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HEARING SAFETY AT AIRTANKER BASES



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INTRODUCTION

The Forest Service operates a number of Airtanker Bases where employees are regularly exposed to aircraft noise. San Dimas Technology and Development Center (SDTDC) was asked to measure noise levels and exposures of employees to determine whether or not they exceed the limits established by the Occupational Safety and Health Administration (OSHA), recommend mitigation methods including new technology such as Active Noise Reduction (ANR), and help base managers implement a hearing conservation program if necessary.

SUMMARY

This report outlines the OSHA regulations, presents some of the data collected by SDTDC, discusses several options for hearing protection, and lists a number of sources for products, services and information to help base managers protect their employees and comply with the law.

OSHA REGULATIONS

OSHA has established regulations intended to ensure that employees are protected against excessive noise levels in the workplace. The full text of these regulations can be found in Title 29 of the Code of Federal Regulations (CFR), Part 1910.95.

Basically, the regulation establishes limits to noise exposures and lists the actions required if the limits are exceeded. The regulation requires that hearing protection be provided and used when employees are subjected to exposures equal to or greater than those shown below. Additionally the

regulations require a detailed hearing conservation program be administered if employee noise exposures equal or exceed the “action level”. Action level is defined as an 8-hour time weighted average (TWA) of 85 decibels (dBA) (this exposure is equivalent to half the exposure times listed below in table 1).

Fortunately, there is plenty of help available to bring a facility into compliance. There are many products available from safety supply companies, and services available from government agencies and consulting firms that can make compliance relatively easy and inexpensive. A listing of a number of companies that supply training materials, hearing protection equipment, and noise monitoring instruments is provided in the appendix. The appendix also lists internet sites that provide more detailed information.

HEARING CONSERVATION PROGRAM REQUIREMENTS

The following is a summary of the requirements of the hearing conservation program specified in 29 CFR 1910.95. Please refer to a current copy of the official document for the full details.

Noise Exposure Monitoring

Monitoring must be done initially and when there are significant changes in machinery or processes that may result in increased noise levels or exposures to determine whether the hearing protection being used is still adequate and whether additional employees need to be included in the program.

Table 1—Maximum permissible noise exposures.¹

Duration per day, hours	Sound Level, dBA (slow response)
8.0	90
6.0	92
4.0	95
3.0	97
2.0	100
1.5	102
1.0	105
0.50	110
0.25	115

¹ From CFR 1910.95, table G-16.

To quantify noise exposure, both the sound pressure level (loudness) and the length of time exposed to that level must be included in the measurement. These are combined to obtain a level TWA in dBA.

Basically, there are two different instruments to measure noise exposures: the sound level meter and the dosimeter. A sound level meter, shown in figure 1, is a device that measures the intensity of sound at a given moment. Since sound level meters provide a measure of sound intensity at only one point in time, it is generally necessary to take a number of measurements at different times during the day to estimate noise exposures over a workday. If noise levels fluctuate, the amount of time the noise remains at each of the various measured levels must be determined.



Figure 1—Sound level meter.

To estimate employee noise exposures with a sound level meter it is also generally necessary to take several measurements at different locations within the workplace.” (from 29 CFR.) Sound

level maps can then be created, and individual exposures can be estimated from the information on employee locations with respect to the map. This measurement method is called “area noise monitoring.”

A noise dosimeter, shown in figure 2, is basically a sound level meter with a built-in clock, data logger, and computer. The dosimeter is usually worn by the employee with the microphone on the shoulder and collects and stores data for a given period of time (usually the entire shift). The data is then “dumped” to a computer or printed, and the TWA is calculated automatically. A graph of sound level versus time, and other statistics can be calculated, displayed and printed. This measurement method is called “personal noise monitoring.” Dosimeters can also be used to provide area noise monitoring by keeping the dosimeter stationary (mounting it on a tripod, for example).



Figure 2—Dosimeter.

Engineering and Administrative Controls

The regulation requires that “feasible administrative or engineering controls” be attempted first, before resorting to hearing protection. Engineering control methods are those that reduce noise at the source by reducing or isolating vibration or constructing enclosures or barriers. At airtanker bases, it would not be feasible to attempt to make the airtanker more quiet, or have barriers out on the ramp, so the only

other options are administrative controls (limiting the amount of time an employee is exposed to the noise by rotating duties, etc.) and hearing protection.

Employee Notification

Employees or their representatives must be given the opportunity to observe any noise measurements, and employees whose exposures are at or above the action level must be notified of the results.

Audiometric Testing

Employees exposed at or above the action level must have a baseline audiogram (hearing test) initially, and annual audiograms thereafter for comparison to the baseline. There are companies that specialize in providing audiometric testing services. Many of these companies have mobile testing vans or trailers, and can provide the service at your facility.

Hearing Protectors

A variety of suitable hearing protectors must be provided (use is optional) when employees are subjected to exposures equal to or greater than the action level TWA of 85 dBA. Additionally, an employer must ensure that hearing protectors are used (use is not optional) by the following employees:

- Those whose exposures exceed maximum shown in table 1.
- Those employees exposed to the action level TWA of 85 dBA that have not had a baseline audiogram.
- Those employees that have experienced a “standard threshold shift” (an indicator of hearing damage).

Hearing protectors reduce the amount of sound energy that gets to the inner ear. This is done by sealing off the inner ear to the outside air.

Ear Plugs and Earmuffs

Ear plugs are the most simple and least costly hearing protection devices that exist (except, perhaps your fingers), and may be the most effective.



Figure 3— Ear plugs and earmuffs.

Earplugs are best used when the person is expected to be exposed for relatively long periods of time, and the user does not need to remove and reinsert them frequently.

When users need protection for frequent, short periods of time, and intend to remove the protectors in between those times, earmuffs tend to be a better option.

When employees are expected to be exposed to levels higher than 110 dBA, using plugs and muffs together is advised.

There are many types, styles, and designs of plugs and muffs available, and it is important (and required) to allow employees to choose which device meets their needs for both comfort and utility.

Active Noise Reduction

Active noise reduction (ANR) is a system that uses a microphone, a miniature signal processor, and a speaker to generate an exact mirror-image of the noise field. When the noise and the mirror-image are combined, they counteract each other and the noise is canceled.

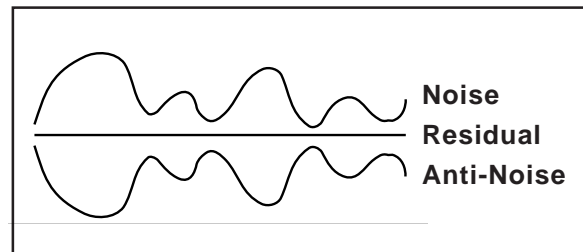


Figure 4—The ANR principle.

Amplified Earmuffs

Amplified earmuffs also use a system with a microphone, signal processor and a speaker, but they do not provide canceling. Instead, they filter the sounds picked up by the microphone, rejecting loud, impulsive sounds (like gunshots, hammering, etc.) while amplifying sounds in the speech frequency range. This results in a system that protects the user from harmful noise levels using the passive attenuation provided by the muff while at the same time allowing speech sounds to pass through.

Proper Fit

Making sure that the hearing protection device—whatever it is—fits properly, is perhaps the most important part of a hearing conservation program. The best protection devices will only provide the best protection when they are used as they were designed. When using earmuffs or a headset, the ear cups must have a good seal all the way around the ear. This can be difficult to achieve when wearing glasses. Stop Gaps®, available from David Clark can help to solve this problem. Ear plugs can also be rendered ineffective if not inserted properly. Always follow the manufacturer’s instructions when fitting a hearing protection device. It is also important that the hearing protectors are comfortable and easy to use, otherwise people will be less likely to use them.

Training

Annual training must be given to each employee in the hearing conservation program. The following information must be included in the training:

- The effects of noise on hearing
- The purpose of hearing protectors
- Advantages, disadvantages, and attenuation of various types of hearing protectors
- Instructions on selection, fitting, use and care of hearing protectors
- The purpose of audiometric testing and an explanation of the test procedures.

Record Keeping

Accurate records of exposure monitoring and the results of all audiometric testing must be kept by the employer.

FIELD MEASUREMENT RESULTS

SDTDC took measurements at five airtanker bases as an initial step towards identifying employees who need to be included in hearing conservation programs. Some frequency content measurements were also made to evaluate the potential effectiveness of ANR technology in this environment.

Santa Barbara

At the Santa Barbara Airtanker Base, two dosimeters were used simultaneously to collect data during heavy tanker activity. One instrument was placed inside the dispatch office adjacent to the loading ramp, and another was placed outside, at the edge of the ramp. The instruments gathered just over five hours of data. Ramp activity was virtually continuous throughout the entire measurement period.

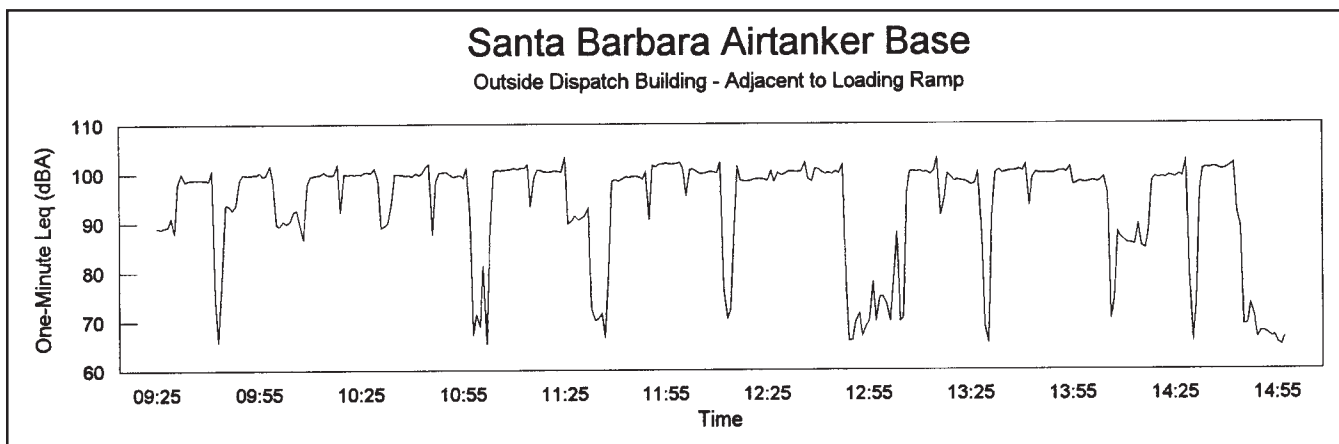


Figure 5—Level vs time with instrument placed *outside* Santa Barbara dispatch office and adjacent to loading ramp.

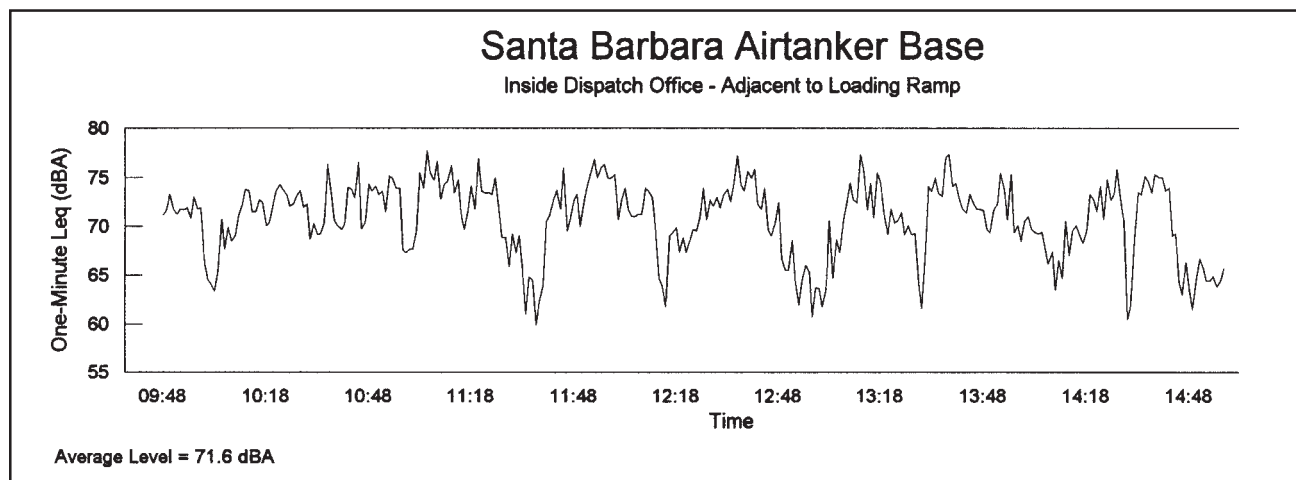


Figure 6—Level vs time with instrument placed *inside* Santa Barbara dispatch office and adjacent to loading ramp.

Fox Field

Several dosimeters were used to obtain personal-noise dose measurements during tanker operations at the Fox Field Airtanker Base. The ramp was busy, with some breaks in the activity while the tankers were over the fire. The results are shown in the following table:

Table 2—Personal dose measurements during tanker operation at Fox Field.

Position	Measurement Period	Average Level
Ramp Manager	3 hours	86 dBA
Ramp Manager	4 hours	82 dBA
Retardant Mixer	4 hours	82 dBA
Retardant Mixer	4.5 hours	83 dBA
Retardant Mixer	4 hours	82 dBA
Retardant Loader	4.25 hours	90 dBA
Retardant Loader	4 hours	89 dBA
Parking Tender	2.5 hours	87 dBA
Parking Tender	4.25 hours	82 dBA
Ramp Tower	4 hours	59 dBA

Fresno

At the Fresno Airtanker Base, three types of measurements were made. Area measurements were made in the dispatch office (upstairs), the employee kitchen (downstairs), and on the ramp outside during tanker operations. Maximum sound levels (L_{max}) were measured both inside the dispatch office and outside, on the ramp, during takeoffs of F-16 fighters operated by the California Air National Guard, and recordings were made of a C-130 tanker for frequency analysis.

The results of these measurements are summarized in the following tables and graph:

Table 3—Personal dose measurements during C-130 operations at Fresno ATB.

Area	Measurement Period	Average Level
Ramp	9.5 hours	95 dBA
Ramp	10.5 hours	94 dBA
Dispatch Office	11 hours	70 dBA
Employee Kitchen	11 hours	72 dBA
Employee Kitchen	4 hours	75 dBA

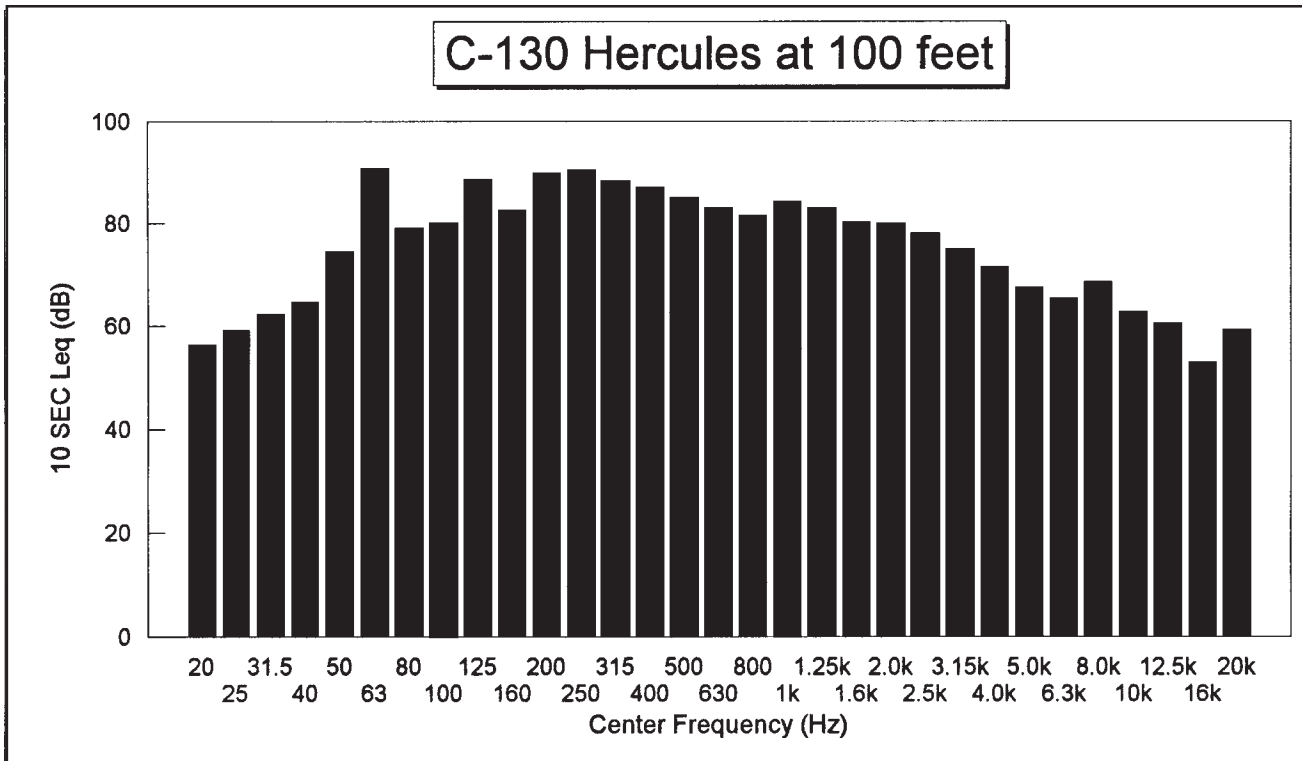


Figure 7—C-130 frequency analysis at Fresno ATB.

The California Air National Guard regularly operates F-16 fighter jets from the airport, and there were concerns about employees' exposure to noise from the fighters as well. Some maximum levels (Lmax) measured during take-offs are shown in the following table:

Table 4—Lmax measurements during F-16 operations at Fresno ATB.

Max Level Outside on Ramp	Max Level Inside Dispatch Office
105 dBA	86 dBA
99 dBA	86 dBA
109 dBA	95 dBA

Boise

There was no fire activity at the time the measurements were made at the Boise Airtanker Base. A Lockheed P2V tanker was present, and the engines were run for a short period of time to allow a recording to be made for frequency analysis. The P2V has two main piston engines and two turbojet engines which are used only when needed. Measurements were made while only the piston engines were running. Maximum sound levels (Lmax) inside the dispatch office and outside, adjacent to the ramp were also measured. The results are shown in the following table and graph:

Table 5—Lmax measurements during P2V operation at Boise ATB.

Lmax Inside DispatchOffice	Lmax Outside on Ramp
71 dBA	94 dBA

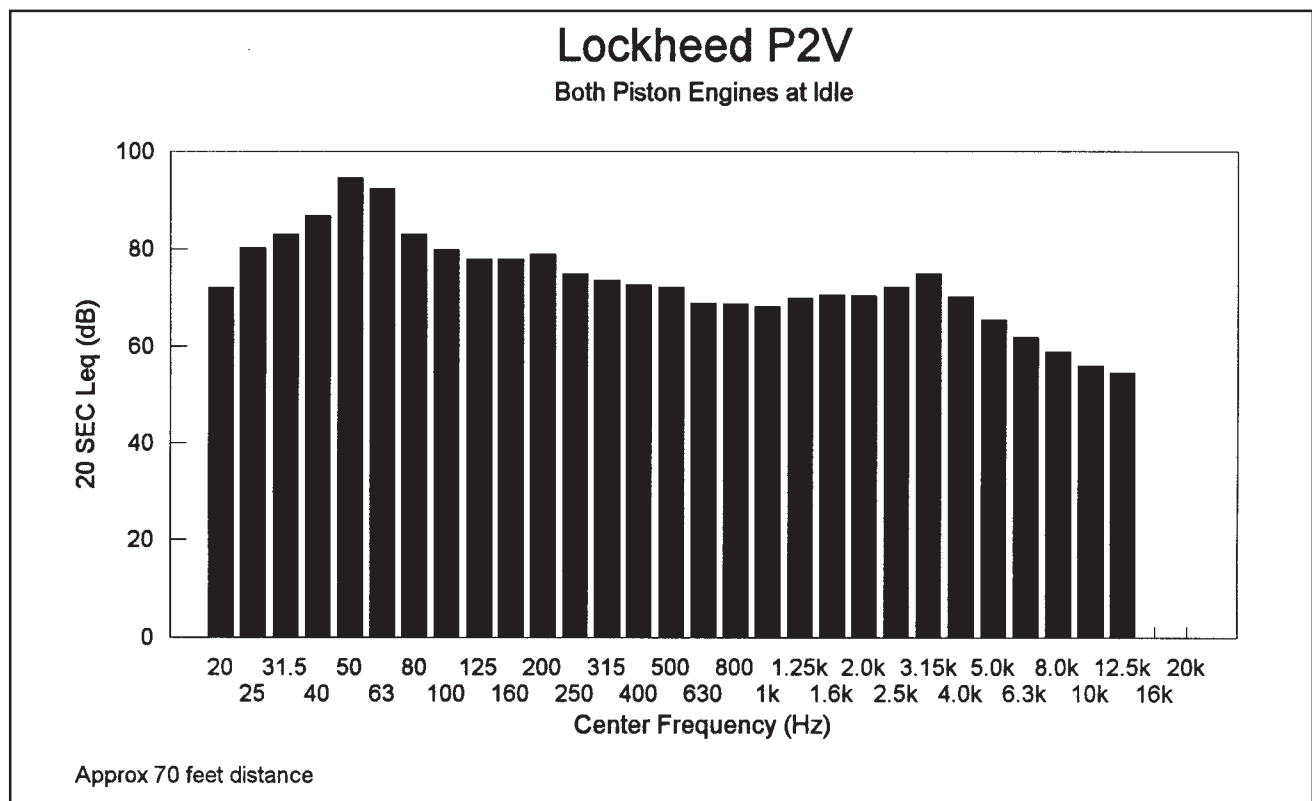


Figure 8—P2V frequency analysis at Boise ATB.

Redmond

Area measurements of the noise from three different airplanes were conducted at the Redmond Air Center. Sound levels were measured during brief engine runs of a C-130 and DC-6 at the tanker base, and a Sherpa at the Smokejumper loft. There was no fire activity at the time the measurements were made.

Table 6—Sound levels of three (3) airplanes at Redmond Air Center.

Aircraft	Inside Adjacent Building	Outside on Ramp
C-130	69 dBA	92 dBA
DC-6	62 dBA	87 dBA
Sherpa	58 dBA	90 dBA

CONCLUSIONS

As expected, results of the field measurements clearly show that those persons working outside, on or near the loading ramp during tanker operations should wear hearing protection. Those employees should also be included in a hearing conservation program if they are expected to be regularly exposed to that environment. The measurements made inside the adjacent buildings suggest that those who work inside will not likely have high enough exposures to require hearing protection or their inclusion in a hearing conservation program. It is recommended, however, that all personnel who work at airtanker bases receive the training portion of the hearing conservation program.

As shown in the graphs of Level vs Frequency, there is a significant portion of sound energy below 500 Hz. This is the range where ANR is most effective, and passive noise reduction such as plugs and muffs are least effective.

This suggests that ANR would be effective for this noise source. ANR headsets have become increasingly popular with pilots and their cost has been decreasing over the past few years. These headsets would be a good choice for those who need to have radio communication while working the airtanker base ramp. ANR muffs are also available without the communication components of the aviation-type headsets and are slightly less expensive.

Amplified earmuffs are most effective with sounds that are impulsive or of short duration, such as gunshots, hammering, etc. Since the noise from the airtankers is not impulsive, but more of a steady, continuous sound, amplified earmuffs would likely be a poor choice for the airtanker base environment.

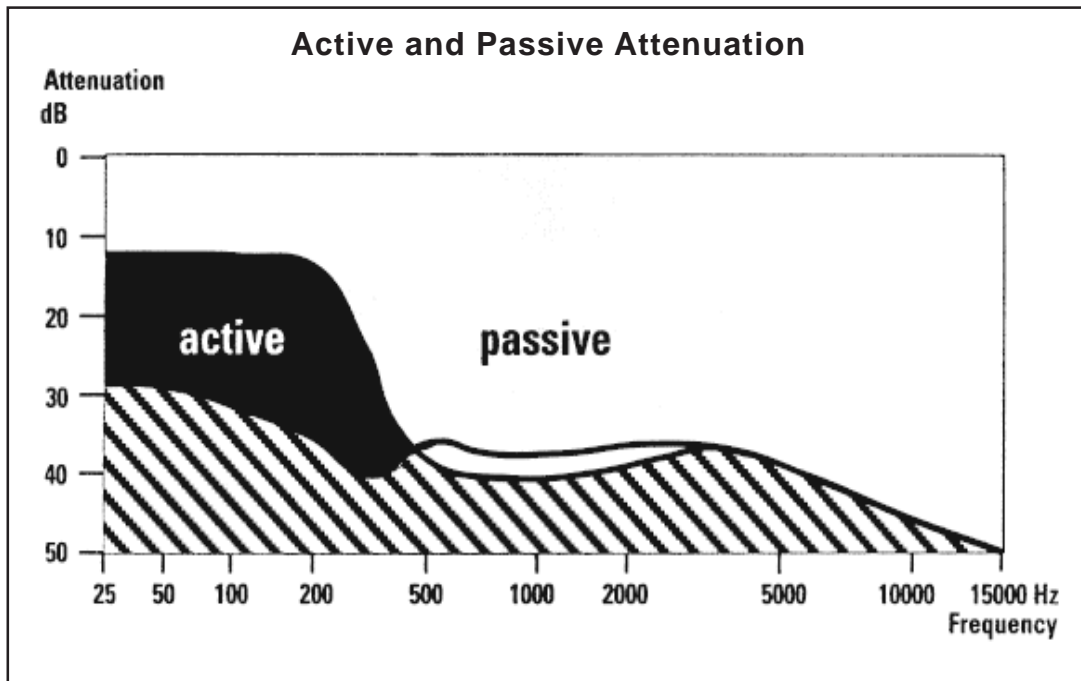


Figure 9—Graph of active and passive attenuation.²

² From Sennheiser Electronics Corporation

APPENDIX

Sources for Products, Services and Information

Training Materials—Books, Videos, CD's, Etc.

Lab Safety Supply

Order: 800-356-0783
Safety Tech Line: 800-356-2501
Web: www.labsafety.com

Interactive Media Communications

230 Second Ave
Waltham, MA 02154
Tel: 781-890-7707
Web: www.safetysite.com

Willson Safety

P.O. Box 622
Reading, PA 19603-0622
Tel: 800-345-4112
Fax: 610-371-7725

Environmental Resource Center

101 Center Pointe Dr
Cary, NC 27513-5706
Tel: 800-537-2372
Web: <http://www.ercweb.com>

Hearing Protectors

David Clark Company

360 Franklin Street, Box 15054
Worcester, MA 01615-0054
Tel: 508-751-5800
Fax: 508-753-5827
<http://www.davidclark.com/>

Lab Safety Supply

Order: 800-356-0783
Safety Tech Line: 800-356-2501
Web: <http://www.labsafety.com>

Industrial Safety Co.

1390 Neubrecht Rd
Lima, OH 45801
Tel: 800-537-9721
Fax: 419-228-5034
Web: <http://www.indlsafety.com>

Hearing Protectors (cont.)

LabelMaster

P.O. Box 46402
Chicago, IL 60646-0402
Tel: 800-621-5808
Fax: 800-723-4327
Web: <http://www.labelmaster.com>

North Safety Products

Health Care Division
1515 Elmwood Rd.
Rockford, IL 61103
Tel: 800-257-7934
Web: <http://SafetyOnline.net/north/>

Willson Safety

P.O. Box 622
Reading, PA 19603-0622
Tel: 800-345-4112
Fax: 610-371-7725
(Billsom@ hearing protectors)

Dosimeters & Sound Level Meters

(Must Meet ANSI S1.4 - Type 2)

Bruel & Kjaer (Spectris Technologies)

2364 Park Central Boulevard
Decatur, Georgia 30035
Tel: 770-981-9311
Toll Free: 800-332-2040
Fax: 770-808-7818
Web: <http://www.bkhome.com/>

Quest Technologies Inc.

Toll Free: 800-245-0779
Fax: 414-567-4047
Web: <http://quest-technologies.com/>

Metrosonics, Inc.

P.O. Box 23075
Rochester, NY 14692
Tel: 716-334-7300
Fax: 716-334-2635
Web: <http://www.metrosonics.com/>

Dosimeters & Sound Level Meters (cont.)

Response Rentals

18207 McDermott East, Suite G
Irvine, CA 92714
Tel: 714-955-3930
Fax: 714-955-3932
Web: <http://www.responserentals.com/>

LabelMaster

P.O. Box 46402
Chicago, IL 60646-0402
Tel: 800-621-5808
Fax: 800-723-4327
Web: <http://www.labelmaster.com>

Active Noise Reduction Equipment

Noise Cancellation Technologies, Inc.

One Dock Street, Suite 300
Stamford, CT 06902
Tel: 203-961-0500 (Wendy Ext. 333)
Tel: 800-278-3526
Fax: 203-348-4106
Web: <http://www.nct-active.com>
(PA-3000 Active Muff)
(PA-3500 Active Communications Headset)

Headsets, Inc.

2320 Lakeview Dr.
Amarillo, TX 79109
Tel: 806-358-6336
Fax: 806-358-6449
(Conversion Kits for existing headsets)

Bose Corporation

Communication Products, MS-272
The Mountain
Framingham, MA 01701-9168
Tel: 800-242-9008
Fax: 508-872-8928
(ANR headsets)

David Clark Company, Inc.

360 Franklin St.
Worcester, MA 01615-0054
Tel: 508-751-5800
Web: <http://www.davidclark.com>
(ANR headsets)

Active Noise Reduction Equipment (cont.)

LightSPEED Technologies, Inc.

15812 SW Upper Boones Ferry Rd.
Lake Oswego, OR 97035
Tel: 800-732-8999
Tel: 503-684-5538
(ANR headsets)

Sennheiser Electronic Corporation

One Enterprise Drive
P.O. Box 987
Old Lyme, CT 06371
Tel: 860-434-9190
Fax: 860-434-1759
Web: <http://www.sennheiserusa.com/>
(ANR headsets)

SoftComm

2310 South Airport Blvd.
Chandler AZ
Tel: 602-917-2328
Web: <http://idt.net/~softcomm/>
(ANR Headsets)

Services & Consultants

A list of professional service organizations by state can be found at:

<http://www.hearingconservation.org/pso.html>

Useful information on the internet

Noise, Ears, and Hearing Protection
American Academy of Otolaryngology - Head and Neck Surgery
<http://www.netdoor.com/entinfo/noiseaao.html>

National Hearing Conservation Association Home Page:
<http://www.hearingconservation.org>

Region 1 Safety, Health & Wellness Page:
http://fsweb.r1.fs.fed.us/hr6700_health_and_safety/index.html