NOISE ASSESSMENT USING SOUND LEVEL METER (SLM)

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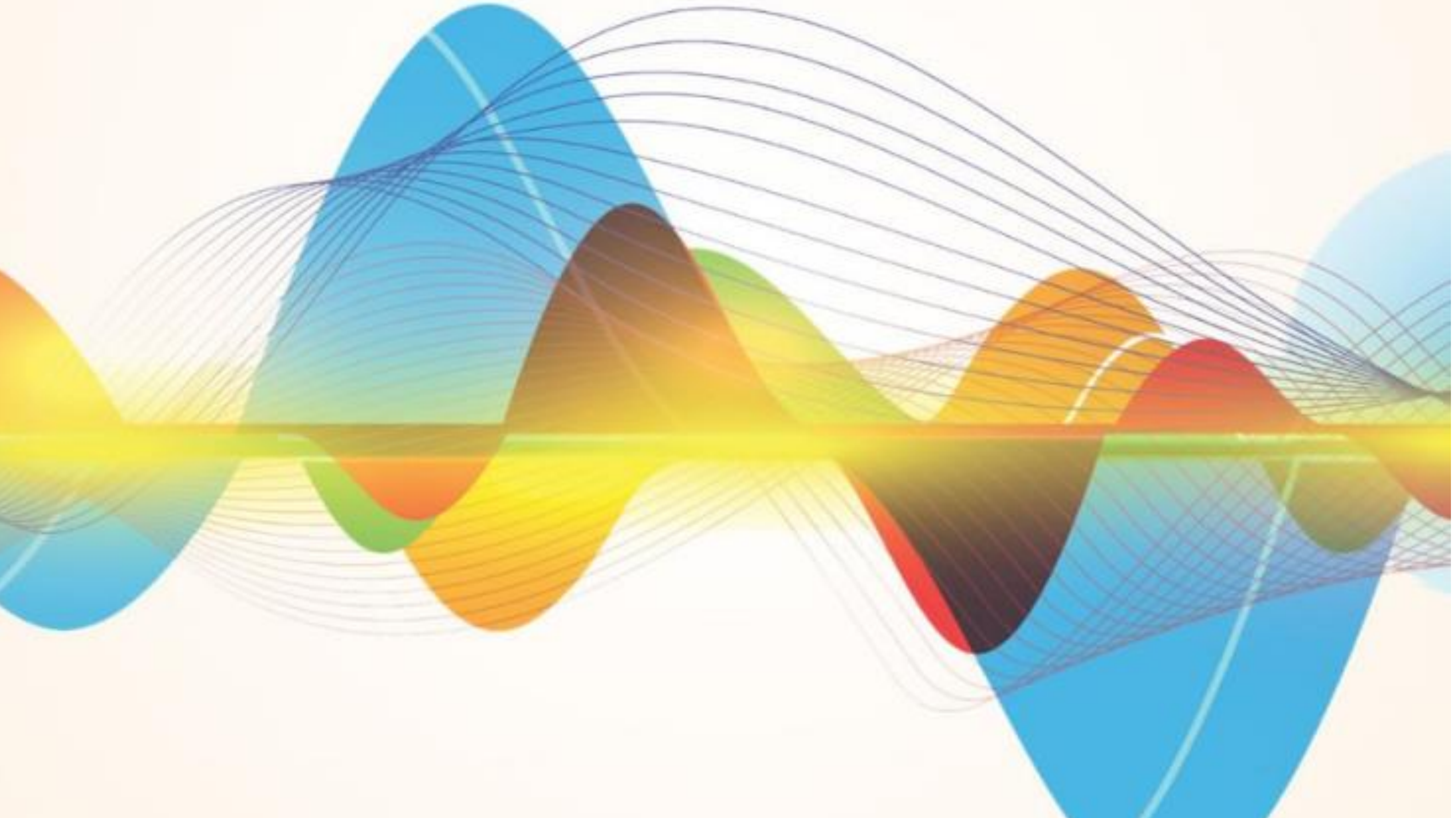

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In noise assessment a hearing noise level cannot be generalized to be similar for workshop activities as noise exposure various depending on application work activities, types of machine and material, layout of workshop design and also duration of noise exposure. This study for occupational, focused on the nature study of the activities undertaken rather than a general noise measurement. Therefore, the objective of this study was to assess the level of noise generated in a teaching workshops and compare the findings with the stated guidelines. This study only focused on the maximum level of sound production in the workshop base on total number of students involved at a certain period of time. The noise level generated in this workshop had never been assessed before. The management believe, potential risk to the students is still in the safe limit. Time weight average (TWA) and dose percentage method was used to produce the profile of the noise reading measured by the sound level meter in 8 hours every day. Exposure maximum noise level is a determining factor that has been identified by performing output data analysis from time measurements exposure of noise level meters in three days observation. Data in three days were finding total TWA amount and dose each noise level depending with time exposure. In summary, this finding can be used appropriately for the same activity for this shop only Evaluation measurements should be taken if it involves different activities in the workshop. During the observation, possibility of measuring income difference is not that significant unless there is unexpected activity when measurements are taken. This studies also developed for noise risk matrix after identify the measurement location with dose percentage and TWA value all each station also states rating of noise.

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CHAPTER 1 : INTRODUCTION

1.0 Introduction

The basic concept of noise clearly understood importantly including derivative used as a guide to the level of the noise. Noise experienced in the selected workshop will be associated with this studies have in common with acoustic problems experienced in the workshop. Selection of place can be categorized as workshops, factories or operation of a busy work area. This category is important to understand that the information sought relates to the study and helped to support this study.

Two parameters are usually used to defined the daily noise exposure level L_{EX}, 8h (= L_{aeq}, 8h = L_{EP}dB) which is the continuous level, in decibel (dB),which would, over a standard daily period of 8 hours, produce the same amount of acoustical energy as the actual daily exposure. Full Day Measurement (FDM) concept is used when the individual is exposed daily for a continuous 3 days per week, at the same level. If this is not the case for instance a work cycle of more than one day or less than 5 days perweek , the concept of weekly noise exposure level, L_{EX},w , is applied: This is a continuous measurement, in dB(A), which over a standard weekly period of 40 hours, would produce the same amount of acoustical energy as the actual weekly exposure.

Noise emission evaluation standards are available for the determination of the noise emission of machines in general or of specific items of equipment. Methods are described which deal with sound power, sound pressure and sound intensity. Kang, et al.(2013).The Factories and Machinery (Noise Exposure) 1989 guideline state that noise level must not exceed 85 dBA without Personal Protection Equipment (PPE). If the level of noise generated excessed 85 dBA, the management needs to take some action to handle this problem (Legal Research Board, 2003). They aim to guarantee the safety and comfort of employees in the workplace and indirectly provide an atmosphere of harmony in the workplace.

1.2 The Difference Between Sound and Noise

Plog et, al, (2002). stated that sounds unpleasant cannot be distinguished by physical characteristics. Sounds that are disliked by listeners will have negative effects, interfering or things that reveal a hazard to the listener. This is because the listener will lose concentration, pressure, and have lower efficiency of the communication. This is supported finding by Matthews, (1986) on the existence of factors that affected hearing related to temporary and permanent damage. Harris,(2006) highlighted that the sound can be source of hearing loss, limit the activities of individuals in the workplace and home, and in various scenarios provide the dangers to human health and welfare. Although hearing loss is the most obvious health hazard that can be measured, the physiological and psychological problems caused by noise cannot be neglected

Quirroutte and Warnock, (1985) define to normal pressure through the sound will be sent through a series of waves, pressure waves will be shot in all directions from the source of the noise generated and subsequently sent to the brain in the form of signal pulses with movement speed of sound in air at about 330 m / s. Sound can travel as vibration waves in solids or liquids. The term air bone and structure borne sound are used depending on the medium the sound is travelling in time. When the medium in which the noise stars to spread from the source is air, the noise is called airbone. When it starts vibration between structure, it is called structure borne. The structure borne noise occurs when wall, floor or other building element are set into vibration by direct mechanical contact with the source, such as mechanical equipment or footstep Burberry, (1977)

1.3 Decibel and Frequency

Malchaire, (2001) discussed various instrument that are typically used to measure noise in the work environment. These instruments are appropriate for different types of noise exposure and they can be employed depending on the noise exposure encountered in the workplace. When measuring noise, different frequency measurements are grouped together automatically by the instrumentation to achieve one average reading. Decibels (dB) are the units used to measure the loudness and intensity of sound. The number 0.0002 mbar is used as a reference pressure to the logarithms of the ratio of the sound pressure. In order to measure noise exposure, sound-pressure level (SPL) is used. SPL value which is 20 log account for the ratio between the Sound Pressure(P) and the reference pressure (PO) where P is the sound pressure and PO is 0.0002 mbar. Noise intensity, sound frequency, and exposure duration are the major factors that need to be considered when measuring noise.

Some instruments contain different scales to calculate the average reading of the noise measurement. The most frequently used scales are labeled “A,” “B,” and “C.” Scale A is the most frequently employed in the measurement of industrial and environmental noise. Scale A is mostly used to indicate low frequencies because the human ear does not readily perceive them. Scale B also discriminates against low frequency sounds. In fact, scale B is the least common used because it serves the same function scale A does with lesser extends. In contrast, scale C does not discriminate against the presence of low frequencies. It actually reflects sound as it occurs in nature, without bias for human response. Therefore, scale C is useful in measuring the effectiveness of hearing protectors in the work environment Gane, (1986).

The most common sound measurement instruments are the sound-level meter (SLM), the octave-band analyzer, and the noise dosimeter. The purpose of the study and characteristics of sound are the major factors that determine the type of instruments used to measure the noise exposure. Malchaire, (2001). A sound-level meter is a sensitive direct instrument with a microphone used to provide instantaneous measurement of noise exposure. An SLM measures the electrical signal emitted from the microphone, then converts it to decibels, which are shown on a digital screen. The most frequent use of an SLM is for settings in which the employee noise exposure is constant throughout the workday, for the design of engineering controls, and for achieving general readings of noise levels. The SLM has a limited capability of determining employees’ average noise exposures throughout the workday if there are significant variations in noise levels National Safety Council, (1988).

1.4 Noise exposure

Noise is one of the most important environment factors, which affects the workers' health and efficiency. Noise can increase the overall workload of operators during a specific task and can affect the performance. As the result, noise affects workers' health directly and indirectly (Parsons, 2000). Bhatia et al. (1991) state exposed their subjects to a 40 dB factory or corridor noise and divided subjects into low and high noise sensitivity using Weinstein's noise sensitivity scale found that arithmetic performance was impaired at this extremely low noise level, although only in the high sensitivity group. Exposure to intense noise had shown damage to the human hearing process and noise has been labeled as the most pervasive hazardous agent in the workplace Milz et al., (2008).

Maximum sound pressure level for 8 h/day exposure is accepted to be 85 dB at frequencies higher than 1000 Hz. At levels lower than this value, the risk of noise becomes the least (Grandjean, 1988). Sumer et al.(2006) explains that, there is a tendency of reducing daily noise exposure to below 90 dBA for an 8-h shift, and hence exposure level of 85 dBA is informally acknowledged to be the informal threshold sound pressure level. Therefore it is crucial to keep sound pressure levels within safety limits to avoid health related disturbances and work related inefficiencies.

1.5 Noise Measurement

If the sound levels from two or more sound sources have been measured separately, and need to know the combined sound pressure level of the sound sources, the sound levels must be added together. However, due to the fact that dBs are logarithmic values they cannot just be simply added together. Basically, there are two different instruments to measure noise exposures: the sound level meter and the dosimeter.

A sound level meter is a device that measures the intensity of sound at a given moment. Since sound level meters provide a measure of sound intensity at only one point in time, it is generally necessary to take a number of measurements at different times during the day to estimate noise exposure over a workday. If noise levels fluctuate, the amount of time noise remains at each of the various measured levels must be determined.

To estimate employee noise exposures with a sound level meter it is also generally necessary to take several measurements at different locations within the workplace. After appropriate sound level meter readings are obtained, people sometimes draw "maps" of the sound levels within different areas of the workplace. By using a sound level "map" and information on employee locations throughout the day, estimates of individual exposure levels can be developed. This measurement method is generally referred to as "area" noise monitoring. Adding Sound Levels.

Area monitoring can be used to estimate noise exposure when the noise levels are relatively constant and employees are not mobile. In workplaces where employees move about in different areas or where the noise intensity tends to fluctuate over time, noise exposure is generally more accurately estimated by the personal monitoring approach. Similarly to the previous described strategy, the application of the FDM strategy implied the compulsory use of sound level meter. The experimental procedures were simpler in this case, because they only included the determination of daily noise exposure level by full-day sound level measurements.

1.6 Noise control strategy

The three primary methods used to control occupational noise exposure are engineering controls, administrative controls, and personal protective equipment (PPE). Each strategy has its own advantages and disadvantages. However, engineering controls are known to be the most efficient and desirable methods used to attenuate occupational noise exposure. Engineering controls can be categorized into three classifications: minimizing noise at the source, sound-absorbing control, and masking sounds. Kurtus, (2007).

Reducing noise at the source can be obtained by adding anti-vibration systems or mufflers. Sound absorbing control includes engineering-control activities such as placing sound-absorbing materials between the employee and the noise source. Sound-absorbing materials can be any material that has the ability to attenuate noise, such as fully or partially reticulated plastic foam, glass fiber, and mineral rock. Seybert, (2002)

Sound masking is actually covering noise, not minimizing the sound. An example of masking noise would be playing natural water sounds to cover an annoying noise. In fact, noise masking adds noise to the existing noise, which might create more damage to the hearing. Routine maintenance on machines, such as tightening and lubrication, can also play a great role in attenuating occupational noise exposure .

Wilkinson, (2002). If engineering controls are not feasible or they do not attenuate noise levels to meet occupational standards and regulations, organizations may seek administrative controls. There are no physical activities involved in administrative controls, so they do not actually attenuate noise. In fact, they are rule-making activities that minimize the duration of exposure to occupational noise. For example, employee relocation, which is a form of job rotation, allows workers an adjustment period to regroup after occupational noise exposure. If job rotation or other administrative controls are not applicable, the organization should provide enclosed booths that limit employees' exposure to occupational noise levels. NIOSH, (1996).

The last alternative for occupational noise reduction is personal protective equipment.There are abundant kinds of ear protection such as earmuffs, which is the most effective personal protective equipment for high-frequency noise exposures. Earplugs are effective for low frequency noise exposure, yet many employees insert them incorrectly, so they annoy the inner part of the ear and become ineffective. Ear protection does not remove the noise exposure, but acts as a barrier between the inner ear and the noise to protect the ear from the exposure.

Personal protective equipment has countless limitations; for example, employees who wear PPE are still exposed to certain levels of noise because, as sound passes through tissues and bones, it can reach the inner ear. This can happen if there are leaks in the protection equipment or if the occupational noise causes vibrations in the protective equipment. Personal protective equipment should be the final option for reducing occupational noise. Harris, (1991). In Malaysia, noise exposure in the workplace is legislated under the Factories and Machinery Act (Noise Exposure) Regulation 1989, and the Occupational and Safety and Health Act (OSHA) 1994. These regulations make mandatory for noise levels and workers' exposure to noise to be measured, assessed and controlled .Leong, (2005).

International Labor Organization (ILO) accepts 85 dBA as warning limit and 90 dBA as limit for continuous work for 8 h. The hearing loss is about 30 dB for first ten years exposure at 4000 Hz and 100 dB (A). It is clear that at 100 dB (A), the ear is much more sensitive to 4000 Hz compared to 1000 Hz. Maximum sound pressure level for 8 h/day exposure is accepted to be 85 dB at frequencies higher than noise becomes the least. Grandjean, (1988). The detail guideline for noise exposure versus the time exposure as shown in Table 1.1

Table 1.1 : Permisibble noise exposure with time period
Source : 29 CFR 1910 .95 table G-16 (NIOSH 1998)

Noise decibel (dB)	Time exposure(hours)
80	32.0
81	27.9
82	24.3
83	21.1
84	18.4
85	16.0
86	13.9
87	12.1
88	10.6
89	9.2
90	8.0
91	7.0
92	6.2
93	5.3
94	4.6
95	4.0
96	3.5
97	3.0
98	2.6
99	2.3
100	2.0
101	1.7
102	1.5
103	1.4
105	1.3
106	1.0
107	0.87

A weighted equivalent sound pressure level of 85 dBA results in temporary hearing losses and 90 dBA increases the blood pressure, accelerates the pulse and breathing, decreases brain liquid pressure, causes tension in muscles, and withdrawal of blood in the skin. Sabanci and Uz, (1984).

1.7 Health effect of occupational noise

Generally, noise can create negative emotions, feeling of surprise, frustration, anger and fear. Noise also delay the onset of sleep, awaken a person from sleep or disturb someone's rest and make it difficult to hear desirable sounds. The effects of noise may produce temporary or permanent alterations in body chemistry, and temporarily or permanently change one's hearing capability too. These could also interfere with some human sensory and perceptual capabilities and there by degrade the performance of a task. Kroemer, (2001)

It was reported by Suter, H.A,(1991) that the level of noise necessary to produce adverse effects was greatly dependent upon the type of task. Simple tasks may remain unaffected at noise level as high as 115 dB or above, while more complex tasks may get disrupted even at much lower levels. In many studies, noise was found to degrade human performance. The performance of human being was adversely affected due to noise-induced stresses Simpson,et al.(1994)

1.8 Type of Occupational Noise

Occupational noise can be divided into three categories: continuous, intermittent, and impact. Each one of these types has a slightly different effect on the human ear than the other types. The first type of occupational noise is continuous noise, which is known as a constant spectrum and level of broadband noise generated by power equipment or any source of noise in the work environment. Normally, employees are exposed to average noise levels during a period of eight hours per workday (National safety council, 1988). Continuous noise is one of the occupational noise types that are regulated by the Occupational Safety and Health Administration. OSHA, (2003).

1.9 Standard Regulation of Noise

The OSHA standard for occupational noise exposure is 29 CFR 1910.95. This standard institutes an 8-hour shift TWA permissible-exposure limit (PEL) of 90 dBA using a 5 dB exchange rate. Exposures at 90 dBA were expected to present a 25% increase in the risk of hearing loss of 25 dB at 1 Hz, 2 Hz, 3 Hz, and 4 Hz (OSHA, n.d). The American Conference of Governmental Industrial Hygienists (ACGIH) and NIOSH have suggested using 85 dBA as the exposure limit for an 8-hour TWA and 3 dB exchange rate. Gilbert, (1997).

The purpose of the study was to show how the OSHA-criteria algorithm under estimates the actual noise exposure in cases of variable noise levels. The measurement of the OSHA criteria dosimeter was less than the measurement of the ACGIH and NIOSH criteria dosimeter by 0.2 dBA to 12.6 dBA. The result of this study shows that the reported exposure of noise levels using OSHA criteria is less than the actual noise levels that employees are exposed to, which means the chance for NIHL to occur is higher than what would be predicted from the reported exposure levels. Petrick, (1996).

Harris,(1991) recommended implementing a device that measures levels between 80 dB and 130 dB in order to control workers' noise exposure. Under the general industry standard, (29 CFR1910.95) (b) (1), organizations are required to implement engineering or administrative control when occupational employees are exposed to noise levels that exceed OSHA's acceptable dose of 1.0. If occupational workers are exposed to noise levels that exceed 4.0, an employer is required to implement engineering controls to minimize the noise exposure. In addition, if these engineering controls reduce the noise levels below a worker dose of 4.0, yet it still exceeds a dose of 1.0, the employer has to provide hearing-protection devices (HPD) for the occupational employees.

Employees who are exposed to a TWA of 85 dB or higher have the right to receive hearing protection from their employer at no cost. The hearing protection must be able to decrease the noise levels to TWA of 85 dB for employees who have experienced STS and 90 dB for other employees. With help of a person who is trained in fitting hearing protection, employees can choose the most suitable size and type of hearing protection for their work environment. It is the employer's responsibility to ensure that employees wear hearing protection properly. Employers are responsible for conducting annual training for their employees who are exposed to a TWA of 85 dB. The training should cover effects of noise, the pros and cons ofdifferent types of protective equipment, aspects of audiometric testing, personal hearingprotective devices, and characteristics of noise attenuation of hearing protection Greene,(1992).

1.10 Occupational Safety and Health 1994

An Act was implemented to make further provision for securing the safety, health and welfare of person at work, for protecting others against risk to safety or health in connection with activities of person work. This regulation by Department of Occupational, Safety and Health . DOSH,(2013)

1.10.1 Part IV – General Duties of Employers

1) It shall be the duty of every employer to ensure, so far as ispracticable the safety, health and welfare at works of all his emplpyees.

2) (a) the provision and maintenance of plant and systems of work that are, so far as is practicable, safe and without risko to health.

   (b) the provision of such information, instruction, training and supervision as is nescessary to ensure, so far as is practicable the safety and health at work of his employees.

1.10.2 Part VI – General Duties of Employees

Section 24

1) It shall be the duty of every employee while working at work :

   (a) To take reasonable care for the safety an health of himself and other person who may be affected by his act or omission at work,

   (b) To cooperate with his employer or any other person in the discharge of any duty or requirement imposed on the employer or that other person.

   (c) To wear or use all the times any protective equipment or clothing provided by the employer for the purpose of preventing risk to his safety and health

(d) To comply with any instruction or measure on occupational safety and health institud by his employee by his employer or any other person.

Macpherson, (1990; 171), Macpherson and Parker, (1991; 101) Worksafe Western Australia, (1999; 144) suggest a method of conducting noise assessments based on "room loss". The principle behind this method is to measure the sound pressure at workstations relative to a reference position. Glass and Singer (1972) reported a series of studies, which indicated that performance may be impaired also after a period of noise exposure. A review of more recent studies is given by Cohen (1980). The tasks that seem to be most sensitive to these after-effects of noise do not primarily measure the capacity to perform, but rather the motivation to perform well

The after-effects are most evident after exposure to uncontrolled or unpredictable noise, where as they are less dependent on the noise level. In fact, after-effects of noise should not be regarded as due to noise in itself but rather as due to a general influence of uncontrollable and unpredictable stressors. Cohen, (1980). Noise level is the only physical noise characteristic that has been studied to any extent in connection with performance effects. Broadbent ,(1979). In this assessement , studies try to evaluate total of noise produce when lathe machine and fitting workshop operating by users Sound Level Meter (SLM) . This workshop have a potential higher sound level compare others workshop within Mechanical Engineering Department. Noise is one of the most important environment factors, which affects the workers' health and efficiency.

Measurement evaluate between lathe machine and operators also for fitting workshop the noise come out from tooling, etc hammer, chisel process,grinding or drilling must be related. During assesement value background noise have contribute but not to verify detail. When looking the previous scenario, official data from noise level not measure at this workshop because they believe sound exposure still legal and under safe limit, this theory can't using because machine factors influence from any aspects to increase noise level limit. The aspects such as machine virbrating come from weakness mounting, internal wear parts or service time periods. It was showed that noise induced hearing loss increase up to 7dB in the first 10 years at 1000 Hz and 100 dB (A), and then gradually increases to 12 dB losses for exposure time of 40 years.

The hearing loss is about 30 dB for first ten years exposure at 4000 Hz and 100 dB (A).In previous assessement, obtained more of survey do at real industries such as automotive, manufacturing, packaging, pneumatic and hydraulic system etc. The noise may be annoying to varying degrees, from being just objection able to being unbearable. The performance may be affected due to a lowering of concentration, fatigue caused by longer exposed, rhythm disturbance, interference with sound cues associated with the work or interference with worker-to-worker communication in a team. Damage to hearing noise may be caused by noise; the character and to a lesser extent, the mechanism of this damage is now being understood. Both temporary and permanent components of hearing threshold shift are possible Matthews, (1968).

Effect to teaching environment roof noise level in classrooms P Settha and K Karmegan,(2008) one of journal to determine noise level in school classroom during hours and identify the effect of noise in teaching environment at classroom using a sound level meter (SLM) and questionaire survey to several teacher and students. In this assesement, researcher do many finding about sound produce and try to related factors noise surrounding also contribute be higher measurement in location, student capacity, design of building and health effect during process teaching and learning.

a. Ranking of noise sources

Lester, Mr H., et al.(2001) state the detection in determining the source of the noise is important because it affects the determination of the total number of workers exposed by the prescribed time period. Control of noise at the workplace does not necessarily concern the noisiest sources, but those that make the largest contribution to the total exposure; this takes into account not only the noise level but also the duration of exposure and the number of people exposed.

b. Compliance

To check compliance of noisy areas with regulations, it is necessary to determine the L_{EX},8hour the L_{EX},w = LEP,w according to the nature of the exposure. In this approach, the conclusions are as follows according to whether or not the noise exposure level exceeds or not the occupational exposure level (OEL = 85 or 90 dB(A) usually): LEX,8h < OEL: the working conditions are acceptable legally L_{EX},8h > OEL: the conditions are unacceptable and control measures must be implemented as soon as possible L_{EX},8h OEL: additional measurements are needed to determine whether L_{EX},8h is lower or higher than the OEL. Paradoxically, if the objective is only compliance, more measurements are made if the exposure is around the OEL than when the exposure level is below or even above the OEL.

c. Risk evaluation

The ISO 1998 standard describes a model for the prediction of the distribution of the hearing loss at a given frequency, in a population of a given age, after a certain number of years of exposure to a L_{EX},8h level. From this standard, Figure 2.2 was derived; it gives, as a function of L_{EX},8h, the percentage of the population aged 60 years, which, after 40 years of exposure, would develop mean hearing impairments (average 500 Hz, 1 kHz, 2 kHz, 3 kHz) greater than 25 dB. The figure shows that the risk of hearing impairment increases quadratically as a function of L_{EX},8h. Therefore, if the risk is to be estimated with a given accuracy (for instance + 2%), the accuracy required for the evaluation of L_{EX},8h increases : for instance 88 + 2 dB(A) but 94 + 1 measurements having a noise level *LAeq,Ti*, carried outwith a specified integration time *Ti*., where the total exposure time is,

Table 1.2 : Criteria for recommended standard, Occupational Noise Exposure, Revised Criteria 1998

Average noise exposure (dB)	Risk of NID(%)
80	1
85	8
90	25

* Excess risk of hearing impairment at age 60 after a 40 year lifetime exposure to occupational
Source : http://www.cdc.gov/niosh/docs/98-126

CHAPTER 2 : MATERIALS AND METHODS

2.1 Introduction

2.2 Preliminary observation

2.3 Instrumentation

2.4 Measurement procedures

2.5 Data calculation

2.6 Data Analysis

2.7 Risk Assessement

2.8 Data stage measurement process

CHAPTER 2 : MATERIALS AND METHODS

2.1 Introduction

This study aims to determine the level of noise exposure that occurs in machine and fitting workshops.The objective was to assess noise exposure level in the workshop, during class activities and compare the value so that outline in the OSHA standards and regulations. Develop the risk matrix for possibility of noise control by reducing exposure to noise. This chapter will discuss the selection of subjects, instruments, procedures, data collection and data analysis. The flowchart working process for this assesment can be seen in Figure 2.1

2.2 Preliminary observation

In preliminary observation, objective have been carried out to obtain the actual value in measurement area. The first stage is to get the entire amount of noise generated in the workshop created by the specified location take measurements. It can be divided into two, environmental conditions of noise exposure and identify factors that could cause systematic variation. The information required at this stage is that the number of students and lecturers, who are involved, the type of machine used, the type of work that is done, tracing the source of the sound, layout of machinery and other equipment in the workshop, explanations that have been stated is valid recommendation Malchaire (1994).

2.3 Instrumentation

Sound Level Meter Quest Model 2800 are shown in Figure 2.2 used during this assessement. Simultaneously three set of SLM unit were use for measurement noise exposure in lathe and fitting workshop.The system consists of

- Microphone receive sound processing and read-out unit. Microphone converts sound signals to electrical
- Display indicate the value of noise present, numeric read out, bar indicator along with BAT (batery), RUN, HLD(hold) and reset
- dB range using when calibrating, selected range to aquarate reading depend the area measurement
- Funtion key including to mode reset, measurement mode fast/slow, previous reading, on/off button, hold and run button.

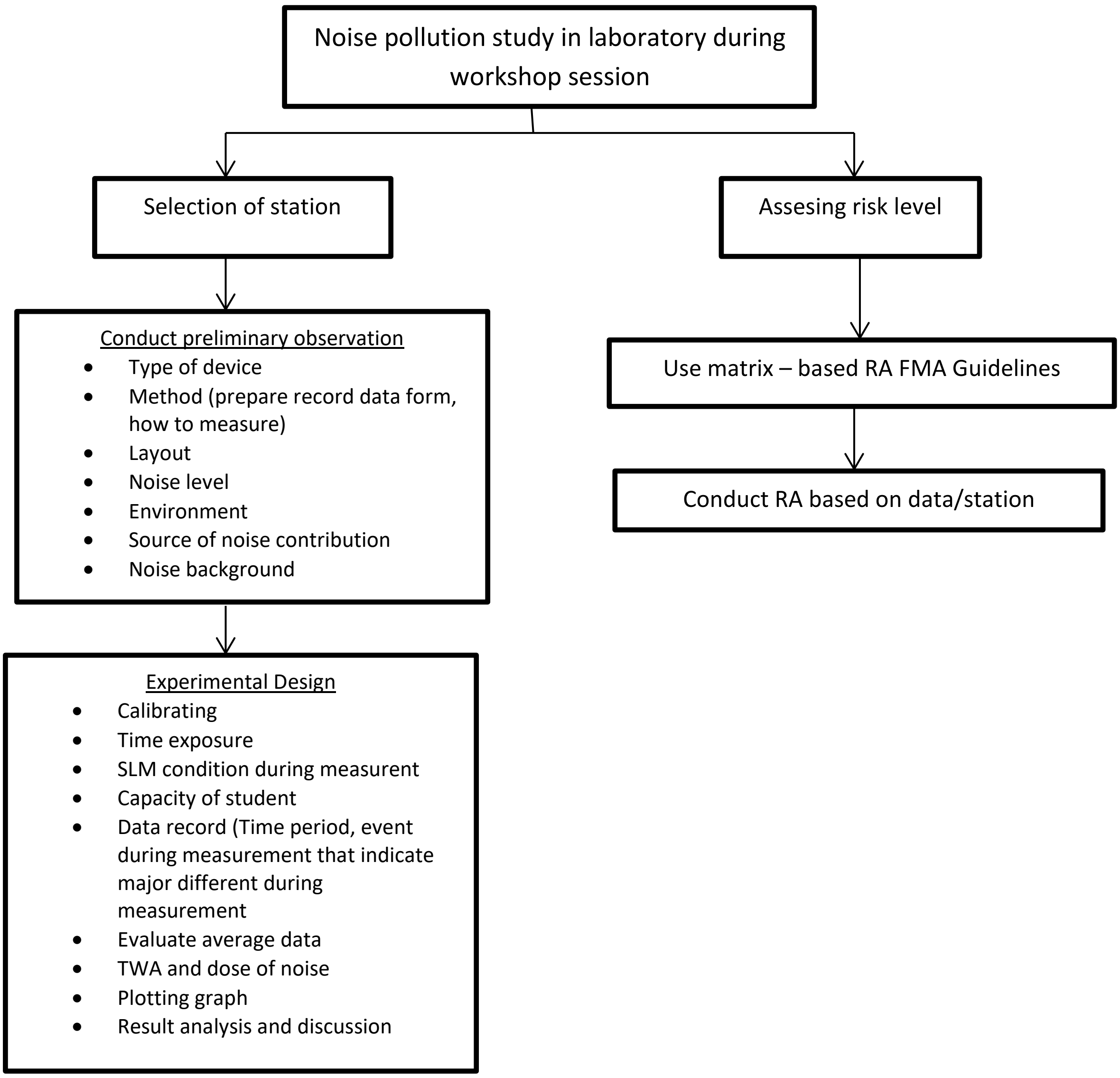


Figure 2.1 : Framework of noise assessment

The type most suitable for the sound level meter microphone condenser microphone, which combines precision with stability and reliability. Electrical signals produced by the microphone is quite small and so it is amplified by a preamplifier before being processed. Several types of processing can be performed on the signal.. It is relatively easy to build an electronic circuit sensitive to different frequencies in the same way as the human ear, thus simulating the strength of the same contour. This has resulted in three international standard characteristics of different so-called "A", "B" and "C" weighting. The last stage of the sound level meter read-out unit which displays the sound level in dB, or a number of units acquired as dB (A) (which means that the noise level was measured A-weighted).

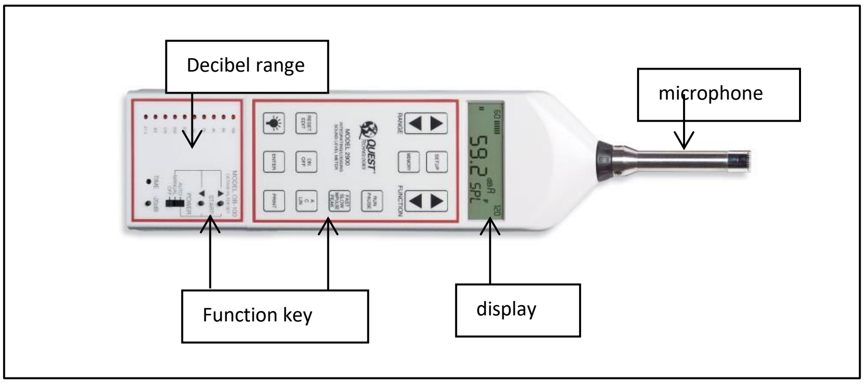


Figure 2.2 : Sound Level Meter Quest Technology Model 2800

Before start measurement, there is a series of quick check were performed, SLM need to callibrated where should be checked and the meter adjusted, if nescessary before each use., in this case, the SLM unit has calibrated by an expert in prior to use. Set the RESPONSE, MODE and dB RANGE (during measurement value range in 20dB~ 80dB, 60dB~120dB) switches as needed in SLOW Mode are selected. Put the SLM in fixed station to take reading until 8 hours, Reset the meter before taking measurement and push run button in 15 minute and stop simultaneously. The time interval 15 minute choosen for noise level record based on preliminary data collected before the study was performed .

To ensure accurate measurements can be carried out to determine the actual noise exposure to students and lecturers at the lathe and fitting workshop , three SLM unit were locate in lathe and two units placed in fitting workshops .SLM sound is calibrated to and 120 dB sound level meter was set to measure noise levels between 30dB and 110 dB. All instruments were calibrated before being used for the measurement of noise exposure. Data were collected simultaneously on the three SLM unit placed at designated location.

2.4 Measurement procedures

The proposed strategy to measure noise exposure, was based on the ISO 9612: 2009 This strategy was based on full-day measurements (FDM). The work has been selected by the environmental features that affect sound output to enable a thorough comparison between the size of the output sound different, daily personal exposure level (LEX, 8h), uncertainties related to the time spent in the work area. Strategy is based Full Day Measurement (FDM) This should be done considering the requirements of each workplace in terms of its exposure characteristics.

As stated in ISO 9612: 2009, the selection of the most appropriate strategy (called “recommended” strategy in the standard) to measure noise exposure will depend on the job characteristics, namely the work type and pattern, including the mobility of the student and the complexity (number and predictability) of the task carried out All display data write in form measurement manually before start to next measurement, any event in time duration must noted in form for futher reference.(see appendix). The sampling done are as metioned

- Sampling of this study includes 30 unit machine in lathe workshop , 4 lecturer and 20 student from Mechanical Engineering Department are involved during this assessement. Noise measurements conducted over three consecutive days for 8 hours but reading for 1 hour noise exposure are not taken into consideration in data analysis. Placement of three measurement locations where the station 1, station 2 and station 3 is generated simultaneously.

- Sampling of this study includes 20 working area in fitting workshop, 4 lecturer and 20 student from Mechanical Engineering Department are involved during this assessement. Noise measurements conducted over three consecutive days for 8 hours but reading for 1 hour noise exposure are not taken into consideration in data analysis. Placement of three measurement locations where the station 4 and station 5 is generated simultaneously.

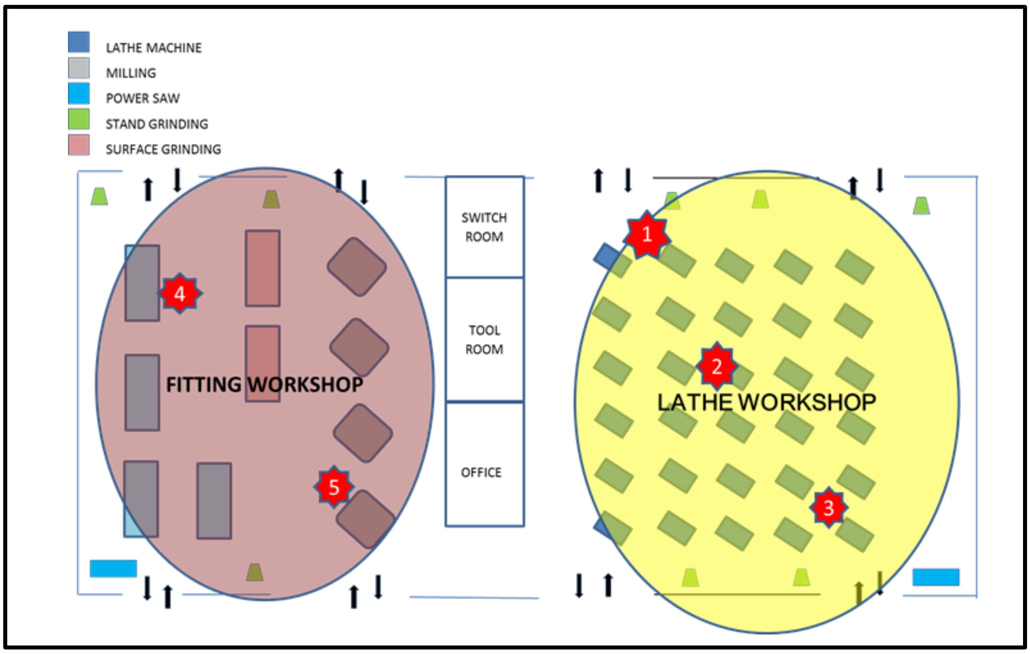


Figure 2.3 : Station layout for noise measurement. The workshop were divided with five station (STN) as shown in figure 3.3

2.5 Data calculation

Background noise can cause considerable error in measurement when its level is close to that of the sound source of interest. When it is not possible elliminate or reduce the background noise. In this case background noise are measure with noise from student activity. n this study the background noise is evaluated once the noise generated during the measurement. It is undeniable that background noise is a matter that affects the measurement because it is difficult to get the exact amount of the sound source to be measured.

The background noise is not considered too specific in this study because the main objective of the study was to exposure to noise emissions produced on students and not to control the sound or how methods for noise reduction. However, the detection of the presence of background noise measurements were taken of students during time break around 2 hours because at this point all machines and workshops must be stopped but the SLM unit is still operating.Equation use to calculate noise as shown below.

$$Noise_{measurement} = Noise_{activity} - Noise_{background}$$

Dose and TWA one the parameters used to determine the amount of noise that is exposed to the student for a period of time around 6 hours in the workshop.This parameter is refered to OSHA regulations for identified actions to be taken based on the amount obtained. For this solution the following formula should be used.

$$Dose = 100 \times (C1/T1 + C2/T2 + C3/T3 + ... + Cn/Tn)$$

$$TWA = 16.61 \, Log10 \, (D/100) + 90$$

2.6 Data Analysis

After the SLM readings were recorded, the data was analyzed to determine the highest noise-exposure level at both of workshop from percentage of dose and time weight average (TWA) data during three day observation . The measured noise levels were then compared to OSHA standards and regulations to determine the compliance with these standards and regulations. The results also will be utilized to determine the compliance of workshop to OSHA recommendations. Based on the data analysis, a risk matrix can be designed to identify the effects of noise hazards that are exposed to students and lecturers during learning sessions.

2.7 Risk Assessement

The purpose of the assessment is to make a valid decision whether action is necessary to prevent or adequately control noise exposure. The legal requirement in the Noise Regulations 2005 to assess risks from noise is an extension of the general duty to assess risks under the Factories and Machinery Act (Noise Exposure) 1968. A suitable and sufficient noise risk assessment is one which:

- Identifies the stundent who are exposed above the lower exposure action values;

- Where exposures are likely to be at or above the upper exposure action values, contains information on noise exposure derived from measurements of noise in the workplace and information on the type and duration of exposure, for the student so exposed

- Identifies the necessary measures to eliminate the risks or reduce them to a minimum;
- Includes such information as is necessary to permit compliance with other duties under the regulations.

2.8 Data stage measurement process

Previous assessement of noise exposure related studies conducted in lathe and fitting workshop at Politeknik Sultan Salahuddin Abdul Aziz Shah didn't have during operates from mid 1997, the approach taken is based on critical analysis of the situation is quite similar to the method used in other places in order to achieve the objectives of this study.

For clearly and understanding of the various stages of the procedure have been discussed to prevent from behind the measures and procedures uptake data. It has been prepared in accordance with 5 stages:

Stage 1: Record raw data of noise during each station.

Stage 2: Plot the graph data of noise exposure during three days each station (STN) and description for higher STN

Stage 3: Calculation solution to find TWA and Dose

Stage 4: Plot graph from calculation finding during three day observation and comparison each station(STN)

Stage 5 : Develop risk matrix from input data noise exposure.

CHAPTER 3 : RESULT AND DISCUSSION

3.1 Data overview

3.2 Graph data of noise exposure during three days for each station (STN)

3.3 Distribution data shown in the Table 3.5 are the result observation of the graph in Figure 3.5

3.4 Calculation data collected during measurement to identify the dose and time weight average (TWA).

3.5 Dose percentage between STN during time exposure per day

3.6 TWA exposure between STN during time exposure per day

3.7 Develope noise risk matrix

CHAPTER 3 : RESULT AND DISCUSSION

3.1 Data overview

Data collected during the first observations in lathe workshop that involved 10 units of machines that means, 2 person per machine and the following week measurement were conducted at the fitting workshop include 20 point working area. This data collection represents 20 students of Mechanical Engineering in first semester and is accompanied by four lecturers as instructors. Monitoring period is over 8 hours in continuous three days. During the recording data, student involved is not applied with ear protection devices. Exposure to maximum level is record for data analysis while the minimum level considered as data recorded for further reference. Data was taken with type Integrating Sound Level Meter 2800 Quest Tech. Selection is based on the suitability of results from preliminary observation and environmental factors measurement area.

3.2 Graph data of noise exposure during three days for each station (STN)

The graph were ploting as Figure 3.1 according from data collected during three day in lathe machine and another three day in fitting workshop. Time of duration measurement were taking are 8 hours but in graph and data collected just mentioned to 6 hours. The time of period were included 6 hours for avoid the droping line when plotting the graph.

Have been plotting a graph of Figure 3.1, according to data collected during three days in the lathe and three other days in the shop fitting. Measurement time period has taken is 8 hours but in the graph and the data collected is only called up to 6 hours. Included a 6 hour time period to avoid a significant drop when plotting graphs. To facilitate detection, the method of finding the graph is described by the table and any existing lines in the graph. For ease of data taken up to the first day of the third calculation noise level has been set at a workshop lathe machine. For the fourth day until the sixth day of SLM has been placed in the workshop fitting.

3.2.1 Day 1 : Review result of noise STN 1, STN 2 and STN 3

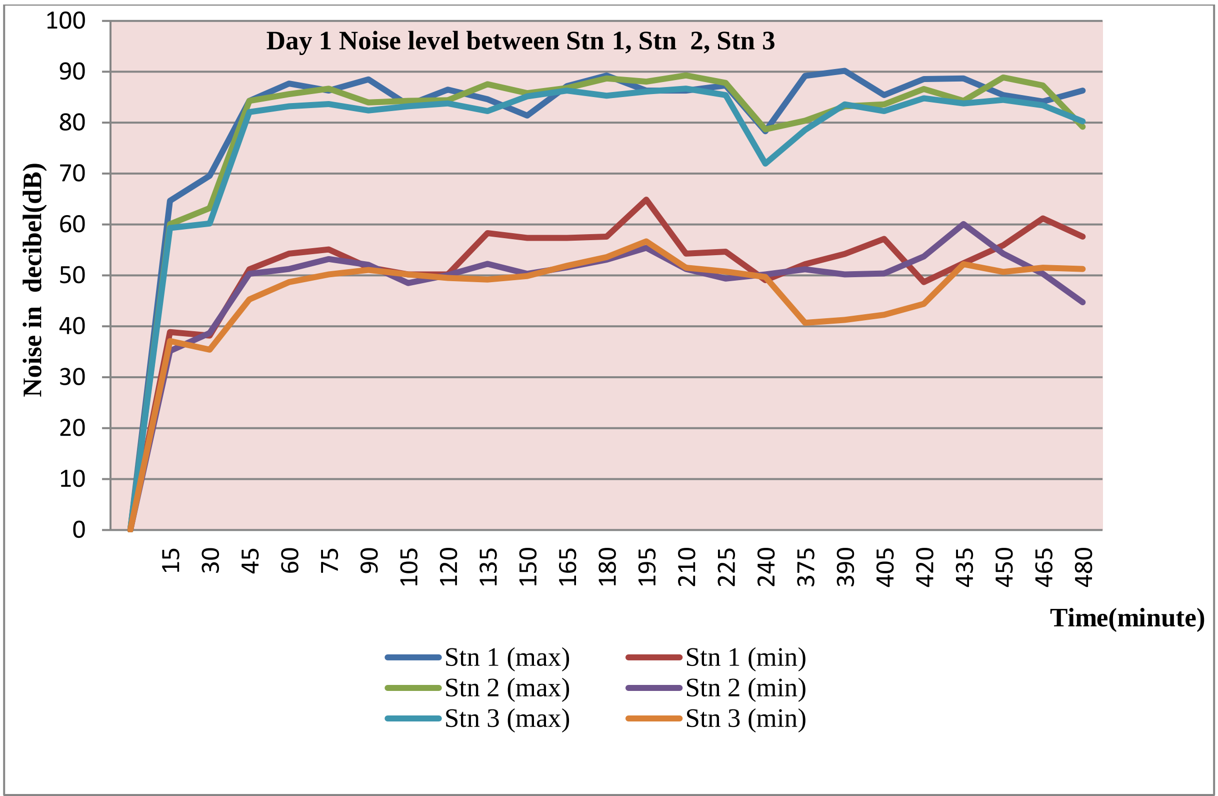


Figure 3.1 : Noise level Stn 1,Stn2, Stn3 on first day for lathe workshop

3.2.2 Distribution data shown in the Table 3.1 are the result observation of the graph in Figure 3.1

Table 3.1 Day 1 - STN 1, STN 2 and STN 3 description at lathe machine workshop

STN	Max noise level dB	Min noise level dB	Exposure Duration exceed PEL	Time of high level	Remarks
1	90.2	49.1	3 hrs	9.00am to 9.15am 11.00am to 12.00pm 2.00pm to 3.45pm	Student make initial lathe process
2	88.9	35.2	1 hrs 45 min	10.00am – 12.00pm	
3	86.3	35.1	1 hrs	10.45am-11.4am	

3.2.3 Day 4 : Review result of noise STN 4 and STN 5

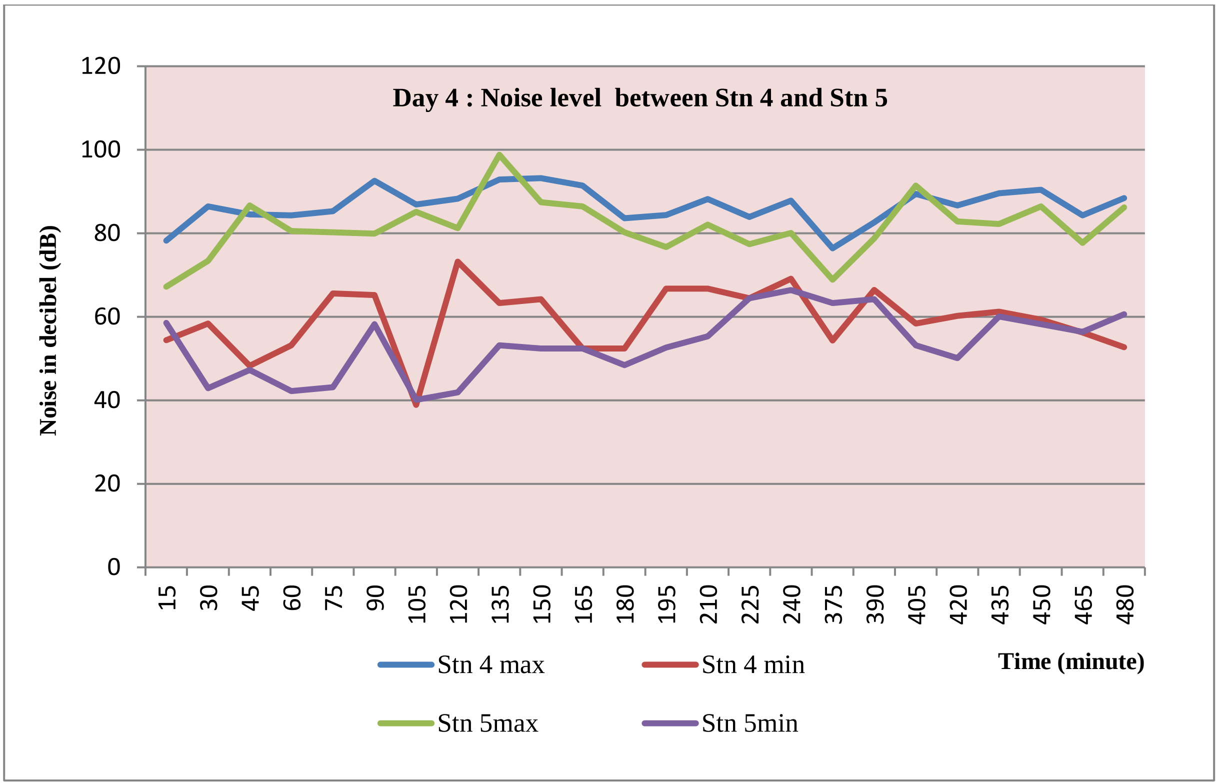


Figure 3.2 : Noise level Stn 4 and Stn 5 on fourth day for fitting workshop

3.2.4 Distribution data shown in the Table 4.2 are the result observation of the graph in Figure 4.2

Table 4.2: Day 4 – STN 4 and STN 5 description at fitting workshop

STN	Max noise level dB	Min noise level dB	Exposure Duration exceed PEL	Time of high level	Remarks
4	92.6	38.9	3 hrs	9.00am to 11.00am 3.00pm to 4.00pm	
5	98.8	40.1	1 hrs 45 min	10.00am to 11.00am 2.00am to 2.30pm 3.00pm to 3.15pm	

3.2.5 Day 2 : Review result of noise STN 1, STN 2 and STN 3

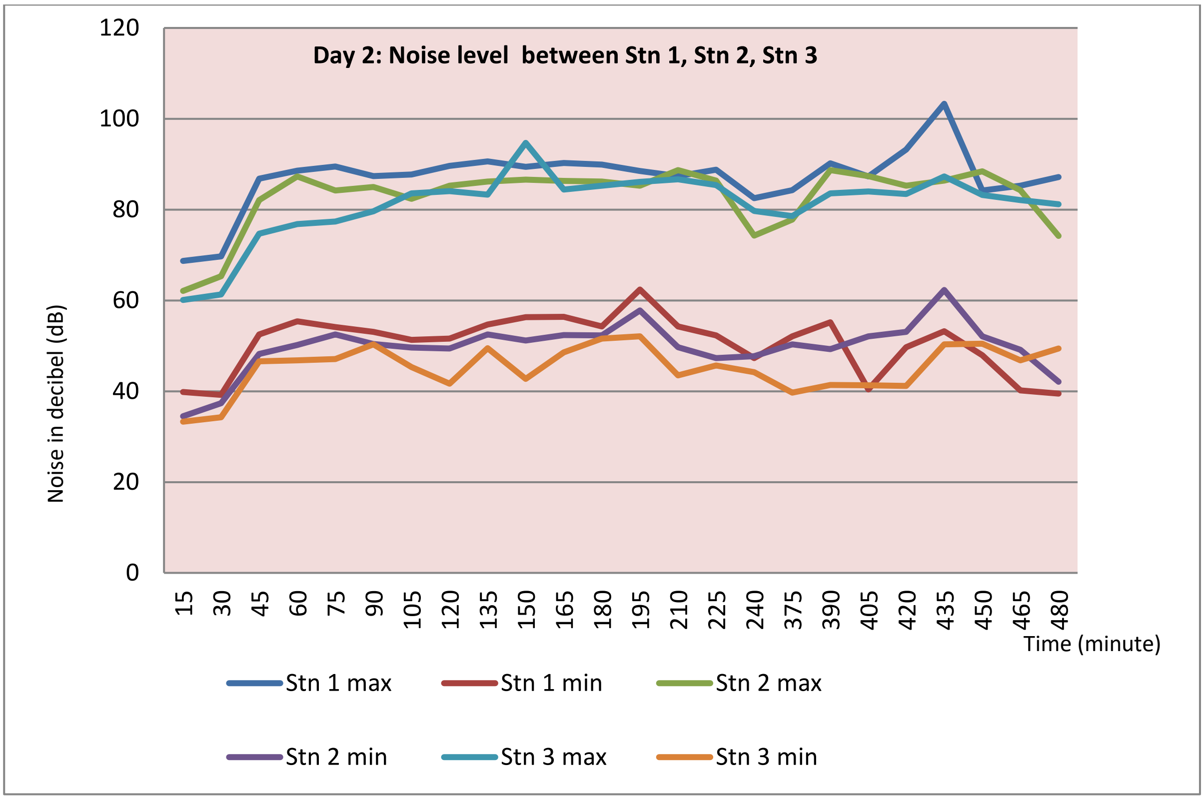


Figure 4.3 : Noise level Stn 1,Stn2, Stn3 on second day for lathe workshop

3.2.6 Distribution data shown in the Table 4.3 are the result observation of the graph in Figure 4.3

Table 4.3 : Day 2 – STN 1, STN 2 and STN 3 description at lathe machine workshop

STN	Max noise level dB	Min noise level dB	Exposure Duration exceed PEL	Time of high level	Remarks
1	103.3	39.5	3 hrs 30 min	8.45am to 11.15am 2.45pm to 3.45pm	At point 435 minute, tool set fall from top machine
2	88.7	35.2	2 hrs 30 min	9.00am to 9.30am 10.00am – 12.00pm	
3	94.7	39.7	1 hrs 15 min	10.45am-11.4am	

3.2.7 Day 5 : Review result of noise STN-4 and STN- 5

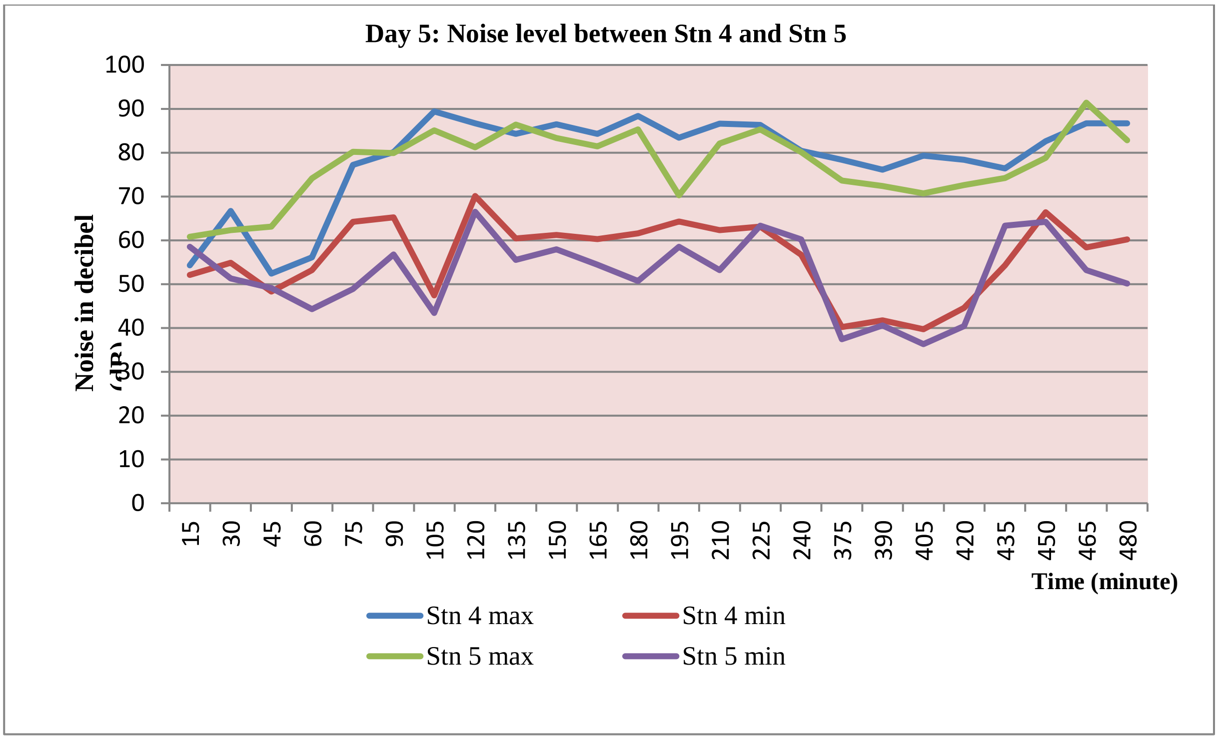


Figure 3.4 : Noise level Stn 4 and Stn 5 on fifth day in fitting workshop

3.2.8 Distribution data shown in the Table 4.4 are the result observation of the graph in Figure 4.4

Table 4.4 : Day 5 – STN 4 and STN 5 description at fitting workshop

STN	Max noise level dB	Min noise level dB	Exposure Duration exceed PEL	Time of high level	Remarks
4	89.4	38.7	1 hrs 45 min	9.45am to 10.00am 11.00am to 12.00pm 3.30pm to 4.00pm	
5	91.4	33.7	1 hrs 45 min	9.45am to 10.30am 11.45am to 12.00pm 3.30pm to 3.45pm	

3.2.9 Day 3 : Review result of noise STN 1, STN 2 and STN 3

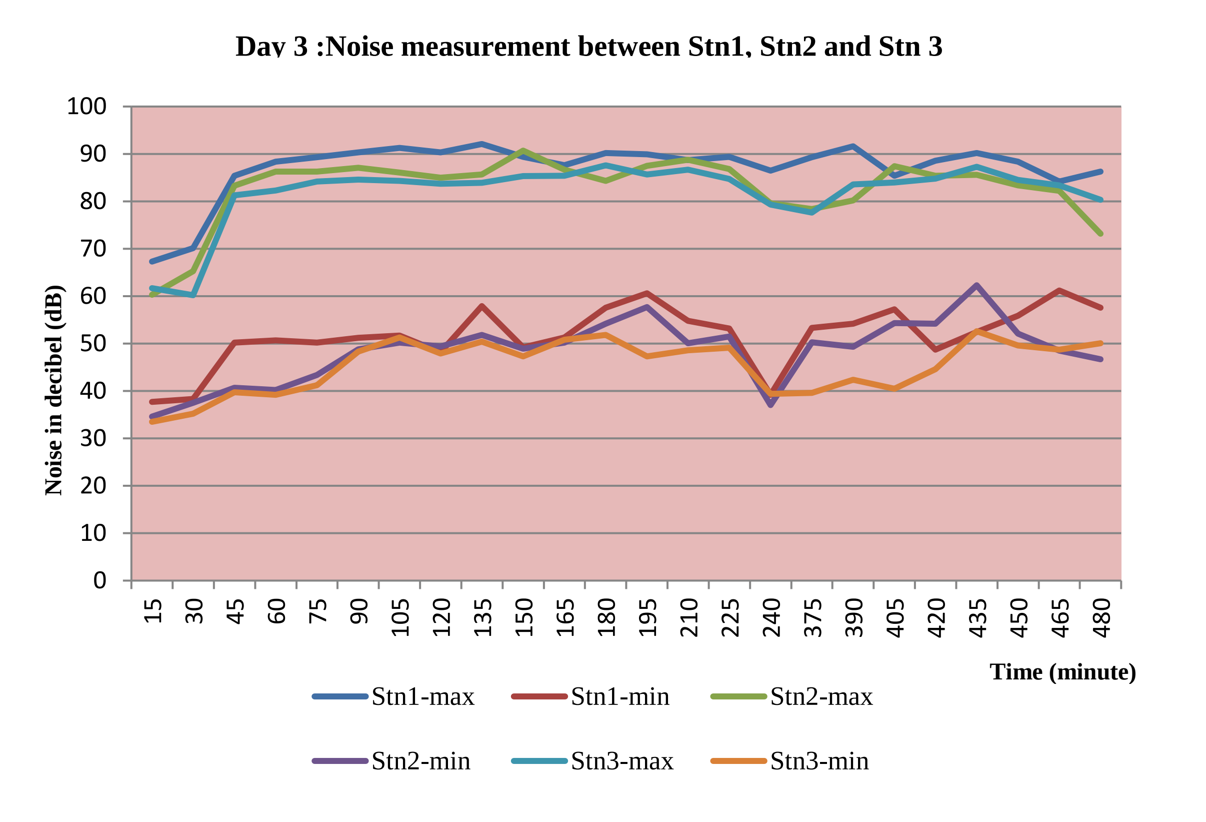


Figure 3.5 : Noise level Stn 1,Stn2, Stn3 on third day for lathe workshop

3.2.10 Distribution data shown in the Table 3.5 are the result observation of the graph in Figure 3.5

Table 3.5 : Day 3 – STN 1, STN 2 and STN 3 description at lathe workshop

STN	Max noise level dB	Min noise level dB	Exposure Duration exceed PEL	Time of high level	Remarks
1	92.1	37.7	4 hrs	9.45am to 11.45am 2.00pm to 4.00pm	Have maintenance activity during class
2	88.7	35.2	2 hrs 30 min	9.00am to 9.45am 11.00am to 12.00pm 3.00pm to 3.45pm	Have maintenance activity during class
3	94.7	39.7	1 hrs 15 min	10.00am-11.15am	Have maintenance activity during class

3.3.1 Day 6 : Review result of noise STN 4 and STN 5

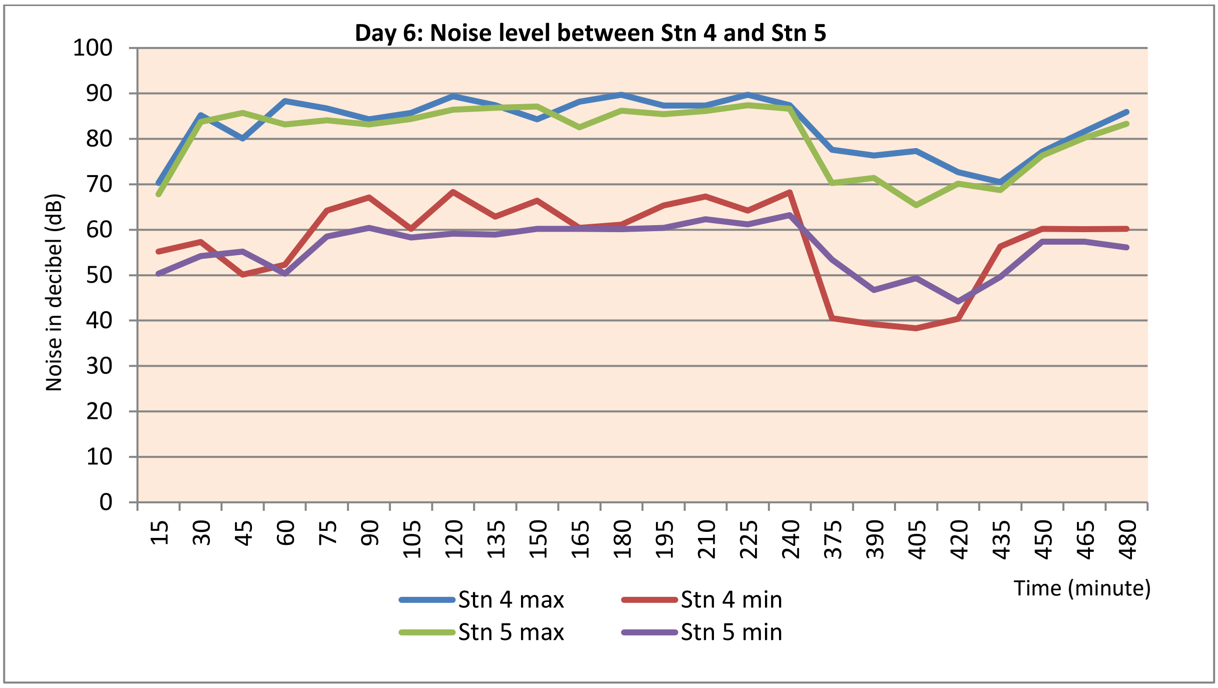


Figure 3.6 : Noise level Stn 4 and Stn 5 on sixth day for fitting workshop

3.3.2 Distribution data shown in the Table 4.6 are the result observation of the graph in Figure 4.6

Table 3.6: Day 6 – STN 4 and STN 5 description at fitting workshop

STN	Max noise level dB	Min noise level dB	Exposure Duration exceed PEL	Time of high level	Remarks
4	89.7	38.3	2 hrs 30 min	9.00am to 10.15am 10.45am to 12.00pm	
5	87.4	44.2	1 hrs 45 min	10.00am to 10.45am 11.00am to 12.00pm	

From the results obtained, the three graphs found not obvious differences during the three days study, noise reading range between 60dB \to 89dB as shown. This difference is caused by external factors such as the workshop location nearest with traffic routes, maintenance work that occurred during the measurement is made, the other involved a combination of classroom learning at certain day in the workshop for a few of the readings in the calculation. For reading increased dramatically can be identified from falling on the top machine. Knocking of hammers also have contributed to this increase in noise.

This can be attributed to the existence of state detection in determining the source of the noise is important because it affects the determination of the total number of workers exposed by the prescribed time period. (Lester, Mr. H, et al. (2001). To trace the source of sounds, events should be remark in the form of measurement as appendices so that it is easy to detect the source of the increase or decrease in decibels, because the noise occurs in various forms of delivery. This method refers to the (National safety council, 1988), which describes the sound transmission is divided into three categories: continuous, intermittent and impact.

3.4 Calculation data collected

From OSHA Regulation (Standard 29 CFR) to calculate dose percentage and time weight average (TWA). See appendix for sample calculation detail.

i. First calculate the Noise Dose as:

Dose = 100 x (C1/T1 + C2/T2 + C3/T3 + ...Cn/Tn) ....(1)

where,

$Tn = \frac{8}{2^{(L-90)/5}}$,Cn = time spent at each noise level

ii. Once have the Dose figure, calculate the TWA using the following equation:

TWA = 16.61 Log10 (D/100) + 90...(2)

where TWA is the 8-hour Time Weighted Average Sound Level

Use equation (1) and (2) to find each station TWA and percentage of dose exposure as shown in Table 3.7

Table 3.7 : Dose percentage and TWA each station during time of assessment.

	1 st Day		2 nd Day		3 rd day	
	TWA (dB)	**Dose (%)**	**TWA (dB)**	**Dose (%)**	**TWA (dB)**	**Dose (%)**
STN 1	83.94	43.22	84.77	48.56	86.38	60.53
STN 2	83.98	43.33	82.63	36.00	82.69	36.33
STN 3	81.39	30.31	81.62	31.30	81.49	30.73
STN 4	85.66	54.76	80.46	26.65	82.80	36.90
STN 5	81.70	31.33	78.76	21.04	80.91	28.38

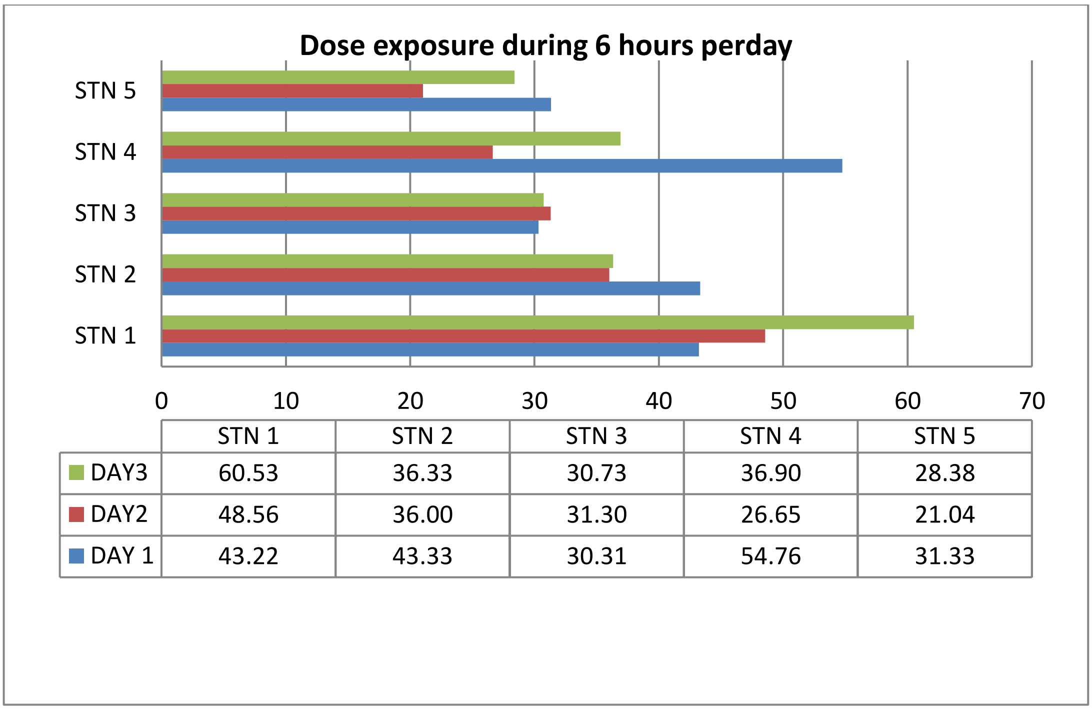
When refer the TWA and Dose percentage at table 4.7 some suggestion to action required at STN 4 and STN 1 as be shown Figure 4.7 following OSHA Occupational Noise Regulations - 1910.95.

Table 3.8 Measured based on noise level exceed permision exposure limit (PEL)

Time weight average (dB)	Dose percentage (%)	Location	Action required
85.66	54.76	STN 4	• Reduce the noise at source wherever possible. • Provide the worker with training about hearing damage and protection. • Provide suitable hearing protection to be worn if the worker chooses to. • Carry out regular monitoring of the noise levels to ensure they have not increased.
86.38	60.53	STN 1	

3.5 Dose percentage between STN during time exposure per day

The difference obtained during measurement percentage of dose was indicated by forms clustered bar according to the number of days and number of stations that are located as Figure 3.7



	STN 1	STN 2	STN 3	STN 4	STN 5
DAY3	60.53	36.33	30.73	36.90	28.38
DAY2	48.56	36.00	31.30	26.65	21.04
DAY 1	43.22	43.33	30.31	54.76	31.33

Figure 3.8: Percentage of dose exposure in 6 hour between station.

3.5.1 Observation Description.

During noise measurements conducted obtained STN 1 shown the total percentage of the highest dose in the second and third days which 60.53 and 48.56 respectively .STN 4 recorded the highest reading on the first day which 54.76%.STN 3 shows a balanced reading for all the measurements and the total percentage of 92.34%. STN 5 is the lowest station noise exposure which total percentage are 80.75% and STN 2 is the second high level 115.33%. If the sum total percentage dose STN 1 is the highest station between each station. However, when referring to OSHA 29CFR it is still within safe levels for all three days of exposure.

3.6 TWA exposure between STN during time exposure per day

The difference obtained during measurement total of time weight average was indicated by forms clustered bar according to the number of days and number of stations that are located as Figure 4.8

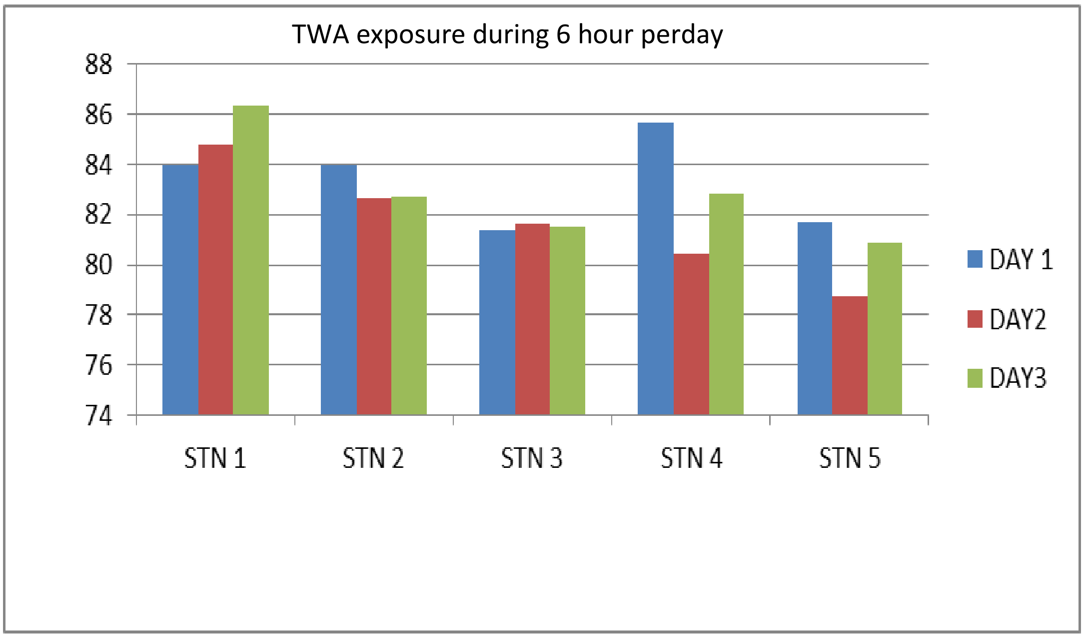


Figure 3.9 Total TWA exposure in 6 hour between station

3.6.1 Observation Description

During noise measurements conducted obtained STN 1 shows the TWA of the highest in the second and third days which 84.77 and 86.38 respectively .STN 4 recorded the highest reading on the first day which TWA 85.66. STN 3 shows a balanced reading all the measurements and the total TWA 244.5. STN 5 is the lowest station total TWA which by 241.37 and STN 2 is the second high level TWA 249.30. If the sum TWA STN 1 is the highest between each station. However, when referring to OSHA 29CFR it is still within safe levels for all three days of time weight average exposure.

3.6.2 Affecting factors of noise exposure at STN 1

Referring to Figure 4.9, some findings can be linked by previous studies of the expression and understanding of theories related to noise exposure. STN 1 percentage trend toward dose and TWA compared STN 2, STN 3, STN 4 and STN 5 were based on several factors

- Individual work processes method by which existing skills, eg mechanical adjustment. speed of spindle, coolant, method of lathe and fitting. Taguchi analysis state a different noise level were produce from speed of spindle although with similar process.
- Workshop environment, which also depends the contributing of noise at STN 1 come from activities of neighboring student eg. using grinding machine or other during measurement.
- During measurement at STN 1, rare acoustic event have contribute to noise level eg.toolset fall from top in Day 2 and maintenance activities during Day 3, that cause exposure to intense noise of short duration.
- Based on data obtained the noise characteristic can be determined between 30dB ~ 110dB. It can be used as a guide for further noise monitoring eg.apparatus and method suitable using for a reduction in noise.

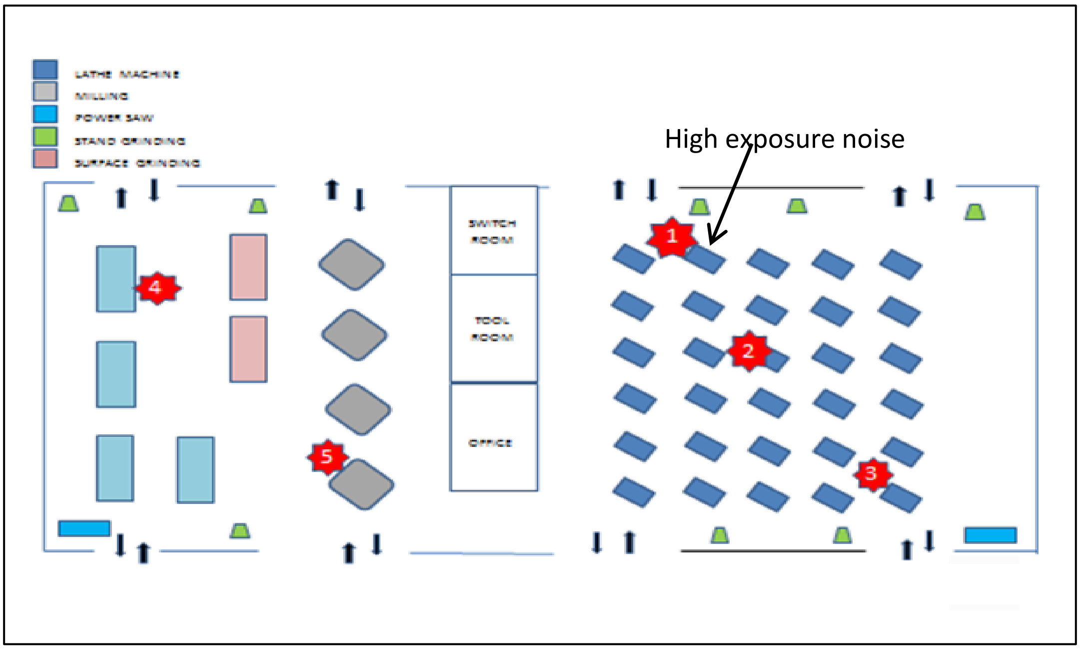


Figure 4.10 Layout of noise exposure in lathe and fitting workshop.

3.6.3 Affecting factors of noise exposure at STN 2

Based on the measurement results obtained at station 2 between the station showed a lower range of 2.14 ~ 3.69 dB on the second day and ketiga.Dapatan obtained is due to several factors:

- A station distance location further from the wall provide back noise is less than STN 1
- Contribution from background noise are less because of being away from the entrance of the workshop, a greater distance from the sound source grinding machine,
- Environment are more vulnerable because of its location in the centre of the workshop cause dispersion rate is higher sound and reverse sound source is small.

3.6.4 Affecting factors of noise at STN 3

Comparison between the three station STN1 and STN 2 are shown that a station STN 3 has a lower TWA . This result is reinforced by several factors:

- Environment are quite cause STN 3 located in isolated location
- Less contributing for background noise exposure. eg grinding machine operation are less, low traffic between entrance.

3.7 Develope noise risk matrix

In this study risk matrix create by risk assessment analysis (risk ranking technique), ranking risk categorized by maximum and minimum noise level produce include both of workshop. The range to state how to state maximum and minimum level through guidelines 29 CFR 1910 .95 table G-16.

3.7.1 State the consequence rating in worksop and the effect trigger during assessment.

Noted evering event in noise level assessment if the sound contribute high level.

Consequence Rating	**Defination (Consequence category)**
Low risk	Negligible health affect, eg.not affecting work perforamance or causing disability
Minor	Minor hearing affect, exposure can slight hearing loss
Medium	Medium hearing effect, exposure can cause mild to moderate loss
Major	Major hearing affect , eg. affect work performance, exposure can cause moderate to severe loss
Extensive	Extensive hearing effect, exposure can cause pemanent hearing loss

3.7.2 Determine the likelihood rating and risk rating. Categorized noise level may affect to student

Likelihood Rating	Risk Rating	Exposure event	Defination
Minima	0 – 5	<85dB	exposure are negligible
Low	6 -10	85 dB -89 dB	exposure can slight hearing loss
Moderate	11 – 15	90 dB – 93 dB	exposure exposure can cause mild to moderate loss
Significant	16 -20	94 dB – 99 dB	exposures exposure can cause moderate to severe loss
High	21 -25	>100 dB	exposure can cause pemanent hearing loss

3.7.3 Risk Matrix noise level assessment

Risk matrix in this assessment use to analyze potential harm be exposure for student do learning process at lathe and fitting worksho depend time be exposure. Statistically, the level of risk can be calculated as the total noise level probability that harm occurs to student based on the OSHA regulations.

			Severity/Consequence				
			1	2	3	4	5
Likelihood	5	high	5	10	15	20	25
	4	significant	4	8	12	16	20
	3	moderate	3	6	9	12	15
	2	low	2	4	6	8	10
	1	minimal	1	2	3	4	5

Risk matrix analysis have low possibility for noise affect to student because during assessment show the noise level still in safe limit. This analysis maybe have major difference and need to reanalysis if capacity of student, total of machine, type of working process and layout of workshop will change. Noise level are the major fact to develop this matrix.

3.7.4 Noise mapping

A Noise Map is a map of an area which is coloured according to the noise levels in the area. The noise levels are shown by contour lines which show the boundaries between different noise levels in an area. green colour indicated to noise level > 85dB and yellow as indicated noise exposure range around 85dB to 89 dB.Action required for this case already previous part. Based on the risk matrix, noise mapping was determine to detect areas at higher risk of noise as shown in Figure 4.11

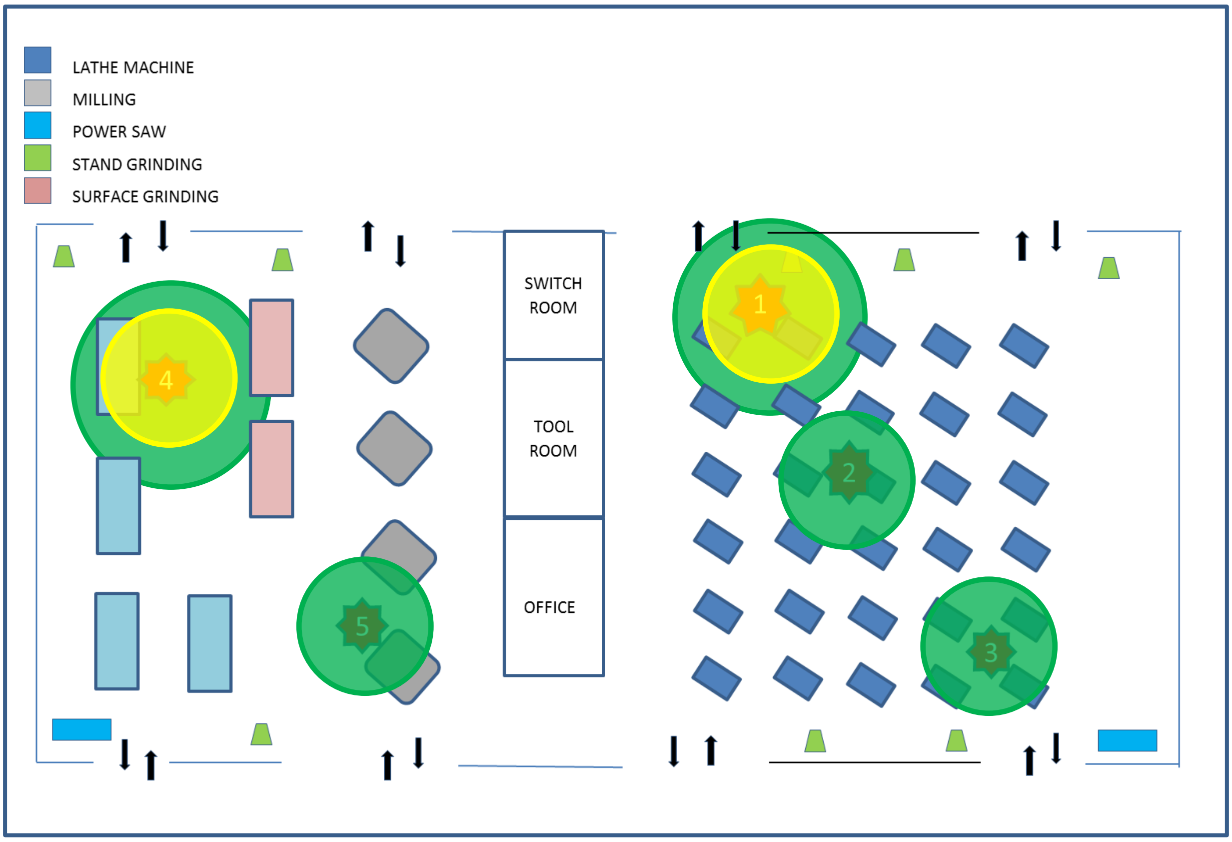


Figure 3.11 Noise Mapping based on matrix risk

CHAPTER 4 : CONCLUSION AND DISCUSSION

The purpose of this chapter is to discuss the data presented in result and state conclusions with regard to the results presented. This chapter also will provide recommendations for improving lathe and fitting workshop performance regarding noise level exposure.

The purpose of this study was to identify and evaluate the noise exposures at lathe and fitting workshop and develop risk matrix to assist a high of noise exposures that might harm for student lead to hearing loss. The goals of this study were to gather and evaluate the current noise exceed OSHA standards and Factories and Machinery (Noise exposure) 1989 and examine the feasibility of the current controls used by Mech. Eng. Dept to reduce the noise exposures if it have happen.

This information was throughout the use of sound level meter. An analysis was conducted on workshop compliance with OSHA standards regard to noise exposure. In addition, the student behavior and compliance in terms of wearing the proper personal protective equipment provided was casually observed as well.

While conducting this study, it was indicated that lathe workshop more potential produce noise exposure compare fitting workshop. It was found that STN 1 has greatest exposure to noise during three day observation. However the results show that the TWA of the sound level in the area measurement was within the range of OSHA standards for noise exposure. The data also indicates that Mech Eng. Dept needs to planning a hearing conservation program to meet both Factories and Machinery (Noise Exposure) Regulations, 1989 and DOSH recommendations for noise exposure.

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