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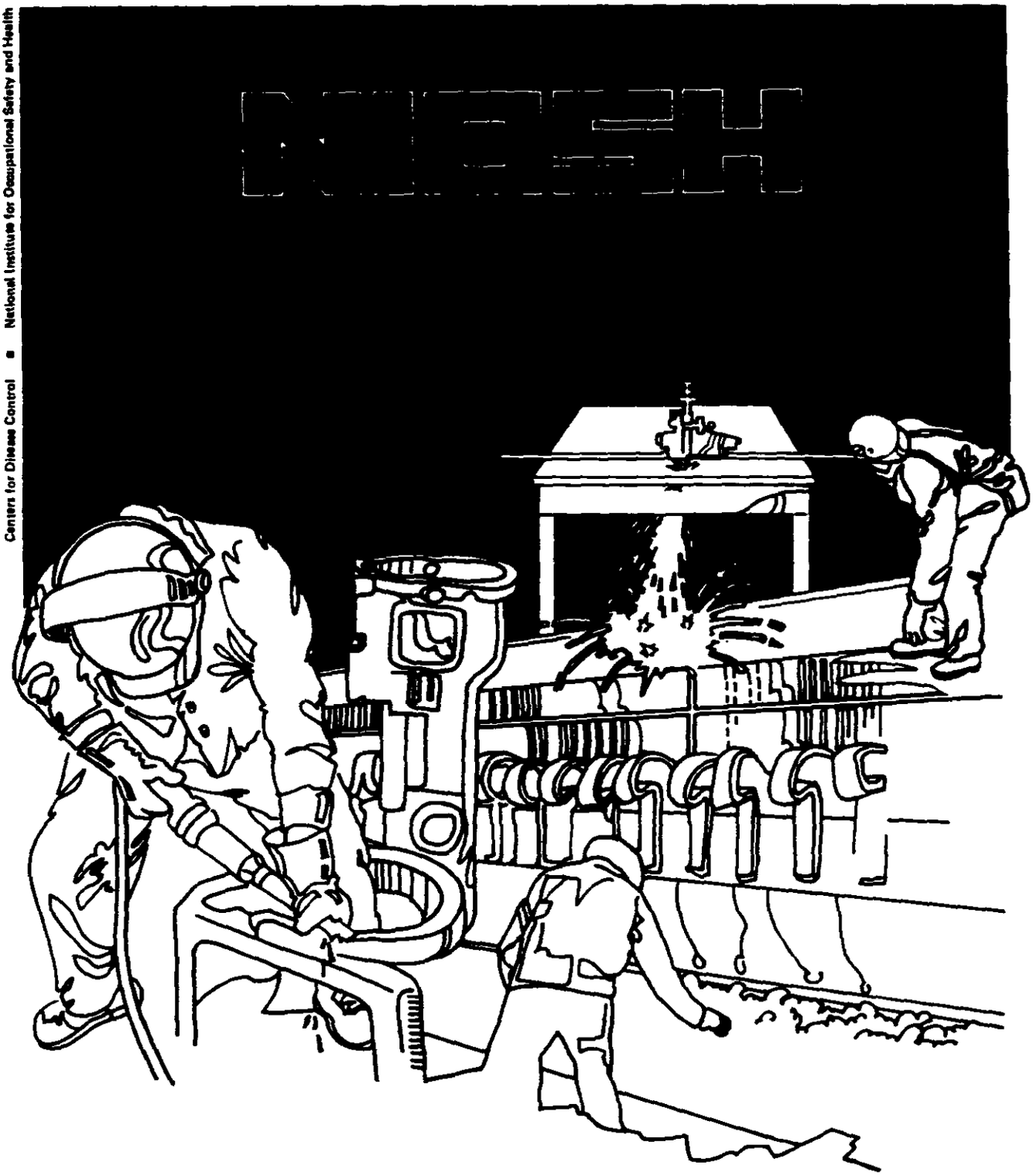

# Health Hazard Evaluation Report

## HETA 88-030-2109
## NEIMAN SAWMILLS, INC.
## HULETT, WYOMING

## PREFACE

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

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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NEIMAN SAWMILLS, INC.
HULETT, WYOMING

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## I. SUMMARY

In October, 1987, management at Neiman Sawmills, Inc. asked the National Institute for Occupational Safety and Health (NIOSH) to assist the company in evaluating feasible noise abatement procedures planned for the sawmills. The Wyoming Occupational Health and Safety Department, Technical Assistance Division had visited the sawmills on three previous occasions and recommended that NIOSH be consulted for further assistance.

Two separate visits were made to Neiman Sawmills, Inc. by NIOSH investigators in order to assess the effects of moving a board edging operation out of the main sawmill building and the effects of enclosing a second planer in the planer mill. Noise dosimeter measurements and spectral determinations were made on the first visit to determine the noise levels before these changes had been made. On the second visit, similar types of noise measurements were made after the equipment changes had been completed in the sawmill and planer mill. Additional noise measurements were made in a trimmer mill at Neiman Sawmills, Inc. and at Blacktail Mill, a separate facility owned by the company. Also on the second visit, 91 of the 108 current employees at the mills were given pure-tone, air conduction audiometric examinations to evaluate the workers' hearing abilities. A short questionnaire was also given to each worker to document the employment history of the worker and any noise exposures or medical problems which might affect their hearing.

The noise dosimetry results revealed that 73% (16 of 22) of the surveyed job descriptions in the mills had time-weighted average (TWA) noise levels in excess of 90 decibels on the slow, A-weighted scale (dB[A]). Only one of the surveyed jobs had TWA noise levels less than the NIOSH recommended exposure limits (REL) of 85 dB(A). The engineering noise controls used in the mill were found to produce differing amounts of noise reduction to the workers. The enclosure around a planer in the planer mill was found to be effective. However, the separation of the edger and trimmer operations to their own buildings was not an effective noise reduction technique.

The hearing tests revealed that 72.5% of the employees exhibited some degree of hearing impairment at one or more audiometric test frequency. The mean hearing curves for these employees also showed a pattern associated with noise-induced hearing losses, characterized by maximum hearing loss at 4 to 6 kilohertz (kHz), with better hearing at adjacent higher and lower frequencies. Analysis of the audiometric data collected during the evaluation found no statistical relationship between the employee's years of employment at Neiman Sawmills, Inc. and the measured hearing losses in the workers.

Because a majority of the noise dosimeter measurements were in excess of the NIOSH REL, NIOSH investigators conclude that a health hazard exists for the employees at Neiman Sawmills, Inc. This conclusion is reinforced by the finding that noise-induced hearing losses were observed in the workers. A comprehensive hearing conservation program which complies with current Occupational Safety and Health Administration regulations should be implemented in order to protect these employees from excessive noise exposures in the work place. Specific recommendations about the hearing conservation program and future engineering controls for the mills are presented in Section VII of this report.

KEYWORDS: SIC 2421 (Sawmills and Planing Mills, General), noise exposure, hearing loss, noise control engineering, hearing conservation programs.

## II. INTRODUCTION

Neiman Sawmills, Inc. produces several varieties of untreated boards and lumber products from pine logs at two separate facilities in Hulett, Wyoming. Neiman Sawmills is the larger of the two mills, having separate buildings which house the saw mill, trimmer saws, edger saws, drying kilns, planer mill, wood chip production, and other associated facilities and offices. Blacktail Mill, the smaller of the two mills, is generally housed in one, large building at a separate location. During the June 1989 survey, a total of 108 people were employed by Neiman Sawmills, Inc. This total includes mill workers, truck drivers, and office personnel. The mills are a family owned and operated business with no union representation for the employees.

In October, 1987, the management at Neiman Sawmills, Inc. requested the National Institute for Occupational Safety and Health (NIOSH) to conduct a Health Hazard Evaluation (HHE) to determine feasible noise abatement and control procedures in the sawmills as a follow-up to three previous visits to the mills from the Wyoming Occupational Health and Safety Department, Technical Assistance Division. Neiman Sawmills, Inc. was in the process of moving a trimmer operation and edger operation out of the main sawmill building and locating them in their own buildings. Also, a planer in the planer mill was about to be enclosed to further reduce noise exposures to employees working in this mill. The HHE plan was to make measurements of the workers' noise exposures in these areas before and after the controls had been implemented. By the time the request was received and acted upon, however, the trimmer operation had already been located to its new building, thereby eliminating the possibility to measure the workers' noise exposures prior to the change. The edger and planer noise control plans had not been initiated; these areas were evaluated both before and after the controls had been put in place. Audiometric examinations of the employees at Neiman Sawmills, Inc. were performed to determine if significant hearing impairment had occurred in this group of workers.

In April 1988 and June 1989, investigators from NIOSH visited Neiman Sawmills, Inc. to conduct personal dosimetry for noise exposures to workers in the mills and to tape record the noise levels in the areas where noise controls were planned for spectral analyses which facilitated evaluating the effectiveness of the controls. Also during the June 1989 visit, NIOSH investigators administered a short work history and noise exposure questionnaire to employees and conducted audiometric examinations. Interim reports on workers' noise exposures, spectral analyses, and engineering data on noise transmission losses were sent to Neiman Sawmills, Inc. in May 1988 and November 1988. Individual participants in the audiometric testing program were sent a copy of their test results and a letter of explanation of these results shortly after the testing had been completed. This final report presents the final compilation of all the survey results and the analyses of these results.

## III. METHODS

During the April 1988 survey, jobs located near the open planer in the planer mill and the edger operators were targeted for the dosimeter measurements. Additional dosimeter measurements were made in the sawmill and in the trimmer mill. These same jobs were measured during the second noise survey in June 1989, in addition to other jobs in the sawmill and planer mill. A second sawmill at the Blacktail facility was surveyed with the dosimeters during the second site visit. Tape recordings of the noise produced by the planer, edger, and trimmer were also made during each of the two site visits for later spectral analyses to determine the frequencies of the major noise sources produced by these machines.

The noise dosimeters used in the survey were Metrosonics Model dB301/26 Metrologgers, a small noise level recording device which is worn on the waist of the employee with a 1/4 inch microphone attached to the worker's shirt collar, or the shoulder area if the shirt has no collar. This dosimeter is designed to measure noise in decibels, A-weighted levels (dB[A]) four times per second. The noise measurements are integrated according to the Occupational Safety and Health Administration (OSHA) noise regulation (see Evaluation Criteria section of this report) for an entire minute and stored separately in the Metrologger for later analysis and final storage. Each dosimeter was calibrated according to the manufacturer's instructions before being placed on the worker. After the recording period was completed, the dosimeter was removed from the worker and placed in the standby mode of operation. The data was later transferred to a Metrosonics Model dt-390 Metroreader/Data Collector following the day's noise sampling. Prior to turning off the dosimeter, it was again calibrated to assure that the device had not changed during the sampling period. The dosimeter information was finally transferred to a NEC Laptop Computer with supporting Metrosonics Metrosoft computer software for permanent data storage and later analysis.

Area noise information from the mill machines was collected with a Panasonic Model SV-250 Portable Digital Audio Tape (DAT) recorder and Sennheiser microphone for later spectral analysis on a Wavetek Model 444A Mini-Ubiquitous FFT Computing Spectrum Analyzer. These data were recorded at locations where noise reduction controls had been put into place in the planer mill, trimmer mill, and edger mill in order to assess the effectiveness of the controls installed by Neiman Sawmills, Inc.

All employees of Neiman Sawmills, Inc. were eligible to participate in the audiometric testing program. Each worker was given a voluntary consent form to sign in front of a NIOSH witness prior to being tested. A questionnaire was administered to each employee by a NIOSH Occupational Hearing Conservationist. The questionnaire asked several basic demographic questions concerning the employee's name, age, sex, address, and years of employment at Neiman Sawmills, Inc. and other employers. Additional information was asked about prior military experience, noisy hobbies or personal activities, and medical conditions associated with hearing loss.

The audiometric screening tests were administered by NIOSH personnel certified as Occupational Hearing Conservationists by the Council for Accreditation in Occupational Hearing Conservation (CAHOC). An audiometric testing booth was set up in a quiet meeting room in the basement of the sawmill's business office to accommodate the hearing tests. Audiometric screening was conducted on a Tracor RA-400 Microprocessor Audiometer. Pure-tone hearing thresholds were obtained at 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hertz (Hz) separately for each of the worker's ears. The total test time was approximately 7-10 minutes in the audiometric booth following a brief instructional explanation of the hearing test procedures. The project officer offered a brief explanation of the results immediately following the test procedure. All audiometers had exhaustive calibrations performed by an authorized audiometer dealer just prior to the survey, and underwent daily biological calibration procedures during the test period.

## IV. EVALUATION CRITERIA

Occupational deafness was first documented among metalworkers in the sixteenth century.[1] Since then, it has been shown that workers have experienced excessive hearing loss in many occupations associated with 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.[2]

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.[3]

### A. Noise

The OSHA existing standard for occupational exposure to noise (29 CFR 1910.95)[4] specifies a maximum permissible exposure level (PEL) of 90 dB(A)-slow response for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship. This means that in order for a person to be exposed to noise levels of 95 dB(A), the amount of time allowed at this exposure level must be cut in half in order to be within OSHA's PEL. Conversely, a person exposed to 85 dB(A) is allowed twice as much time

at this level (16 hours) and is within his daily PEL. Both NIOSH, in its Criteria for a Recommended Standard,[5] and the American Conference of Governmental Industrial Hygienists (ACGIH), in their Threshold Limit Values (TLVs),[6] propose an exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard. Both of these latter two criteria also use a 5 dB time/intensity trading relationship in calculating exposure limits.

Time-weighted average (TWA) noise limits as a function of exposure duration are shown as follows:

| Duration of Exposure (hrs/day) | Sound Level (dB(A)) NIOSH/ACGIH | OSHA |
|---|---|---|
| 16 | 80 | 85 |
| 8 | 85 | 90 |
| 4 | 90 | 95 |
| 2 | 95 | 100 |
| 1 | 100 | 105 |
| 1/2 | 105 | 110 |
| 1/4 | 110 | 115 * |
| 1/8 | 115 * | - |
| | | ** |

* No exposure to continuous or intermittent noise in excess of 115 dB(A).

** Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

The OSHA regulation has an additional action level (AL) of 85 dB(A) which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the AL. The program must include monitoring, employee notification, observation, an audiometric testing program, hearing protectors, training programs, and recordkeeping requirements. All of these stipulations are included in 29 CFR 1910.95, paragraphs (c) through (o).

The OSHA noise standard also 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. Also, a continuing, effective hearing conservation program shall be implemented.

B. Audiometry

The audiometric test results obtained for the Neiman employees were averaged according to two different criteria to determine the degree of hearing handicap that had been sustained. Additionally, a single-frequency, degree of hearing impairment criterion was used to initially screen the data to determine the amount of hearing loss found in this

population. The first criterion was proposed by NIOSH in its criteria document for occupational noise exposure.[5] This criterion, which is intended to determine the amount of handicap in speech perception and communication abilities, averages the hearing level in decibels (dB HL re ANSI S3.6-1969)[7] at the pure-tone frequencies of 1000, 2000, and 3000 Hz for both ears. This measurement will be referred to in this report as the "mid-frequency" variable. The criterion incorporates a 25 dB "low fence" value. This means that the dB HL average value must exceed 25 dB before a hearing impairment is said to exist. The percentage of impairment is calculated by multiplying each decibel in excess of 25 dB HL by 1.5%. For example, an average dB HL of 40 for the "mid-frequency" variable would represent a 22.5% hearing impairment.

The second variable used in this report has been proposed by the American Academy of Otolaryngology - Head and Neck Surgery.[8] The criterion combines the pure-tone frequencies of 3000, 4000, and 6000 Hz. This combination will be most sensitive to the sensorineural effects on the ear from noise because of the propensity of these frequencies to deteriorate sooner when exposed to loud noises.[9] For this report, the second criterion will be called the "high-frequency" variable.

Finally, a criterion proposed by Eagles, et al. [10] for single-frequency hearing impairment determination also uses a low fence of 25 dB HL. With this criterion, any person who had a hearing level of 26 dB HL or greater was classified as having some degree of hearing loss. The degree of loss could range from "mild" (26-40 dB HL) to "profound" (> 90 dB HL). This criterion differs from the other two criteria in that it looks at single test frequencies rather than average hearing levels across several frequencies.

## V. RESULTS

### A. Noise

The seven noise dosimetry measurements made in the planer mill and sawmill during the first site visit were all in excess of the OSHA PEL for noise exposures. In the planer mill, the dosimeter measurements ranged from 95 dB(A) to 102 dB(A). The noise levels measured in the sawmill ranged from 97 dB(A) to 100 dB(A). The newly relocated trimmer mill was the only area found to have a noise level less than the OSHA PEL on the first noise survey. However, this same area's noise levels exceeded the OSHA PEL during the second site visit (94 dB(A) TWA). The noise levels in other mill areas also generally exceeded 90 dB(A) during the return visit, including the new edger mill. Although the TWA levels were greater than 90 dB(A) in the edger mill, the exposure levels in this area were reduced by 4 dB as a function of moving the operation from the sawmill building to its separate building.

All of the dosimeter data are summarized in Tables 1-3. Included in these tables are the 8-hour TWA values measured during the April 1988 visit and the mean TWA values and ranges measured during the June 1989 survey. The column labeled the 1-minute maximum period (1-min. MAX) is the highest one-minute average captured by the dosimeters during the sampling period. While it is not a peak noise value, it does give an indication of the maximum exposure potential that a worker faced during the work day. Finally, a column of the percentage of time a worker was under the NIOSH Recommended Exposure Level (REL) of 85 dB(A) is included in the tables.

Inspection of the tables reveals that workers are exposed to high noise levels during the work day with the 1-min. MAX values ranging from 97 dB(A) to 116 dB(A) for at least one minute during the day. The time workers are exposed to noise less than 85 dB(A) is relatively low, as indicated by the percentage values in the tables. The average amount of time that a worker in the planer mill is under the NIOSH REL is approximately 90 minutes (18.3% of 8 hours). This value is 2 hours in the sawmill, 80 minutes in the edger mill, 2 hours in the trimmer mill, and 2.5 hours in the Blacktail mill.

The data obtained at the Blacktail Sawmill (Table 3) are similar to the findings at the Neiman mills. The 1-min. MAX values generally are greater than 100 dB(A), and the TWA levels range from 86 dB(A) to 98 dB(A). The job operation description shows multiple job categories for the same worker. This is because several of the employees would change jobs after the morning break period, continue in the new job until the afternoon break, and then return to their initial job. This form of administrative control will work to reduce workers' noise exposures only in situations where one of the jobs has noise levels which are much less than the other job. A good example of this is the peeler operation (Figure 1). The middle portion of this worker's work day has lower noise levels. The control does not work well when both jobs produce excessive noise exposures, as is evidenced in Figure 2, which shows a switch between working the unscramble table and the twin resaw.

The major changes which took place in the planer mill between the two site visits involved the enclosing of a second planer and the addition of an automatic board feeder to the newly enclosed planer. The enclosure was made of concrete blocks and mortar, with openings in two sides of the enclosure large enough to allow the boards to go into the planer, through the planer blades, and out the other side to the lumber grader. A doorway and door were included in the enclosure for access to the planer. The automatic board feeder is a scrambler table which moves the boards into position to be fed through the planer. The scrambling action yields some noise resulting from the boards falling into each other and into the table as they line up for planing.

The noise levels inside of the planer enclosure are shown in Figure 3. The 1/3 octave bands reach a maximum level above 110 dB in the 630 Hz

band. Inspection of a 400 line spectrum on the FFT analyzer during the analysis clearly showed that the primary frequency component of the turning of the planer blades when no product was being fed through the planer was at 700 Hz. Spectral peaks are also seen at the fundamental frequencies above 700 Hz (1400 Hz, 2800 Hz, etc.), which can also be seen in the 1/3 octave band spectrum. The overall level measured inside the enclosure was 117 dB. The spectral levels shown in Figures 4 and 5 are of the feeder positions which serve the two planers. Measurements are shown when the second planer was not enclosed and boards were fed by hand, and also when the enclosure and automatic feeder had been put in place. Each figure shows noise level reductions in the higher frequency range (4000 Hz and above) following the installation of the enclosure, with slight increases in spectral levels below 500 Hz. Both figures also show a maximum noise level at the 630 Hz 1/3 octave band as a result of the planer blades, with an overall level of 106 dB, sound pressure level (SPL).

Neiman Sawmills, Inc. was in the process of moving some of the operations in the mill to separate buildings with more automated operations. The trimmer had already been moved to its new location before NIOSH investigators made the first visit to the mills. The edging operation, however, had noise measurements made while two edger operations were located in the main sawmill building and after a new edger had been installed in a separate building containing one edger and an automatic feeder table. The effects on the noise output of the edging operation from this change is shown in Figure 6. The two spectra from this operation are quite similar in shape and amplitude. There appears to be a slight increase in the noise levels below 100 Hz and a slight reduction in noise levels above 2500 Hz as a result of the change.

B. Audiometry

A total of 91 employees took part in the audiometric screening and questionnaire portion of the HHE. These 91 employees represent 84% (91 out of 108) of the current worker population included in the latest payroll list provided to NIOSH investigators by the company. Only 2 or 3 workers actually presented themselves to the test site and then declined participation in the voluntary testing. The remaining workers were not available during the two days of audiometric testing.

Prior to instructing the employee about the audiometric testing procedures, one of the Occupational Hearing Conservationists recorded the worker's answers to the information requested in the questionnaire. The predominately male workers (87%) had a median age of 29 years (range: 18 - 59 years) and a median employment time of 2.75 years (range: 0 - 25 years) at Neiman Sawmills, Inc. Fifty-six employees also reported at least one job not with the Neiman company. Only 16% of the workers reported any military history. The group as a whole reported several noisy hobbies, with at least half of the workers

stating that they participated in hunting (70%), the use of a chain saw outside of work (60%), motorcycling (50%), and work on a farm tractor (50%). Sixty-nine percent of the workers reported that they had experienced no trouble with their ears during their lifetime and had not noticed any major changes in their hearing ability. Two employees reported wearing hearing aids for congenital hearing difficulties. These two employees were given audiometric tests without their aids in place.

The audiometric results for the 91 employees were averaged at all seven test frequencies for each of the worker's ears. Individual results were then grouped into five-year age brackets for analysis. This resulted in the formation of five separate groups of workers, who fell into the age categories of (1) less than 25 years, (2) 25 - 29 years, (3) 30 - 34 years, (4) 35 - 39 years, and (5) greater than 39 years of age. The results (Figure 7) are characteristic of individuals who have been exposed to excessive noise during their lifetime. The pattern seen in Figure 7 is that of maximum hearing loss at 6000 Hz, with better hearing at the two adjacent test frequencies. With the exception of the 35 - 39 year group, which exceeds the hearing losses of the oldest group of workers at all frequencies, there is an increase in high-frequency hearing loss as the age of the workers increases.

When the data were evaluated according to the Eagles, et al. [10] single-frequency impairment criterion, 25 workers (27.5%) were classified as having normal hearing, that is, they had no measured hearing levels (HL dB) greater than 25 dB. Twenty-five workers (27.5%) were found to have a mild hearing loss, 14 (15.4%) had moderate losses, 7 (7.7%) had moderately severe losses, 13 (14.3%) had severe losses, and 4 (4.4%) had at least one frequency where they were unable to hear any tone at the intensity extreme of the audiometer (profound loss). A total of three employees were found to exhibit a conductive pattern of hearing loss, characterized by equivalent amounts of hearing loss at all tested frequencies.

The mid-frequency variable (1000 Hz, 2000 Hz, and 3000 Hz) and the high frequency variable (3000 Hz, 4000 Hz, and 6000 Hz) were calculated for each of the employees. These two measures were used as dependent variables in a multiple linear regression analyses,[11] along with the age of the employee and the time spent at Neiman Sawmills, Inc., as the independent variables in the regression model. Neither the age nor length of employment time of the employee were significant predictors of the mid-frequency variable. Both age ($p = 0.056$) and length of employment time ($p = 0.547$) failed to reach a 0.05 level of statistical significance. However, when the high frequency variable was analyzed, age was a statistically significant predictor ($p = 0.009$), but length of employment time ($p = 0.463$) still failed to be a significant factor in the analysis. Age of the employee was calculated to yield a change of 0.65 dB per year for the high frequency audiometric test values.

## VI. DISCUSSION AND CONCLUSIONS

The results of the noise dosimeter measurements show that the employees of Neiman Sawmills, Inc. were consistently exposed to noise levels in excess of the OSHA PEL of 90 dB(A) TWA and the NIOSH REL of 85 dB(A) TWA for occupational noise exposures. Of the 45 measurements made during the two site visits, 36 had TWA values greater than 90 dB(A), and 43 measurements exceeded a TWA of 85 dB(A). The management of the company was actively pursuing ways to reduce worker exposure through several means. During both survey periods, several of the employees were observed wearing hearing protection devices (HPDs) while at their work station. No information was asked on the questionnaire about past use of HPDs by workers or on the percentage of time during the workday that they would wear HPDs. The HPDs were readily available to the employees, and the company offered more than one type. Because the measured noise exposures rarely exceeded 100 dB(A) TWA, any earplug or earmuff worn properly should offer adequate protection to the employees. However, most areas of the facility had TWA noise levels exceeding 85 dB(A), and therefore, the use of HPDs should be made mandatory for all employees working in these levels of noise.

The only job which had a TWA noise exposure less than the NIOSH REL was the head saw operator working in the main sawmill building (83.2 dB(A)). This worker performed his job inside of a sound-attenuating enclosure which reduced the saw noise to a level below any of the evaluation criteria. The operator of the head saw at Blacktail also had a relatively lower noise exposure, with a TWA value of 87 dB(A). This employee also did his job inside of an enclosed booth which reduced the noise exposure. A worker enclosure was also seen for the peeler operator at Blacktail mill. However, because of the job rotation policy at Blacktail mill, the middle-of-the-day operator of this equipment was exposed to excessive noise during part of his shift, resulting in a TWA exposure in excess of the OSHA PEL (Figure 1).

An attempt by the Neiman management to implement administrative noise controls at their Blacktail mill was pointed out in the Results section of this report. The control involved the switching of jobs by employees at the morning break period and then switching back to the originally assigned job during the afternoon break period. This type of control did not work well at this mill and probably would not work well at the main sawmill because there are not enough quiet jobs associated with the manufacturing of the lumber. Until more jobs can be identified or created through other kinds of controls, which produce less noise exposure to the employee, then this administrative control has limited utility as a noise control measure. Furthermore, engineering controls are preferable to administrative controls.

The engineering controls attempted by Neiman Sawmills, Inc. fall into two categories. The first type of control was the separation of operations into their own distinct buildings. This was the case in the removal of the trimmer operation and edger operation from the main sawmill building and relocating them in individual locations. Of note is the fact that noise was reportedly not the major factor in the determination to implement these changes in operation. The new trimmer and edger saws are computer-

controlled systems with laser optical processes that are more efficient and accurate than the older versions of these operations. Noise control as a result of these changes would be an added benefit of the newer technology. The results of the dosimeter measurements and the spectral analyses reveal that the changes resulted in only a minimum reduction in workers' noise exposures.

The initial dosimeter results in the new trimmer mill during the first survey were below the OSHA PEL on the one day of the survey. However, the levels exceeded the PEL in four cases (two workers on two separate days) during the second site visit. This may have been the result of differences in the amount of lumber processed during the two surveys, or it may have been caused by additions to the scrambler table at the front end of the trimming operation between the two survey dates. The scrambler table moves the boards up an incline in order to line the boards up in a singular fashion so that the optical system can scan the board and determine the most efficient cut for it by the trim saws. The boards that do not fall into line tumble back down the incline, creating a lot of noise as they fall onto the metal table and into other boards. Noise created by the product hitting itself is very difficult to reduce at the source since the composition of the wood cannot be changed to a form which produces less noise. It is possible, however, to reduce the noise from the board hitting the metal table by installing noise-damping materials which prevent the metal from "ringing" when it is hit by a board. While it is impossible to predict the amount of noise reduction from this latter change, it would probably not contribute much to the reduction of the overall noise exposure to the worker because there are so many other sources of noise in this operation.

The noise reductions in the new edger mill resulting from the separation of this operation from the rest of the main sawmill were also minimal (Figure 6). The two spectra for the edger operation taken before and after the structural changes are very similar. However, the noise exposure to the worker at the new edger is now only from the edger operation, not from the rest of the sawmill. Therefore, any noise reduction controls, such as worker enclosures, sound barriers, etc., will reduce the noise exposure to the operator of this machinery.

The second category of noise control observed at Neiman Sawmills, Inc. was enclosing the noise sources, as was seen in the planer mill. The concrete block building erected around the planer certainly reduced the noise emitted by the planer. Comparison of the noise spectra inside the planer enclosure (Figure 3) to the noise measured immediately outside of the enclosure at the new feeder position (Figure 5) reveals levels 8 - 12 dB lower at several of the 1/3 octave bands. This reduction also resulted in exposure levels to the workers at the feeder positions that were about 5 dB(A) lower for the daily TWA exposure. This kind of control did work well in this situation and may be applicable to other operations in the sawmill.

The results from the audiometric testing of the employees at this facility revealed that 72.5% of the workers had some degree of hearing loss. However, this loss was not related to the amount of time that these employees had worked at Neiman Sawmills, Inc. The workers from this rural area reported a high percentage of non-occupational noise sources, such as hunting and shooting, farming, motorcycle and off-road vehicle usage, and woodcutting. The statistical analyses did not find a significant relationship between the workers' hearing loss and the time that they had been at their jobs; however, the noise dosimeter results conclusively show that the potential for excessive noise exposure does occur on their jobs. Although the statistical tests showed a relationship between the workers' age and their high frequency hearing loss, the pattern seen in Figure 7 is not typical of age-related hearing loss by itself. Presbycusis (aging) is characterized by high-frequency losses which progressively get worse at higher frequencies.[5] A typical aging curve will not show consistent improvement in hearing as one goes from 6000 Hz to 8000 Hz, as is seen in this figure. This is more typical of noise-induced hearing losses, which have a profile showing the worst thresholds in the 3000-5000 Hz range, with better thresholds above and below these frequencies.[12] Perhaps, if these relatively young workers continued to be exposed to these levels of noise for more years at Neiman, then the occupational relationship might be found. Of course, this relationship will be dependent on the workers' use of hearing protection devices in a proper fashion at work as well as being dependent on any additional noise exposures encountered off of the job. However, the implementation of a comprehensive hearing conservation program should help to lessen the effects of the occupational noise exposures to the workers.

## VII. RECOMMENDATIONS

The finding of workers' noise exposure levels that consistently exceeded all of the evaluation criteria leads to the following recommendations. These recommendations are based on the noise and audiometric findings from this Health Hazard Evaluation, as well as from other observations made at Neiman Sawmills, Inc. during the two site visits to the facilities.

1. A comprehensive hearing conservation program must be implemented at this company. The program should minimally be tailored to meet the requirements set forth in the Department of Labor's OSHA noise regulation.[1] Included in the regulation are sections addressing the need for audiometric testing, noise surveys, worker training, hearing protection devices, and recordkeeping. These requirements, as well as suggestions for engineering controls and program evaluation are included in a recent NIOSH publication[13] which should be referred to while setting up the hearing conservation program.

2. The use of hearing protection devices should be made mandatory in all areas of the facility where noise levels exceed 85 dB(A). The results of the dosimeter survey show that this includes nearly all of the areas of the mill. Workers should be given the opportunity to choose from among the available, effective types of HPD. Area supervisors must

consistently enforce the use of the HPDs for all employees, including workers assigned to the area, workers assigned to other areas who are visiting the area, management officials, and visitors, while they are in the noise areas. The areas should be identified with warning signs posted at all entrances to the affected area.

3. Audiometric testing must be done on an annual basis at this company. The recorded noise exposure levels are of sufficient intensity to regulate this practice, according to OSHA.[1] The tests will identify individual employees who have changes in their hearing over their work history. This will allow for intervention to slow down the progression of loss before it becomes a more severe handicap to the employee. These annual audiometric tests can also be used to evaluate the effectiveness of the hearing conservation program. New methods of audiometric database analysis are being developed in order to accomplish this kind of feedback on how the program is working.[14,15,16,17]

4. The practice of installing worker enclosures as a noise engineering control should be pursued wherever it is possible. It was observed during the evaluation that workers in some of the job classifications were generally immobile, needing to move toward their machine only to clear a jam or some other maintenance operation. If these workers can escape the noise in the mill for even a portion of the workday, then their TWA noise exposures will be reduced. This type of control might be possible for the worker in the sawmill who directs boards to resaw or to the edger mill, or for the operator of the new edger.

5. The noise levels on the chain in the planer mill might be reduced if a barrier was erected behind the two planers and the trim saw. This control would separate the several workers on the chain who pull the finished product off the line from the noise produced by the planers and trim saws. Such a barrier is a simple control, which would isolate these workers from their major noise source. The six dosimeter measurements taken on employees in this area ranged from 88 to 92 dB(A). A small reduction in noise exposure for these employees might change a posted noise area to an area where HPDs were not required.

6. Lift trucks, lumber stackers, and log trucks in the sawmill facilities were observed without audible warning devices on them. In order to avoid accidents between employees and these vehicles, audible warning alarms should be installed on all vehicles operating in the facility in accordance with the OSHA regulation 1910.265 (c) (30) (ii).[1]

7. During the evaluation, some workers in the planer mill were observed working without any covering on their upper body. Because of the potential for scrapes and splinters from the pulling of boards off the chain to the storage bin, this practice should be discontinued.

8. The NIOSH investigator observed that boards coming from the newly enclosed planer would come very close to the lumber grader's right hand

and arm, particularly if the worker was delayed in grading the board from the other planer. A guard should be installed which would prevent the grader from extending an arm into the path of a board coming from the second planer, thus, reducing the possibility of a hand or arm injury.

9. The NIOSH investigator observed that the operator's booth in the chipper mill had its windows and doors open while the operator was in the booth. Any protection from noise or flying wood chips is lost when this is done. Doors and windows in this booth and all other booths and enclosures should be closed whenever the machinery is operating.

## VIII. REFERENCES


1. Alberti [1591 (1970)], cited by Bunch, C.C. Traumatic deafness. In E.P. Fowler, Jr. (Editor), Medicine of the ear, chapter X. Reprinted Translations of the Beltone Institute for Hearing Research, No. 23.

2. 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.

3. Ward WD, Fleer RE, Glorig A [1961]. Characteristics of hearing loss produced by gunfire and by steady noise. Journal of Auditory Research, 1:325-356.

4. Code of Federal Regulations [1989]. OSHA. 29 CFR 1910.95. Washington, DC: U.S. Government Printing Office, Federal Register.

5. NIOSH [1972]. Criteria for a recommended standard: occupational exposure to noise. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 73-11001.

6. ACGIH [1990]. 1990-1991 threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists.

7. ANSI [1970]. Specifications for audiometers. New York, NY: American National Standards Institute, Inc. ANSI Standard S3.6.

8. AAO - HNS [1983]. Otological referral criteria for occupational hearing conservation programs. Washington, D.C.: American Academy of Otolaryngology - Head and Neck Surgery Board of Directors.

9. Kryter KD [1970]. The effects of noise on man. New York, NY: Academic Press.

10. Eagles EL, Hardy WG, Catlin FI [1968]. Human communication: The public health aspects of hearing, language, and speech disorders (NINDB Monograph #7). Washington, D.C.: Government Printing Office, U.S.Public Health Service Publication No. 1745.

11. Hays WL, Winkler RL [1971]. Statistics: probability, inference, and decision. New York, NY: Holt, Rinehart and Winston, Inc.

12. Cantrell RW [1981]. Occupational hearing loss. In: Gates GA, ed. Clinical auditory evaluation. Rochester, MN: American Academy of Otolaryngology - Head and Neck Surgery, pp. 113-117.

13. NIOSH [1990]. A practical guide to effective hearing conservation programs in the workplace. 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. 90-120.

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

15. Royster LH, Royster JD [1988]. Getting started in audiometric data base analysis. Seminars in Hearing, 9:325-337.

16. Royster JD, Royster LH [1986]. Audiometric Data Base Analysis. Chapter 9. In: Berger EH, Ward WD, Morrill JC, Royster LH, eds. Noise & hearing conservation manual. 4th ed. Akron, OH: American Industrial Hygiene Association, pp. 293-317.

17. Royster JD, Royster LH [1990]. Hearing conservation programs: practical guidelines for success. Boca Raton, FL: Lewis Publishers, Inc.

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5. Wyoming Department of Health and Social Services

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

Table 1

Noise Dosimeter Results - Planer Mill

HETA 88-030
Neiman Sawmills, Inc.
Hulett, Wyoming

| | April, 1988 Survey | | | June, 1989 Survey | | | | |
|---|---|---|---|---|---|---|---|---|
| Job/Operation | TWA* | 1-min. MAX* | % Time | # Samples | Mean TWA* | Range* | Mean 1-min. MAX* | Mean % Time |
| Planer | 94.8 | 111 | 30.2 | 2 | 96.6 | 93.9 - 99.2 | 115.5 | 40.4 |
| Feeder | 101.6 | 110 | 9.0 | 2 | 96.5 | 95.1 - 97.9 | 111.0 | 13.8 |
| Trimmer | 96.9 | 101 | 6.7 | 2 | 96.6 | 95.9 - 97.4 | 103.0 | 11.6 |
| Lumber Grader | 96.2 | 100 | 2.3 | 2 | 95.9 | 95.0 - 96.8 | 102.5 | 12.3 |
| Piler | -- | -- | -- | 3 | 91.1 | 90.5 - 92.0 | 102.0 | 18.3 |
| Stacker | -- | -- | -- | 1 | 87.5 | --- | 97.0 | 30.7 |
| Lift Truck Driver | -- | -- | -- | 2 | 87.9 | 87.8 - 88.1 | 102.5 | 26.4 |

* - All values are reported in dB(A). Column headings are described in the body of the report.

Table 2

Noise Dosimeter Results - Sawmill and Trimmer Mill

HETA 88-030
Neiman Sawmills, Inc.
Hulett, Wyoming

| | April, 1988 Survey | | | June, 1989 Survey | | | | |
|---|---|---|---|---|---|---|---|---|
| Job/Operation | TWA* | 1-min. MAX* | % Time | # Samples | Mean TWA* | Range* | Mean 1-min. MAX* | Mean % Time |
| Gang Saw Operator | 99.6 | 102 | 4.8 | 4 | 98.5 | 97.7 -100.7 | 103.5 | 12.8 |
| Head Saw Operator | -- | -- | -- | 2 | 83.2 | 81.7 - 84.6 | 101.0 | 81.6 |
| Slab Chaser | -- | -- | -- | 2 | 94.4 | 94.2 - 94.5 | 100.5 | 6.3 |
| Edger** | 97.3 | 104 | 14.8 | 2 | 92.9 | 92.2 - 93.6 | 101.5 | 19.8 |
| Trimmer: Operator | 88.3 | 104 | 48.8 | 2 | 93.9 | 93.5 - 94.3 | 103.0 | 13.2 |
| Trimmer: Stacker | -- | -- | -- | 2 | 91.6 | 91.5 - 91.6 | 99.5 | 10.4 |

* - All values are reported in dB(A). Column headings are described in the body of the report.

** - Two employees were monitored during the April, 1988 survey. Values are reported as mean values.

Table 3

Noise Dosimeter Results - Blacktail Sawmill

HETA 88-030
Neiman Sawmills, Inc.
Hulett, Wyoming
June 8, 1989

| Job/Operation | TWA* | 1-min. MAX* | % Time |
|---|---|---|---|
| Saw Filer | 86.9 | 102 | 50.2 |
| Loader Driver | 85.9 | 101 | 38.3 |
| Twin Saw/Peeler | 92.7 | 102 | 55.4 |
| Canter Saw | 90.2 | 104 | 28.3 |
| Head Saw | 87.0 | 97 | 37.5 |
| Edger/Bypass Trimmer | 97.5 | 103 | 9.0 |
| Bypass Trimmer/Edger | 98.5 | 104 | 9.8 |
| Unscramble Table/Twin Resaw | 97.5 | 113 | 18.1 |
| Peeler/Unscramble Table | 94.5 | 103 | 44.0 |

* - All values are reported in dB(A). Column headings are described in the body of the report.

Figure 1

Twin Resaw/ Peeler Operator
HETA 88-030
Nelman Saw Mills - Blacktail Mill
June 8, 1989

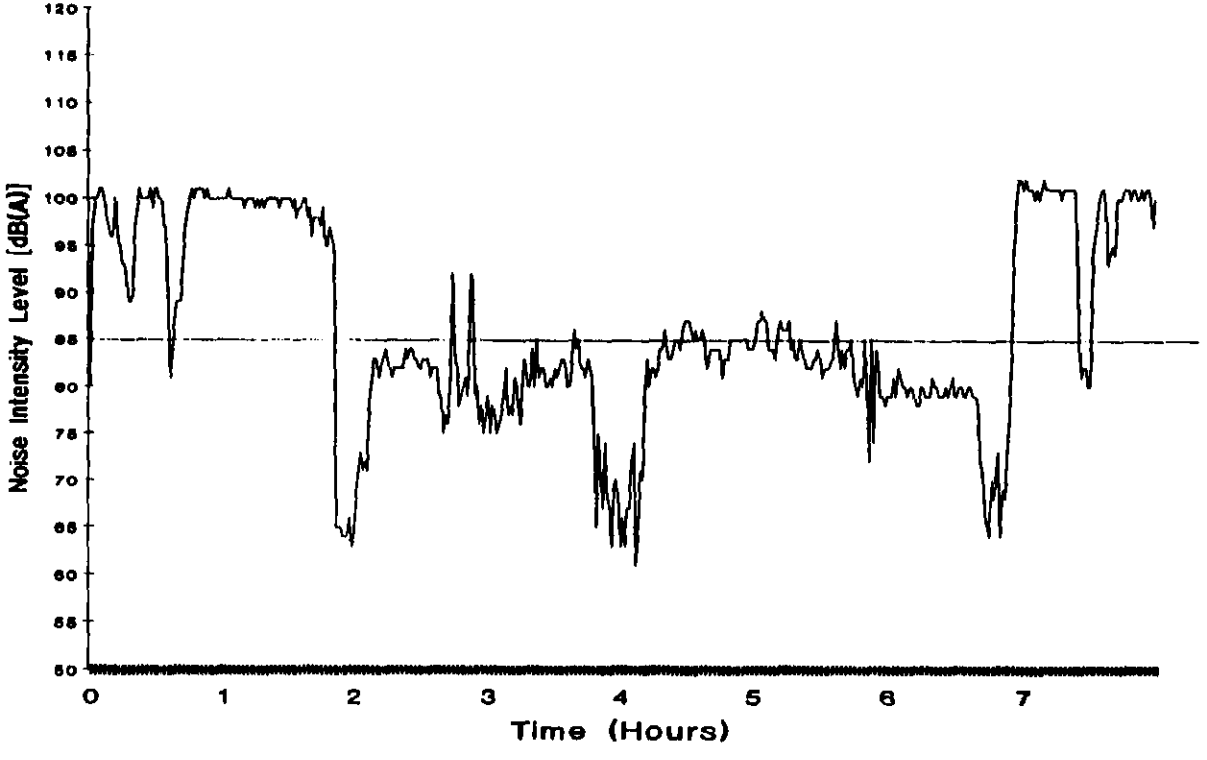
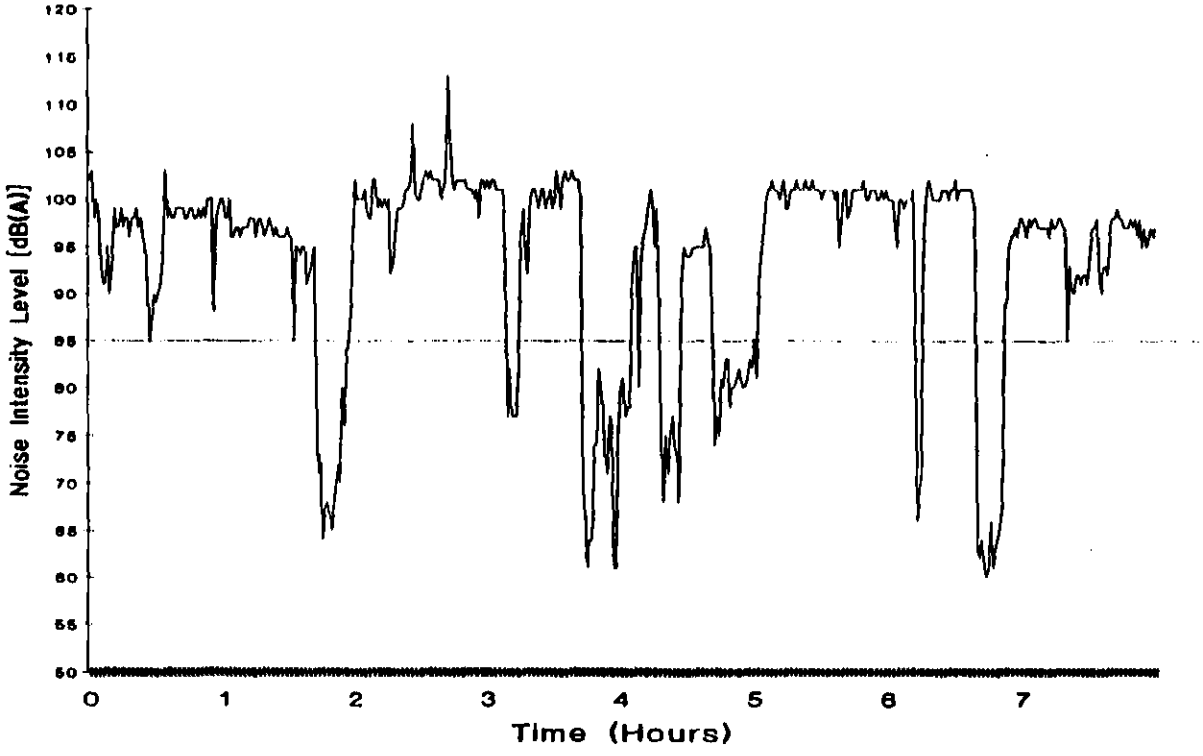


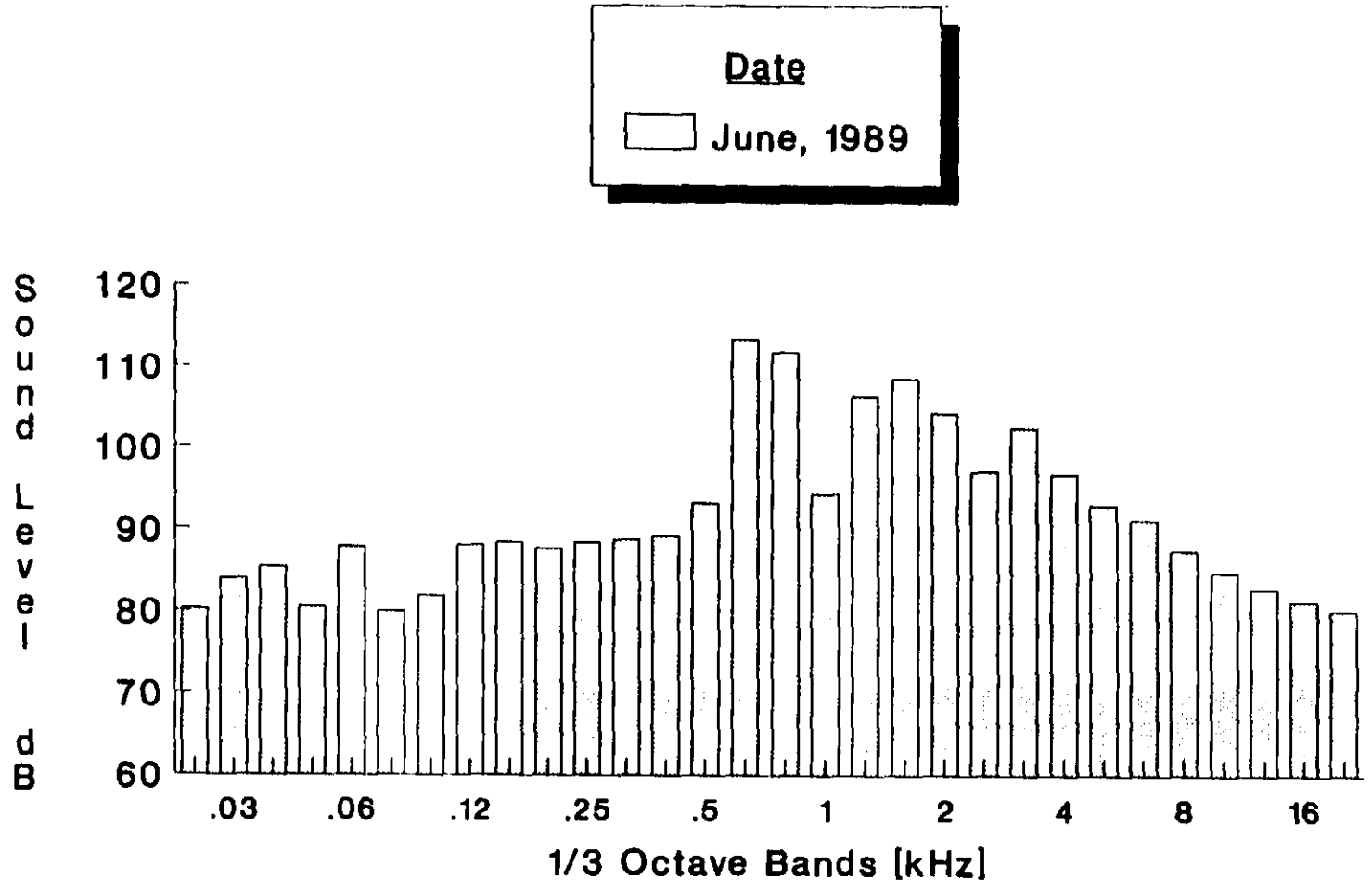
Figure 2

Unscrambler/Twin Resaw Operator
HETA 88-030
Neiman Saw Mills - Blacktail Mill
June 8, 1989



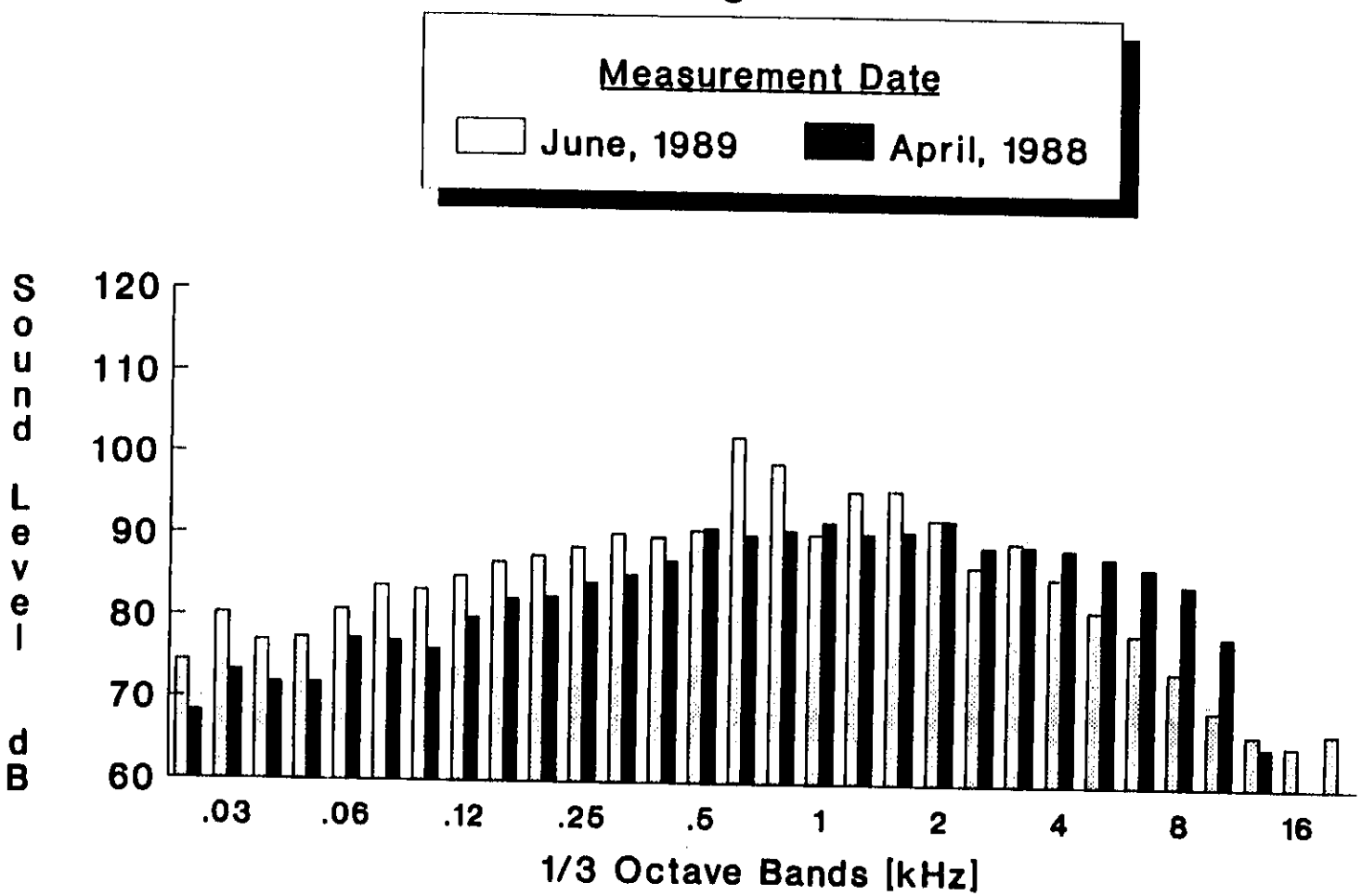
Inside New Planer Enclosure
Neiman Sawmills
HETA 88-030

Figure 3



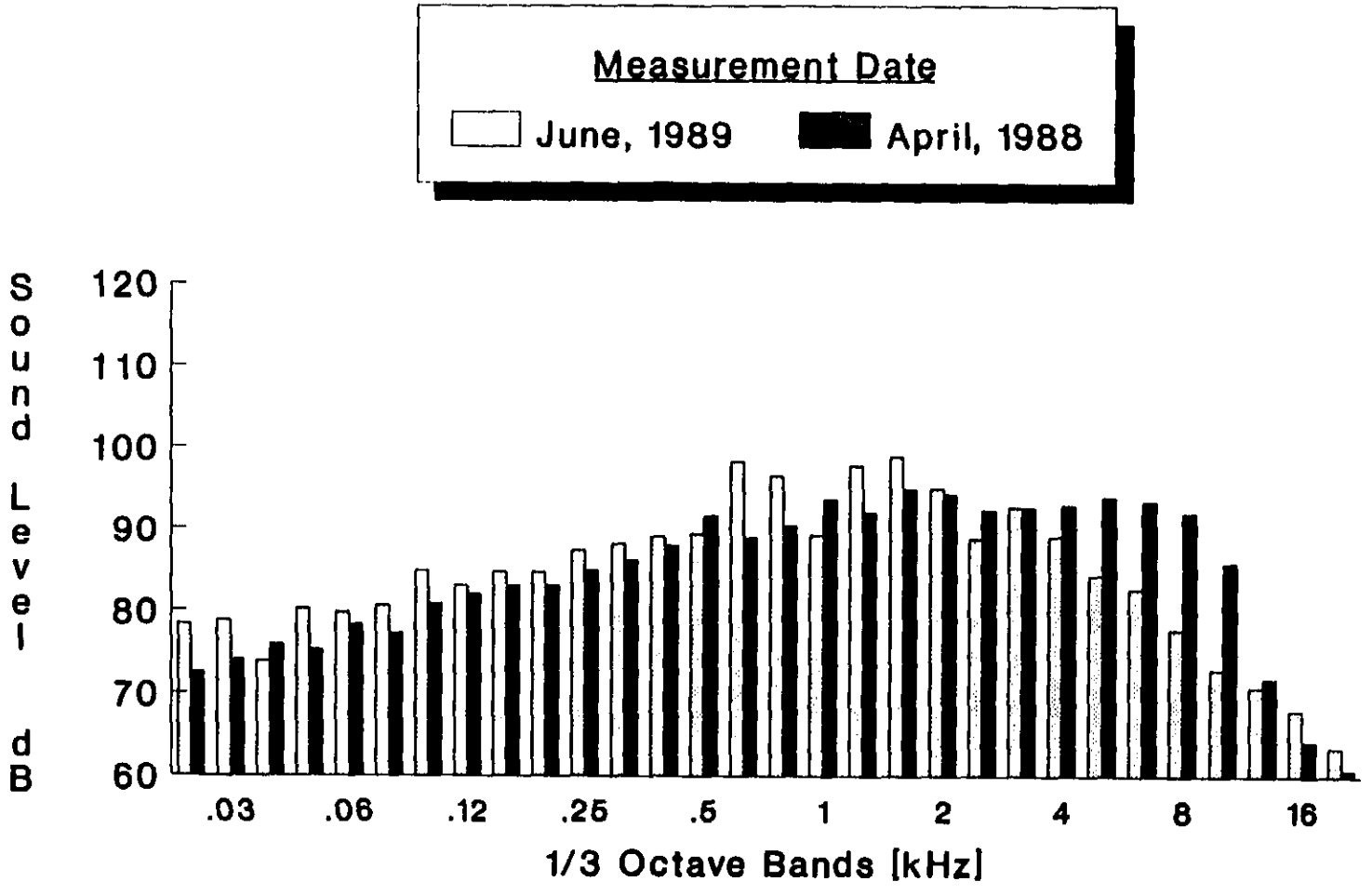
Planer Mill - Original Feeder Position
Neiman Sawmills
HETA 88-030

Figure 4



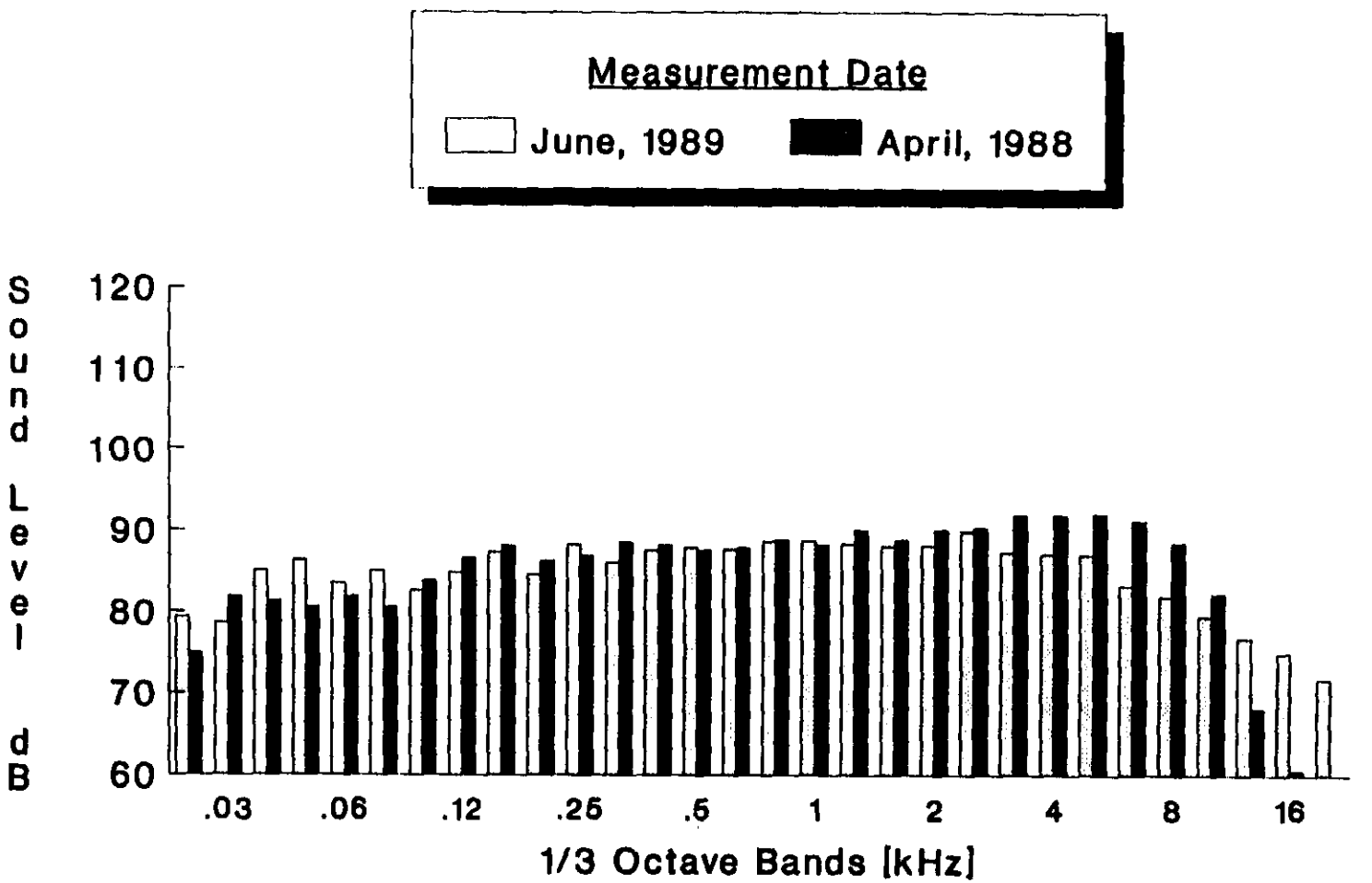
Planer Mill - New Feeder Position
Neiman Sawmills
HETA 88-030

Figure 5



Edger Operator
Neiman Sawmills
HETA 88-030

Figure 6



# Mean Hearing Levels by Age Groups
# Neiman Saw Mills
# HETA 88-030
# June, 1989

Figure 7