

Compliance Monitoring of Standard of Permissible Exposure Limit for Noise at Workplaces in Nepal



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1. Introduction

The government set the standard of permissible exposure limit for noise at the workplace in April 2017 through a gazette notification. Since then though there are some studies outside the capital city, no compliance monitoring has been carried out in the noisiest industries located in the largest industrial area of the capital city and hence aimed to be included in this proposed research and technical project.

The standard to this effect was published by the Ministry of Labour, Employment and Social Security (MOLESS) Government of Nepal. Section 36 of the Labour Act, of 1992 has vested in the government the power to determine the standards of safety in the workplace.

According to the notification published in the Nepal Gazette, a noise Permissible Exposure Limit (PEL) of 90 dBA for all workers for an eight-hour time-weighted average (TWA). No exposure over 115 dAB shall be permitted in the workplace. Pl,s find the Nepal Gazette of PEL in Annex 1.

With noise, the permissible exposure limit (PEL) is 90 dBA for all workers based on an eight-hour-Time Weighted Average (TWA) Sound levels above this range are perceived as noise. Noise can distract the workforce, creating an unsafe workplace. Or, worse yet, it can cause hearing loss.

Evidence from various reports and research findings proved that high noise levels over prolonged periods can lead to permanent hearing loss and several other health implications like hypertension, reproductive failure, diabetes, and increases risk of cardiovascular disease.

OSHA's requirement to protect all workers in the general industry calls for employers to implement a Hearing Conservation Program where workers are exposed to a time-weighted average noise level (called the "action level") of 8-Hour TWA of 85 dBA or higher. Hearing Conservation Programs require employers to measure noise levels, and provide free annual hearing exams, free hearing protection, and training.

The United States Occupational Safety and Health Administration (OSHA) established a threshold limit of 90 dBA and an exchange rate of 5 dBA. The exchange rate is the quantity by which the sound level may increase if the exposure time is reduced by one-half. This discrepancy results in inconsistency when reporting noise levels. In 1994 the American Industrial Hygiene Association (AIHA) and since then others, including Prince et.al. (1997), Daniel et.al. (2007), and Suter (2009), recommended an exchange rate of 3dBA and an 8-hour criterion level of 85 dBA.

There are several ways to control and reduce worker exposure to noise in a workplace where exposure has been shown to be excessive.

Engineering controls involve modifying or replacing equipment, or making related physical changes at the noise source or along the transmission path to reduce the noise level at the worker's ear. Examples of inexpensive, effective engineering controls:

- Choose low-noise tools and machinery
- Maintain and lubricate machinery and equipment (e.g., oil bearings)
- Place a barrier between the noise source and employee (e.g., sound walls or curtains)
- Enclose or isolate the noise source.

Administrative controls are changes in the workplace or schedule that reduce or eliminate the worker exposure to noise. Examples:

- Operate noisy machines during shifts when fewer people are exposed
- Limit the amount of time a person spends at a noise source;
- Provide quiet areas where workers can gain relief from hazardous noise sources; and
- Control noise exposure through distance is often an effective, yet simple and inexpensive administrative control. Specifically, for every doubling of the distance between the source of noise and the worker, the noise is decreased by 6 dBA.

Noise controls are the first line of defense against excessive noise exposure. The use of these controls should aim to reduce hazardous exposure to the point where the risk of hearing is eliminated or minimized. With the reduction of even a few decibels, the hazard to hearing is reduced, communication is improved, and noise-related annoyance is reduced. There are several ways to control and reduce worker exposure to noise in a workplace. Noise-induced hearing loss is a permanent sensorineural hearing loss caused by regular exposure to loud noise. It is characterized by high-frequency hearing loss.

Based on the result of compliance monitoring results, the report will be prepared and disseminated through organizing an awareness and capacity building workshop and advocating for the required improvement and Hearing Conservation Program if required.

2. Objectives

- 1) Compliance monitoring of the standard of permissible exposure limit for noise at the workplace.
- 2) Compliance monitoring report prepared and disseminated by organizing an awareness and capacity-building workshop.
- 3) Advocating for the required improvement and Hearing Conservation Program if required.

3. Literature Review:

3.1. What is Noise?

Noise¹ is an unwanted sound that your brain reacts unpleasantly to upon hearing. Noise is usually loud or disruptive to hear. The medium through which noise or sound travel is air and structural.

Airborne noise is often a form of noise that travels through the air. The sound waves travel in the open space with the flow of air. Some examples of airborne noise are people talking, television noise, conversations, etc.

Structural or impact noise is a form of noise that is created when one object impacts another object and vibrations of the molecules of the object impacted travel through the surface of the object creating unwanted sounds as it travels. Examples include: washing machines or dishwashers using vibrating.

Noise and Sound are indistinguishable. The difference arises when the brain receives and perceives a sound.

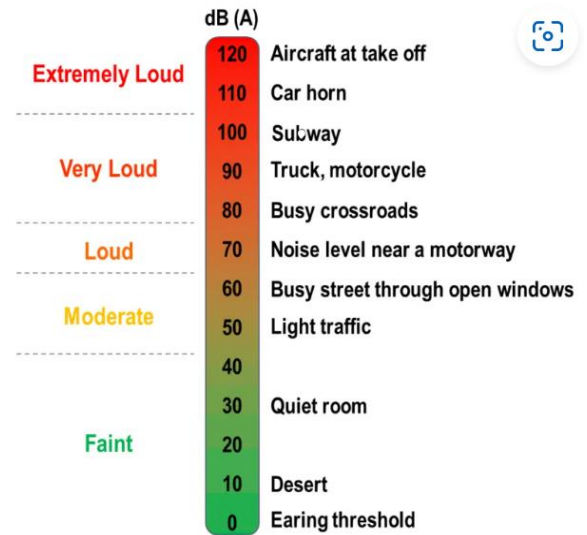


Figure 1. Noise generation and its categories

3.2 What are Safe Exposure Limits?

Noise is always considered an unwanted sound. Most people will suffer some hearing damage if they are repeatedly exposed to noise levels above 85 dBA 8 Hour weighted average or even an acoustic shock at levels of over 137 dBA.

80 dBA is the lower Exposure Action Value in most Health and Safety legislation. After prolonged exposure to decibel levels above 80 dB(A) people can start to suffer from permanent hearing loss. Hearing gets damaged because high noise exposure over some time can damage the delicate hair-like sensory cells in the ear.

The government of Nepal, Ministry of Labour, Employment and Social Security (MoLES) has gazette a Permissible Exposure Limit (PEL) at work of 90 dBA with three major provisions.

- (1). No Exposure over 115 dBA is to be permitted
- (2). Exposure to impulsive or impact noise should not exceed the dBA peak sound pressure level in the C weighting network.
- (3). Hearing protection shall be mandatory above 85 dBA.

3.3 Health Impact of Noise:

Hearing damage can happen to anyone if they are exposed to a dangerous amount of noise. But it will depend on the individual sensitivity to the noise. Everybody is different. Some people are most sensitive to noise than others. With this noise level chart in dBA, you will be able to understand how much the sound level some equipment and appliances have when in operation.

¹ [Noise Level Chart and the dBA - Soundproof Empire](#)

Exposure to high levels of noise can cause permanent hearing loss. Neither surgery nor a hearing aid can help correct this type of hearing loss. Short-term exposure to loud noise can also cause a temporary change in hearing (your ears may feel stuffed up) or a ringing in your ears (tinnitus). These short-term problems may go away within a few minutes or hours after leaving the noise. However, repeated exposure to loud noise can lead to permanent tinnitus and/or hearing loss.

Loud noise can create physical and psychological stress, reduce productivity, interfere with communication and concentration, and contribute to workplace accidents and injuries by making it difficult to hear warning signals. The effects of noise-induced hearing loss can be profound, limiting your ability to hear high-frequency sounds, understand speech, and seriously impairing your ability to communicate.

Evidence of an association between occupational noise and cardiovascular outcomes was recently evaluated. It has been found the risk of hypertension increases with a clear dose-response relationship at noise levels > 80 dB(A). Additional high-quality research on epigenetic effects, oxidative stress, work-related injuries, diabetes, acoustic neuroma, and pregnancy outcomes are also needed. Urgently needed (increased) measures of workplace noise reduction will reduce the incidence of noise-induced hearing loss and help prevent cardiovascular diseases, especially hypertension.

Another review of cardiovascular disease conducted by the World Health Organization (WHO) and the International Labour Organization (ILO) found an increased risk of incident ischemic heart disease at noise exposures ≥ 85 dB(A).

Noise is one of the most common work-related occupational hazards. According to the 2015 European Survey on Working Conditions (ECWS), 28% of European workers reported being exposed to loud noise during at least one-fourth of their working time, with the percentage ranging from 18% in Malta and Portugal to 44% in Turkey. In the USA, 25% of workers reported a history of occupational noise exposure, with a point prevalence of 14%. Of the estimated 22 million workers in the USA exposed to loud noise at work, 34.3% report never using hearing protection devices.

Noise-induced hearing loss (NIHL) is also the most frequently recognized occupational disease in many countries. NIHL was the most commonly confirmed occupational disorder in Finland between 2012 and 2016. In Germany, NIHL is continuously the most frequently recognized occupational disease, comprising 38.3% (n = 6951) of all recognized occupational diseases in 2019. A comparison of five countries, France, Spain, Italy, Germany, and Denmark, found the recognition of NIHL as an occupational disease ranged from 6 cases per 100,000 persons in France to 33 cases per 100,000 in Denmark. Thus, understanding and recognizing the health effects of noise exposure is essential to promoting a safe workplace for millions of workers.

A growing body of evidence indicates that noise exposure increases the risk of cardiovascular disease, and recent World Health Organization (WHO) reviews of environmental noise find increased psychosocial and cardiovascular risks associated with traffic noise levels ranging from around 40 to 80 dB(A).

Epidemiology of Noise-induced hearing loss (NIHL)-International Comparison

Noise-induced hearing loss (NIHL) plays an important role worldwide, with over 450 million people—corresponding to more than 5% of the world’s population—suffering from disabling

hearing loss. For adults, the latter is defined as hearing loss exceeding 40 decibels (dB) measured in the better-hearing ear. **According to the WHO, disabling hearing loss occurs in about 30% of all people older than 65 years of age, the majority of them living in low- and middle-income countries.** While hearing loss can be induced by congenital abnormalities, injuries, use of ototoxic medication, or exposure to environmental or recreational noise, occupational noise exposure is the most common cause of NIHL.

Today, occupational noise-induced hearing loss is a work-related disease of international importance. It is considered the most prevalent work-related disease worldwide, affecting more than 10% of all workers in developed countries. A recent systematic review from China estimated a prevalence of 21.3% for occupational NIHL in noise-exposed Chinese workers over the last 26 years. A similar figure was calculated for workers in the USA: there, the prevalence of hearing loss in noise-exposed workers was about 20% between 1981 and 2010. However, a slow but steady decrease in the incidence of noise-induced hearing loss in the USA can be observed in most industry sectors.

According to a WHO report, about 16% of the disabling hearing loss in adults worldwide could be attributed to occupational noise exposure, and the global burden of disease caused by occupational NIHL was estimated at over 4.1 million (4,151,000) disability-adjusted years of life lost (DALY1) in 2005. However, this number probably underestimates the global burden of occupational noise exposure. It only comprises burdens due to NIHL, and other health-affecting consequences of occupational noise exposure—e.g., hyperacusis or tinnitus—are not considered. The burden of occupational NIHL is also increasing. It has been reported that the health burden due to occupational NIHL increased from 3.3 to 6 million DALYs between 1990 and 2017 with low-income countries experiencing the highest increase in burden. Actual DALY data from the Institute for Health Metrics Evaluation (IHME) show the burden increasing most in the Western Pacific WHO Region (including, e.g., China, Japan, South Korea, Philippines, Australia, and New Zealand while remaining relatively stable in the rest of the world).

Typical for NIHL caused by occupational noise exposure are its bilateral occurrence and sensorineural appearance, the latter due to the damaged hair cells in the cochlea of the inner ear. Usually, hearing loss due to noise exposure does not exceed 40 dB in lower (≤ 1000 Hz) and 75 dB in higher (> 1000 to 8000 Hz) frequencies. However, this must not be true for other forms of hearing loss, such as presbycusis. The first sign for NIHL can be seen in an audiometric curve, which typically shows a “notch” at high frequencies in the range of 3 to 6 kHz with a recovery at 8 kHz. This recovery at even higher frequencies can be used to demarcate NIHL from age-induced hearing loss (presbycusis), which leads to a declining curve at high frequencies without recovery. However, the exact form of the audiometric curve depends on several factors, such as the particular frequency or length of noise exposure. Besides the level of noise exposure, there are several modifiable and non-modifiable risk factors associated with an increase in the prevalence of NIHL in general, such as increasing age, genetics, smoking, lack of exercise, or the presence of diabetes and cardiovascular diseases.

Furthermore, it should be considered that NIHL can have a meaningful impact on safety and quality of life. For example, it has been shown that workers with NIHL are at a higher risk for hospital admission due to work-related injuries than people with normal hearing. Also, NIHL can induce social consequences such as fear, depression, and difficulties in relationships, as well as

increased annoyance, and is independently associated with incident cognitive impairment and accelerated cognitive decline.

Five systematic reviews on occupational NIHL were published in the last 5 years. Of these reviews, one focused on asymmetric hearing loss, another focused on hearing loss in China, and three reviews considered occupational NIHL in general.

Lie et al. 2016 conducted a comprehensive review of occupational NIHL that comprised a qualitative summary of 187 articles. Although different criteria for recognizing occupational NIHL complicated international comparisons, the authors found 7 to 21% of hearing loss is attributable to occupational noise. Increased risks for occupational NIHL were observed for workers in industry, shipbuilding, construction, the military, and farming. No increased risk was observed for kindergarten workers, and research on professional musicians was inconclusive. **The summarized research also indicated exposure to impulse noise is more damaging than exposure to continuous noise, and exposure to solvents and secondhand smoke might increase the risk of NIHL.** The review by 1 DALY (disability-adjusted years of life lost) is a metric used to determine the overall burden of a disease or health condition in a population. Chen et al. 2020 summarized 108 studies on the epidemiology, pathogenesis, and prevention of NIHL published between 2000 and 2020, finding the raw **prevalence of occupational NIHL ranged from 11.2% in a group of South African gold miners to 58% in a group of construction workers in the USA (average age = 59.2 years).**

Zhou et al. 2020 synthesized 88 articles on occupational NIHL in Chinese workers and found that Chinese workers in manufacturing, transportation, mining, and agriculture were exposed to hazardous levels of noise averaging 98.6 ± 7.2 dB(A). Masterson et al. 2016 looked specifically at the etiology of asymmetrical hearing loss. Since occupational NIHL is typically symmetrical, the occupational etiology of asymmetrical hearing loss is sometimes challenged. In this review, six studies offered limited evidence of an association between occupational noise and asymmetrical hearing loss. The authors postulate that physiological differences between ears or differential shielding of one ear might lead to one ear being more susceptible.

Pathomechanism—How Does Noise Affect Health?

Noise exposure can affect health in two ways. On the one hand, there are auditory effects. These describe the damage to hair cells in the inner ear caused by overstimulation of the cochlea through excessive and prolonged noise exposure. Excessive vibration of the inner ear structures due to intense noise exposure does not only harm single hair cells but can also destroy cell junctions connecting cochlear cells or lead to a decrease in synaptic connections between hair cells and the auditory nerve. In particular, exposure to noise levels exceeding 130 dB(A) is said to cause direct mechanical damage to the ear. For gradual-onset NIHL, metabolic changes or ischemia play an important role in the underlying pathomechanisms. For example, vasoconstriction caused by noise exposure can reduce cochlear blood supply, followed by decreasing hair cell function. Furthermore, noise exposure can provoke an accumulation of reactive oxygen species, which can also induce several biochemical pathways leading to cell death. As hair cells cannot regenerate, their recurring impairment leads to the abovementioned hearing loss.

The second way by which noise affects biological functions is the HPA axis. This biochemical pathway is activated by the release of corticotropin-releasing hormone (CRH) in the hypothalamus.

CRH then causes the release of adrenocorticotropin (ACTH) in the pituitary gland, which in turn activates the production of various hormones in the cortex of the suprarenal gland. These include cortisol as a glucocorticoid, which in response to the stressor stimulates the supply of energy in the body and enhances the catecholamine effect. For cortisol, a dose-dependent increase was found with an increasing level of occupational noise exposure.

Recent Reviews on Occupational Noise and Cardiovascular Health

The last two decades have seen an increase in research on the non-auditory effects of noise exposure. To summarize evidence from recent reviews on occupational noise exposure according to health outcome categories beginning with the outcome most frequently researched: cardiovascular disease and other health implications.

Table 1 Summary of recent reviews on the health effects of occupational noise exposure

Outcome	Summary of findings
Noise-induced hearing loss (NIHL)	<p>Lie et al. (2016) narratively summarize 187 articles on occupational NIHL. 7 to 21% of hearing loss is attributable to occupational noise.</p> <ul style="list-style-type: none"> • Masterson et al (2020). Asymmetrical hearing loss is observed in 2.4 to 22.6% of subjects with NIHL. • Zhou et al. in China in 2020. found a pooled OR for NIHL in the high-frequency range of 5.63 (95% CI 4.03–7.88) for exposed groups (average noise levels of 102.2±7.2 dB(A)) versus the control groups (average noise levels of 63.5±3.8 dB(A)) • Chen et al. 2021. The raw prevalence of occupational NIHL ranged from 11.2% in a group of South African gold miners (average age not reported) to 58% in a group of construction workers in the USA (average age = 59.2 years).
Cardiovascular disease (e.g., including ischemic heart disease, hypertension)	<p>Most systematic reviews find evidence of increased risks of hypertension and cardiovascular disease in noise-exposed workers:</p> <p>A majority of the studies on incident IHD reported an increased risk due to noise exposure.</p> <ul style="list-style-type: none"> • occupational and environmental noise exposure and hypertension risk for exposure to various levels of occupational noise OR = 1.08 (95% CI 1.05–1.11). • Chinese studies of occupational noise exposure and hypertension and ECG abnormalities increase the risk of hypertension, hypertension OR = 2.55 (95% CI 1.94–3.36,); ECG abnormalities OR = 2.27 (95% CI 1.96–2.62,); • objectively measured occupational noise exposure > 80 dB and hypertension. Hypertension OR=1.72 (95% CI 1.48–2.01). • occupational noise ≥ 85 dB. A statistically increased risk of incident ischemic heart disease was found (RR=1.29, 95% CI 1.15–1.43,); no

Outcome	Summary of findings
	statistically significant increased risk for IHD mortality, stroke incidence, stroke mortality, or incident hypertension was detected.
Noise-related injury risk	studies on noise-related injury risk. Noise exposure more than doubled the risk for work-related injury (RR=2.16; 95% CI 1.61–2.90); per 5 dB(A) RR= 1.22 (95% CI 1.15–1.29).
Reproductive outcomes (i.e., small for gestational age, low birth weight, gestational hypertension, congenital malformations)	<ul style="list-style-type: none"> • Dzhambov et al. conducted a meta-analysis of environmental and occupational noise studies using varying noise exposure thresholds. Using broad categories (high vs. low noise), statistically significantly increased risks were detected for: <ul style="list-style-type: none"> ➢ small for gestational age RR=1.19 (95% CI 1.03–1.38), ➢ gestational hypertension RR=1.27 (95% CI 1.21–1.79), and ➢ congenital malformations RR=1.47 (95% CI 1.21–1.79) <p>A large population-based study published in 2019 by Selander et al. finds increased risks for low birth weight and preterm birth (noise exposure estimated with a JEM).</p>
Acoustic neuroma	Two reviews with inconclusive results and high heterogeneity.
Diabetes	<p>Two reviews with inconclusive results:</p> <ul style="list-style-type: none"> • No statistically significant result for occupational noise > 85dB: RR=0.91 (95% CI 0.78–1.06).
	<p><i>GRADE</i> Grading of Recommendations, Assessment, Development, and Evaluation; <i>JEM</i> job-exposure matrix, <i>HR</i> hazard ratio; <i>OR</i> odds ratio; <i>ECG</i> electrocardiograph; <i>RR</i> relative risk</p> <p>From: Health Effects of Occupational Noise</p>

3.4 Preventing Hearing Damage

Now at least we have identified the level of sound exposure that is dangerous to our health and hearing. we should always pay attention to warning signs such as if you have difficulty talking or hearing others talk over the sound, the sound makes your ear hurt, other sounds seem muffled after workers have left the area of the loud sound and their ears are ringing after hearing the sound.

In these cases, workers should wear hearing protection to prevent hearing loss or damage. The hearing protector can help prevent both moderate and loud sounds from getting into workers ears.

The hearing protectors can reduce the high levels of noise to manageable levels that won't damage hearing by using passive or active noise protection devices.

Industries workers should use all applicable engineering /mechanical as well as administrative noise control measures in their industry to protect workers from ill effect of occupational noise.

Engineering controls involve modifying or replacing equipment, or making related physical changes at the noise source or along the transmission path to reduce the noise level at the worker's ear. **Administrative controls** are changes in the workplace or schedule that reduce or eliminate the worker exposure to noise.

4. Methods & Materials

To establish criteria for collecting data, we conducted an initial meeting with stakeholders and experts in this field to discuss the noisiest industries, sample locations, and methods as well as equipment to be used for.

- 1) Coordination with the Government of Nepal, Occupational Safety and Health Center (GON OSHC), and obtained the letter of support for the fieldwork.
- 2) Coordination and Orientation with SMS Environmental and Engineering (SMSEE) Pvt. Ltd. were done towards envisioning the methodology of taking sound level measurements, its location, and duration as well as questionnaire design.
- 3) Approached the Industrial state in Kathmandu, Lalitpur, and Bhaktapur and solicited their support in the form of a letter to the respective selected industries in their respective industrial areas/estate.
- 4) Approached the selected Industries in Patan Industrial Area, Bhaktapur Industrial Estate, and Balaju Industrial Estate.
- 5) Field Visit for sound level measurement and questionnaire survey in the selected noisiest industries in all three Industrial areas.

SLM 4012 Model , IEC 61672, Fast Auto Mode of operation were selected to take the measurements. Before going to the field, instruments were calibrated by Professional Calibrator OSH Expert.

The industries were selected based on the assumption that if the compliance status of the noisiest industries known through this study, will give a good indication of the status of the noise and its compliance with the permissible exposure limit of other industries.

Thus known noisiest group of industries located in the three industrial estate of Kathmandu Valley were selected.

To establish criteria for collecting data, we conducted an initial survey at the selected Industrial State of Kathmandu, Lalitpur & Bhaktapur Industrial Area & Balaju Industrial Area, we selected and surveyed 3 types of industries: Aluminum Pottery Industry, Textiles & Metal fabricators. In Bhaktapur Industrial Area, we visited 4 industries (two textiles industries,



Figure 2. Sound Level Meter used for noise measurement

and two welding fabricating industries). In Balaju Industrial Estate, we visited 5 industries (3 Aluminum industries, 1 Welding, and 1 Textiles Industries). In Lalitpur industrial estate we visited 3 industries (1 Textile and 2 Metal Fabricating).

Table 2. Industries studies (12 industries in 3 Industrial Estate)

Particulars	Patan Industrial Estate, Lalitpur	Bhaktapur Industrial Estate, Bhaktapur	Balaju Industrial Area, Balaju
Textiles Industry	Shree Textiles	Subhalabh (Samriddhi)Textiles , Arun Textiles.	Bishnu Textiles
Structural Engineering Workshop	Purna Metal Concern, Structo Nepal	Nepal Transformer, Dibyashwori Grill udhyog.	Balaju Yantrasala
Metal Industries			Shakya Aluminium, Balaju Metal Industries, Eco-rolling
Total	3	4	5

In Every industry, 5 Questionnaire was done, with the workers, and Sound was measured with the sound level Meter (SLM) was measured and tabulated. Sound levels at different locations and operations within about proximity of a meter from the equipment were taken. Sound levels were noted for 2 Minutes continuously in each section at an interval of 2 hours.

Table 3. Questionnaires survey in 60 industries.

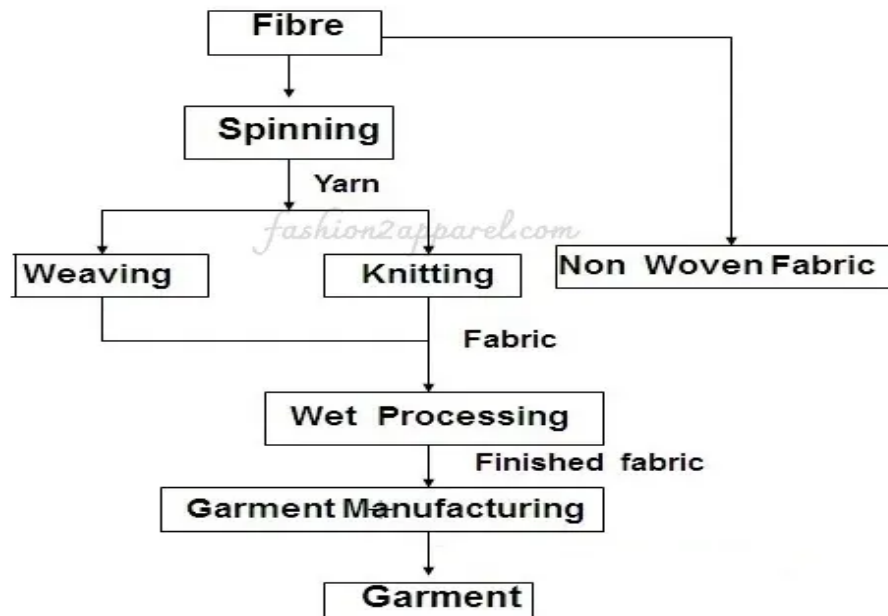
Particulars	Textiles Industries	Structural Engineering Workshop	Metal Industries
Patan Industrial Estate	Shree Textiles – 5	Purna Metal Concern – 4 Structo Nepal – 5	
Bhaktapur Industrial Estate	Arun Textiles—5 Subha labh Textiles – 5	Nepal Transformer – 5 Dibyashwori Grill Udhyog—6	
Balaju Industrial Estate	Bishnu Textiles – 5	Balaju Yantrasala- 5	Shakya Aluminium – 5 Balaju Metal Industries- 5 Eco- rolling- 5
Total	20	25	15



Figure 3: Questionnaire survey with the industrial workers.

4.1 Textile Industry

The Process of making clothes in the textiles industries was very difficult, first of all, they brought thread from India and roll the thread in small sticks and placed 10/12 roll in a once, and start the machine continuously for 8 hours and after that clothes prepared from the machine they take out that clothes and take it for dyeing and after dyeing completed they take out that clothes from dyeing machine and let them for dry and after drying they fold them and make ready for supply



A schematic diagram of the textile industrial process has been described below.



Figure 4: Textile Industry different units where noise measurement is taken.

4.2 Aluminum Metal Industry

In Aluminum Metal Industries, first of all, they recycle the old equipment and make it ready for melting all equipment, melting them in a very high flame and melting let them cooled. After cooling will be placed in casting to make a plate. casting placed in the hot rolling machine for thickness rolling. The hot rolling is followed by a cold rolling machine for anal cut and then placed in another machine for circle cut. The circular plate thus prepared can be ready to use for making pots of the required size, shape, and uses. The potteries thus prepared are ready to supply to the market. Some industries are producing circular plates that have been used by other industries to produce pottery.

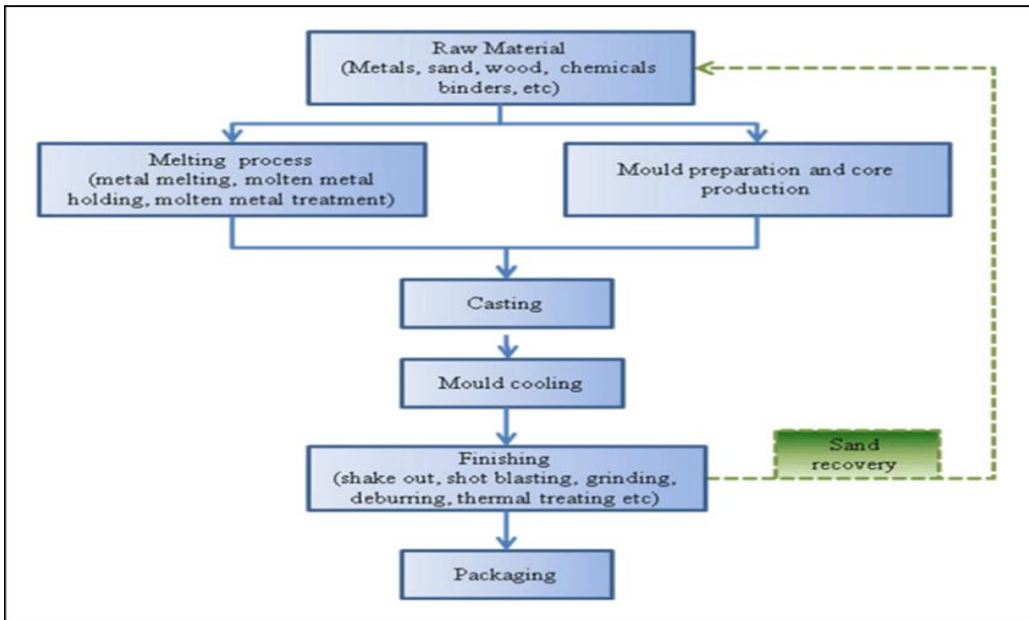


Figure 5: Figure showing the Aluminum Metal industry Process where noise measured



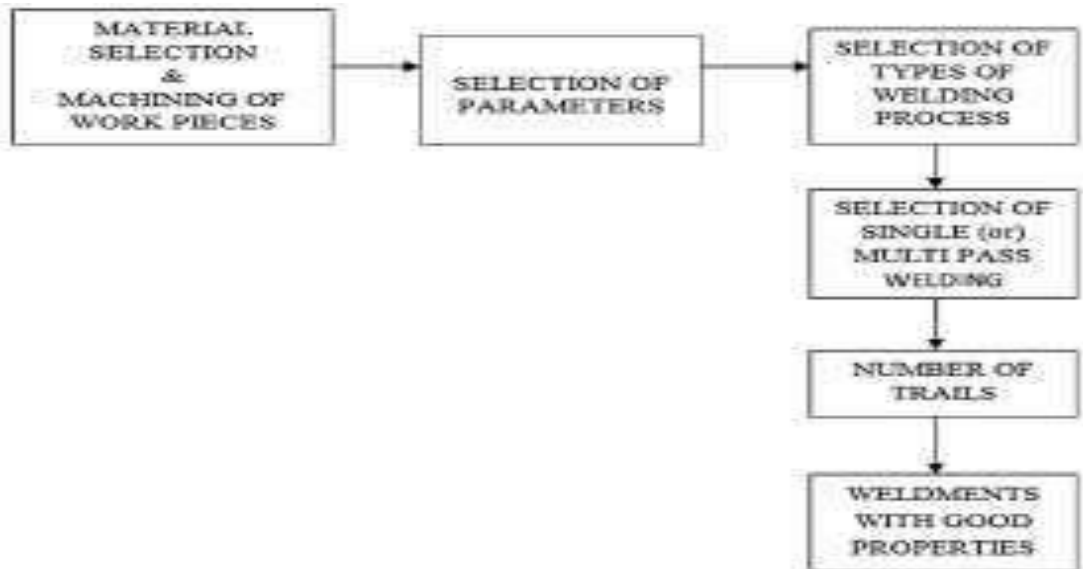
Figure 6: Noise Level Measurement in Aluminum Industry.

A schematic diagram of the Aluminum industrial process has been described below



4.3. Engineering Structure and Welding Industry

In welding Industries, cutting, grinding, and welding was the main process carried out to perform engineering structure as well as other metal fabricating work. First of all, they cut the iron in the appropriate size which is needed for work, and after cutting they weld them together, after welding they grind that metal and make it in a final shape. pieces that are assembled later to make a required structure of different size and shape through welding.



A schematic diagram of Engineering structure and welding industry



Figure 7: Figure showing the Structural engineering and Welding Process.

4.4. Noise level monitoring and Leq Derivation

Above mentioned selected industries have been visited along with the Noise Level Meter and set of Questionnaires. The Sound pressure level was measured for 2-3 min continuously at the interval every 2 hours based on the fact that the sound the remain same throughout the process. The measured value was average and Leq, L10, and L90 have been derived using the formula given below the result can be tabulated in the Result and Discussion Section of the Report.

Similarly, 60 Workers from 12 Industries were interviewed with the help of a Pre-Tested Structured questionnaire. The information thus obtained has been analyzed using Microsoft Office and the Findings are described in e Results section.

Leq (or LAeq) is the Equivalent Continuous Sound Pressure Level

Equivalent Continuous Sound Pressure Level, or Leq/LAeq, is the constant noise level that would result in the same total sound energy being produced over a given period.

LAeq is a fundamental measurement parameter designed to represent a varying sound source over a given time as a single number. This number is a measure of the energy contained within the sound at the point of the receiver. This is useful in terms of the potential for sound to damage or disturb and is extensively used in environmental noise standards as well as many other regulations and documents.

Derivation of Leq

It can be measured in either A, C, or Z (Linear) modes, but you should remember that it's not an 'average sound level', as it is sometimes referred to. In the equation used to calculate Leq, it's important to remember that this doesn't calculate a specific average level.

Leq can be described mathematically by the following equation:

$$L_{eq} = 10 \log_{10} \left(\frac{1}{T_M} \int_0^{T_M} \left(\frac{P(t)}{P_0} \right)^2 dt \right)$$

Where:

- *Leq is the equivalent continuous linear weighted sound pressure level re 20μPa, determined over a measured time interval Tm (secs)*
- *P(t) is the instantaneous sound pressure of the sound signal*
- *P0 is the reference sound pressure of 20μPa*

When the instantaneous A-weighted sound pressure (PA) of the sound signal is introduced the equivalent continuous A-weighted sound pressure level determined over time interval Tm is as follows:

$$L_{eq} = 10 \log_{10} \frac{1}{T_M} \int_0^{T_M} \left(\frac{P_A(t)}{P_0} \right)^2 dt$$

In practice, it is possible to take Leq readings in durations as short as 5 minutes, so long as your sound meter provides all variations of noise emissions. As with any sample of data, the more you have the more accurate your results.

For this reason, we'd recommend longer than 5 Leq measurements to ensure greater accuracy.

How to add Leq values together

Adding Leq values requires taking an anti-log of each value.

The addition can be performed as shown:

$$\text{Total Leq} = 10\log\left(10^{\frac{\text{Leq1}}{10}} + 10^{\frac{\text{Leq2}}{10}} + 10^{\frac{\text{Leq3}}{10}} + \dots + 10^{\frac{\text{Leqn}}{10}}\right)$$



Figure 8: Meeting with Industry Owner

5. Legal and Institutional Review:

Nepal promulgated a Constitution through the Constituent Assembly on 20 September 2015 which encompasses over 30 different fundamental rights including that of workers and/or labours in line with the International Labour Standards and others and also includes the compensation provision in case of failure of ensuring these fundamental rights by the perpetrator. The Constitution of Nepal have provision for fundamental right such as the Right to live in a Clean Environment(Article 30) the Right related to Labour (Article 34) and the Right relating to Health (Article 35). Furthermore, Article 34(2) Every laborer shall have the right to appropriate remuneration, facilities, and contributory social security.

In summary, the right to employment and social security, the right to form trade unions, and the right to collective bargaining, etc. are major labor-related rights already included in the constitution of Nepal. Similarly, the government, with the consent of Workers' and Employers' Organizations, has also formulated new labour and social security bills that comply with minimum labour standards and have already been promulgated. These bills, ensure fundamental rights and are expected to address more than ninety percent of the labor-related issues and problems up to their effective implementation.

Chapter 12 of this Act dealt mainly with **Health and Safety issues** and has made very good provisions listed below in different sections of the Act.

Section 68: Formulation of Safety and Health Policy: As per the Labour Act, the entity should formulate the safety and health policy as per the Regulation or Directive. Such policy should be registered with Labour Office. Labour Office can do regular monitoring and evaluation of the implementation of the Health and Safety policy prepared by employers.

Section 69: Employer's Duties towards Labour- The Labour Act has set out the duties of employers towards workers which include making appropriate safety and health arrangement, arrangements ensuring no adverse effect on workers from the use, operation, storage, or transport of chemical, physical or biological substances, disseminating necessary notice, information and training related to safety and health arrangements, etc. It also sets out the general obligation of employers towards non-workers such as putting the signs to indicate the safety or health hazards, to manage the gas, chemicals waste of the entity so as not to cause adverse effect on local animals, people or environment, etc. It also ensures the availability of adequate needed personal protective equipment (PPE) and another arrangement as prescribed. No, the fee will be charged to labour against making available any PPE or accessories.

5.1. Laboratory-induced Hazardous Allowance Guideline 2015:

As per the power conferred by the Local Governance Act 2007 (Section. 45), the Government of Nepal has prepared this guideline. According to this guideline, people working in a laboratory for analysis, research, and training under the controlled condition using different chemicals, radiation,

microorganism, and scientific equipment hampering the health in any Government of Nepal's Offices and working place are entitled to get a laboratory-induced hazardous allowance as decided by the hazardous allowance committee.

Section 10 of the Industrial Enterprises Act 2020 the provision of regular Monitoring and Inspection of the Industry by the concerned ministry and agencies that provide registration of the industry.

Section 48 of IEA 2020 has the provision of Nepal Enterprises/Occupational Forum for effective implementation, coordination, and facilitation of laws and policies related to industrial enterprises.

This act has the provision of requiring permission or license for establishing some of the industries having significantly caused adverse effects on security, public health, environment shall require to obtain permission for their establishment, extension, and diversification.

5.2. Labour Act 2017

Labour Act 2017 aims to protect the right of employees as well as employers to **eliminate all forms of labour injustice and boost production**. The recently endorsed Labour Act-2017, which requires employers to ensure a safe working environment for workers' health and safety.

The guarantee of Occupational Safety and Health (OSH) of workers at the workplace in the latest labor legislation is the first-ever instance of workers' health and safety of workers being secured by the country's law. This is a milestone for Nepal's labour rights.

Under the Act, employers must be responsible for keeping workers safe from health hazards that might come from the use, storage, and operation of any chemical, physical materials, and equipment at the workplace (Labor Act 2017, Section 69, 1. b). "In cases of factory and industry workers, they are worn at adverse conditions here they are likely to get exposed to toxic chemicals and other hazards. With the Act, it now becomes imperative that the safety and health of such workers have to be ensured by their employers (Labor Act 2017, Section 69, 1. a)."

The Act has a special provision for the treatment of workers if they suffer from diseases or are maimed due to lax health and safety measures in their workplace (Labor Act 2017, Section 82, 1). In such a case, the concerned employer should bear all treatment expenses. And if the condition is incurable, there is also a provision of compensation. "After working at the workplace for a long time, a worker may contract life-threatening diseases or suffer injuries, making them disabled for the rest of their life. For such a situation, the new law has made arrangements for free treatment and compensation, which is praiseworthy (Labor Act 2017, Section 82, 1),"

"This law comprehensively tries to cover several issues related to workers' safety from possible workplace accidents and injuries as well as post-accident situations," The Act has a provision (Labor Act 2017, Section 74, 1) that states the formation of a safety and health committee within the organization with 20 or more workers. Where 10 or more employees are engaged in the entity,

the employer shall also constitute the Collective Bargaining Committee as per Section 116 of the New Labor Act 2017.

The Labour Act and its subsidiary rules are the main legislation in the country that covers exclusively the working conditions, welfare of workers, **safety, and health**, and industrial disputes. The coverage of the Labour Act is confined to enterprises employing ten or more workers^[1].

Labour Act 2017 especially aims to protect the rights of the employees as well as employees to eliminate all forms of labour injustice and boost production.

Section 78: Special arrangement for Occupational Safety and Health: Enterprises working in the following sector should adhere to the prescribed OSH standards

- a. Eye protection
- b. Prevention of chemical exposure
- c. Pressure plants operation
- d. Protection from Machines partition
- e. Heavy weight lifting
- f. Other required arrangements etc.

Section 82. Medical Expenses- In case any worker suffers from a work-related occupational disease, he/she should be provided medical expenses. And where such disease cannot be cured the worker should be provided compensation as prescribed. If victims get treatment from the Social Security fund, employers are not liable to make payment for any medical expenses.

5.3 Labour Regulation 2018

Rule 34 (Chapter 7) of the Labour Regulation required to formulate of Occupational Safety and Health policy at any enterprise comprising assurance of complete OSH condition.

Rule 44 has provisions for other additional Occupational Safety and Health such as

- Maintain cleanliness and hygienic conditions to prevent workers from waste smell and diseases.
- Arrange adequate and clean air, light, and appropriate temperature.
- Appropriate management of waste and other small parts.
- **Use of appropriate noise control equipment to protect health impact associated with excessive noise pollution.**

Rule 48: Role and Responsibility of OSH Inspectors

Sub-rule 48(1) The Senior OSH and OSH Inspectors shall have the following role, responsibilities, and power concerning OSH including • Compliance monitoring of the responsibilities carried out by employers as per the rules 39, 40, 41, 42, and 44.

Once a year, inspect boilers and pressure vessels, and other life-threatening dangerous machines and permit their operation for a year;

5.4 Regulatory Provisions on Industrial Inspection in Nepal

As per the Labour Act 2017 of Nepal, Chapter 1, Section 2: Definition (7) has defined the term “Inspectors “as Senior Labour Inspector, Labour Inspector, Senior OSH Inspector, OSH Inspectors including all other Officials deputed for inspection.

Chapter 15: Provisions relating to Inspection: Section 93 have provision for the establishment of the Labour Office and Labour Inspectors. Subsection 93(1), as per the needs, the Government of Nepal can have established a Labour Office as prescribed in the prevailing Labour Act and any other labor-related regulatory mechanism, with define the scope of the district covered (93-2) and can **appoint needed one or more Inspectors** by notification in the **Nepal Rajapatra (Gazette)**, for any specific region as necessary (93-3).

Section 94 of the Labour Act has a provision about the Role, Responsibilities, and Duties of the Labour Office.

General monitoring of wages, allowance, group contract terms and conditions, benefits, and effective implementation of regulations and directives. Provide training, and technical support to conduct training.

Monitoring child labour employment status, if found, immediately rescue the children and take appropriate actions against employers.

Inspect the effective implementation of all provisions enshrined in Chapter 12 related to **OSH** (Sections 68 to 83).

- Monitoring the compliance of minimum wages, allowance, and group contract terms and conditions about set terms, conditions, and benefits prescribed under this Act.
- Regular monitoring of the effective implementation of regulation and issuing necessary directives.
- Provide training about the code of conduct and standards formed under this act, and related labor-related laws and also carry out regular monitoring of effective implementation.
- Provide necessary technical support to conduct the training to employees and employers.

- Issue directives to provide information about OSH-related standards or official regulations or any other important documents.
 - Implements the group contract terms, contend, and mediator's decisions.
 - Monitoring child labor employment status, if found, immediately rescue the children and take appropriate actions against employers.
 - **Inspect the effective implementation of all provisions enshrined in Chapter 12 related to OSH.**
 - Observe or Inspect established machines, equipment, or any other objects or substances as per their prescribed standards or not? A sample can be drawn if deemed necessary to test.
 - Regular and ad hock inspection of enterprises and offices.
 - Ask for making available any record on electricity, registers, and written documents. If not made available, Inspectors can directly enter the office/enterprises and obtain the original copies in their custody of the same or a Xerox copy with their affidavits.
 - Obtain required information on necessary matters from administrative-level employees.
 - Take affidavits from the administrative level or any other employee by calling them into the labor office.
 - Issue directive order to take necessary corrective measures in case of receiving any information regarding a violation of this act and regulation during the inspection and/or received complaints from any other means.
 - Maintain the record of any application, documents, or information from any other sources. Provide the registration no. of such complaint,
 - Discharge any other duties as prescribed.
- Additional required support from local administration, police, or any other organizations can be obtained by making a formal request.

5.5 Institutional Arrangement for Factory Inspection

Several institutional arrangements exist in Nepal responsible for factory inspection. In addition to that the OSH Policy 2019 have provision for formulating three-level (Federal, provincial and local) OSH-related institutional arrangements.

- Ministry of Labour, Employment and Social Security (MoLESS)
- Department of Labour and Occupational Safety (DoLOS)
- Labour and Employment Offices (11 No.)
- 13 factory inspectors including 1 Female (Mechanical engineer is the inspector) including One Senior Factory Inspector and one Technical Director
- Occupational Safety and Health Center (OSHC).

As per the provision of the Labour Act 2017, Section 93 about the establishment of a **Labour Office and Labour Inspectors, the Government of Nepal, Ministry of Labour, Employment and Social Security (MoLESS) has allocated some 11 Labour Officers with their scope and coverage district through publishing a gazette notification dated 2075/8/10 BS (26 November 2018), Gazette Number 42, Part 5.** According to this gazette notification, the following labour

offices cover these details districts for their area of jurisdiction related to labour and occupational safety-related issues.

Table 4. Labour Offices and their jurisdiction

S.No	Office Name	Districts under their Jurisdiction	No. of Districts
1	Labour and Employment Office, Bhadrapur, Jhapa	Taplejung, Panchthar, illam, Jhapa, Terhthum and Dhankuta.	6
2	Labour and Employment Office, Biratnagar, Morang	Solukhumbu, Okhaldunga, Khotang, Udaypur, Bhojpur, Sakhuwabha, Sunsari and Morang	8
3	Labour and Employment Office, Janakpur, Dhanusha	Dhanusha, Mahotari, Sharlahi, Siraha, and Saptari	5
4	Labour and Employment Office, Birgunj, Parsa	Bara , Parsa and Rauthat	3
5	Labour and Employment Office, Hetauda, Makwanpur	Makwanpur, Chitwan, Dhading, Ramechhap, Sindhuli, Dolkha	6
6	Labour and Employment Office, Teku, Kathmandu	Kathmandu, Lalitpur, Bhaktapur, Kavreplanchowk, Sindupalchowk, Nuwakot, Rasuwa	7
7	Labour and Employment Office, Pokhara, Kaski	Nawalparasi, Gorkha, Tanahu, Lamjung, Manag, Mustang, Kaski, Parbat, Baglung, Maygdi and Shayanja	11
8	Labour and Employment Office, Butwal, Rupandehi	Gulmi, Palpa, Arghakhachi, Kapilvastu, Rupandehi, Nawalparasi, Rolpa, Pyuthan	8
9	Labour and Employment Office, Nepalgunj, Banke	Rukum, Banke, Bardiya, Dang	4
10	Labour and Employment Office, Birendranagar, Surkhet	Rukum, Surkhet, Dailekh, Jajarkot, Kalikot, Jumla, Humla, Mugu, Dolpa, Salyan	10
11	Labour and Employment Office, Dhangadhi, Kailali	Kailali, Kanchanpur, Dadelhura, Doti, Bajhang, Bajura, Achham, Darchula, Baitadi	9
Source: Kand 68, Gazette notice dated 2075/8/10 BS (26 November 2018), Gazette Number 42, Part 5.			

Powers to Determine the Standards: (1) Government of Nepal may prescribe the standards of safety required under this Chapter as per necessity by publishing a notice in the Nepal Gazette. (2) Except those mentioned in Sub-section (1), other provisions relating to health and safety to be adopted while using machinery, instrument, or equipment in the Enterprise shall be as prescribed.

6. Results and Discussion

The Sound pressure level was measured for 2-3 min continuously at the interval of every 2 hours based on the fact that the sound remain the same throughout the process. Measured values were average and Leq, L10, and L90 have been derived using the formula given the result can be tabulated in the Result and the Discussion has been included below.

6.1 Result of Compliance Monitoring of PEL of Noise

Table 5. Compliance Monitoring Results of PEL of Noise at the Workplace of Nepal

SN	Name of Industry	Statistically Analyzed Noise Data dBA			GON, PNL 90 dBA Using a 5 dB exchange rate	OSHA Noise Limit 85 dBA (Using a 5 dB Exchange Rate)
		Leq*	L10**	L90***		
1	Shree Textile, Patan,	84.1	83.4	84.2	Comply	Comply
2	Structo Nepal, Patan	83.9	82.3	84.6	Comply	Comply
3	Purna Metal Industry, Patan	84.9	82.1	86.7	Comply	Comply
4	Samridhhi Textile, Bhakatapur	80.6	74.1	82.9	Comply	Comply
5	Arun Textile, Bhakatapur	91	90.1	91.3	Non-Comply	Non-Comply
6	Nepal Transformer, Bhakatapur	82.4	79.4	83.2	Comply	Comply
7	Balaju Yantrashala, Kathmandu	90.7	87.8	92.5	Non-Comply	Non-Comply
8	Shakya Aluminum Industry Kathmandu	96.2	83.5	98.4	Non-Comply	Non-Comply
9	Bishnu Textile, Kathmandu	82.3	71.5	83.9	Comply	Comply
10	Balaju Metal, Kathmandu	96.3	84.1	98.4	Non-Comply	Non-Comply
11	Eco Rolling, Kathmandu	95.9	82.8	98.7	Non-Comply	Non-Comply
12	Divyeshwori, Bhaktpur	89.4	86.1	89.4	Non-Comply	Non-Comply
Inference					6/12 (50%) Comply	6/12 (50%) Comply
* Leq ²	<ul style="list-style-type: none"> Leq is the equivalent continuous sound level and represents the total sound exposure for the period of interest or an energy average noise level for the period of interest. Leq is often described as the “average” noise level during a noise measurement which although not technically correct, is often the easiest way to think of Leq. If the noise is varying quickly, the average energy over some time is a useful measurement parameter and it is, for this reason, Leq is often called the Equivalent continuous level. Leq values should be written with a Frequency Weighting, such as dB(A), and also the measurement duration. For example, LAeq, 5min = 90d 					
** L10	The noise level exceeded 10% of the measurement, calculated by statistical analysis					
*** L90	The noise level exceeded 90% of the measurement, calculated by statistical analysis					

In Leq: 6 out of 12 which is 50% of the industries exceeded more than 85 dBA.

In L10: 3 out of 12 which is 25% of the industries exceeded more than 85dBA

In L90: 6 out of 12 which is 50% of the industries exceeded more than 85 dBA.

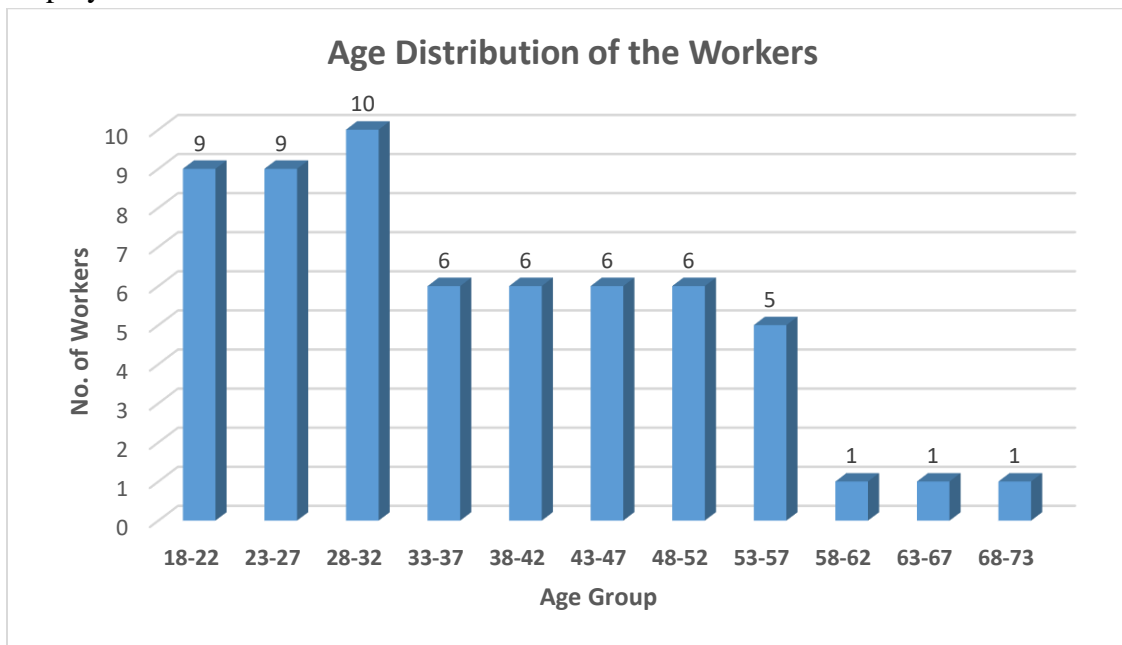
² [noise-measurement-terminology-guide.pdf \(cirrusresearch.co.uk\)](https://www.cirrusresearch.co.uk/noise-measurement-terminology-guide.pdf)

6.2 Questionnaire Survey Analysis

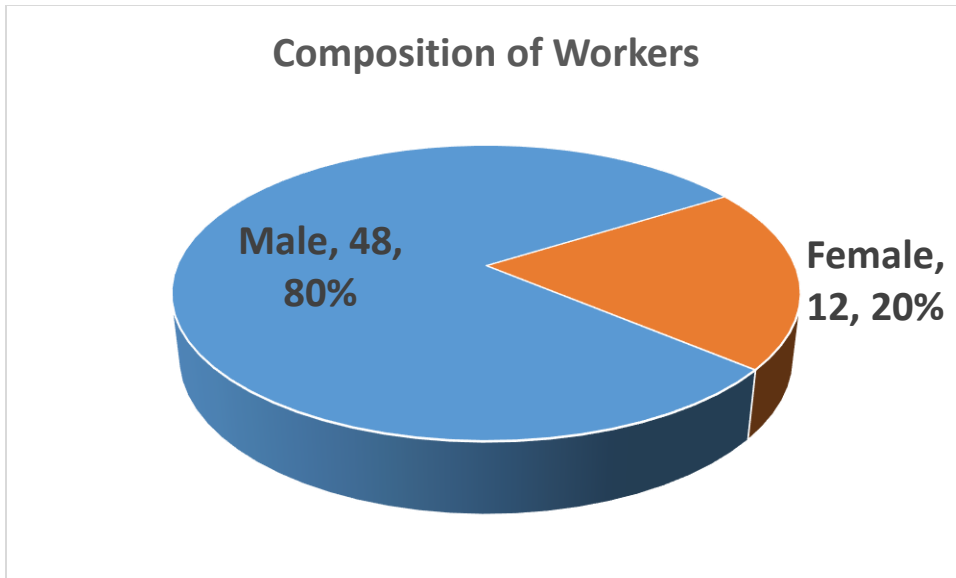
Similarly, 60 Workers from 12 Industries were interviewed with the help of a Pre-Tested Structured questionnaire. The information thus obtained has been analyzed using Microsoft Office and the Findings are described in the following section.

I. Age and Gender Distribution of the Workers

Various age groups of workers are being employed by different industries. Most of them. The age of the workers ranges from 18 to 73. As per the age distribution, no child labor is employed in the studied industries.

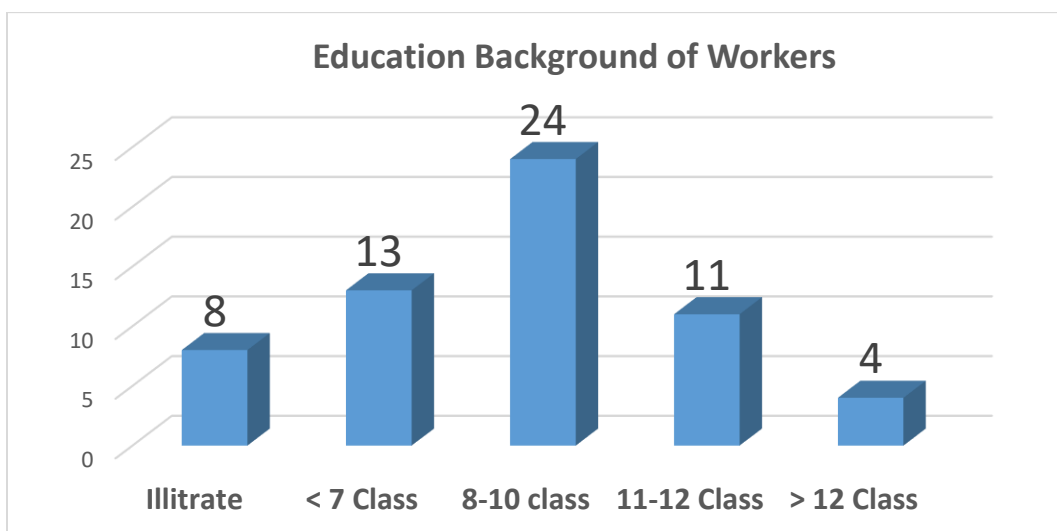


In the industries studied from the textile, metal, and engineering workshops, dominant workers were male over lesser female workers. Among the total 60 respondents, 48(80%) were male and only 12 (20%) were female. Female workers were dominant in the textile industry.



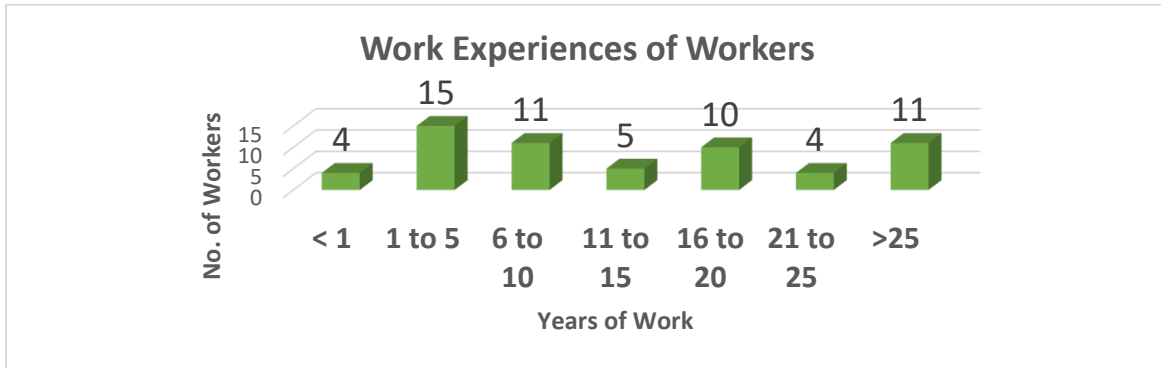
II. Education Level of Workers:

Poor education levels have been found among workers which is one of the hindering factors to made aware of occupational safety and health issues among them. There were very few numbers of workers who studied more than 12 classes which were only 4 in number among a total of 60. The workers who studied (the 11-12) class were 11 in number, Likewise, the workers who studied (the 8-10) class were 24 in number, the workers who studied less than 7 class were 13 in number and the workers who has never attended the school were 8 in numbers.



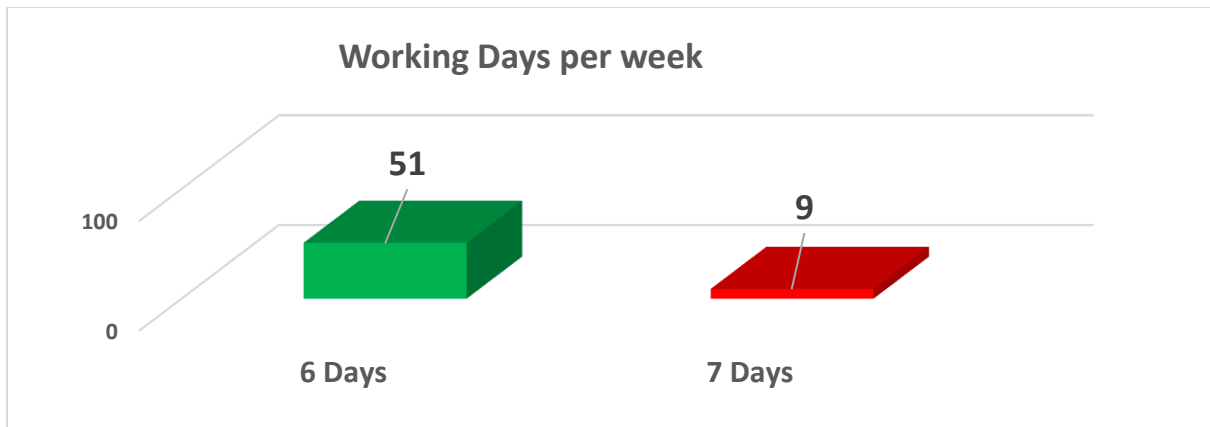
III. Duration of Work:

Workers have worked a varied number of years in the Nosiest Workshop. The workers who worked with welding fumes for more than 25 years were 11 in number, more than 21 years are 4 in number, more than 16 years are 10 in number, more than 11 years are 5 in number, more than 6 years are 11 in number. The majority of the workers have fewer years of working experience 15 in numbers workers have worked for (1-5) years which is the highest among all and less than the one-year working experience of workers 4 in numbers.



IV. Working Days of Workers:

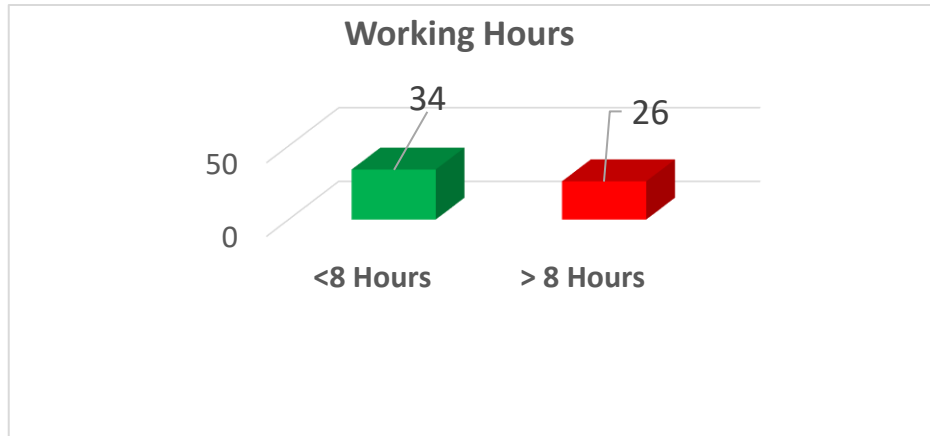
The majority of the workers (85%) were found to be working 6 days a week.



V. Working Hours

The workers who work for (0-8) hours per day were 34(56.66%), the workers who worked for more than 8 hours per day were 26(43.33%) and most of the workers work for more than 8 hours to earn extra money as overtime. The Labor Act 2017 of the Government of Nepal has the provision of 8 hours per day normally. For the continuous nature of work, a half-hour break time has to be given after continuously working for 5 hours. Overtime working hours is not a compulsion. There is some provision for working not more than 4 hours of overtime per day or a

total of 24 hours of overtime a week. A substantial number of workers (43.33%) were reported to be working over normal hours. **Some of the workers found to be working 12 hours a day as normal duty hours in some industries is illegal as per the labor laws.**

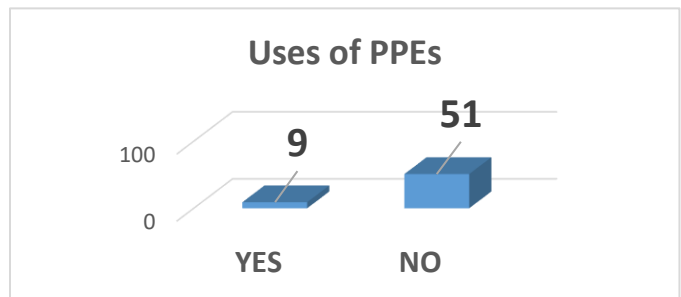


As a significance number of workers work more than 8 hours per day. This means it reduced the noise exposure limit might prevail better. Thus for such situation for a 12 hours per day, the noise exposure limit would be 82 dBA using a 3 dB exchange rate, or for a 10hr/day, it would be 83 dBA . Looking at this ,non-compliance rate would go to even higher range.

The number of workers who worked for 6 days in a week was 51 (85%) and 7 days in a week was 9 (15%), most of the workers work for 6 days in a week. The Labor Act 2017 of the Government of Nepal has the provision of working 6 days a week however, some of the workers were reported to be working all 7 days a week.

VI. The Practice of using PPEs (Personal Protective Equipment)

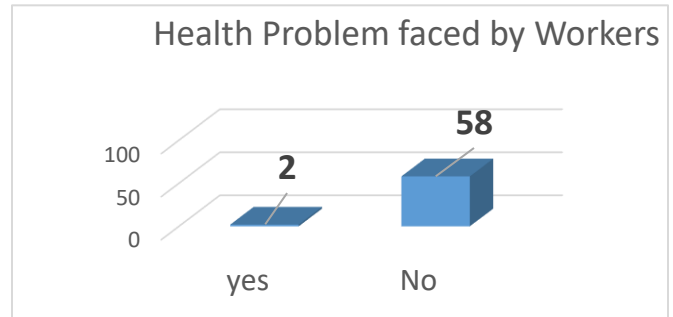
The Welding Workshops, Textiles Industries & Metal Industries were claimed to be provided with all the PPEs to workers are not using them all, in all, welding workshops, Textiles Industries & Metal Industries, the works were hardly seen using full PPEs. Most frequently they were seen using gloves in welding industries & Metal Industries. In Textiles Industries no workers used PPEs. They said PPEs make it difficult while doing work.



None of the woekrs in any industries has given the Hearing Protection Devices (HPD) and any PPEs for ear protection like ear plugs or ear muffs.

VII. Health Problems of Workers:

Among the total number of workers who complain about health problems was very less in number which is 2 (3.33%). Most of them were not related to the noise problem. They mostly complain about back pain and knee joint pains. The number of workers who didn't complain about their health was 58 (96.66%) in numbers.



None of the workers complain about the hearing related health problems rather other ergonomic related issues needs to be further studied in large scale and with more scientific ways.

VIII. Knowledge about the GON's Permissible Noise Limit

None of the workers and even industry owners were aware of the GON's permissible Exposure Limit (PEL) of Noise at the workplace thus massive awareness program should be launched.

7. Conclusion:

This is the first-ever study carried out by an independent Non-Governmental Organization (NGO) called the Center for Public Health and Environmental Development (CEPHED). A mixed method of scientific measurement of the continuous noise level for about 2-3 Minutes and at an interval of 2 hours was taken using SL-4012 (IEC 61672 Class 2), Auto range Sound level meter in some 12 noisiest industries of three categories (Metal workshop, Textile and Aluminum industries from Balaju, Patan and Bhaktapur industrial estates of Kathmandu, Bhaktapur, and Lalitpur.

The result thus obtained was converted into an 8-hour weighted average to compare with the Government of Nepal's and OSHA's permissible exposure limits (pls see Table 3).

The average 8 Hour time-weighted average personal noise levels measured in this study ranged from 71 to 99 dBA. From this study, the compliance of GON PEL of Noise at the workplace for 8 hours TWA Hearing protection shall be mandatory above 85 dBA has been found to comply only in 6 of 12 (50%) of industry. And only 58% of the industry has been found to comply with the 90 dBA standard value that has aimed to be amended after 5 years since Gazette notification on 6th April 2017. This indicates that 50% of Workemployed of the noisiest industries are in a vulnerable state of work and exposed to high levels of noise beyond the permissible exposure limit. Whereas the compliance rate against the OSHA standards of 85 dBA is the same in 6 of 12 (50%) of the studied industries in Nepal. This calls for immediate action needs to be taken as there has been least compliance has been achieved even after elapsing more than 6 years of gazetting the permissible exposure limit of noise by the Government of Nepal.

No child labor is employed in the studied industries. Various age groups of workers are being employed by different industries ranging from 10 to 73 years of age. One-third of workers surveyed are below 32 years of age. So it can be inferred that the younger the workers longer would be the

exposure period to a higher level of noise as they work for a longer duration in comparison with their old age colleagues.

In the industries studies from the textile, metal, and engineering workshops, dominant workers were male over lesser female workers. Among the total 60 respondents, 48(80%) were male and only 12 (20%) were female. Female workers were dominant in the textile industry.

Poor education levels have been found among workers which is one of the hindering factors to made aware of occupational safety and health issues among them.

The majority of the workers have fewer years of working experience 15 in numbers workers have worked for (1-5) years which is the highest among all and less than the one-year working experience of workers 4 in numbers.

The majority of the workers 51 of 60 (85%) were found to be working 6 days a week and 9 of 60 (15%) workers work for 7 days a week

Workers who work for (0-8) hours per day were 34(56.66%), and the workers who worked for more than 8 hours per day were 26(43.33%).

The Labor Act 2017 has the provision of working 6 days a week however, some of the workers were reported to be working all 7 days a week and more than the prescribed 24 hours of overtime a week

Very few workers 2 (3.33%). complain about health problems was found to be a good sign however, that needs to be verified by large-scale study. Most of the problems were related to ergonomics rather than audiometry. However, they wish to have regular medical check-ups.

Industries were claimed to be provided with all the PPEs to workers are not using them all, in all, welding workshops, Textiles Industries & Metal Industries, works were hardly seen using full PPEs. Most frequently they were seen using gloves in welding industries & Metal Industries. In Textiles Industries no workers used PPEs. They said PPEs make it difficult while doing work. **None of the workers in any industries has given Hearing Protection Devices (HPD) and any PPEs for ear protection like ear plugs or ear muffs.**

Publishing standards in Gazette is not enough to be effective. As very important finding of this study was, **none of the workers and even industry owners were aware of the GON's Permissible Noise limit standard at the workplace** thus massive awareness programs about the popularization of the PEL of Noise at the workplace as well as the impact of occupational noise needs to raise.

8. Recommendations:

1. As the 5-year time of amendment has already passed, It is time to amend the PEL of Noise at the workplace based on the formulation of the standard.

2. As the compliance rate of PEL of Noise at the Workplace is just 50%, enforcement of the standards should be made effective and increases compliance through regular monitoring.
3. Technology improvements through Tax /Subsidies, barrier mechanisms, silencer provision, acoustic material construction of the industry, etc. should be immediately made,
4. Regular grease and oiling of the machine to reduce the noise level.
5. Arrangement of the enclosure across the noisiest equipment and operation process under the engineering and organizational controls program.
6. Awareness among the workers and industry owners about noise pollution and its impacts on workers' health as none of the industry owners and workers were known about the existence of the PEL of Noise at the workplace.
7. Regular medical check-ups including audiometry-related issues. As per the Labour Law, the provision of annual medical checkups should include an audiometric assessment.
8. Large-scale compliance monitoring of PEL of noise levels as well as noise exposure assessment, and hearing-related health issues in all types of industries should be carried out regularly **in periodic and more scientific ways.**
9. PEL Standards has the provision of Hearing protection shall be mandatory above 85 dBA. Thus, the Hearing Conservation program should be launched in each industrial estate regularly is even more important as only 50% of the studied industries have more than the prescribed noise level for the mandatory hearing protection program.
10. Training programs should be developed for workers, employers, and contractors that include the importance of communication.
11. Full PPEs should be given to all including Hearing Protection Devices (HPD) should be worn by employees with annual training provided etc.

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10. Acknowledgement

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Annex 1. Permissible Exposure Limit (PEL) of Noise for Workplace, 2017

The standard of permissible Exposure Limit (PEL) to this effect was published by the Government of Nepal based on the power enshrined according to section 36 of the Labour Act of 1992 through a gazette notification published in Khand 66, Number 63, Nepal Gazette, Part 5 dated 2073/12/14

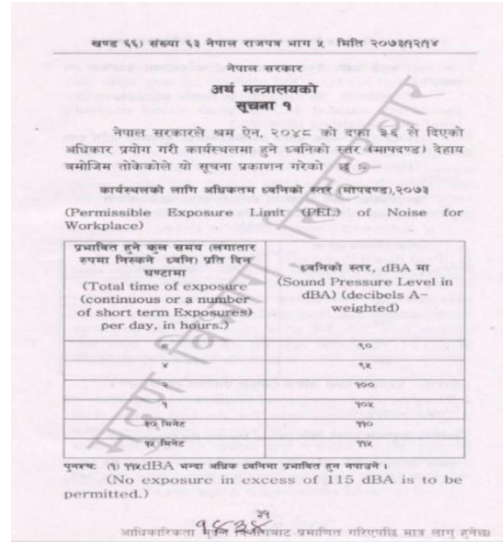
Maximum Noise Level (Standards) at Workplace

Permissible Exposure Limit (PEL) of Noise for Workplace

Total time of exposure continuous or several short-term Exposures per day, in hours	Sound Pressure Level in dBA (decibels A-weighted)
8	90
4	95
2	100
1	105
30 minutes	110
15 minutes	115

Furthermore:

- (4). No Exposure over 115 dBA is to be permitted
- (5). Exposure to impulsive or impact noise should not exceed the dBA peak sound pressure level in the C weighting network.
- (6). Hearing protection shall be mandatory above 85 dBA.



Permissible Exposure Levels (PEL) of Impulsive or Impact Noise

Peak sound Pressure Levels in dB(decibels)	Permitted number of Impulses or impacts per day
140	100
135	315
130	1000
125	3160
120	10000

No exposure over 140 dB peak sound pressure level is permitted.

The noise monitoring procedure should be guided by international Standards ISO 1996 and 1999.

Acoustics Description, measurement, and Assessment of environmental noise Part 1: Basic Quantities and assessment procedures.

Acoustics Description, measurement, and assessment of environmental noise Part 2: Determination of environmental noise levels.

Acoustics Determination of occupational noise exposure and estimation of noise-induced hearing impairment.