


“ Saya akui bahawa saya telah membaca karya ini dan pada pandangan saya, karya ini adalah memadai dari segi skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Mekanikal (Struktur & Bahan)”

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**AN ALTERNATIVE TECHNIQUE TO MAP NOISE EXPOSURE AND
PREDICTION OF NOISE LEVELS IN INDUSTRY COMPLIANCE TO NOISE
EXPOSURE REGULATIONS 1989**


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**Laporan ini diserahkan kepada Fakulti Kejuruteraan Mekanikal
sebagai memenuhi sebahagian daripada syarat penganugerahan
Ijazah Sarjana Muda Kejuruteraan Mekanikal (Struktur & Bahan)**

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“Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya”

Tandatangan : 

Nama Penulis : Hilton Smith Judan

Tarikh : 5/5/2007

To my beloved Daddy and Mummy and my beloved
brother and two sisters, Priscilia, Ronnie, and Emelia

With love

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First of all, I would like to thank God, The Father in Heaven for His countless blessing upon me and make all things possible. After so many obstacles, I manage to finish this project with success and made it to the time. I also want to thank my whole family especially my mother and my father for their endless supports, love and encouragement to me while I was doing this project even though we are far away from each other. Also to my supervisor, Mr. Lee Yuk Choi, I want to thank him for his guidance and advices so that this project can be done resourcefully and smoothly. Last but not least, to all my friends and colleagues that helps me on this project, directly or indirectly, their help are very much appreciated. I hope that with this project, it can be a guide to all the readers and enhance their knowledge and make any good for the next research to come in the near future. Thank you.

ABSTRAK

Projek ini mempersembahkan teknik alternatif untuk memeta pendedahan bunyi dan ramalan aras bunyi-bunyi bising dalam industri dengan mematuhi dan berdasarkan peraturan pendedahan bunyi bising 1989. Projek ini dijalankan secara eksperimen, dan tumpuan adalah untuk mendapatkan kontur-kontur bunyi untuk pemetaan di persekitaran tempat kerja atau di tapak pengukuran di mana senario yang berbeza boleh dinilai. Di sesuatu kawasan seperti di sebuah bilik yang dipenuhi mesin dalam industri, ada sumber-sumber bunyi bising yang dikeluarkan oleh beberapa mesin-mesin secara berdekatan. Asas-asas teori-teori dan perumusan seperti aras tekanan bunyi atau *sound pressure level*, pemalar bilik dan keterarahan indeks digunakan sebagai beberapa sumbangan untuk membuat pengukuran dan analisa ini. Pemetaan bunyi bising boleh dilakukan dengan menggunakan meter aras bunyi. Data kemudiannya akan dipindahkan ke dalam lembaran beralgoritma. Dengan menggunakan algoritma ini yang kemudiannya disedia menggunakan satu program iaitu Microsoft EXCEL, perkiraan untuk aras atau tahap bunyi boleh dibuat. Kemudian, peta bunyi akan dilukis secara manual dengan pelan susun atur yang telah disediakan. Senario yang berbeza dipilih untuk melihat ramalan teori aras tekanan bunyi bising dalam satu kawasan dan beberapa penilaian daripada keputusan-keputusan boleh dibuat selepas itu. Didapati terdapat beberapa perbezaan di antara nilai-nilai eksperimen dan nilai-nilai teori tahap bunyi bising dan ia ditunjukkan dengan pengiraan peratusan ralat daripada nilai-nilai tersebut. Parameter seperti pekali-pekali penyerapan bunyi untuk permukaan-permukaan bilik dan luas permukaan adalah penting untuk menentukan nilai-nilai eksperimen dan teori yang relevan untuk pengukuran tahap bunyi bising. Dengan menjana satu kontur peta pengilustrasian pendedahan bunyi, tahap bunyi di persekitaran tempat kerja dapat ditunjukkan. Ianya juga akan menunjukkan bahawa tahap atau aras bunyi bising boleh mematuhi peraturan-peraturan yang dikehendaki seperti yang dinyatakan dalam Akta Kilang dan Jentera (Pendedahan Bunyi) 1989.

ABSTRACT

This project present the alternative technique to map noise exposure and prediction of noise levels in industry compliance to noise exposure regulation 1989. This project conducted experimentally, which was focused on obtaining noise contours to map out the entire workplace or the measurement site where different scenarios can be evaluated. In an area such as a machinery room in industry, there are a number of closely placed noise sources emitted by the machines. Basics theories and formulation such as the sound pressure level, room constant and the directivity index are used as some contributions to make measurement and analysis of this experiment. Noise mapping can be performed by using the readily available integrating sound level meter. The data then will be transferred to the spreadsheets algorithm. By using these algorithms that was developed using a programme preferably the Microsoft EXCEL, the calculations of noise levels can be made. Then, the noise map will be created manually after being provided with the layout plan. Different scenarios are selected to see the theoretical prediction of noise level in an area under assessments and some evaluation from the results can be made thereafter. It was found that there are some differences between the experimental and the theoretical values of the noise levels and it is shown by the calculations of the error percentage from both values. Parameters such as the sound absorption coefficients for the room surfaces and the area of the room surfaces participated importantly to determine the relevant experimental and theoretical values for the noise measurements. By generating a noise map illustrating the distribution of noise, one is provided with a graphical representation of sound pressure levels, that is the level of noise within the workplace and moreover, it can meets or compliance with the rules and regulations required as stated in the Factories and Machinery (Noise Exposure) Regulations 1989.

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LIST OF SYMBOLS

SYMBOL	DEFINITIONS
dB	Decibel
Hz	Frequency
log	Logarithm
Q	Directivity factor
<i>r</i>	Distance
<i>R</i>	Room constant in Sabine
<i>RT</i>	Reverberation time
<i>S</i>	Surface area
<i>SPL</i>	Sound Pressure Level
<i>SWL</i>	Sound Power Level
<i>V</i>	Volume
<i>W</i>	Power
GREEK ALPHABET	DEFINITIONS
α	Sound absorption coefficients

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CHAPTER 1

INTRODUCTION

1.1 Overview

This project present the alternative technique to map noise exposure and to predict the noise levels in industry compliance to noise exposure regulations 1989. Noise mapping is an increasingly important method of assessing environmental noise, particularly in this project, the industrial noise. Noise maps are being generated for projects ranging from small scale new developments with a single noise source to large agglomerations with many noise sources.

The largest noise maps require too many of calculations to be carried out and this can lead to long processing times and significant costs for hardware and software. This also required a general understanding of noise that considered on the theories and formulation of it and also the mapping methods that will be used to undergo the experiment on mapping the noise levels. The noise mapping also required the representation of noise sources in terms of sound power level and also the locations. General preparations are made for the noise measurement such as the equipments and the data sheet needed.

The noise measurement was conducted at a factory in a machinery room. Important parameters such as the dimensions of the room, the material used for the room surfaces and also the dimension of the machines are taken. All of the data for the noise mapping will be transferred into a computational form via spreadsheets algorithm. The spreadsheet algorithm will be developed using the Microsoft EXCEL. With the spreadsheets, the noise level would be calculated automatically by key in the data from the survey conducted and the noise map will be created manually with the provided of the sketch of the plan layout.

1.2 Objectives of the project

The objectives of this project are as follows:

- i. To determine the alternative method for mapping occupational noise exposure in industry.
- ii. To predict noise levels with additional add in machinery
- iii. To create a spreadsheet algorithm that is to be use in evaluating the noise exposure in industry.

1.3 Scopes of the project

The scopes of this project are as follows:

- i. Collect data, plan layout of machines equipment and conduct noise exposure measurement in industry.
- ii. Obtain noise contours to map out the entire workplace or measurement site where different scenarios can be evaluated.
- iii. A noise mapping is created from a database for the area under assessment. Appropriate color code must be used conforms to the Factories and Machinery (Noise Exposure) Regulations 1989.

1.4 Problem statements

Noise is considered as unwanted sound. Noise in the industry is a major problem nowadays. Most of the occupier in the industry particularly in the factories is not keen or aware about the noise exposure in their workplace and the effects to the employees. Even though some of them are aware, they still have to spend some amount of money and time for consultancy regarding the noise exposure activities. The cost comes from the software for assessment of the noise and also they had to buy and renewed for the license for the software.

Some of the occupier takes another way for the assessment of the noise exposure in the workplace. The most common method is the walk around survey that they had to conduct using the measuring instrument such as the sound level meter and make a noise map. However this is time consuming and not really practical to some area considering a large workplace.

In this experiment, an alternative method or technique will be created to map out the noise levels. This technique will then developed via spreadsheet algorithm by using a simple and most used program that is the Microsoft EXCEL. The noise mapping will be created or draw manually. The data to make or generated the noise map will be from the spreadsheet of the Microsoft EXCEL. This technique will be an alternative technique to map noise and it is reliable and can work as a tool for educational purposes.

CHAPTER 2

LITERATURE REVIEWS

Franks, et.al (1996), had conducted an area surveys should to estimate noise exposure. In an area survey, one measure environmental noise levels, using a sound level meter to identify work areas where workers' exposures are above or below hazardous levels, and where more through exposure monitoring may be needed. The result may be plotted in the form of a "noise map," showing noise level measurements for the different areas of the workplace. Dosimetry involves the use of body-worn instruments (dosimeters) to monitor an employee's noise exposure over the work-shift. Monitoring results for one employee can also represent the exposures of other workers in the area whose noise exposures are similar. It may also be possible to use task-based exposure methods to represent the exposures of other workers in different areas whose exposures result from having performed the same task

In 1983, the Occupational Safety and Health Administration (OSHA, 1983) promulgated the Hearing Conservation Amendment to the Occupational Noise Standard of 1971, which specified the components of a hearing conservation program. It requires that such a program be started if workers have an exposure of 85 dBA or greater. A hearing conservation program must include an assessment of noise exposure, audiometric tests of exposed workers, noise abatement and/or administrative controls, maintenance of records on noise and hearing data, availability of hearing protectors and employment training and education.

In 1985, Tempest had stated that most noise standards are specific for sources and they normally consider several additional exposure factors. This leads to a large variety of acoustical noise descriptors.

In 1987, Diamond and Rice had conducted a case study and found out that planners need to know the likely effects on the noise pollution in a community of introducing a new noise source as well as increasing the level of an existing source.

A. Cohen, et.al (1970), had compared the mean hearing levels of exposed workers with those of a control group for several noise intensities and several durations of exposure and found that sound pressure levels between 85 dBA and 88 dBA (or more) could be harmful to the ear.

Martin, et.al (1975), said that there is a definite risk of hearing damage associated with prolonged exposure to sound levels between 85 dBA and 90 dBA, or more.

K. Stevens, et.al (1957), have gave a main suggestion to use the equivalent sound pressure level in the 300-600 Hz band based on an energy average over a 1-h period. Weighted in accordance with seasonal effects, it constituted the Composite Noise Rating (CNR) measure.

In 1975, Von Gierke recommended that all environmental noise impact assessments should use Ldn (Day-Night Average Sound Level; also abbreviated DNL) which is based on the A-weighted energy equivalent level, penalized 10 dB for nighttime exposure, and that it be supplemented with the SEL (Sound Exposure Level; time-integration referred to 1 s, A-weighted) as a single noise event measure.

In 1971, Kurze and Beranek had stated that, in prospective noise control, the anticipated exposure has to be predicted from parameters of various sound emissions from sources as well as sound propagation models from emission to emission.

CHAPTER 3

THEORY

3.1 Sound absorption coefficients

The sound absorption coefficient is a measure of the proportion of the sound striking a surface which is absorbed by that surface, and is usually given for a particular frequency. Thus, a surface which would absorb 100% of the incident sound would have a sound absorption coefficient of 1.00, while a surface which absorbs 45% of the sound, and reflects 55% of it, would have a sound absorption coefficient of 0.45. The sound absorbing efficiency of the surface involved is given in terms of an absorption coefficient nominated by the symbol α . Absorption coefficients for different materials are having different coefficient.

3.2 Reverberant field

Reverberant field is a region in which the majority of sound energy arriving from the sound source at a point has been reflected at least once. In the statistical limit of an infinite number of reflections, the reverberant field approaches diffuse field conditions. In the reverberant field, reflections from walls and other objects may be just as strong as the direct sound from the machine. Figure 3.1 shows the reverberant field.

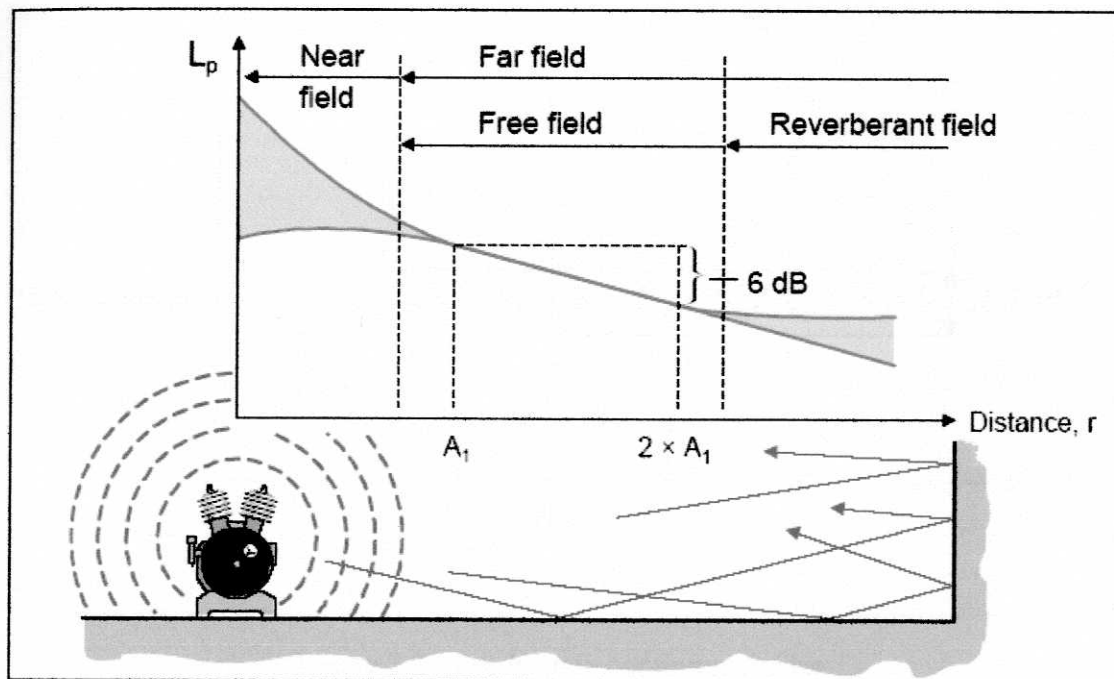


Figure 3.1: Reverberant field

3.3 Steady State Continuous Noise

Steady state continuous noise is sound whose quality and intensity is practically constant (changeable less than or equal to 5 dB) over a substantial period of time. Unremitting steady state of sound is continuous sound. An example is noise emitted from machines in a factory is a steady state continuous noise. This kind of characteristic of noise is practically used in measuring the noise in a factory. Figure 3.2 shows the steady state continuous noise in a time domain.

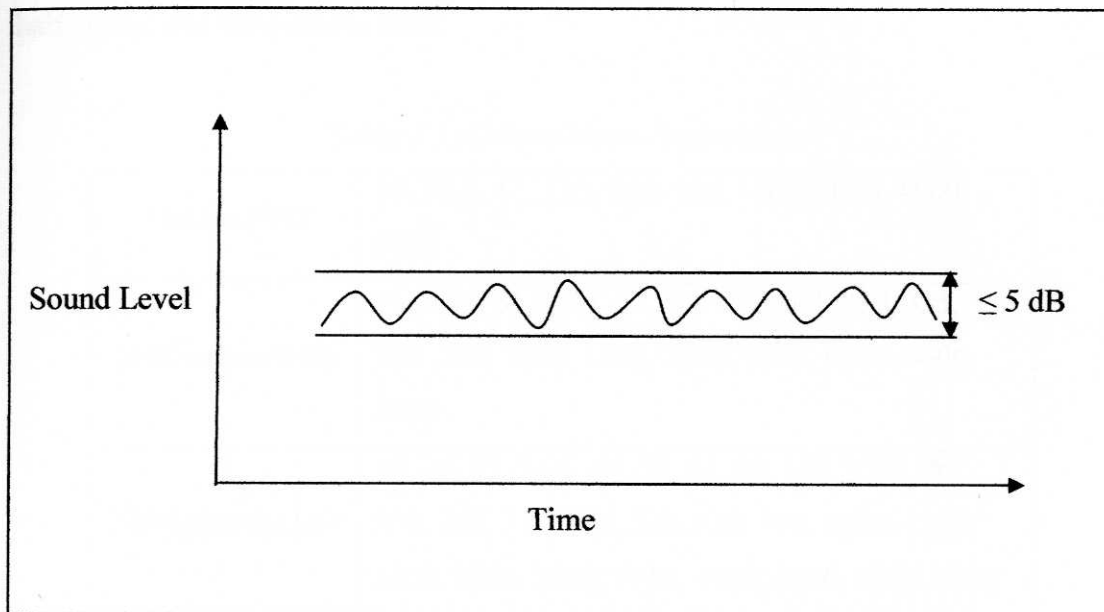


Figure 3.2: Steady state continuous noise

3.4 Octave bands

Sound (noise) does not usually consist of single frequency notes, but a vastly complex combination of tones. The octave band analyzer is generally used for simplified analysis of noise having complex combination of tones. Typically it is adequate to know the magnitude of the sounds contained within octave bands that are 75-150 Hz, 150-300 Hz, 300-600 Hz, 600-1200 Hz, 1200-2400 Hz, 2400-4800 Hz, 4800-9600 Hz. Noticed that one octave band consists of all sounds from any frequency to twice that same frequency. Table 3.1 shows the frequency of octave, half octave and third octave band.

Table 3.1: Octave bands frequencies

Octave (Hz)	16, 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000
Half octave (Hz)	16, 22.4, 31.5, 45, 63, 90, 125, 180, 250, 355, 500, 710, 1000, 1400, 2000, 2800, 4000, 5600, 8000
Third octave (Hz)	16, 20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150, 4000, 5000, 6300, 8000

The ideal series of octave bands for acoustic measurement are the center frequency of these bands. Those center frequencies are 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz. However the most widely and commonly use of octave band for acoustic measurement are the frequencies of 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz.