HETA 95-0167-2539
NOVEMBER 1995
THE WESTERN STATES MACHINE COMPANY
HAMILTON, OHIO

NIOSH INVESTIGATOR:
RANDY L. TUBBS, Ph.D.

I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a request from employees and from UAW Local 176 at The Western States Machine Company in Hamilton, Ohio, to conduct a health hazard evaluation (HHE) at the facility. The concern was worker noise exposure in the Main Building, particularly the noise associated with a recently installed air compressor. In the request, it was pointed out that a few employees had been identified as having hearing loss by a local hospital. The employees were concerned that the losses may be occupationally related.

On May 31, and June 1, 1995, a NIOSH investigator conducted a full-shift noise survey in the Main Building of the facility using noise dosimeters. Additional noise measurements were made with a real-time analyzer to determine the spectral content of specific noisy operations. A total of 26 full-shift noise dosimetry samples were collected over the two days. Nineteen of the 26 samples exceeded the NIOSH recommended exposure limit (REL) for noise. The spectral noise analysis revealed that the new air compressor did not contribute significantly to workers' noise exposures.

Based on the results of the noise data analyses and observations made during the evaluation, the NIOSH investigator concludes that a health hazard related to potential hearing loss exists for employees at The Western States Machine Company. A majority of the workers were exposed to time-weighted noise levels in excess of the NIOSH recommendation, while 35% of the sampled employees exceeded the OSHA action level which stipulates that a hearing conservation program needs to be implemented. Section IX of this health hazard evaluation report offers hearing conservation program recommendations toward reducing the noise exposures and preventing further hearing losses.

KEYWORDS: SIC 3559 (Special industry machinery, not elsewhere classified), industrial centrifugal equipment manufacture, noise exposure, noise dosimetry, hearing conservation.

II. INTRODUCTION

In February 1995 the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at The Western States Machine Company in Hamilton, Ohio, from employees and representatives of Local 176 of the United Auto Workers. The request concerned general noise exposures to employees working in the Main Building, and specifically, the noise emanating from an air compressor located in the Main Building. A few employees had recently received audiometric testing at a local hospital that identified some hearing loss. The requesters wanted NIOSH to investigate the occupational noise to which workers were exposed at The Western States Machine Company.

An opening conference and walk-through survey of the facility was held on April 20, 1995. Representatives of management, members of the health and safety committee, and a NIOSH investigator were in attendance at the meeting. During the meeting, it was noted that the air compressor in the Main Building was to be replaced by the end of May 1995. It was decided to postpone any noise testing until after replacement of the equipment. A plant-wide noise survey was conducted on May 31, and June 1, 1995, where personal noise dosimeter samples were collected from employees during the workshift. Area spectral noise samples of certain operations and equipment were also made. A closing conference where preliminary findings and recommendations were discussed was held on June 2, 1995, with the same individuals who were in attendance at the opening meeting.

III. BACKGROUND

The Western States Machine Company is a manufacturer of industrial centrifugal equipment. The Hamilton, Ohio, facility consists of two separate buildings, the Main Building and the Annex. Metal for the centrifugal is cut, machined, welded, and assembled at the plant which employs 68 production workers. Most employees work from 6:00 a.m. until 3:30 p.m. on the day shift, with a one-half hour lunch period. A few workers are on the afternoon shift.

NIOSH personnel had visited this plant on three separate occasions to investigate hazards associated with welding operations. One of the investigations resulted in the issuance of a final report.[1] The Division of Safety and Hygiene, Bureau of Workers' Compensation for the State of Ohio conducted a limited noise survey in the Main Building in January 1995 that identified a possible hazard from noise exposure and recommended that the company's plan to replace an existing air compressor should continue. The

report also recommended that a plant-wide noise survey be conducted to identify employees who should be included in a hearing conservation program. No formal hearing conservation program was in effect at the time of this NIOSH evaluation; however, employees were able to obtain hearing protection devices from the company if they desired to wear them.

IV. MATERIALS AND METHODS

A two-day noise survey was conducted at The Western States Machine Company, following the installation of a new air compressor. During the walk-through survey in the Annex Building, none of the employees interviewed by the NIOSH investigator noted that noise was a problem in this building. Therefore, noise samples were taken only in the Main Building where metal cutting operations, milling, welding, grinding, assembly, and product shipment took place. Both personal, full-shift noise exposures and area spectral noise samples were obtained on the two days.

To continuously monitor noise exposures, Quest® Electronics Model M-27 Noise Logging Dosimeters were worn by employees during the work shift. The dosimeters were attached to the employee's belt and a small remote microphone was fastened to the work uniform (facing forward) at a mid-point between the ear and the outside of the employee's shoulder. The dosimeters were worn for the entire work day, including the employees' breaks and the lunch period, if the employee remained at the facility. For those few employees who left work for lunch, the dosimeter was removed and paused during lunch and then replaced as soon as the worker returned. At the end of the workshift, the dosimeters were removed and paused to stop data collection. The information was downloaded to a personal computer with Quest® Electronics Metrosoft computer software for interpretation. The dosimeters were calibrated before and after the workshift according to the manufacturer's instructions.

Real-time area noise sampling was conducted with a Larson-Davis Laboratory Model 2800 Real-Time Analyzer. The analyzer allows for the analysis of noise into its spectral components in a real-time mode. One-third octave bands over the audible frequency spectrum were sampled near the new air compressor in order to view the frequency components of the noise impacting workers in the area. Also, a one-third octave band frequency spectrum of a grinding operation on the Basket Floor area was made after several employees commented on the loudness of this operation.

V. EVALUATION CRITERIA

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]

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 dBA, 10 dBA, and 20 dBA 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 Occupational Safety and Health Administration (OSHA) standard for occupational exposure to noise (29 CFR 1910.95)[4] specifies a maximum permissible exposure limit (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. NIOSH, in its Criteria for a Recommended Standard,[5]

proposed a recommended exposure limit (REL) of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard. The NIOSH 1972 criteria document also used a 5 dB time/intensity trading relationship in calculating exposure limits. However, in 1995, NIOSH changed its official recommendation for an exchange rate of 5 dB to 3 dB.[6] The American Conference of Governmental Industrial Hygienists (ACGIH) also changed its Threshold Limit Value (TLV) in 1994 to a more protective 85 dB(A) for an 8-hour exposure, with the stipulation that a 3 dB exchange rate be used to calculate time-varying noise exposures.[7] 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.

The duration and sound level intensities can be combined in order to calculate a worker's daily noise dose according to the formula:

$$\text{Dose} = 100 \text{ X } (C_1/T_1 + C_2/T_2 + ... + C_n/T_n),$$

where C_n indicates the total time of exposure at a specific noise level and T_n indicates the reference duration for that level as given in Table G-16a of the OSHA noise regulation.[4] 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 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. However, in 1983, a compliance memorandum (CPL 2-2.35) directed OSHA compliance officers not to cite employers for lack of engineering controls until workers' TWA levels exceed 100 dB(A), so long as the company has an effective hearing conservation program in place. Even in TWA levels in excess of 100 dB(A), compliance officers are to use their discretion in issuing fines for lack of engineering controls.

VI. RESULTS

Personal noise dosimetry was conducted for two full day-shifts on May 31, and June 1, 1995, on 12 employees the first day and on 14 employees the second day. The dosimeters used in the survey simultaneously record noise data according to a 5-dB exchange rate (L_{OSHA}) and a 3-dB exchange rate (L_{eq}) so that the different evaluation criteria can be compared to the data collected from each employee. The L_{OSHA} data presented in Table 1 use the 80-dB threshold that is stipulated for the hearing conservation regulations.[4]

Table 1
Noise Dosimeter Results
HETA 95-0167
The Western States Machine Company
Hamilton, Ohio

WORK AREA	# SAMPLES	MEDIAN % DOSE	MEDIAN L_{OSHA}	MEDIAN L_{eq}
Balance Machine	2	49	84.8	87.8
Basket Floor	2	150	88.5	93.4
Boring Mill - Main Bay	4	39	83.1	84.6
Crating	4	30	81.2	86.8
Fitting Floor	8	44	84.2	87.4
Inspection	1	5	67.8	77.7
Welding	5	62	86.6	90.8

The median personal noise exposure data are near or above the OSHA action level of 85 dB(A) for the employees on the balance machine, basket floor, fitting floor, and in the welding department. When the individual dosimeter results are compared to the evaluation criteria, 35% (9/26) of the noise samples exceeded the OSHA action level, 8% (2/26) were greater than the OSHA PEL, and 73% (19/26) surpassed the NIOSH REL.

All of the workers' noise exposures seem to depend on the type of task in which the employee was engaged and/or the type of tool the worker was using. Quite often, the use of pneumatic hand tools was associated with higher noise exposures to the employee. Several examples of this finding are presented in Figures 1 - 4. The employee on the Basket Floor was involved in grinding welded seams with a pneumatic grinder in the morning and early afternoon of June 1. The grinding activities can be seen in Figure 1 as episodes of noise that exceed 100 dB(A). The lower noise seen in the May 31 dosimeter readout is related to the fact that no grinding occurred during the sampling period. The two dosimeter readouts from the employee in the Welding Department (Figure 2) reflect more welding, chipping, and grinding being conducted on May 31 as opposed to June 1. Employee #1 on the Fitting Floor (Figure 3) used a pneumatic sander (small hand-held belt sander) on the first day of sampling and a small pneumatic grinder on the second day. The grinder was the noisier of the two tools, which is reflected in the June 1 data where a large portion of workshift is at noise levels above 90 dB(A). Finally, employee #2 did not use pneumatic tools much on May 31, but was required to use these tools on the second day. Higher noise levels are clearly seen in the June 1 dosimeter readout (Figure 4).

One of the noisiest activities, the grinding of the welded seam in the Basket Floor area, was investigated further by analyzing the spectral content of the noise with the real-time analyzer. The results of this analysis are shown in Figure 5. The one-third octave band display of these data show energy peaks at and near the 250 Hz band. Also, sound levels near 90 dB are observed for the higher frequencies, 1 kHz and above. These high frequency sounds are potentially more damaging to hearing. Throughout the period of grinding on the basket, the employee doing the grinding wore hearing protection as well as other personal protective equipment. However, other employees in the same room were observed not wearing any hearing protective devices while grinding took place.

The original area of complaint in the evaluation was the Fitting Floor area near the air compressor. The earlier report from the State of Ohio's Bureau of Workers' Compensation stated that the previous air compressor did not contribute significantly to the workers' overall noise exposures, but was irritating to employees because of its high-frequency noise component. The spectral analysis of the new air compressor (Figure 6) revealed an overall noise level of 78.0 dB(A) when the compressor was operating during the lunch period and no other equipment was in operation. The maximum noise energy is at 125 Hz. The higher sound frequencies are appreciably lower than the maximum level, with levels 10-20 dB below the maximum sound energy. The reduction of high frequency noise should lower the irritation factor that employees experience in the vicinity of the compressor. Informal interviews with workers in the area confirmed that the new air compressor is no longer an annoyance to them.

An unrelated concern expressed in the request for an HHE involved the use of cutting fluids in the Annex Building. During the walk-through survey of the facility, the air in the Annex Building did not appear to have gross visible contamination in the form of smoke or haze. The NIOSH investigator did request that copies of the Material Safety Data Sheet (MSDS) for the cutting fluids in use in the building be sent to NIOSH for further review. Two MSDS were received, one for Safety-Cool® 800 from Castrol Industries, Inc. and TRIM®SOL from the Master Chemical Corporation. Both products have petroleum oils or petroleum distillates as their major component, accounting for 30-40% of the material. The MSDS for both products note that the material is to be regulated according to OSHA as an oil mist with a PEL of 5 milligrams per cubic meter of air (mg/m^3).

VII. DISCUSSION

The personal noise exposures measured at The Western States Machine Company during the HHE were observed to be near the action level for noise as regulated by OSHA. On the two days of the survey, 35% of the sampled workers were observed to have TWA exposures greater than 85 dB(A). An additional 35% were also found to have full-shift noise exposures between 80 and 85 dB(A). Most employees reported that their workshifts were fairly normal, with no or few unusually loud events. Thirteen of 68 production employees were absent from work on the first survey day and 7 were missing on the second, so that it can be considered that the facility was near normal work capacity. As was mentioned earlier in the report, it is believed that the type of assigned task and the type of tool used by the employee influences the daily noise dose. It is not unreasonable to expect that some of the 80 to

85 dB(A) TWA exposures could be above 85 dB(A) when the noisier jobs are done or the louder tools are used by the workers in the normal course of their job.

Many of the pneumatic hand tools used by employees of The Western States Machine Company are of an older design with mufflers that are not as effective as some of the newer models on the market. Also, as tools get older, they tend to get louder due to worn bearings and bent shafts and other normal wear and tear on the tool through repeated use. Management officials at The Western States Machine Company are aware of this situation and are actively pursuing pneumatic tool manufacturers who offer quieter designs.

Hearing protection devices (HPDs) are offered to employees who wish to wear them. However, many employees were observed not wearing protection during the NIOSH evaluation. An exception to this observation was some of the employees performing noisy tasks which involved pneumatic tools; they did use HPDs when performing the loud work. Unfortunately, workers in the immediate vicinity of the loud activity were observed without protection. It was also noted during the survey that the company had issued a pair of ear muffs to an employee that was not appropriate for the noise environment at the facility. The ear muffs were developed for impulsive noise environments, e.g., gun fire noise, and not for steady-state noise.

VIII. CONCLUSIONS

The majority of the employees in the production areas of The Western States Machine Company were found to have noise exposures that exceed the NIOSH REL of 85 dB(A). Nineteen of the 26 sampled employees had noise levels greater than the criterion. Additionally, 35% of the workers (9 of 26) were measured with noise exposures that exceeded the OSHA action level for hearing conservation requirements. Thus, it is concluded that a potential for exposure to hazardous noise levels exists at this company.

The attempt by The Western States Machine Company to reduce noise in the facility by replacement of the air compressor was a successful venture. The measured sound levels emitted by the compressor barely exceeded the background noise produced by other machines and equipment in the area. This resulted in the feeling of employees that the air compressor could not be heard any longer over the noise produced by other operations.

The cutting fluids in use in the Annex Building do not appear to pose a health hazard for employees as long as they are used correctly and do not become contaminated by bacterial growth. Research in the use of cutting fluids has shown that they may become contaminated if left untreated for long periods of time and that the improper addition of biocides to prevent biological contamination may pose more of a health hazard than the fluids themselves.[8-11]

IX. RECOMMENDATIONS

Because of the sample results obtained at The Western States Machine Company as well as the observations made by the NIOSH investigator during the survey, the following recommendations are made to reduce employees' exposure to hazardous noise at the facility and to improve working conditions.

1. A hearing conservation program should be instituted at The Western States Machine Company to reduce exposure to hazardous noise for its employees. At a minimum, the specifics of the program should meet the requirements stipulated in the OSHA noise regulation, including audiometric testing, employee notification, noise measurement, use of HPDs, employee training, and record keeping. The NIOSH technical report, "A practical guide to effective hearing conservation programs in the workplace," has been furnished to management and union personnel at the company to be used as a guide in implementing the program.[12]

2. Detailed observations of the various work tasks performed in the facility should be made to determine those tasks that produce hazardous noise. Noise measurements of the identified activities should be made to verify that the noise is potentially hazardous. Once identified, the employees should be instructed that hearing protection is necessary whenever the work is undertaken. The observations also should take into account the noise exposures to adjacent workers who also may need to be protected whenever the task is performed. If several employees are impacted by the activity of one worker, then engineering controls which isolate the activity should be considered, such as barriers and acoustic-isolation booths.

3. The ear muff which was seen being used by the employee at the balance machine should be replaced with a muff more appropriate for a steady-state noise environment. Consultation with the company who made the muff currently in use should direct management to a HPD that is better suited for the employee. Additionally, a preventive maintenance program for ear muffs used by employees that looks at the cup seals and tension of the headbands to replace defective components should be implemented.

4. The practice of replacing noisy tools and equipment with quieter models should be continued by management at The Western States Machine Company. The replacement of the air compressor was seen by interviewed employees as a success. The pursuit of finding pneumatic hand tools that produce less noise should also be accepted by the employees who use these tools. This replacement practice will eventually reduce the number of tasks where workers will be required to wear HPDs in the performance of certain jobs.

X. REFERENCES

1. Crandall MS [1984]. Health hazard evaluation: The Western States Machine Co., Hamilton, Ohio. HHE Report No. 83-095-1484. National Institute for Occupational Safety and Health, Cincinnati, Ohio.

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

4. Code of Federal Regulations [1992]. 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. Niemeier RW [1995]. Memorandum of April 13, 1995, from R.W. Niemeier, Division of Standards Development and Technology Transfer, to NIOSH Division Directors, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Public Health Service, U.S. Department of Health and Human Services, 1995.

7. ACGIH [1995]. 1995-1996 threshold limit values (TLVs™) for chemical substances and physical agents and biological exposure indices (BEIs™). Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

8. Burgess WA [1995]. Recognition of health hazards in industry. 2nd ed. Chapter 9: Conventional metal machining practice. New York: John Wiley & Sons, pp. 140-166.

9. Olenchock SA [1994]. Health effects of biological agents: The role of endotoxins. Applied Occupational and Environmental Hygiene, 9(1): 62-64.

10. Cohen S, Sarer J [1984]. Health hazard evaluation: Torrington Co., Torrington, Connecticut. HHE Report No. 82-107-1444. National Institute for Occupational Safety and Health, Cincinnati, Ohio.

11. Rossmoore HW [1981]. Antimicrobial agents for water-based metalworking fluids. Journal of Occupational Medicine, 23(4): 247-254.

12. Suter AH, Franks JR [1990]. A practical guide to effective hearing conservation programs in the workplace. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 90-120.

XI. INVESTIGATORS AND ACKNOWLEDGMENTS

Investigator:	Randy L. Tubbs, Ph.D. Psychoacoustician Industrial Hygiene Section Hazard Evaluations and Technical Assistance Branch
Report Typed By:	Kate L. Marlow Office Automation Assistant Industrial Hygiene Section
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies

XII. DISTRIBUTION AND AVAILABILITY

Copies of this report may be freely reproduced and are not copyrighted. Single copies of this report will be available for a period of three years after the date of this report from the NIOSH Publications Office, 4676 Columbia Parkway, Cincinnati, OH 45226. To expedite your request, include a self-addressed mailing label along with your written request. After this time, copies may be purchased from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Requester
2. Employee Relations Manager
   The Western States Machine Company
3. President, UAW Local #176
4. OSHA, Region V

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.