Royster. D.P. Driscoll & M. Layne (Editors), *The Noise Manual,* Fifth Edition. American Industrial Hygiene Association, 2000.
4. Berger, E.H., Royster, J.D., Royster, L.H., and Brus, D. *An Earful of Sound Advice About Hearing Protection.* Indianapolis, Indiana: E-A-R Division of Cabot Corporation, 1988.
5. Royster, L.H., Berger, E.H., and Royster, J.D. Noise Surveys and Data Analysis. In E.H. Berger, L.H. Royster, J.D. Royster, D.P. Driscoll & M. Layne (Editors), *The Noise Manual,* Fifth Edition. American Industrial Hygiene Association, 2000.
6. Driscoll, D.P. and Royster, L.H. Noise Control Engineering. In E.H. Berger, L.H. Royster, J.D. Royster. D.P. Driscoll & M. Layne (Editors), *The Noise Manual,* Fifth Edition. American Industrial Hygiene Association, 2000.
7. Purcell, W.E. Materials for Noise and Vibration Control. *Sound and Vibration,* Volume 14(7), pages 8–32, 1980.
8. Purcell, W.E. Systems for Noise and Vibration Control. *Sound and Vibration,* Volume 14(8), pages 10–36, 1980.
9. Irwin, J.D., and Graf, E.R. *Industrial Noise and Vibration Control.* Englewood Cliffs, New Jersey: Prentice-Hall, 1979.
10. Wilson, Charles E. *Noise Control: Measurement, Analysis, and Control of Sound and Vibration.* New York: Harper and Row Publishers, 1989.
11. Royster, L.H., and Royster, J.D. Hearing Protection Devices. In A.S. Feldman and C.T. Grimes (Editors), *Hearing Conservation in Industry.* Baltimore: Williams and Wilkins, 1985.
12. Berger, E.H. Hearing Protection Devices. In E.H. Berger, L.H. Royster, J.D. Royster. D.P. Driscoll & M. Layne (Editors), *The Noise Manual,* Fifth Edition. American Industrial Hygiene Association, 2000.
13. Royster, J.D. Audiometric Evaluations for Industrial Hearing Conservation. *Sound and Vibration,* Volume 19(5), pages 24–29, 1985.
14. Royster, J.D. Audiometric Monitoring Phase of the HCP. In E.H. Berger, L.H. Royster, J.D. Royster. D.P. Driscoll & M. Layne (Editors), *The Noise Manual,* Fifth Edition. American Industrial Hygiene Association, 2000.
15. Stewart, A.P. The Comprehensive Hearing Conservation Program. In D.M. Lipscomb (Editor), *Hearing and Conservation in Industry, Schools, and the Military.* Boston: College Hill Publications, 1988.
16. Gasaway, D.C. *Hearing Conservation: A Practical Manual and Guide.* Englewood Cliffs, New Jersey: Prentice Hall, 1985.
17. Royster, L.H., and Royster, J.D. Making the Most out of the Audiometric Data Base. *Sound and Vibration,* Volume 18(5), pages 18–24, 1984.
18. Royster, L.H., and Royster, J.D. Getting Started in Audiometric Data Base Analysis. *Seminars in Hearing,* Volume 9, pages 325–338, 1988.
19. Royster, J.D. and Royster, L.H. Evaluating Hearing Conservation Program Effectiveness. In E.H. Berger, L.H. Royster, J.D. Royster. D.P. Driscoll & M. Layne (Editors), *The Noise Manual,* Fifth Edition. American Industrial Hygiene Association, 2000.

Resources

1. American National Standards Institute (ANSI)—headquarters
   1819 L St. NW
   11th Floor
   Washington, DC 20036
   202-293-8020
   http://www.ansi.org
2. Council for Accreditation in Occupational Hearing Conservation (CAOHC)
   555 E. Wells St.
   Suite 1100
   Milwaukee, WI 53202-3823
   414-276-5338
   http://www.caohc.org
3. Sound and Vibration: The Noise and Vibration Control Magazine
   P.O. Box 40416
   27101 E. Oviant Road
   Bay Village, OH 44140
   440-835-0101
   http://www.sandv.com
4. Series of "EARlogs" (reference pamphlets concerning practical topics in hearing protection and hearing conservation). Available from:
   E-A-R Division, Aearo Co.
   3M OH & ESD
   7911 Zionsville Rd.
   Indianapolis, IN 46268
   317-692-3066
   http://www.e-a-r.com/hearingconservation/
5. National Hearing Conservation Association (NHCA)
   3030 W. 81st Ave.
   Westminster, CO 80031
   303-224-9022
   http://www.hearingconservation.org
6. American Speech-Language-Hearing Association (ASHA)
   2200 Research Blvd.
   Rockville, MD 20850-3289
   1-800-638-8255
   http://www.asha.org
7. American Industrial Hygiene Association (AIHA)
   2700 Prosperity Ave., Suite 250
   Fairfax, VA 22031
   703-849-8888
   http://www.aiha.org

8. U.S. Department of Commerce
   National Technical Information Service (NTIS)
   Springfield, VA 22161
   703-605-6000
   http://www.ntis.gov
   Distributes certain National Institute for Occupational Safety and Health (NIOSH) publications, including:

   Compendium of Materials for Noise Control, Second Edition.
   NTIS No. PB85177152.

   Industrial Noise Control Manual.
   NTIS No. PB297534

   Self-Evaluation of Occupational Safety and Health Programs.
   NTIS No. PB87108338.

   Survey of Hearing Conservation Programs in Industry.
   NTIS No. PB274235.

   Franks, J.R., Merry, C.J., Stephenson, M.R.;
   Preventing Occupational Hearing Loss: A Practical Guide (revised).
   NTIS No. PB97137004.

9. U.S. Department of Labor, OSHA Technical Manual, Section III, Chapter 5, *Noise and Hearing Conservation.*
   http://www.osha.gov/dts/osta/otm/otm_toc.html

OSH Publications

We provide a variety of OSH publications. These include general industry and construction regulations, industry guides that cover different OSH topics, quick cards, fact sheets and brochures that cover a wide variety of serious safety and health workplace hazards. Workplace labor law posters are available free of charge. To obtain publications, call toll free at 1-800-NC-LABOR (1-800-625-2267) or direct at 919-807-2875. You may view the list of publications and also download many of them at **www.nclabor.com/pubs.htm.**

Occupational Safety and Health (OSH)
Sources of Information

You may call 1-800-NC-LABOR (1-800-625-2267) to reach any division of the N.C. Department of Labor; or visit the NCDOL home page on the World Wide Web: http://www.nclabor.com.

Occupational Safety and Health Division

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Local Telephone: 919-807-2900 Fax: 919-807-2856

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 3rd Floor)

For information concerning education, training, interpretations of occupational safety and health standards, and OSH recognition programs contact:

Education, Training and Technical Assistance Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2875 Fax: 919-807-2876

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 4th Floor)

For information concerning occupational safety and health consultative services contact:

Consultative Services Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2899 Fax: 919-807-2902

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 3rd Floor)

For information concerning migrant housing inspections and other related activities contact:

Agricultural Safety and Health Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2923 Fax: 919-807-2924

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 2nd Floor)

For information concerning occupational safety and health compliance contact:

Safety and Health Compliance District Offices

Raleigh District Office (3801 Lake Boone Trail, Suite 300, Raleigh, NC 27607)
Telephone: 919-779-8570 Fax: 919-420-7966

Asheville District Office (204 Charlotte Highway, Suite B, Asheville, NC 28803-8681)
Telephone: 828-299-8232 Fax: 828-299-8266

Charlotte District Office (901 Blairhill Road, Suite 200, Charlotte, NC 28217-1578)
Telephone: 704-665-4341 Fax: 704-665-4342

Winston-Salem District Office (4964 University Parkway, Suite 202, Winston-Salem, NC 27106-2800)
Telephone: 336-776-4420 Fax: 336-767-3989

Wilmington District Office (1200 N. 23rd St., Suite 205, Wilmington, NC 28405-1824)
Telephone: 910-251-2678 Fax: 910-251-2654

*****To make an OSH Complaint,* OSH Complaint Desk:** 919-807-2796***

For statistical information concerning program activities contact:

Planning, Statistics and Information Management Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2950 Fax: 919-807-2951

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 2nd Floor)

For information about books, periodicals, vertical files, videos, films, audio/slide sets and computer databases contact:

N.C. Department of Labor Library

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2850 Fax: 919-807-2849

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 5th Floor)

N.C. Department of Labor (Other than OSH)

1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-733-7166 Fax: 919-733-6197