EVALUATION OF OCCUPATIONAL NOISE AND AN INVESTIGATION INTO RESPIRATORY SYMPTOMS AND LUNG CAPACITIES AT TOLL PLAZA WORKERS

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ABSTRACT: Noise is among the most pervasive pollutants today. Noise from road traffic, jet planes, trucks, construction equipment, manufacturing processes, lawn over's etc. are among the audible letter that are routinely broadcast into the air. Noise negatively affects human health and well-being. Problems related to noise include hearing loss, stress, high blood pressure, sleep loss, distraction and lost productivity, and a general reduction in the quality of life. This paper deals with the study of noise at two different places, one at toll plaza and the second one a forging unit. It starts with the fundamentals of acoustics, including the quantities to be measured and their relation to the psychology of hearing. Excessive dust emissions can cause both health and industrial problems like; respiratory diseases, irritation to eyes, ears, nose and throat, irritation to skin, damage to equipment, impaired visibility, unpleasant smell, and problems in community relations. The greatest concern is the health hazard to workers who are excessively exposed to harmful dusts. In order to evaluate the severity of health hazard in a workplace, the American Conference of Governmental Industrial Hygienists (ACGIH) has adopted a number of standards, commonly known as threshold limit values (TLVs). These values are used as guides in the evaluation of health hazards. TLVs are time-weighted concentrations to which nearly all workers may be exposed 8 hours per day over extended periods of time without adverse effects. MSHA uses these TLVs for health hazard evaluation and enforcement.

Keywords: Noise, Respiratory Symptoms, Toll Plaza, Expose, Disease

1. INTRODUCTION:

Occupational noise exposure is an aspect of growing importance in today's era of industrialization. Noise is an insidious of all industrial pollutants, involving every industry and causing severe hearing loss in every country of the world. Exposure to excessive noise is the major avoidable cause of permanent hearing impairment. Worldwide, 16% of the disabling hearing loss in adults is attributed to occupational noise, ranging from 7% to 21% in various sub regions. The estimated cost of noise to developed countries ranges from .2 to 2% of the gross domestic product (G D P). In this chapter we would have an introduction to what an occupational noise is, its ill-effects on the individuals who are exposed to it, psycho-acoustics, various noise evaluation indices, quantification of sound and the sound measuring instruments used by us during studies ahead.

1.1 The properties of noise which are important in the workplace:

- Frequency
- Sound pressure
- Sound power
- Time distribution

1.1.1 Frequency and pitch

Frequency is the rate at which the source produces sound waves, i.e. complete cycles of high and low pressure regions. In others words, frequency is the number of times per second that a vibrating body completes one cycle of motion. The unit for frequency is the hertz (Hz= 1 cycle per second) Pitch is the subjective response to frequency. Low pitched or bass sounds have low frequencies. High-pitched or treble sounds have high frequencies. A healthy, young person can hear sounds with frequencies from roughly 20 to 20,000 Hz. The sound of human speech is mainly in the range 300 to 30,000 Hz.

1.1.2 Amplitude

The maximum deviation from the average or equilibrium value of any repeatedly changing quantity, such as the position of a vibrating object, pressure, velocity, voltage, current and many others. The amplitude of a sound wave is the maximum amount by which the instantaneous sound pressure differs from the ambient pressure.

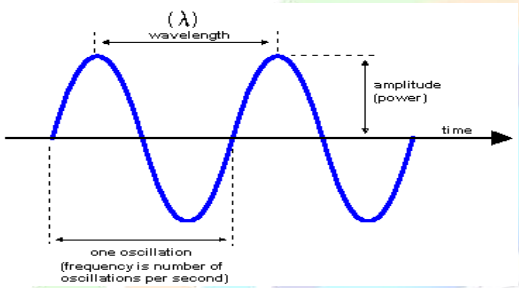


Figure 1.1 Pressure variations vs. time

1.1.3 Sound Power (W) and Intensity (I)

Sound intensity is defined as the sound power per unit area. The usual context is the measurement of sound intensity in the air at a listener's location. The basic units are watt/m^2 or watts/cm^2. Many sound intensity measurements are made relative to a standard threshold of hearing intensity I_o.

1.1.4 Sound Pressure Level

Sound pressure level in decibels is defined in the following way: $dB = 20 \log (p/p_0)$

Where P is the sound pressure being measured and P_0 the reference sound pressure, normally taken as 0.0002 μ bar (= 20μ Pascal's). This gives a nominal range of 0-120 dB, with zero as the reference minimum threshold and 120dB as the approximate threshold of pain. Sound pressures converted to the decibel scale are called sound pressure levels, abbreviated L_p. So, the sound pressure level of the quietest noise the healthy young person can hear is calculated in this way:

$L_p = 20 \log(.0002/.0002) = 20 \log (1) = 0$ dB

The sound pressure level or L_p in a very quiet room, where the sound pressure is 0.02 Pa, is calculated:

$L_p = 20 \log (.02/.0002) = 20 \log (100) = 40$ dB

The sound pressure level of a typical gasoline-powered lawn mower, which has a sound pressure of 1 Pa, is calculated: $L_p = 20 \log (1/.00002) = 20 \log (50000) = 94$dB

1.1.5 Sound Power Level

Sound power or acoustic power P_{ac} is a measure of sonic energy 'E' per time't' unit. Sound power level (PWL or L_w), which identifies the total sound power emitted by a source in all direction. Sound power, is measured in watts. In the case of sound, the amount of power is very small, so the reference selected for comparison is the Picowatt (10-12 watt). It is measured in watts and, can be computed as sound intensity (I) time's area (A): $\mathbf{P_{acoustic} = I.A}$

The difference between two sound powers can be express in decibels using this equation:

$\mathbf{L_w = 10 \log_{10} (P_1/P_2)}$ **dB Where** P_1, P_0 are the sound powers.

The sound power level SWL, L_W, or L_{Pac} of a source is expressed in decibels (dB) and is equal to 10 times the logarithm to the base 10 of the sound. It is thus a log measure. The reference sound power in air is normally taken to be

$P_0 = 10^{-12}$ watt, that is 0 dB SWL. Sound power is neither room dependent nor distance dependent. Sound power belongs strictly to the sound source.

2. Methodology

A. Toll Booth Selection

A typical toll collection facility, Beas Toll Collection Plaza, was selected as the survey location due to its high traffic volume and high noise level. The Toll Plaza is located at jalandhar-amretsar Hiway. The Toll Plaza contains eight toll booth of same size serving at times, lanes of traffic. The structure of the booths is made of glass, aluminum and stainless steel.

B. Instrument Used to Measure the Noise

The noise exposure measurement data of this research project has been achieved with one unit of an Integrating Sound Level Meter (ISLM) and noise dosimeter.

The configuration of the sound level meter is as follow:

• Range - 70 - 140 dB.

• Bandwidth - 1/3 octaves.
• Peaks over - 140 dB.
• Time weighting - Slow.
• Frequency weighting - A.
• Spectrum-Slow time weighting and L frequency weighting.
• Global measures – A & L frequency weightings.
• Logging – 1 record/Second.

The configuration of the dosimeter is as follows:
• Range – 70–140 dB.
• Time weighting-Slow.
• Frequency weighting-A.
• Frequency weighting for peaks-C.
• Exchange rate-5dB.
• Threshold-90 dB.
• Logging-1 record/minute.

C. Instruments Used For Check the Lungs Capacity

1. Spirometer

A **spirometer** is an apparatus for measuring the volume of air inspired and expired by the lungs. It is a precision differential pressure transducer for the measurements of respiration flow rates. The spirometer records the amount of air and the rate of air that is breathed in and out over a specified period.

2. Dust Sampler

A schematic diagram of the PEM is shown in Figure 1.The sampler weighs 48 grams (1.7 ounces) and consists of three basic sections: an inlet nozzle cap, impaction ring assembly, and base. Inlet nozzle cap - The PEM designed for PM2.5 collection at 10 L/min has 10 nozzles located in a circle along the outer edge of the nozzle cap through which the aerosol enters the

D. Questionnaires

Survey has been done by giving questionnaires form to the toll tellers to get the demographic data and feedbacks from the toll tellers on how their perception and sensitivity toward noise exposure at the workplace. Questionnaires were given to the worker by the supervisor. The questionnaire is divided into four sections that are demographic, workplace information, perception toward noise and symptoms of potential NIHL. Awareness, satisfaction and other subjective effects related to health in term of auditory and non auditory effects were also included in the questionnaires.

E. Analysis data

Measurement and survey data were analyzed by using statistical tools, SPSS 16 software. Descriptive statistics were computed for 8 hr work shift and t-test was conducted to determine if mean noise level between certain variables had statistically significant differences. P-values less than 0.05 were considered statistically significant.

3. Results

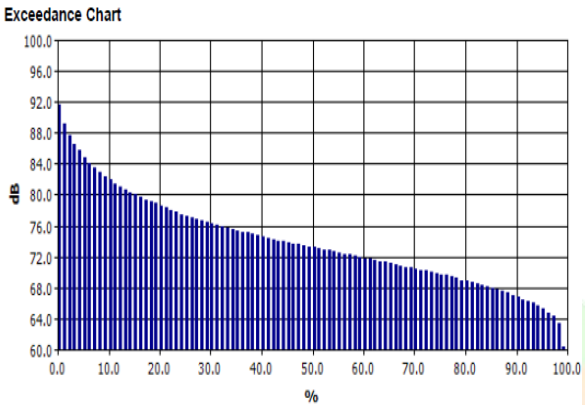
(a) Result of noise

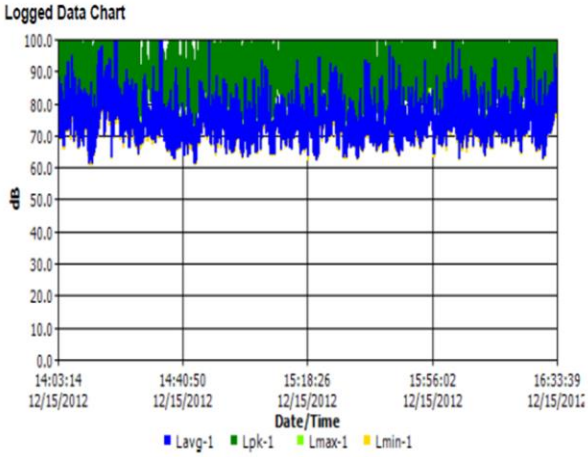
The OSHA standard for noise exposure limits the noise exposure level to 90dB for 8 hrs/day with six working days per week. Exposures above this level can be harmful and may lead to a variety of problems like hearing disorders, annoyance, problems in communication etc. This in turn would lead to decline in productivity.

In this study we found that average noise level at toll plaza is 74-80 dB (A) and suitable noise level for human ear is 55-65 dB (A)

Table1 Sound Pressure Level at toll plaza

Lane	Time(pm)	L_{avg} (dB)	L_{min} (dB)	L_{max} (dB)	L_{pk}(dB)
1	2PM-10PM	77.5	60.5	105.4	121.9
2	2PM-10PM	76.6	62.9	104.9	120.3
3	2PM-10PM	74.6	62.7	100.8	123.2
4	2PM-10PM	75.6	57.7	108.5	126.3
5	2PM-10PM	78.5	68.5	100.1	120.5
6	2PM-10PM	78.8	64.5	106.5	126.2
7	2PM-10PM	78.2	66.5	104	125.6
8	2PM-10PM	78.8	66	100.4	122.5





(b) Result of respiratory symptoms and lungs capacity

Table 2 shows that function parameters such as FVC, FEV_1, FEV_1/FVC%, PEFR, PIFR, are lower in exposed workers than the controlled, but the difference was statistically significant. The lowering in FVC, FEV_1, and FEV_1/FVC% suggests a combination of obstructive and restrictive pattern in their lungs.

Comparison of lung functions in exposed and controls (ANOVA)

Demographic data	Exposed Male (35)	Controlled Male (40)	P value
	Mean ± SD	Mean ± SD	
Age (yrs)	31.47±9.96	21.61±1.67	.00
BMI	22.85± 3.50	22.66 ± 3.02	.00
FVC	3.58 ± 0.49	3.74± 0.41	.128
FEV_1	3.10 ± .44	3.38± .35	.004
FEV_1/FVC%	86.89 ± 6.56	90.51 ± 4.82	.009
FEF_{25-75}	3.42 ± .74	4.20± .80	.006
PEFR	7.44± 1.66	8.28 ± .97	.009
PIFR	4.08 ±1.55	4.94 ± 1.41	.015

Respirable dust reading

Table3 Respirable dust reading in (mg/m³) at toll plaza

place	Initial Weight of Filter	Final Weight of Filter	Volume of Air (liters)	V= Volume of Air m³	M= Net wt. of Dust (mg)	C= M/V	Pump Running Time (8 hrs)	Dust in 8 hrs
TP	60.5	61.1	545	.545	.6	1.0092	1	8.72

Table 3 shows the value of dust level at toll plaza. It is clear from subjective data that the toll plaza workers are exposed to high levels of dust and temperature as they showed unnecessarily tiredness and weakness in daily routine life. This is also evident from the results of dust sampling technique which revealed that respirable dust exposure in all sections exceeds the respirable dust limit as given by OSHA and the Indian Union Ministry of Labour. According to American Conference of Governmental Industrial Hygienists (ACGIH) 1988, a general dust hazard is considered to exist in jobs whose respirable dust concentration exceeded 5mg/m³. The United States Occupational Safety and Health Administration (OSHA) and the Indian Union Ministry of Labour have established a respirable dust exposure limit of 5mg/m³. Exposure to silica dust amounts is insufficient to produce pulmonary fibrosis, but it can result in chronic obstructive pulmonary disease as reflected in aggravated reduction of expiratory flow rates in workers participated in this study Golshan et al. (2003).

4. CONCLUSIONS

The following broad conclusions can be drawn from this study:

(a) Noise Exposure Studies:

Noise Exposure at toll plaza: In this study we found that the noise level at toll plaza is 65 to 80 dB at all eight lanes. According to Indian standards the threshold limit for noise is 90 dB but the level of noise which is suitable for human ear is 55 to 65 dB and we found that the noise level at toll plaza is below the threshold limit (90 dB) but noise level is greater as compare to the suitable noise level, so the noise level at toll plaza is harmful for toll plaza workers. Noise study concludes that the workers who work on toll plaza at high risk of noise which causes to produce hearing loss, annoyance, headache, stress etc.

(b) Spirometry test results:
In this study we found that the workers at the toll plaza were found to have a lower lung function than workers in those areas with lower dust concentrations. This shows that there is strong association between hazardous environmental conditions and the physical and respiratory health of industrial workers. The decrease in lung function values of industrial workers as compared to control workers can be attributed mainly to respiratory disorders. The absence of pollution control and monitoring devices at workplace add to the hazardous environmental conditions. Moreover most of industrial workers showed reluctance in use of safety equipment which indicates lack of safety awareness and appropriate managerial steps. This is either due to negligence of the company or due to them being uneducated. This brings some workers in toll plaza under risk of developing Chronic Obstructive Pulmonary Diseases like asthma. As they are not wearing any protective equipment, health problems facing them are severe so they must be educated regarding the benefits of PPE and be made to wear them. The study also reveals that the toll plaza company lack in the will to enforce the health and safety norms. Undoubtedly it is their responsibility to implement the health and safety norms and provide counseling to the workers to educate them regarding the benefits of wearing PPEs. The study validates findings of international labour office (ILO) which estimate that in year 2001, there were 2.2 million deaths due to work-related injuries and diseases. There is a strong need to implement the occupational exposure norms related to working hours. This study conducted focus on the respiratory symptoms and lung capacities in brick kiln workers also made the company take notice of this problem and they agreed that this was hampering the efficiency of the workers and in turn was having an effect on their production.

LIST OF ABBREVIATIONS

TLVs	Threshold limit values
REL	Recommended exposure limit
TWA	Time weighted average
PEL	Permissible exposure limit
BMI	Body Mass Index
FVC	Forced Vital Capacity
FEV_1	Forced Expiratory Volume in First Second
FEF_{25-75}	Mean expiratory flow rate in the middle half
PEFR	Peak Expiratory Flow Rate
PIFR	Peak Inspiratory Flow Rate
COPD	Chronic obstructive pulmonary disease
PPE's	Personal Protective Equipments
ANOVA	Analysis Of Variance
SPM	Suspended Particulate Matter
SME's	Small scale Manufacturing Enterprises
EPA	Environment Protection Agency
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SLM	Sound Level Meter
ISLM	Integrated Sound Level Meter

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