**HETA 98–0149–2734**
**U. S. Army Corps of Engineers**
**Libby Dam Project**
**Libby, Montana**

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

# PREFACE

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# ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Randy L. Tubbs, Ph.D., of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by Nichole Herbert. Review and preparation for printing was performed by Penny Arthur.

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# National Institute for Occupational Safety and Health (NIOSH) Evaluation of Noise Exposure and Hearing Loss at Libby Dam Summary of Findings

## What NIOSH Did

- # Measured employees personal noise exposures
- # Measured low pitched sounds in the powerhouse
- # Reviewed program's hearing test results
- # Evaluated the overall hearing conservation program at the facility

## What NIOSH Found

- # Personal noise exposures did not exceed OSHA regulations
- # Area noise measurements did not find hazardous levels of low pitched sounds
- # There may be some building vibrations that employees feel
- # The hearing test program is flawed
- # The "Draft Hearing Protection Plan" is a good beginning for the project's hearing conservation program

## What Libby Dam Project Managers Can Do

- # Make sure the provider of the hearing tests follows professional guidelines
- # Continue to meet with the employees and develop the hearing protection plan
- # The safety office should continue to log the noise measurements made in the powerhouse
- # Move all office and control room operations to the new building

## What the Libby Dam Project Employees Can Do

- # Wear hearing protection devices in all required areas all of the time
- # Tell management any problems they are having with the hearing protection plan. Also, point out the good things about the plan.
- # Use the new lunchroom as a break area to be away from noise
- # Use good hearing conservation judgment away from the job

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National Institute for Occupational Safety and Health
NIOSH

# Health Hazard Evaluation Report 98–0149–2734
# U. S. Army Corps of Engineers
# Libby Dam Project
# Libby, Montana
# April 1999

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

## SUMMARY

The U.S. Army Corps of Engineers requested that NIOSH conduct a health hazard evaluation at the Libby Dam project in Libby, Montana. The management and employees of this hydroelectric powerhouse were concerned about low frequency noise exposures to the employees working in the facility. A site visit was conducted by a NIOSH investigator on May 20–21, 1998, where area and personal noise measurements were obtained. The audiometric examinations of the employees were also provided to the NIOSH investigator for analysis.

The full–shift, personal noise exposure measurements collected from five Libby Dam employees did not exceed any OSHA criteria for noise. The NIOSH criterion was equaled in two of the five samples. The area sound measurements revealed a predominant sound energy in the 125 Hz third–octave band that is most likely the result of the generation and distribution of electricity. No intense sound energy was measured in the very low (less than 20 Hz) frequency range. There was some indication that structure–borne vibrational energy may be perceived by workers, particularly those who sit in front of computers at a desk. The analysis of the audiometric data collected from the employees showed that the hearing testing program was extremely variable, making it difficult to use these data to pin–point deficiencies in the hearing conservation program at this project.

The findings collected in this evaluation are inconclusive as to whether the employees are subjected to hazardous levels of noise in their jobs. The OSHA limits for occupational noise exposure were not exceeded in the five employees surveyed. The analysis of the audiometric data does, however, show many deficiencies are present in this component of the facility's hearing conservation program. Recommendations are made that will improve the audiometric testing program and the rest of the project's hearing conservation program.

Keywords: SIC 4911 (Electric Services), hydroelectric power plant, noise, structure–borne vibration, dosimetry, spectral analysis, audiometry

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# INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request from the U.S. Army Corps of Engineers, Libby Dam Project on March 16, 1998. The request for a health hazard evaluation (HHE) was concerned about noise and vibration exposures to employees of the Libby Dam hydroelectric power plant and the hearing losses measured in them. Previous evaluations of the facility by the Region X's Federal Occupational Health (FOH), U.S. Public Health Service found noise levels that did not explain the hearing loss exhibited by the employees. However, FOH was unable to measure the noise spectrum of power plant operations below 31.5 Hertz (HZ) and it was thought that maybe the low frequency noise exposures could possibly account for the hearing decrements. FOH personnel recommended that NIOSH be consulted.

A NIOSH investigator visited the Libby Dam power plant on May 20–21, 1998. An initial walk–through survey of the facility was conducted on May 20, and full–shift noise dosimeter sampling and spectral noise analyses were completed on May 21, 1998. The NIOSH investigator requested the hearing test results from employees at the Libby Dam project during the visit. The audiometric tests from 1977 to 1998 were sent to NIOSH in June 1998.

# BACKGROUND

Libby Dam spans the Kootenai River 17 miles upstream of Libby, Montana. The dam is a straight–axis, concrete gravity structure that was authorized by Congress in 1951. Construction by the U.S. Army Corps of Engineers and their contractor began in 1966. The dam was finished in 1972 and the powerhouse in 1976. The power plant has 5 Francis turbines that generate 120,000 kilowatts (kW) of electricity each. The number of generators that are placed in service depends on the amount of headwater in the reservoir and how much water is needed downstream of the dam. On the day of the NIOSH evaluation, four of the five turbines were operational. Construction activities were present during the HHE with a new, separate control room and office building being built adjacent to the power plant. Libby Dam has 32 permanent employees, of whom 23 work in the powerhouse. Job classifications include engineers, electricians, mechanics, control room operators, technicians, laborers, and administrative personnel. Day shift personnel in the powerhouse normally work a 10–hour period.

Parts of a hearing conservation program have been in effect at Libby Dam for many years. Audiometric testing has been given to employees since at least 1977. Hearing protection devices have also been made available to employees for several years. An initial writeup of a new hearing conservation program developed jointly by the employees and management was given to the NIOSH investigator during the site visit.

# METHODS

Quest® Electronics Model M–27 Noise Logging Dosimeters were worn by five employees, selected because of their job titles, on March 21, 1998. The noise dosimeters were attached to the wearer's belt and a small remote microphone was fastened to the wearer's shirt at a point mid–way between the ear and the outside of the employee's shoulder. Because the employees remained at the powerhouse during lunch, they were asked to wear the dosimeters throughout the day. One of the employees wearing a dosimeter carried a small notebook with him during the day and wrote down the times of major noise events so that the noise data could be correlated to the particular event. At the end of the shift, the dosimeters were removed and paused to stop data collection. The information was downloaded to a personal computer for interpretation with QuestSuite for Windows® computer software. The dosimeters were calibrated before and after the work shift according to the manufacturer's instructions.

Real–time area noise sampling was conducted with a Larson–Davis Laboratory Model 2800 Real–Time Analyzer and a Larson–Davis Laboratory Model 2575 1" pressure response microphone. The analyzer allows for the analysis of noise into its spectral components in a real–time mode. The 1" diameter microphone has a frequency response range (± 2 decibels [dB]) from 2.6 Hz to 8 kilohertz ( kHz) that allows for the analysis of low frequency sounds. The one–third octave center frequency bands from 2 Hz to 8 kHz were integrated for 60 seconds and stored in the analyzer. The analyzer was mounted on a tripod placed at various locations in the powerhouse with the microphone at approximately the level of employees' ears if they had been in the area. Employees were generally not present while sampling took place.

# EVALUATION CRITERIA

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

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[1] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[2] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[3] NIOSH encourages employers to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard.

## Noise

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

The A–weighted decibel [dB(A)] is the preferred unit for measuring sound levels to assess worker noise exposures. The dB(A) scale is weighted to approximate the sensory response of the human ear to sound frequencies near the threshold of hearing. The decibel unit is dimensionless, and represents the logarithmic relationship of the measured sound pressure level to an arbitrary reference sound pressure (20 micropascals, the normal threshold of human hearing at a frequency of 1000 Hz). Decibel units are used because of the very large range of sound pressure levels which are audible to the human ear. Because the dB(A) scale is logarithmic, increases of 3 dB(A), 10 dB(A), and 20 dB(A) represent a doubling, tenfold increase, and 100–fold increase of sound energy, respectively. It should be noted that noise exposures expressed in decibels cannot be averaged by taking the simple arithmetic mean.

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

$$\text{Dose} = 100 \text{ X } (C1/T1 + C2/T2 + ... + Cn/Tn),$$

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

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

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

# RESULTS

The Quest dosimeters collect data in a manner that allows one to directly compare the noise levels to the OSHA PEL and AL, and to the NIOSH REL, i.e., three different criteria are simultaneously used in the calculation of the employee's noise dose. The OSHA criteria use a 90 dB(A) criterion and 5 dB exchange rate for both the PEL and AL. The difference between the two is the threshold level employed, with a 90 dB(A) threshold used for the PEL and a 80 dB(A) threshold for the AL. The NIOSH criterion differs in that the criterion is 85 dB(A), the threshold is 80 dB(A) and it uses a 3 dB exchange rate. These threshold comparisons for the five employees sampled during the evaluation are shown in Table 1. In no instance are the OSHA criteria exceeded for the surveyed employees. The electrician and one of the mechanics match the NIOSH REL, both showing results of 85 dB(A) for the sampled period. The real–time noise exposures were plotted and are shown in Figures 1–5. The electrician carried a small notebook during the day and noted the times of noisy events or locations. These are marked on Figure 1. Inspection of all the real–time data show that each of the employees spent much of the day in noise levels between 70 and 80 dB(A).

In addition to the employees' personal noise exposure measurements, various areas in the powerhouse were chosen for a spectral analysis of the sound. Over 20 locations were selected and sound measurements made with the real–time analyzer while either four or five of the generators were in operation. Throughout the facility, a predominant sound frequency of 125 Hz was seen in most of the data. An example of this pattern is seen in Figure 6, from data obtained at the top floor of the powerhouse next to unit #3. Unit #5 was not in operation at the time this measurement was made, but the other four units were on–line. As can be seen in this figure, the 1/3 octave band sound energy centered at 125 Hz is 15 dB greater than any other third–octave band. The predominance of sound energy at 125 Hz is seen in other areas of the power plant (Figure 7) as well as outside of the facility near the transformers (Figure 8).

Office locations in the powerhouse were measured with the real–time spectral noise analyzer (Figures 9–12). While not as pronounced, the 125 Hz third–octave band sound energy is consistently one of the highest in these locations. However, the overall sound energy is low, ranging from 59.5 to 71.5 dB(A) and 74.7 to 85.0 dB(C). The 16 Hz third octave band energy is also one of the higher sound energy bands in the office areas. Finally, sound levels in the old lunchroom located in the powerhouse and the new lunchroom recently occupied in the new building next to the power plant were compared. The new lunchroom (Figure 14) clearly offers a quieter environment for workers to take their breaks. The overall levels for the two spaces were measured at 63.6 dB(A) and 81.1 dB(C) for the old lunchroom and 38.1 dB(A) and 66.0 dB(C) in the new building.

The U.S. Army Corps of Engineers medical department forwarded audiometric examinations from 53 individuals to NIOSH for analysis. The hearing test results went back to 1977 for some of the employees and up to January 1998, the last time hearing tests were given to employees before the HHE occurred. Not all of the records belonged to employees who worked in the powerhouse; some tests were for park rangers or others who worked in the Welcome Center of the Libby Dam project. Nearly all of the employees had gaps in their audiometric data, having years where they were not given a hearing test for an unknown reason. A total of 315 hearing tests were analyzed for the 53 employees. Some employees had as few as one audiometric test and one employee had 14 hearing tests.

The OSHA noise regulation defines a standard threshold shift (STS) as a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear when the baseline audiogram is compared to the annual hearing test.[6] For these data, the earliest hearing test was used as the initial baseline audiogram. If a STS was discovered, it was recorded and the annual audiogram became the new baseline for comparison to future hearing tests, as specified in the OSHA regulation. This procedure was duplicated whenever an employee met the definition of a 10dB average shift at the designated test frequencies. In this manner, an individual could exhibit multiple STSs over the data record. Of the 53 employees whose records were available for analysis, 5 individuals only had one audiometric test so that a comparison was not possible. Twenty–two of the remaining 48 employees did not exhibit a STS while 26 employees had at least one STS. This latter group broke down as follows: 16 had one STS, 5 had two STS's, 4 had three STS's, and 1 worker showed five shifts.

The audiometric data were reviewed from a hearing conservation program effectiveness perspective using the American National Standards Institute (ANSI) S12.13 percent better or worse sequential metric (%BW).[8,9] This metric uses the percent of the tested population that shows a 15–dB shift either toward better hearing or worse hearing at any test frequency in either ear between two sequential annual audiograms. As noted earlier, most employees with multiple tests had time gaps in their hearing tests. Workers were included in this analysis only when their hearing tests were on an annual schedule. If hearing tests were given, but the employee was not included, for whatever reason, then they were not analyzed for that year. For example, if an employee had hearing tests in 1984, 1985, 1987, 1992, and 1993, their tests would be analyzed for the %BW metric for 1984 to 1985 and 1992 to 1993. No comparison would be made between the years 1985 and 1987, or between 1987 and 1992 because hearing tests were given by the U.S. Army Corps of Engineers for the years in between their examinations, but the employee was not tested. Of the 315 audiometric tests in this population, a %BW comparison was made for 184 of them as they met this criterion. In order to evaluate the hearing conservation program, the percentage of workers who exhibit a 15 dB or greater change are recorded for each time period where a comparison can be made. According to the ANSI standard, if the percentage exceeds 25% of the compared population the program is labeled as marginal. If the percent of employees compared exceeds 40%, then the program is labeled as unacceptable. The results are graphically displayed in Figure 15. Only 2 of the 11 comparison periods fall into the acceptable range, while 4 of them were found to be unacceptable.

# DISCUSSION

Noise exposure levels measured during the NIOSH evaluation were not exceedingly high. In no instance were the OSHA criteria for noise surpassed. The NIOSH REL was met in two of the five dosimeter measurements. Inspection of the dosimeter results do show a potential for intense noise exposures to employees since there were occasions where the real–time exposure data approached 100 dB(A). However, the amount of time spent in noisy activities was brief on the day of this survey. This finding is not surprising due to the nature of the work at the Libby Dam project. Noise exposures are dependent on the tasks that these maintenance employees perform and the levels will vary from days when normal operations are occurring to days when preventative overhaul and emergency repair operations happen.

The area noise measurements made in the powerhouse show a predominant low frequency centered at 125 Hz, which is most likely attributable to the actual generation of electricity. Very low frequency sounds (less than 16 Hz) are not present in the power plant at high energy levels. During informal discussions with employees during the survey, the office workers described uneasy feelings while working in the powerhouse, particularly when using their computers. Many of them felt symptoms that they equated to "motion sickness." Because these kind of symptoms can be related to structure–borne vibration, the NIOSH investigator attempted to measure vibration in the facility in a rudimentary fashion by placing a dime on the surface of various structures to see if there was sufficient energy to cause the coin to move. Movement would indicate that the vibration force exceeded the force of gravity which is an acceleration value of 9.81 meters per second per second ($m / sec^2$). No movement was detected in the dime when placed on top of unit #2. However, the dime did move in some locations on the top of unit #3. Also, the dime would move when placed on stair railings near units #1, #3, and #4. When the coin was placed on the console in the control room, no movement was detected. This primitive examination of structure–borne vibration points to a possible problem for the employees. If the work area has sufficient vibration energy to put it into motion, this movement will be perceived by employees. Visual tasks, such as looking at a computer screen, may cause the person to lose a sense of a stable horizon which can lead to feelings of motion sickness. The phenomenon is similar to reading a book while riding in an automobile; the rider loses visual sight of the horizon while their body is moving in the car.

Inspection of the hearing test data for employees at the Libby Dam project seems to indicate that longer–term workers do have high frequency hearing loss that is indicative of excessive noise exposure. However, the fluctuations in the year–to–year test results make it difficult to determine if the losses are persistent or if they might be of occupational origin. Nine of the 11 possible comparisons of the audiometric tests fell into the marginal to unacceptable program range. This amount of variability calls into question the reliability and validity of the hearing test data. Before any conclusions can be made about occupational hearing loss, this project's audiometric test program needs to be strengthened. In the interim, the draft Hearing Protection Plan given to the NIOSH investigator seems to be a reasonable guideline for employees and management to follow until better audiometric data become available. The mandatory use of hearing protection in the powerhouse when three or more units are on line and the use of double protection for the louder maintenance activities seems to be a conservative approach to protecting the hearing of the employees at the Libby Dam project.

# CONCLUSIONS

The survey results from this evaluation are inconclusive as to whether a noise hazard exists for this facility. The personal noise exposure measurements made with the dosimeters were not especially intense. The NIOSH REL was reached in only two of the five samples. OSHA criteria were not exceeded. The area spectral measurements did not reveal any excessive low frequency sound energy in the power plant's work areas. There were indications that structure–borne vibrations are being perceived by employees, resulting in symptoms of motion sickness for a few of the workers.

Analysis of the audiometric testing program revealed many deficiencies. Several employees have been tagged as exhibiting STSs as defined in the OSHA noise regulation. Thirteen of

53 employees were labeled as having multiple shifts, a finding more indicative of a workplace that has very intense noise exposures. The reliability of these data come into question when analyzed for stability. The hearing tests of the workers vary tremendously, both for the better and for the worse, from year to year. These fluctuations make it very difficult to determine the validity of the hearing losses and the source of the losses in order to make changes in the hearing conservation program to better protect the employees' hearing.

# RECOMMENDATIONS

Based on the measurements and observations made during the evaluation at the Libby Dam project and the subsequent analysis of employees' hearing tests, NIOSH investigators offer the following recommendations to improve the work environment for employees at the facility.

1. The U.S. Army Corps of Engineers needs to improve its audiometric test program. Even though hearing tests have been provided to all employees for many years, the information gained from this testing program is too variable to provide the necessary feedback to improve the effectiveness of their hearing conservation program. The U.S. Army Corps of Engineers needs to make sure that the provider of the audiometric testing services follows professional guidelines established to ensure that accurate and valid hearing tests are obtained during the annual tests.[10]

2. Management at the Libby Dam project should take an audit of their hearing conservation program. The draft Hearing Protection Plan certainly is an excellent beginning towards implementation of a more effective program. The draft plan is a very conservative approach to reducing hearing loss in employees of the facility. However, because of the unreliable audiometric data currently available, it would be prudent for management to take this kind of an approach until the hearing tests show that the workers are adequately protected and that some of the requirements of the Hearing Protection Plan can be reduced or eliminated. Additional help in facilitating an effective program can be found in a recent NIOSH technical report.[11]

3. The documentation of workers' noise exposures by the Safety Office should be continued. Periodic monitoring of daily noise exposures for routine power generation days and for scheduled and unscheduled maintenance activities should be logged along with the area sound level survey results.

4. Employee reports of symptoms similar to motion sickness may be the result of structure–borne vibration in their work areas. The vibration levels are well below any criteria related to health problem or performance decrements.[12] However, people can still perceive the motion which may lead to their uneasy feelings. The fact that a new administration building has been recently erected outside of the powerhouse leads to the recommendation that all office/administrative activities be moved to this new location as soon as possible. This will eliminate any structure–borne vibration that may be affecting the employees. This would include the movement of the control room to the new building. The new building also offers a better quiet area for workers to take breaks away from the noise of the powerhouse in the new lunchroom.

# REFERENCES

1. NIOSH [1992]. Recommendations for occupational safety and health: compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92–100.

2. ACGIH [1998]. 1998 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Code of Federal Regulations [1997]. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.

4. Ward WD [1986]. Anatomy & physiology of the ear: normal and damaged hearing. Chapter 5. In: Berger EH, Ward WD, Morrill JC, Royster LH, eds. Noise & hearing conservation manual. 4th ed. Akron, OH: American Industrial Hygiene Association, pp 177–195.

5. Suter AH [1978]. The ability of mildly hearing–impaired individuals to discriminate speech in noise. Washington, DC: U.S. Environmental Protection Agency, Joint EPA/USAF study, EPA 550/9–78–100, AMRL–TR–78–4.

6. Code of Federal Regulations [1992]. OSHA. 29 CFR 1910.95. Washington, DC: U.S. Government Printing Office, Federal Register.

7. NIOSH [1998]. Criteria for a recommended standard: occupational noise exposure (revised criteria 1998). Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98–126.

8. ANSI [1991]. Draft American national standard: evaluating the effectiveness of hearing conservation programs. New York, NY: American National Standards Institute, Draft ANSI S12.13–1991.

9. Royster JD and Royster LH [1990] Hearing conservation programs: *Practical guidelines for success.* Chelsea, Michigan: Lewis Publishers, Inc.

10. Suter AH [1993]. Hearing conservation manual. Third Edition. Milwaukee, WI: Council for Accreditation in Occupational Hearing Conservation.

11. Franks JR, Stephenson MR, and Merry CJ [1996]. Preventing occupational hearing loss – a practical guide. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 96–110.

12. ISO [1997]. Mechanical vibration and shock – evaluation of human exposure to whole–body vibration Part 1: general requirements. Geneva, Switzerland, ISO 2631–1:1997(E).

**Table 1**
**Noise Dosimeter Data**
**U.S. Army Corps of Engineers**
**Libby Dam Project**
**Libby, Montana**
**HETA 98–0149**
**May 21, 1998**

| Job Title | Sample Time | OSHA PEL[a] | OSHA AL[b] | NIOSH REL[c] | Maximum Level[d] |
|---|---|---|---|---|---|
| Electrician | 8 hr : 40 min | 73.0 dB(A) | 79.4 dB(A) | 84.7 dB(A) | 111 dB(A) |
| Mechanic "A" | 8 hr : 29 min | 74.7 dB(A) | 78.5 dB(A) | 85.4 dB(A) | 108 dB(A) |
| Mechanic "B" | 8 hr : 34 min | 57.7 dB(A) | 71.8 dB(A) | 79.0 dB(A) | 111 dB(A) |
| Powerplant Operator | 8 hr : 24 min | 61.3 dB(A) | 71.4 dB(A) | 78.6 dB(A) | 100 dB(A) |
| Laborer | 8 hr : 21 min | 66.0 dB(A) | 73.2 dB(A) | 80.7 dB(A) | 110 dB(A) |
| Evaluation Criteria | | 90 dB(A) | 85 dB(A) | 85 dB(A) | |

a – Data collected with a 90 dB criterion, 90 dB threshold, and 5 dB exchange rate
b – Data collected with a 90 dB criterion, 80 dB threshold, and 5 dB exchange rate [$L_{avg}$]
c – Data collected with a 85 dB criterion, 80 dB threshold, and 3 dB exchange rate [$L_{eq}$]
d – Maximum slow–response level measured during sampling period

**Figure 1**
Libby Dam Power Plant
Electrician
HETA 98-0149
Libby, Montana

May 21, 1998

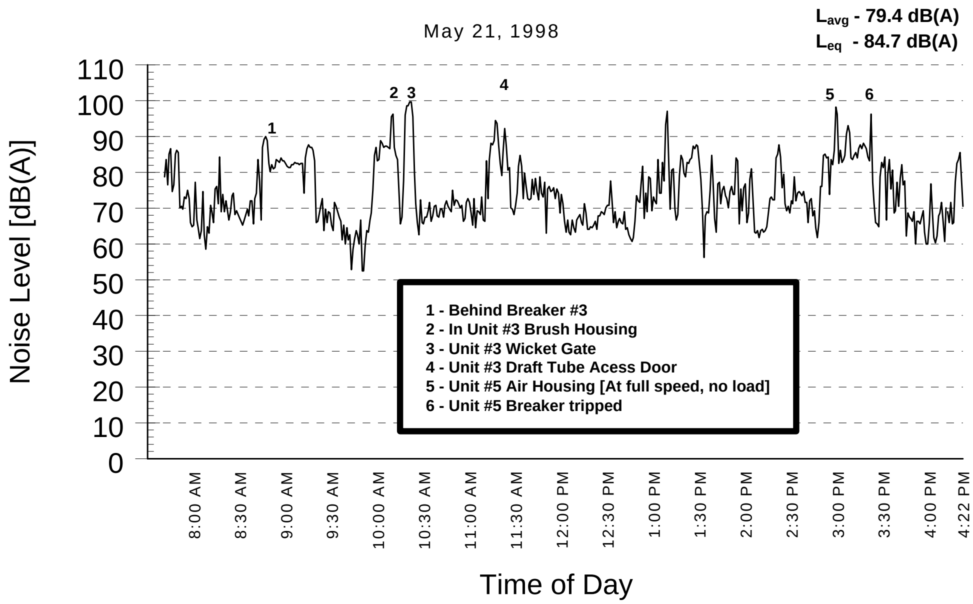



**Figure 2**
Libby Dam Power Plant
Mechanic "A"
HETA 98-0149
Libby, Montana

May 21, 1998

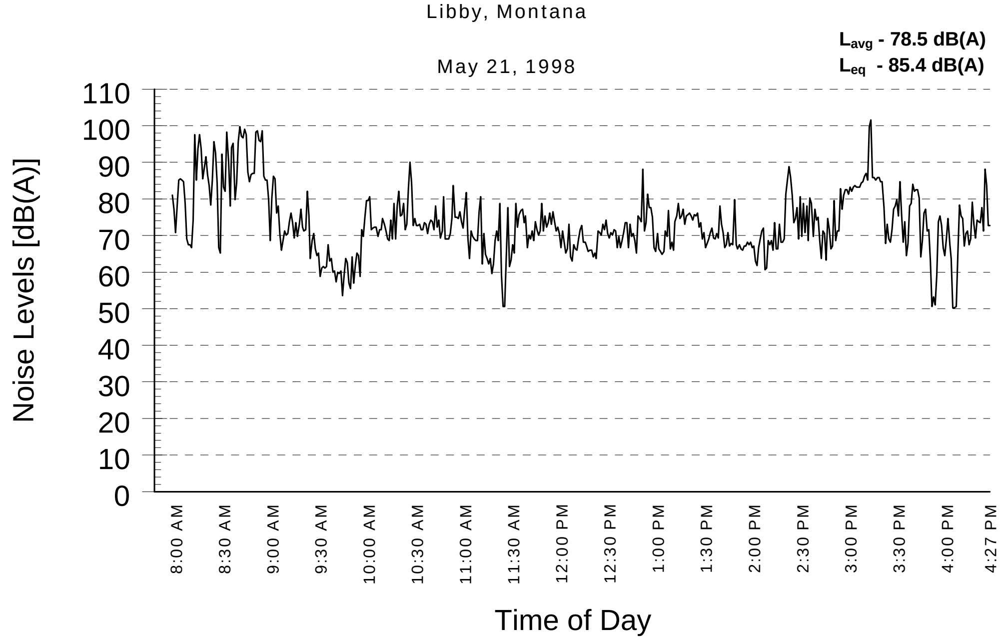


**Figure 3**
Libby Dam Power Plant
Mechanic "B"
HETA 98-0149
Libby, Montana

May 21, 1998

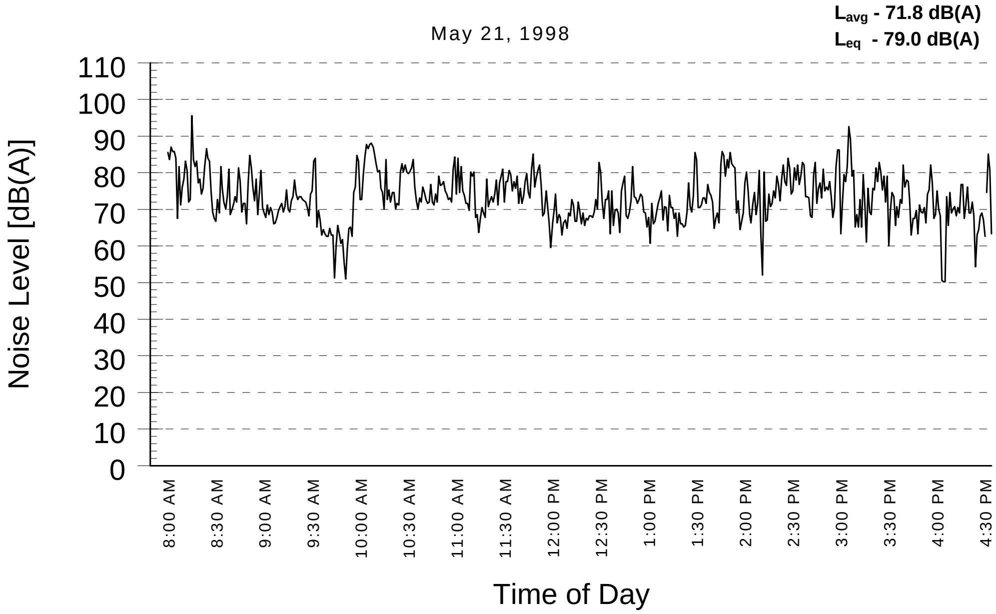



**Figure 4**
Libby Dam Power Plant
Control Room Operator
HETA 98-0149
Libby, Montana

May 21, 1998

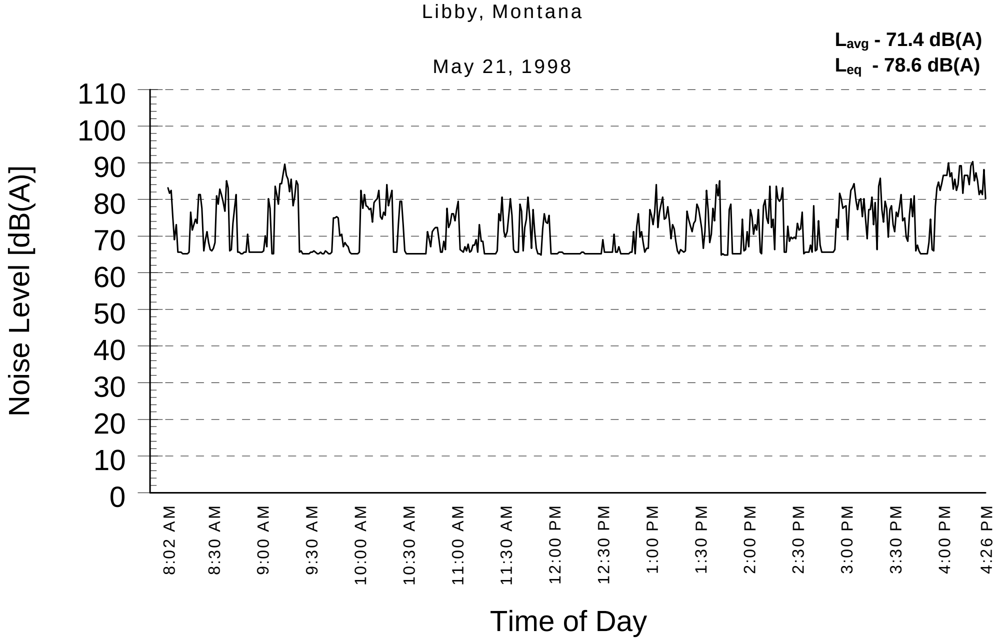


**Figure 5**
Libby Dam Power Plant
Laborer
HETA 98-0149
Libby, Montana
May 21, 1998

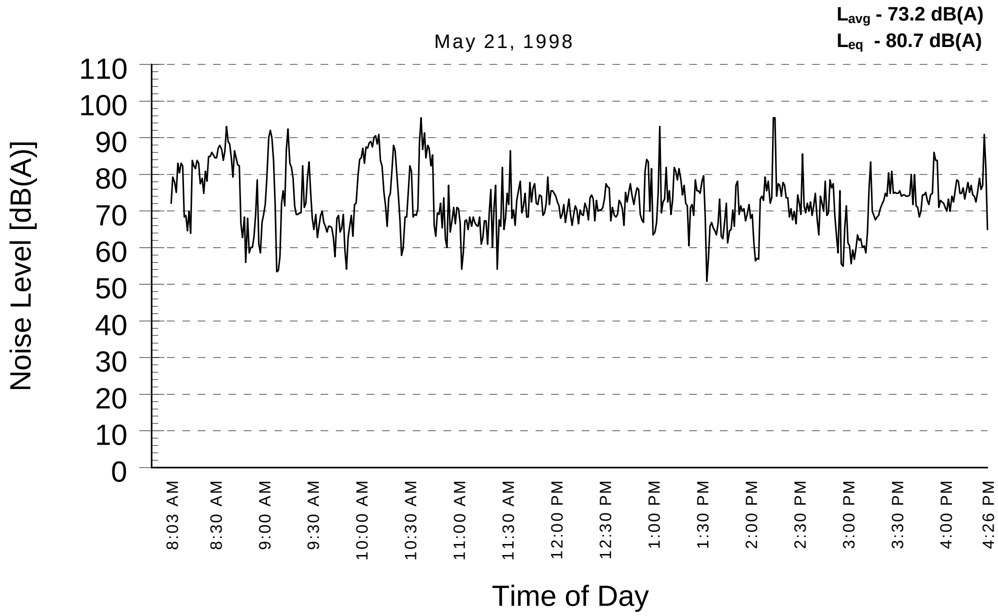



Figure 6
Libby Dam Power Plant
Generator #3 - Top Floor
HETA 98-0149
Libby, Montana
May 21, 1998

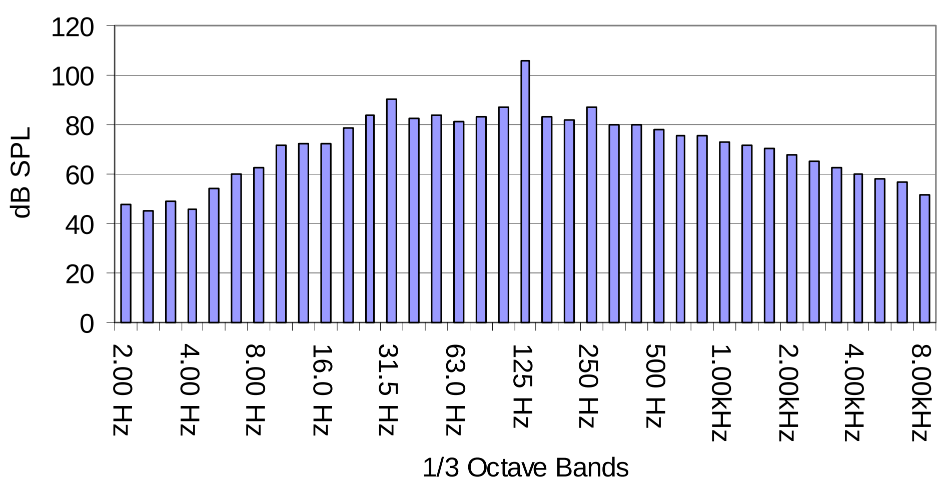


Figure 7
Libby Dam Power Plant
Generator/Turbine Floor Between #3 & #4
HETA 98-0149
Libby, Montana
May 21, 1998

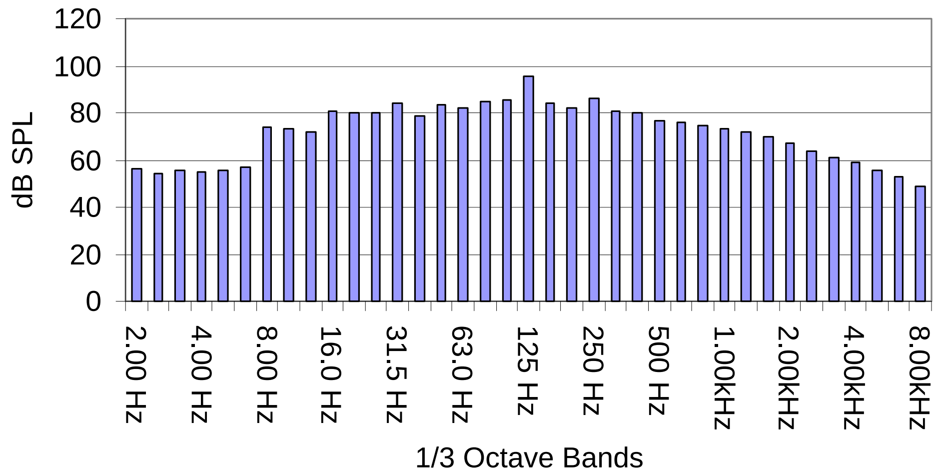



Figure 8
Libby Power Plant
Outside Transformer
HETA 98-0149
Libby, Montana
May 21, 1998

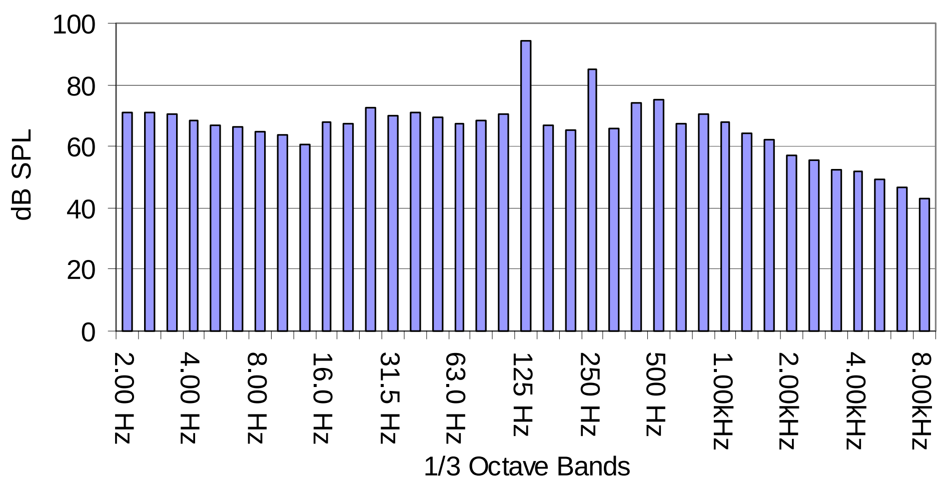


Figure 9
Libby Dam Power Plant
Administrative Office
HETA 98-0149
Libby, Montana
May 21, 1998

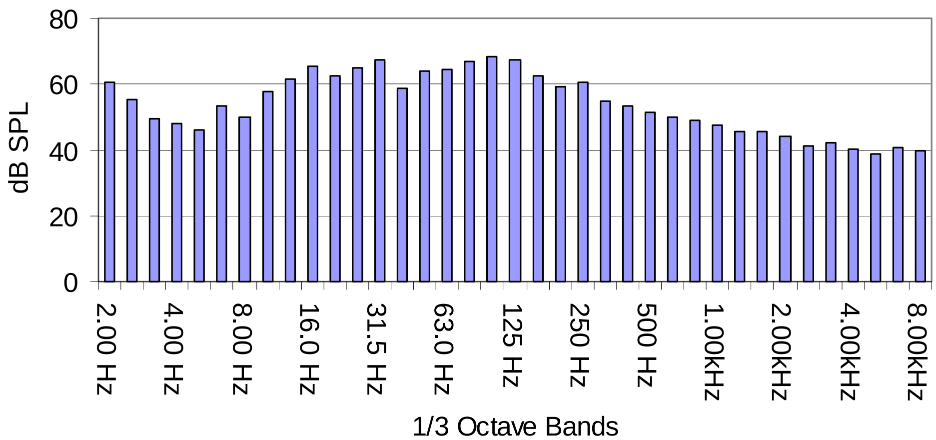



Figure 10
Libby Dam Project
Project Manager's Office
HETA 98-0149
Libby, Montana
May 21, 1998

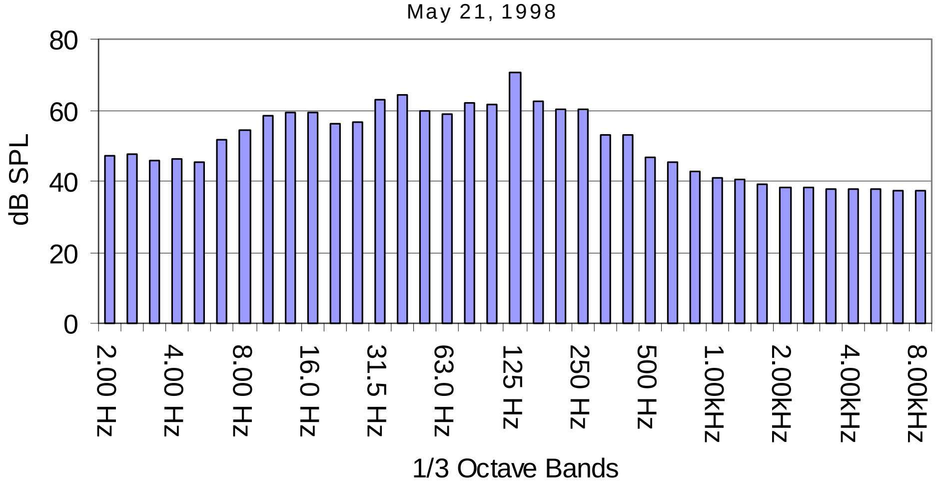


Figure 11
Libby Dam Project
Control Room
HETA 98-0149
Libby, Montana
May 21, 1998

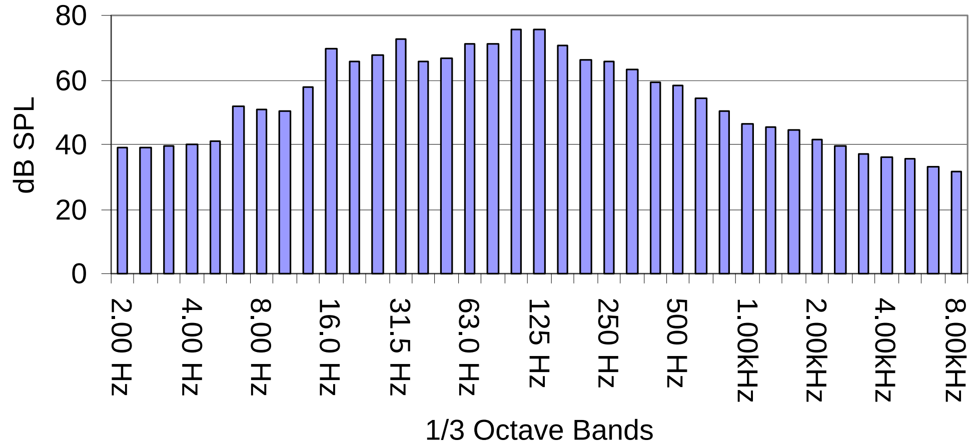



Figure 12
Libby Dam Project
Safety Office - Five Units Operating
HETA 98-0149
Libby, Montana
May 21, 1998

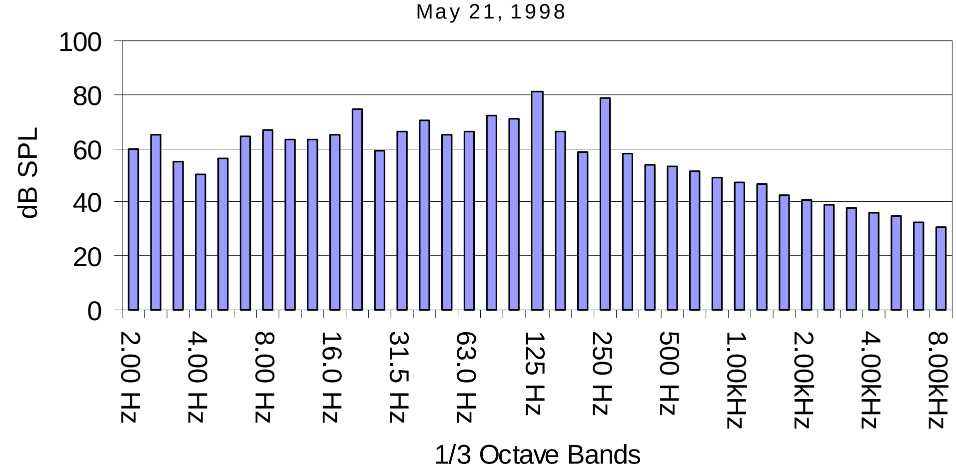


Figure 13
Libby Dam Project
Old Lunchroom
HETA 98-0149
Libby, Montana
May 21, 1998

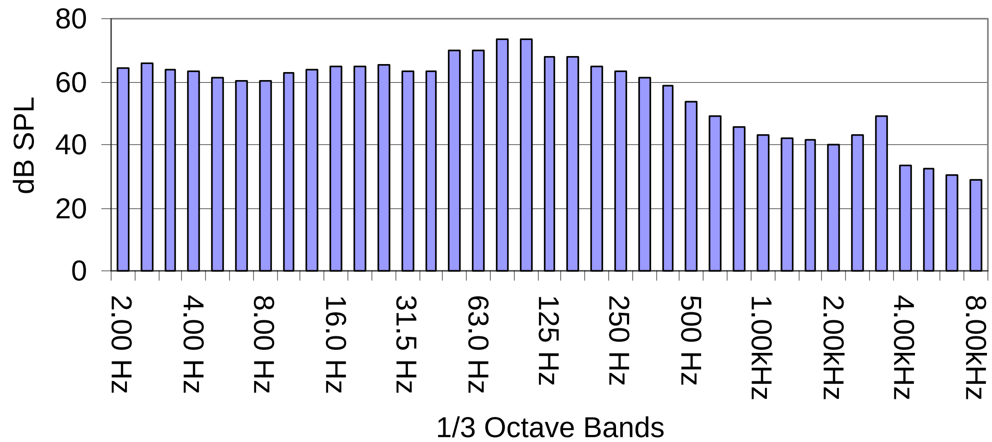



Figure 14
Libby Dam Project
New Lunchroom
HETA 98-0149
Libby, Montana
May 21, 1998

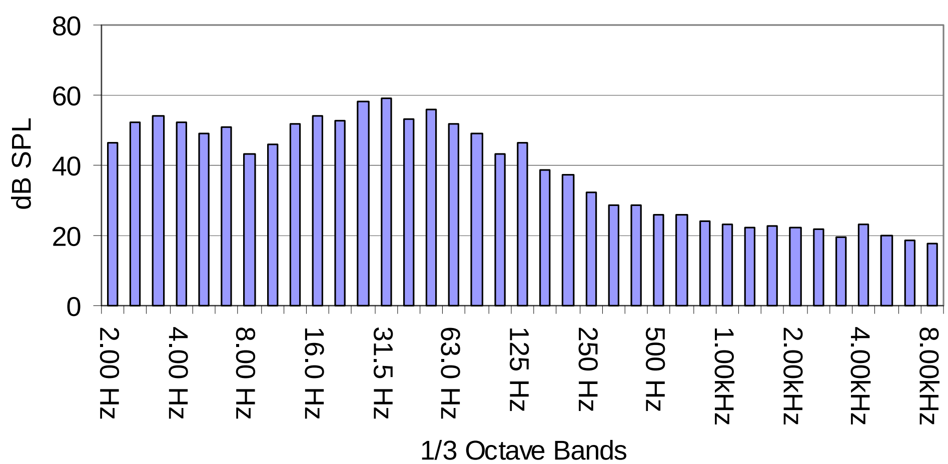
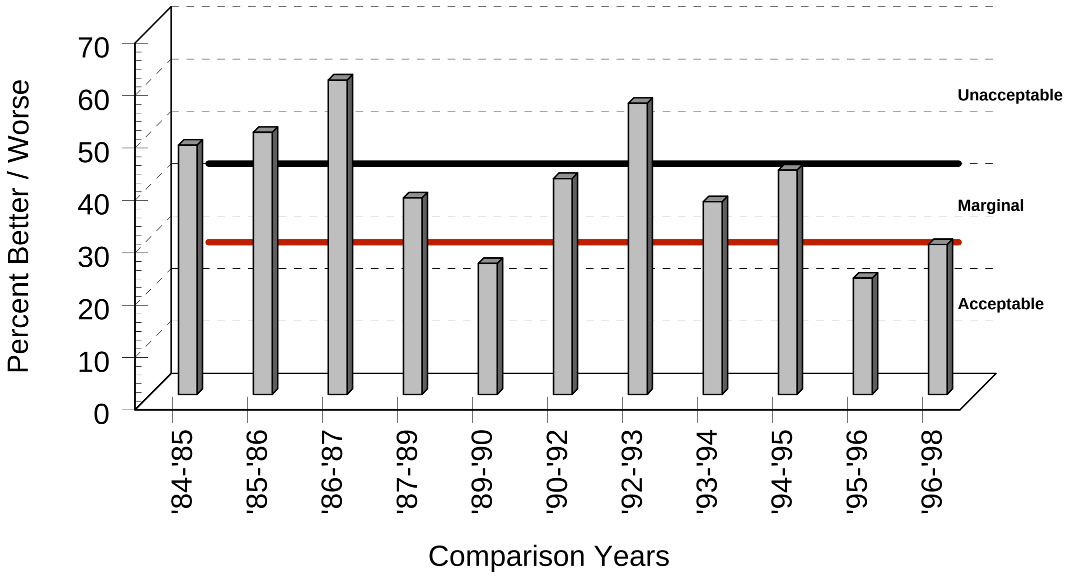


Figure 15
Libby Dam Project
Better / Worse Audiograms by Year
HETA 98-0149
Libby, Montana



For Information on Other
Occupational Safety and Health Concerns

Call NIOSH at:
1–800–35–NIOSH (356–4676)
or visit the NIOSH Homepage at:
http://www.cdc.gov/niosh/homepage.html