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Measurement of hazardous personal noise exposure in spice manufacturing industry

Measurement of hazardous personal noise exposure in spice manufacturing industry

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Abstract: There are many sources of hazardous noise that contributed to the hearing impairment, that resultant from over exposure noise level from workplace. This study examined the contribution of machine that used in the spice manufacturing towards to the employee. Initially, the background noise of each workstation needed to be measured using a sound level meter. Then, monitoring levels including machine noise levels and daily self-reported duration noise exposure to workers was elucidated. A total of 30 workers were identified as having workplace noise exposures. The average noise levels were between 81 and 97 dBA in high and low noise exposure areas, respectively. The average self-reported workplace noise measure time was 8 hours/day. The estimated mean daily noise exposures were calculated from machine noise were found to be higher than the Factories And Machinery (Noise Exposure) Regulations, specifically 90 dBA eight-hour time weighted average (TWA). In addition, 750% of production workers had estimated greater than TWA value exposures. It is therefore recommended that industries either limit workplace use among the production workers or require device and technological advanced to prevent occupational noise-induced hearing loss

1. Introduction

Noise is commonly defined as any unwanted or undesirable sound. Sensorineural noise-induce that brought by exposure to hazardous levels of workplace noise has been termed as an occupational noise-induced hearing loss (NIHL). NIHL is preventable through a hierarchy of controls which is used of engineering controls over administrative controls and personal protective equipment. Here, it has been cleared the hazardous levels of workplace noise that substantially contributed to the overall hearing impairment of the workers can be reduced with the all components of hearing loss prevention programs are being in place.

The National Institute on Deafness and Other Communication Disorders (NIDCD), an estimated twenty-six million Americans workers may suffer from NIHL [1]. In addition, the National Institute for Occupational Safety and Health (NIOSH) reported that as many as 30 million manufacturing workers are exposed to hazardous levels of noise that could contribute to NIH, where the levels of noise specifically greater than 85 dBA as an eight-hour time weighted average (TWA) [2]. Resultant from unacceptable number of overexposed employees, NIOSH has identified that hearing loss as one of the 21 priority areas for research. Machinery, equipment, and work practices are typically the sources of excessive noise in the workplace. In addition, Environmental Protection Agency's Office of Noise Abatement estimated the number of American workers that exposed to noise above 85 decibels at A-weighted (dBA) present in time weighted average (TWA) exposure levels where the number of workers expected to incur hearing impairment over a working lifetime of 40 years indicated that between 80-85 dBA there

are 2.85 million workers exposed and 1 percent are at risk based on 80 dBA. Furthermore, Killburn et al [4] A 1992 study of found that 25% of the ironworkers had hearing loss at the 500 Hz frequency, while 60% had hearing loss at 8000 Hz. This study also mentioned hearing loss in ironworkers increasing the balance dysfunction, an obvious concern for a workers commonly performing work at elevated locations.

Many studies has been conducted around the globe for the effect of the overexspose noise disposure toward NIHL. In 1997 Miyakita *et al* [5] hightlighted that the Ministry of Labor in Japan estimated that 16.0% of Japanese construction workers, or 410,000 of 5.8 million employed construction workers, suffer from NIHL. Arndt et al, [6] found NIHL to be one of the most common occupationally-related ailments in the German construction industry. The Program to Reduce Exposure by Surveillance System (PRESS) conducted by the Department of Labor Safety and Health of Taiwan, estimated that 38.6% of construction workers in that nation suffer from severe NIHL[7]. Welch et al, [8] reported an NIHL incidence of 30 case per 10,000 construction workers in Finland, but acknowledges that this number is likely low. The Workers' Compensation Board (WCB) of British Columbia conducted 32,800 audiometric tests in 1989, and found that 50% of these tests showed significant hearing loss, with 22% of these being classified as severe to profound. The WCB estimated that covering the roughly 10,000 potential claims in British Columbia in 1989 could cost C$20 million (9).

A 1995 study in Canada assessed noise levels on 27 construction sites over a 14 month period from May 1991-July 1992. Participants in this study wore dosimeters for up to five hours; the authors asserted that the repetitiveness of the work justified partial-workshift sampling procedures. Canadian regulations required that the researchers utilize a 3 dB exchange rate on the dosimeters used for the study. The residential construction sites analyzed had TWA noise exposures with an arithmetic mean of 93.1 dBA; the average TWA exposure for the carpenters included in the study was 89.6 dBA, while ironworkers were found to have an average TWA exposure of 105.4 dBA (10). This study collected 103 samples; however, the number of samples collected for any given trade was very small. In addition, the large number of sites characterized further dilutes the sample distribution, and the authors' use of a partial shift TWA is questionable given the intrashift task variability inherent in construction work.

SLM readings, upon which many of the existing studies are based, are dependent upon the skill level of the meter's operator [11], making comparison between studies utilizing SLMs somewhat uncertain. This is a notable deficit in available data on the construction industry. The SLM data currently available are useful for determining areas of construction which deserve further attention, but dosimetry is required to determine the contribution of the individual pieces of equipment measured via SLM to TWAs.

The study aims to identify whether the employee in a spice manufacturing company are exposed to hazardous level of accupational noise from the operating machines and equipments in their workplace. Several potential sites in the factory have been identify as hazardous area are monitored using statically positioned dosimeter. Whereas to study the acceptable noise level among the workers, a personel dosimeter are attached on the individual worker. Possible control measures then be suggested to the workers to reduce the risk high noise exposure.

2. Materials and methods

2.1 Noise mapping of the work area

The apparatus used to measure the existing background noise level is as shown in **Figure 1.** The apparatus complies with the International Electro-technical Commissioning (IEC) specifications. The instrument is located at a height of about one meter above the ground and a distance of one meter from the noise source to ensure no reflections take place near the instrument. The monitoring time selected for the measurements of the environmental noise as recommended by ISO 1996/1 standard is used. Four types of noise level trend such as steady continuous, intermittent, impulsive and fluctuating are recorded.

Model: Noise Pro DLX
(a)

Model: QC10
(b)

Figure 1. (a) Noise dosimeter and (b) calibrator for noise monitoring at working area

2.2 Personal noise monitoring

The noise logging dosimeter and calibrator from Bruel and Kjaer are illustrated as in **Figure 2**. After the initial calibration, the dosimeter is attached onto the selected worker, where a microphone is placed as near as possible to the worker's ear. In addition, it is set to follow the OSHA Permissible Exposure Limit (OSHA PEL) with the highest reading is recorded using the 'slow' mode of response. OSHA PELs are based on 8-hour time weighted average (TWA) exposure. The 6 hours of sampling durations are measured and the results are also recorded before final calibration of the noise dosimeter. The production floor has two shifts of operations, where the first and second shift started at 6am till 3pm and at 3pm till 12am respectively. In this study, the noise exposures from four employees of different sections are recorded.

Model: 4448
(a)

Model: 4231
(b)

Figure 2 (a) Noise dosimeter and (b) calibrator for personal noise monitoring

3. Results and discussion

Table 1 summaries the noise exposure for production floor and packaging room. It can be seen that the production floor generated noise level at or above the permissible exposure limit (PEL) of 90 dB (A). This is indicated by red colour in the noise mapping as shown in Figure 3. Besides this area, the packaging section produced noise level between 84 dB(A) to 89 dB(A). This section is highlighted in yellow in the noise mapping.

Table 1. Area noise monitoring for production floor and packaging room

Department	Noise Source	Noise Level Range dB(A)	Type of Noise
Production Floor	Section 1 (S1)	100.7-105.0	Intermittent
	Section 2 (S2)	96.3-97.2	Intermittent
	Section 3 (S3)	97.2-98.2	Intermittent
	Section 4 (S4)	92.3-95.6	Intermittent
	Section 5 (S5)	93.5-94.7	Intermittent
	Section 6 (S6)	94.5-95.1	Intermittent
Packaging Room	Machine 1 (M1)	87.0-88.1	Steady Continuous
	Machine 2 (M2)	85.8-86.4	Steady Continuous
	Machine 3 (M3)	84.3-84.6	Steady Continuous
	Machine 4 (M4)	84.2-84.5	Steady Continuous

Based on noise mapping, it is found that there are some areas (M3 and M4 from the packaging room) in the factory that are exposed to noise level below 85 dB (A). Therefore, these particular areas are considered as safe working place and hearing protection devices are not necessary. These locations are coloured in white in noise mapping as shown in **Figure 3**.

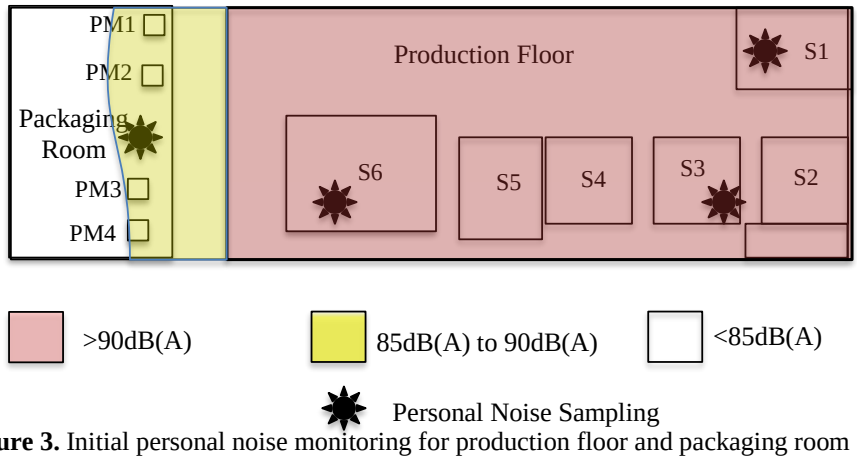

Figure 3. Initial personal noise monitoring for production floor and packaging room

Figure 4 shows the initial data that recorded using personal noise dosimeter at packing room area. The data retrieved is based on slow response setting at 5 dB (A) exchange rate. **Table 2** shows the permissible noise level, expressed in dose, that a person is exposed during working hours. Daily noise dose that are allowed for workers is calculated as 90 dB (A) for 8 hours of working operation as stated in the Factory and Machinery (Noise Exposure) Regulations 1989 [12]. 'Percent' dose is simplified as the ratio of the actual dose divided by the maximum

permitted and multiplied by 100. From the dose value the "Equivalent Continuous Sound Level", L_{eq} is calculated. It is also known as "Time Weighted Average" (TWA).

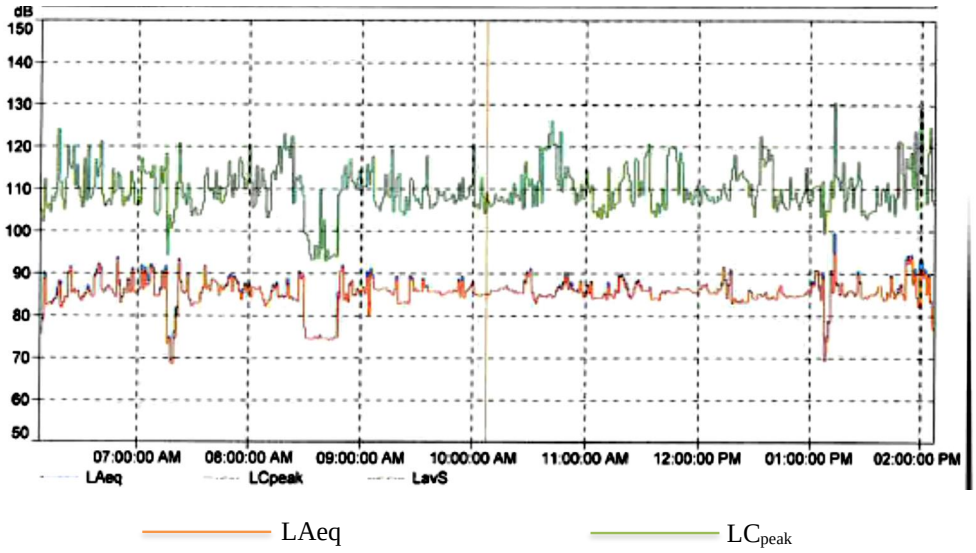

Figure 4. Noise measurement at packing room.

Table 2 indicates that Worker 1, 2 and 3 have been exposed to noise level exceeding the permissible exposure level of 90 dB(A) for workers working at 8 hours shift. However worker 4 has been exposed to noise level exceeding the action level of 85 dB(A) but within the permissible exposure level of 90 dB(A) for workers working at 8 hours shift. In addition, worker 3 has been exposed to noise level exceeding maximum level (L_{max}) of 115 dB(A). L_{max} is the maximum noise level recorded using frequency-weighting (denoted by A) and time-weighting (denoted by S). Based on the regulation [12], all employees are not allow to be exposed to maximum noise level exceeding 115 dB(A) at any point of time during working hours. Furthermore, Worker 1 and 3 were exposed to noise level exceeding the peak level (L_{peak}) of 143.7 and 140.9 dB(C) respectively. As stated in Factory and Machinery (Noise Exposure) Regulations 1989 [12], the permitted maximum peak noise level is 140 dB(A).

Table 2. Initial personal noise monitoring for production floor and packaging room

Employee	Section	Duration (h:m:s)	$Dose_8$ (%)	Leq_8 dB(A)	Max Level (L_{max}) dB(A)	Peak Level (L_{peak}) dB(C)	Type of Exposure
Worker 1	S1	7:59:05	229.2	96.00	114.1	143.70	Fluctuating
Worker 2	S3	8:00:50	239.5	96.30	109.7	134.00	Fluctuating
Worker 3	S6	7:44:59	200.5	95.00	120.6	149.80	Fluctuating
Worker 4	PM2	7:00:00	65.00	86.90	113.8	130.40	Fluctuating

3.1 Control measure assessment

It is important for the management to ensure that their employees are exposed only to the noise level below the permissible exposure. A certain control measures in order to protect employees

from overexposed to noise hazard must be taken. In this study, the management has already provided a couple of 3M-1271 Corded Reusable Earplugs as shown in Figure 5, with the value of noise reduction ratio (NRR) of 24 for workers at Section S1, S3 and S6.

Figure 5. The corded earplugs provide to control the noise level

Here, a protected exposure (L_{prot}) with NRR of noise measured on the weighted decibel scale is calculated as following;

$$\text{for frequency (A)} : L_{prot} = L - (NRR - 7)/2 \quad (1)$$

$$\text{for frequency (C)} : L_{prot} = L - NRR/2 \quad (2)$$

The suitability of the earplugs is expressed in Table 3. It can be seen that this type of earplug is not recommended for all three sections.

Table 3. Control measure for personal noise monitoring in production floor

Employee	Section	NRR (dB)	Before Protection			After Protection		
			Leq_8 dB(A)	Max Level (L_{max}) dB(A)	Peak Level (L_{peak}) dB(C)	Leq_8 dB(A)	Max Level (L_{max}) dB(A)	Peak Level (L_{peak}) dB(C)
Worker 1	S1	24	96.00	114.10	143.70	87.50	105.60	131.70
Worker 2	S3	24	96.30	109.70	134.00	87.80	101.20	122.00
Worker 3	S6	24	95.00	120.60	149.80	86.50	112.10	137.80

Based on the personal noise exposure monitoring results, the recommended NRR as tabulated in **Table 4.** NRR was selected based on highest NRR required for each person. The suitable type of hearing protectors should be provided to all employees working under noise exposure above action limit which is 85 dB(A). The workers are subjected to 8 hours of exposure, thus the action level is 85 dB(A) and the permissible limit is 90 dB(A).

Table 4. Noise reduction ratio (NRR) for effected workers

Employee	Section	Leq_8, dB(A)	L_{max} dB(A)	L_{peak} dB(C)	NRR (dB)
Worker 1	S1	96.0	114.1	143.7	29
Worker 2	S3	96.3	109.7	134.0	30
Worker 3	S6	95.0	120.6	149.8	27

Worker 4	PM2	86.9	113.8	130.4	11

4.0 Conclusion

Based on personal noise exposure monitoring, employees who are working at Section S1, S3 and were exposed to noise level exceeding permissible exposure level of 90dB(A), however, employees at PM2 were exposure to noise level above action level of 85dB(A). Work schedule in high noise exposure area should be changed or rotated so that the exposure times are within permissible dose level of 100%. Based on the Personal Exposure Dose and Noise Source Measurement, it is required to be applied to employees at production floor since the employees are exposed to high noise level all the time. Employer should enforce the operator to wear the hearing protectors when they are entering these zones. Procedures for the issuance, maintenance, inspection and training in the use of hearing protection devices shall be established. Approved hearing protection devices shall also be provided to non-production staff and visitors who are required to enter or pass through noisy areas. The management shall take recommended actions to maintain employee exposure to noise level below the action level as far as reasonably practicable.

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