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Hegerle, Jason T. ***An Analysis of Noise Exposures and Hearing Conservation Program Practices at Company XYZ's Upper Midwest Hot-Mix Asphalt Plant***

Abstract

An investigative study was conducted to research and quantify occupational noise exposure levels at Company XYZ's upper Midwest hot-mix asphalt plant. Company XYZ's hearing conservation program and practices were also assessed to determine the adequacy of current procedures to protect employee hearing. An Extech sound meter was utilized to measure sound levels produced at specific locations throughout the plant and 3M Edge dosimeters were used to measure the cumulative sound levels that each worker was exposed to during the study. Area sound levels which were collected throughout the plant ranged from 68.8 to a peak of 105.3 decibels on the A scale (dBA). Eight-hour time-weighted average exposure sound level for the monitored workers ranged from 61.6 to 89.9 dBA. This data demonstrates that the plant generates hazardous noises levels that with repeated exposure, may contribute to noise-induced hearing loss. An examination Company XYZ's written hearing conservation program confirmed that it was compliant with the requirements set by OSHA's hearing protection regulations, however, the implementation of the program at the upper Midwest hot-mix asphalt plant was deficient. Recommendations to Company XYZ included performing routine employee hearing conservation training, involving elevated noise exposure employees in initial and annual audiometric exams, to assess the effectiveness of hearing conservation devices to attenuate hazardous noise levels and to require all employees to wear hearing protection while they are working outside of control rooms and loader cabs.

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Chapter I: Introduction and Problem Statement

Occupational noise-induced hearing loss is among the most common work-related illnesses in the U.S., which affects approximately 22 million U.S. workers each year (Tak et al., 2009). While a sudden burst of a loud noise is hazardous to hearing, noise-induced hearing loss is commonly associated with prolonged exposes to loud sound (Hammond, 2016). Most occupational hearing losses occur gradually over time and the associated workers are unaware that their ability to hear is degenerating until the loss spreads into frequencies which are needed to perceive speech (National Institute for Occupational Safety and Health [NIOSH], 2010). Historically, noise-induced hearing loss was not covered by worker compensation statues because hearing loss did not affect employees' ability to work and therefore, resulted in no lost time wages (Suter, 1993). After the 1940s, occupational noise-induced hearing loss was covered under worker compensation and this shift in coverage influenced the development of hearing conservation programs (Suter, 1993). Today, the U.S. government regulates occupational noise exposure under the Occupational Safety and Health Administration (OSHA) regulations. Although noise-induced hearing loss is widely recognized there is still a lack of urgency to protect against noise-induced hearing loss because the occupational disease produces no visible effects and generally occurs without pain (NIOSH, 1996).

Company XYZ is a construction materials and asphalt paving organization that is located in the midwestern U.S. and employs approximately 500 employees across five offices and ten hot-mix asphalt plants. The organization's primary product, which is used internally and sold externally, is hot-mix asphalt. After purchasing another business, Company XYZ acquired an old hot-mix asphalt plant in the upper Midwest and retained the existing workers of this facility. While this upper-midwestern plant is functional, it is older than the other hot-mix asphalt plants

that are operated by Company XYZ. It was apparent that this upper Midwest hot-mix asphalt plant is louder than modern hot-mix asphalt plants, however, sound level samples were never collected at this facility. Although the plant workers wear hearing protection, a portion of workers appear to suffer from hearing loss however, no employees filed worker compensation claims for hearing loss thus far. The previous plant owner did not implement a hearing conservation plan and consequently, the workers lacked an established hearing baseline. Thus, a failure to perform noise monitoring at Company XYZ's upper-midwestern asphalt plant may exceed OSHA's permissible exposure limit and lead to an increase in noise-induced hearing loss and related employer worker compensation claims.

Purpose of the Study

The purpose of the study was to conduct a noise-based risk assessment at Company XYZ's hot-mix asphalt plant.

Goals of the Study

The goals of the study were to:

- Conduct area noise sampling of the hot-mix asphalt plant to identify and measure hazardous noise sources.
- Monitor employees' exposures to hazardous levels of noise during a routine shift.
- Assess Company XYZ's hearing protection policy and plant-related practices to evaluate the effectiveness against hazardous levels of noise.

Background and Significance

Company XYZ's health and safety policy strives to promote the existence of a reduced-risk work environment in order to benefit employees and to prevent the occurrence of occupational injury. The company established an accident prevention program to encourage the

development of safety practices that exceed compliance with state and federal health and safety regulations in order to prevent safety and health issues. Company XYZ requires the use of hearing protection when employees are exposed to elevated or injurious noise levels over an extended period of time. However, Company XYZ has not conducted noise monitoring at its upper Midwest hot-mix plant and therefore has insufficient evidence to support the level of hearing protection that is required to properly protect the respective employees.

Hazardous occupational noise is a concern for Company XYZ because hot-mix asphalt plants operate up to 24-hours a day and employees work up to 14 hours a shift. Exposures to hazardous levels of noise produced by the upper Midwest hot-mix asphalt plant may result in employee noise-induced hearing loss. Employees with hearing loss may experience job restrictions, a reduction in productivity, a lower standard of living and a potential for additional workers compensation claims. This research intends to gather data that will assess sound levels produced within the upper Midwest plant and determine if any action is required to correct and thus protect employees from hazardous noise exposures.

Assumptions of the Study

The study was conducted under the assumption that weather conditions present during the study will not significantly affect the collected noise data.

Definition of Terms

The following is list of terms defined as they apply to occupational noise exposures.

Decibel (dB). A unit used to express sound-power level and sound-pressure level (Plog et al., 1996).

Decibel (dBA). Sound level in decibels read on the a-scale of a sound level meter. The A scale discriminates against low frequencies similar to the function of the human ear (Plog et al., 1996).

Frequency. The rate of pressure oscillations produced, measured in hertz (Plog et al., 1996).

General industry. A term OSHA uses to refer to industries that are not agriculture, construction or maritime (OSHA, n.d.-b).

Hearing conservation. The use of hearing protector devices, minimizing exposure to noise through the use of engineering controls, evaluating employees' ability to hear and educating workers on the consequences of occupational noise-exposures to prevent noise-induced hearing loss (Plog et al., 1996, p. 953).

Hertz (Hz). A unit that measures the number of pressure variation cycles per second (Plog et al., 1996).

National Institute for Occupational Health (NIOSH). A research agency focused on the study of worker health and safety to promote safe and health workplaces (NIOSH, n.d.).

Noise-induced hearing loss. Slowly progressive hearing loss resulting from exposure to continuous noise over a long period of time (Plog et al., 1996, p. 964).

Occupational Safety and Health Act of 1970. A U.S. labor law to ensure worker and workplace safety. This law is to hold employers accountable for providing work environments free from recognized safety and health hazards (Occupational Safety and Health Act of 1970).

Occupational Safety and Health Administration (OSHA). In addition to the Occupational Safety and Health Act of 1970, Congress created OSHA to set and enforce

occupational safety and health standards and provide training, outreach, education and assistance (OSHA, n.d.-a).

Permissible exposure limit. The time-weighted average threshold limits a person working an eight-hour shift can be exposed to. (OSHA, 1970)

Worker compensation insurance. Insurance that covers payment of workers compensation that the employer must provide to employees who are occupationally disabled due to a work-related accident or illness (Rejda, 2011, p. 705).

Limitations of the Study

The study was conducted under the following limitations:

- Noise monitoring results would be subject to the specific production demands and schedule at the time of noise monitoring.
- Equipment and tasks which are required for normal production demands were measured for noise exposures. Non-routine tasks were measured as such became apparent to the researcher.

IRB-Approved Methodology

This section will discuss subject selection and description, the instrumentation, data collection procedures, and data analysis.

Subject Selection and Description

This study was conducted to determine the extent of occupational noise that Company XYZ hot-mix asphalt plant workers are exposed to during a full work shift. Three workers are typically on duty during facility operation and include a plant operator, a general laborer and a loader operator. The plant operator functions operational controls from a control room located on-site. The plant laborer works on the ground to grease equipment, clean up spilled materials

and perform other daily maintenance tasks. The loader operator spends a majority of the shift in the loader machine to fill bins with various aggregates and recycled asphalt product. During this study, there was a second loader operator tasked with loading dump trucks with gravel to be transported away from the plant.

Instrumentation

To identify hazardous levels of noise exposure levels at Company XYZ's hot-mix asphalt plant, an Extech sound meter serial number Z376261 was used to spot-check sound levels at chosen hearing zone points throughout the plant. In additional to area sound sampling, 3M Edge noise dosimeters serial numbers ESP080140, ESP080141, ESP080142 and ESP080143, were used utilized to sample sound exposure levels for all of the workers throughout their shift. The 3M Edge noise dosimeters are small devices with a mounted microphone to measure and collect sound levels surrounding the wearer. The microphone of each dosimeter was clipped to a subject on the shoulder to be close to the subject's hearing zone. The dosimeters were set to measure sound according OSHA's occupational noise exposure standard, which uses an exchange rate of five dB, the frequency rating in the A range, slow response, a criterion level of 90 dB and a threshold of 90 dBA. An Extech sound calibrator serial number Z376260 was used to calibrate the sound meter and a 3M AC-300 sound calibrator was used to calibrate the sound dosimeters before and immediately following the sound sampling to ensure accurate results per the manufacture's guidelines.

Data Collection Procedures

Sound sampling of the hot-mix asphalt plant and the workers utilizing the calibrated sound meter and dosimeters was conducted over the period of a ten-hour shift. Area sound sampling occurred during the plant's largest production rate of approximately 300 tons of asphalt

per hour. The sound meter was calibrated after the data was collected at the conclusion of the sound sampling session. The dosimeters were collected from the workers and were also immediately calibrated to verify accurate results. Results of the sound sampling was recorded manually on the Company XYZ Noise Monitoring Data Collection Form found in Appendix A.

To determine the effectiveness of current occupational noise safety policies and practices, various forms of documentation regarding the hearing conservation practices which are utilized by Company XYZ were collected. Company XYZ produced documents containing written policies, general practices, training records and utilized forms of personal protective equipment required by employees to mitigate occupational noise exposures at the hot-mix asphalt plant. These documents and the results of the sound sampling conducted during this study were compared against OSHA's occupational noise exposure standard to determine if current policies and practices provide adequate protection from occupational noise.

Data Analysis

Sound level data collected from the area sound sampling and local sound sampling was compared against OSHA's occupational noise exposure standard to identify sources of hazardous noise exposures and areas of non-compliance. Documentation provided by Company XYZ was reviewed for compliance with OSHA's hearing conservation program and recordkeeping requirements.

Chapter II: Results and Discussion

Company XYZ operates a hot-mix asphalt plant that could expose workers to excessive levels of occupational noise. Therefore, the purpose of this study was to identify and evaluate the occupational noise exposures at Company XYZ's hot-mix asphalt plant and determine the controls that are needed to mitigate potential noise-related exposures. The goals of the study were to:

- Conduct area noise sampling of the hot-mix asphalt plant to identify and measure hazardous noise sources
- Monitor employee's exposures to hazardous levels of noise during routine tasks
- Assess Company XYZ's hearing protection policy and practices to evaluate its effectiveness against hazardous levels of noise

The remainder of this chapter presents the results of the data that was collected and discusses the findings as it relates to the purpose and goals of the study.

Area Sound Sampling

The area sound sampling was conducted with an Extech sound meter to measure noise levels at specific locations throughout the hot-mix asphalt plant. The area noise sampling data is summarized below in Table 1.

Table 1

HMA Plant Area Sound Sampling with an Extech Sound Meter

Plant Location	Sample 1 (dBA)	Sample 2 (dBA)	Sample 3 (dBA)	Range (dBA)
Aggregate Shaker	94.7	92.2	93.3	92.2 – 94.7
Bag House	82.1	87.6	83.2	82.1 – 87.6
Blower	98.4	104.2	99.8	98.4 – 104.2
Burner	94.4	94.6	95.9	94.4 – 95.6
Generator Trailer	105.3	105.3	100.8	100.8 – 105.3
Lab Trailer	68.9	71.2	68.8	68.8 – 71.2
Oil Heater	88.0	88.0	84.0	84.0 – 88.0
Silos	85.6	85.9	83.2	83.2 – 85.9
Silos (dumping)	99.1	100.8	98.4	99.1 – 100.8

The collected area noise levels indicate that the loudest location during the operation of the hot-mix asphalt plant is within the generator trailer which yielded a peak of 105.3 dBA. Located near the asphalt drum, the burner and blower sound levels were recorded at a peak of 95.9 dBA and 104.2 dBA respectively. The sound level of the measured aggregate shaker was recorded at a peak of 94.7 dBA. The area alongside the baghouse recorded sound levels of a peak of 87.6 dBA. The oil heater sound level was recorded as a peak of 88.0 dBA, but the sound level fluctuates depending on if the heater is heating oil or maintaining the oil's temperature. The sound levels at the asphalt silos were recorded at a peak of 85.9 dBA and then increased while dumping asphalt to a peak of 100.8 dBA. The sound levels recorded in the lab trailer peaked at 71.2 dBA and thus is the lowest sound level recorded throughout the facility.

Personal Dosimetry

The employee exposure data collection process was conducted utilizing 3M Edge dosimeters which were attached to four individuals who worked within the hot-mix asphalt plant.

These four workers included the plant operator, a laborer, and two loader operators. The dosimeters measured cumulative sound levels that each worker was exposed to during the shift and thus provided a time-weighted average. The personal sound level sampling data is summarized below in Table 2.

Table 2

HMA Plant Worker Personal Sound Sampling with 3M Edge Noise Dosimeters

Worker Position	Time Measured (HH:MM)	Time-Weighted Average (dBA)	Peak Sound Level (dBA)
Plant Operator	10:22	79.2	100.4
Plant Laborer	9:36	89.9	104.9
Loader Operator #1	9:53	61.6	84.5
Loader Operator #2	9:47	69.6	95.3

The plant laborer spends a majority of the shift on the ground level to conduct maintenance of the equipment and therefore exposes this employee to noise that is produced by the associated machinery. The dosimetry sampling indicated that the worker with the greatest noise exposure was the plant laborer with a full-shift time-weighted average of 89.9 dBA. The plant operator spends a majority of the shift within the control room and thus is isolated from the plant-produced noise. However, the plant operator must periodically inspect the plant, assist the laborer and conduct various tasks outside of the control room. The plant operator's time-weighted average noise exposure was 79.2 dBA for the 622-minute work-shift. The two loader operators remained in their equipment for a majority of their shift and thus were isolated from the noise which was produced by the plant. The loader operators experienced time-weighted average noise exposures of 61.6 and 69.6 dBA. The lower measured time-weighted average, (i.e. 61.6 dBA) involved the operation of a 2013 CAT 972 K loader which was tasked with loading

aggregate bins throughout the plant. The higher measured time-weighted average (i.e. 69.6 dBA) involved the operation of a 2006 CAT 966 H loader which was loading trucks with gravel to be hauled off-site.

Policy and Practices

An analysis of company XYZ's hearing conservation program indicated that such aligns with the requirements set by OSHA's 29 CFR 1910.95 standard. The hearing conservation program applies to operations which produce employee noise exposures in excess of 85 dBA time-weighted average for eight hours. Sound level surveys are to be conducted in areas that are suspected to contain hazardous levels of noise or upon request by an employee. Area sound level measurements and individual noise exposures are to be measured using noise dosimeters which have been calibrated to the respective manufacturer's specifications. Sound surveys need to be conducted when changes in a work environment have occurred and all affected employees must be notified in writing within 15 days of determining that an eight-hour time-weighted average exposure exceeds the action level of 85 dBA.

Company XYZ's hearing conservation program indicates that employees need to be trained on the effects of noise on hearing ability. The employee training must be conducted within 30 days of enrollment in the hearing conservation program and refresher training needs to occur annually. Employees must be trained on the purpose of hearing protection, including the advantages and disadvantages of various hearing protectors, instruction on selection, fit, and use of hearing protectors, and the workers' responsibility to maintain hearing protectors. In addition, employees must be trained on the purpose of audiometric testing, the process of exam administration and interpretation of the results of the test.

From a medical surveillance standpoint, Company XYZ's hearing conservation program indicates that a baseline audiometric test and an annual audiogram must occur when an employee is enrolled into the hearing conservation program. Employees who receive an audiogram during the workday must wear hearing protectors prior to the audiometric test. Employees are encouraged to avoid loud non-work-related activities 14 hours prior to the audiometric exam. If a standard threshold shift occurs for an employee, the individual must be retrained, evaluated in his/her fit and use of hearing protectors, and provided with hearing protection which offers greater protection if necessary. If a follow-up audiometric exam occurs, the employee must be informed if the results of the audiometric exam indicate whether or not his/her standard threshold shift is permanent.

Company XYZ's administrative follow-up measures indicate that all noise levels and monitoring measurement records for each operation that falls under the hearing conservation program must be documented and retained on file for two years. The contractor that conducts the audiometric exams must provide the employee test results. The complete records of the results of audiometric exams for affected employees must be retained on file. Hearing conservation training documentation requires complete records of the associated participants and must be retained on file for a minimum of three years.

With regard to its ability to follow the established policies and procedures, Company XYZ has not conducted noise monitoring at its upper Midwest hot-mix plant and therefore lacks evidence to support the level of hearing protection required to properly protect the respective employees. Due to the suspected elevated levels of hazardous noise, plant employees wear company-supplied Honeywell Howard Leight Lase Lite® ear plug hearing protectors. Honeywell Howard Leight Lase Lite® ear plug hearing protectors provide a noise reduction

rating of 32 dB when worn properly. The four workers observed during this study donned these hearing protectors whenever they were preforming work outside of the control room. Initial hearing protection training, including the use of hearing protectors, was performed during each worker's new employee orientation training, but annual training documentation was not identified during this study. Company XYZ has not performed baseline or annual audiometric exams for the workers at its upper Midwest hot-mix plant thus far. Given the fore-mentioned analysis of Company XYZ's hearing conservation policy in relation to the organization's actual practices and the area as well as personal noise sampling results, there is evidence that one or more of the hot-mix plant employees are at risk of incurring a certain level of hearing loss and thus a standard threshold shift in their hearing abilities.

Chapter III: Conclusions and Recommendations

The purpose of this study was to identify, quantify, and evaluate the occupational noise exposures at Company XYZ's upper-Midwest hot-mix asphalt plant. To accomplish this purpose, goals were established and included conducting area noise sampling of the hot-mix asphalt plant to identify and measure hazardous noise sources, measuring workers' exposures to hazardous levels of noise during a typical work shift, and assess Company XYZ's hearing protection policy and practices to evaluate the effectiveness against hazardous levels of occupational noise and thus compliance with applicable OSHA standards. The exposure assessment goals were achieved by utilizing an Extech sound meter to measure sound levels at specific locations throughout the hot-mix asphalt plant as well as equipping workers with 3M Edge dosimeters to measure their eight-hour time-weighted average exposures to occupational noise. In addition, the researcher reviewed Company XYZ's hearing protection policies in relation to applicable OSHA standards as well as observed practices. The data obtained was used to determine the necessary actions to correct and thus further protect employees from hazardous occupational noise exposures.

Conclusions

The following conclusions were drawn from the results of the study:

- Company XYZ's upper Midwest hot-mix asphalt plant generates hazardous noises levels that with repeated exposure, may contribute to noise-induced hearing loss.
- Company XYZ's hearing conservation program meets the requirements of OSHA's general industry standard on occupational noise control, however, the organization's implementation of its hearing conservation program is deficient at the upper Midwest hot-mix asphalt plant.

    - Prior to this research, noise level monitoring had not been conducted at the upper Midwest hot-mix asphalt plant. Additional monitoring must be performed whenever a change in production, process, equipment, or controls may increase noise exposures.
    - Employees who are exposed to noise levels which exceed an 8-hour time-weighted average of 85 dBA must be trained on the effects of noise on hearing, the use of hearing protectors, and the purpose of audiometric testing. This training must be conducted and documented annually for as long as the employee is enrolled in the hearing conservation program.
    - Company XYZ has not performed baseline or annual audiometric exams for its employees at the upper Midwest hot-mix plant and thus needs to indicate such an activity for employees who are likely to exceed an 85 dBA exposure level during an eight-hour work shift.
- Honeywell Howard Leight Lase Lite® ear plug hearing protectors provide a noise reduction rating of 32 dB when worn properly. This level of protection is adequate for the observed levels of noise at Company XYZ's upper Midwest hot-mix asphalt plant.

Recommendations

The following recommendations are proposed to mitigate the occurrence of noise-induced hearing loss and related worker compensation claims for Company XYZ employees.

- Employees who are exposed to or exceed an eight-hour time-weighted average sound levels of 85 dBA should be enrolled into a hearing conservation program and receive baseline as well as annual audiometric exams.

- Annual training on hearing conservation protection practices and equipment should be performed and documented for Company XYZ employees.
- The effectiveness of a hearing protector may diminish if not worn properly, and thus observations should be performed to ensure that hearing protectors are properly worn to maximize worker hearing protection. A variety of hearing protectors should be made available to Company XYZ employees in order to ensure a proper fit.
- Although certain worker's noise exposure was less than the eight-hour time-weighted average of 85 dBA, it is recommended that hearing protection be worn by Company XYZ employees when such individuals are exposed to equipment that produce noise levels in excess of 85 dBA to prevent noise-induced hearing loss.

Areas of Further Research

This study was limited to the specific production demands and schedule at the time of noise monitoring. Equipment and tasks which are required for normal production demands were measured for noise exposures, however many non-routine tasks occur during the operation of the upper Midwest hot-mix asphalt plant. Due to the limitations of the study, the following should be explored to achieve a greater understanding of the noise-based loss exposures which are present at Company XYZ's hot-mix asphalt plant.

- Due to the dynamic nature and variability of hot-mix asphalt production and plant operation, follow-up noise monitoring should be conducted to verify that collected data is representative of day-to-day plant operation.
- Task-specific noise-monitoring should occur to identify tasks that pose potential damage to hearing. Particularly, non-routine tasks should be monitored as such

activities were not performed during this noise study to identify worker noise exposures during an average shift.

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Appendix: Company XYZ Noise Monitoring Data Collection Form

Company XYZ Noise Monitoring Data Collection Form

Researcher:_____ Date:_____

Location:_____

Noise level meter make, model and S/N:

_____

Noise dosimeter make, model and S/N:

_____

Area Noise Sampling Results

Location # and description	Sample time / noise level	Sample time / noise level	Sample time / noise level	Sample time / noise level
1-				
2-				
3-				
4-				
5-				
6-				
7-				

Employee Dosimetry Noise Monitoring Results

Employee #	Work Duties	Dosimeter S/N	Total Hours Worked	Time-Weighted Average (dBA)