



**UNIVERSITI PUTRA MALAYSIA**

***PREVALENCE OF HEARING IMPAIRMENT AND ITS ASSOCIATED  
FACTORS AMONG MALE AIRCRAFT MAINTENANCE WORKERS AT  
AIRCRAFT INDUSTRY***

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DECLARATION

PREVALENCE OF HEARING IMPAIRMENT AND ITS ASSOCIATED  
FACTORS AMONG MALE AIRCRAFT MAINTENANCE WORKERS AT  
AIRCRAFT INDUSTRY

which have been duly acknowledged



BY

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This thesis submitted in fulfilment of the requirement for the degree of Bachelor of Science (Environmental and Occupational Health) from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

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## ABSTRACT

### PREVALENCE OF HEARING IMPAIRMENT AND ITS ASSOCIATED FACTORS AMONG MALE AIRCRAFT MAINTENANCE WORKERS AT AIRCRAFT INDUSTRY

AFINA BINTI AFANDI

**Background:** Noisy environment is anticipated to be present in the population of aircraft maintenance workers in aircraft industry. This study aims to measure noise exposure, hearing threshold level and the factors associated with the hearing impairment among aircraft maintenance workers. An audiometric assessment was carried out to analyze the prevalence of hearing impairment among the workers.

**Methods:** A total of 87 aircraft maintenance personnel participated in a self-administered questionnaire to determine their smoking habits, age, chemical exposure and ototoxic drug exposure of the workers and audiometric test to assess their hearing status. Noise exposure level was measured using noise logging dosimeter to obtain 8-hour Time weighted average (TWA). The data was analyzed using SPSS version 20.1.

**Results:** The aircraft maintenance workers were exposed to high level of noise exposure of more than 85 dB(A) indicating exceeding action level. The prevalence of hearing impairment was 25.3%. Among all frequencies tested (500,1000,2000,3000,4000,6000,8000Hz), the percentage of hearing loss is the highest in both right and left ears at frequency 6000Hz which is 41.41% that represent 36 out of 87 respondents. Besides, the result showed that there is significant relationship ( $p < 0.05$ ) between smoking and hearing status among the aircraft maintenance workers ( $p = 0.003$ ). However, for other factors such as chemical exposure, age nor ototoxic medication there is no significant relationship which their value is ( $p > 0.05$ ).

**Conclusion:** There is no significant relationship for factors such as age, chemical exposure, ototoxic exposure and noise dose with hearing impairment. There is significant relationship between noise exposure level and chemical exposure (paint stripper) with hearing status in this study.

**Keywords:** Hearing Threshold, Audiometric Assessment, Time-Weighted Average (TWA), Hearing Impairment.

## ABSTRAK

# PREVALENS CACAT PENDENGARAN DAN FAKTOR-FAKTOR YANG MEMPENGARUHI DALAM KALANGAN LELAKI PEKERJA PESAWAT PENGENDALIAN INDUSTRI KAPAL TERBANG

AFINA BINTI AFANDI

**Latar belakang:** Persekitaran bising dijangka hadir dalam populasi pekerja penyelenggaraan pesawat dalam industri pesawat. Kajian ini bertujuan untuk mengukur pendedahan bunyi bising, pendengaran tahap ambang dan faktor-faktor yang berkaitan dengan pendengaran di kalangan pekerja penyelenggaraan pesawat. Penilaian audiometrik telah dijalankan untuk menganalisis kelaziman pendengaran di kalangan pekerja.

**Kaedah:** Sebanyak 87 kakitangan penyelenggaraan pesawat mengambil bahagian dalam soal selidik yang ditadbir sendiri untuk menentukan tabiat mereka merokok, umur, pendedahan kimia dan pendedahan dadah ototoxic pekerja dan ujian audiometrik untuk menilai status pendengaran mereka. Tahap pendedahan bunyi bising telah diukur dengan menggunakan bunyi pembalakan pengukur Dosis untuk mendapatkan 8 jam Masa wajaran purata (TWA). Data yang telah dianalisis dengan menggunakan perisian SPSS versi 20.1.

**Hasil:** Pekerja-pekerja penyelenggaraan pesawat terdedah kepada tahap pendedahan bunyi melebihi 85 dB (A) yang menunjukkan melebihi tahap tindakan. Penularan pendengaran adalah 25.3%. Antara semua frekuensi yang diuji (500,1000,2000,3000,4000,6000,8000 Hz) peratusan kehilangan pendengaran adalah yang tertinggi di telinga kiri dan kanan pada frekuensi 6000Hz yang 41.41% yang mewakili 36 daripada 87 responden. Selain itu, hasilnya menunjukkan bahawa terdapat hubungan yang signifikan ( $p < 0.05$ ) antara merokok dan status pendengaran di kalangan pekerja penyelenggaraan pesawat ( $p = 0.003$ ). Walau bagaimanapun, faktor-faktor lain seperti pendedahan kimia, umur mahupun ubat ototoxic terdapat hubungan yang signifikan yang nilai mereka adalah ( $p > 0.05$ ).

**Kesimpulan:** Terdapat hubungan yang signifikan bagi faktor-faktor seperti umur, pendedahan kimia, pendedahan ototoxic dan dos bunyi dengan pendengaran. Terdapat hubungan yang signifikan di antara pendedahan kima (*paint stripper*) dan status pendengaran dalam kajian ini.

**Keywords:** Ambang Pendengaran, Audiometrik Penilaian, Purata Berwajaran Masa (TWA), Pendengaran.

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## LIST OF ABREVIATION

WHO	Time Weighted Average
OSHA	Occupational Safety and Health
SOCSSO	Social Security Organisation
dB (A)	Decibel in A- Weighted Scale
NIOSH	National Institute of Occupational Safety and Health
Hz	Hertz
Pa	Pascal
ENT	Ear, Nose and Throat
SPSS	Statistical Package for Social Sciences
PPE	Personal Protective Equipment

## CHAPTER ONE

### INTRODUCTION

#### 1.1 BACKGROUND

Noisy environments are hazardous to the hearing. It is well established that exposure to the sufficient intensity and duration damages the hearing of those exposed (Nasir and Rampal, 2012). One of the identified noisy environment that can contribute to hearing loss is in airport area. This was proven by a study that showed Jomo Kenyatta International Airport (JKIA) has been documented to have potentially hazardous noise from aircrafts and motorized ground equipment (Mutinda, 2004). The issue on aircraft noise has been addressed since the introduction of the first jet, the technological improvements, the introduction of larger aircraft (Johnson, 2005).

Different aircraft have different noise levels and frequencies which come from three main sources which are from aircraft noise itself, aerodynamic noise (between air and the surface of the aircraft such as fuselage, wings, control

surfaces and landing gear) and engine/ mechanical noise. Noise from aircraft can be produced by virtue of aircraft equipment, propellers, transmission systems, rotors, hydraulic and electric actuators, air conditioning and cabin pressurization systems, alert systems and communication equipment (Antunano,1998).

Recently aircraft maintenance technicians that exposed to the aircraft noise have come into focus (Kaufman *et al.*, 2004). They involved in noisy operations such as aircraft movement, engine testing, maintenance equipment and powered tools, and other maintenance and repair activities (Noweir and Zytoon, 2013). A study on hearing loss among aircraft maintenance workers, airport fireman, airport policemen, airline ground staff, and airport civil servants highlighted that the prevalence of hearing loss is 65% which is the highest among maintenance workers compared to the others (Chen, 1992).

Hearing loss represents an ongoing social and economic burden world-wide with noise being universally recognizes as main risk factor (Nasir and Rampal, 2012). Risk factors such as noise exposure level, years of noise exposure, non-occupational noise exposure, history of ear disease, ototoxic drug use, cigarette smoking, hypertension, and use of hearing protective device is identified to cause hearing loss (Hong (2001). Aircraft maintenance personnel may also be exposed to jet fuels and solvents and occupational exposures to organic solvents may have detrimental effect on hearing (Sliwinska-Kowalska, 2007). In a meanwhile, combination of noise exposure and exposure to solvents may increase the risk of hearing loss. Workers with noise and jet fuel exposure had an increase in hearing

loss, even at fuel exposure estimates well below the threshold limit values (Kaufman, 2005).

## 1.2 Problem statement

Occupational noise is the most common cause of noise-induced hearing loss (Sataloff and Sataloff, 1993). Since the early days of aviation, noise has been recognized as problem, both environmentally and operationally (Nair and Kasyap, 2009). Many studies have reported a high percentage of hearing problems either hearing loss or hearing impairment.

There was a study conducted among airport workers in Malaysia which comprised of 3 units included engineering, aviation security and fire rescue unit. The results showed that among the workers that involved in the study, 33.5% and 8.1% had hearing loss and hearing impairment respectively (Nasir and Rampal, 2011). In a meanwhile, there was a study investigated the prevalence of noise induced hearing loss among workers in and around the Kotoka International Airport. The severity of hearing loss among the affected workers was in the category of mild hearing loss were 66% and moderate hearing loss were 19%. Only about 3% had moderately severe hearing loss, 5% had severe and 8% had profound NIHL (Asamoah-Baidoo, 2011).

Besides, there was a study among Indian Air Force Personnel revealed an overall incidence of Noise Induce Hearing Loss of 22.9% in the personnel with a higher prevalence among technical trades which is 26.18% as compared to non technical trades which is 12.5% (Nair and Kasyap, 2009). In another cross-sectional study done at the Khartoum International Aiport, Sudan showed high incidence of Noise Induce Hearing Loss (NIHL) which is 55%. The study showed that 55% of affected employees did not use personal hearing protection devices (PHPD), but even those who used it, most of them which 81% used the PHPD irregularly (Humeda and Amal, 2008).

In a similar research conducted at the Jomo Kenyatta International Airport in Kenya, showed the overall prevalence of NIHL was 15.3% with ground crew at 14.8% and aircrew was 16.1%. These study showed that workers with higher age have high risk in hearing problems (Anino *et al.* 2010).

The aim of this study was to study the prevalence of hearing impairment among male workers at aircraft maintenance industry and to study its associated factors.

### **1.3 Study Justification**

Nowadays, Malaysia has become a country that undergo economic transformation to become a develop country in achieving 'Wawasan 2020'. In the line with that, aerospace industry of Malaysia has become one of strategic industries in the Economic Transformation Program (ETP). One of the goals of Malaysian Government agencies is to provide Human Capital development to support the

Aerospace growth needs. This leads to increase in employment opportunities, causing more workers are exposed to the health hazard of the noisy workplace environment.

One of the affected workers in this industry is the aircraft maintenance workers. In Malaysia, there is still inadequate research regarding to the noise hazards towards the aircraft maintenance workers. Since that, hopefully this research will manage to contribute a baseline data for government bodies and other agencies. There is previous study conducted in airport at Korea shows the highest prevalence of hearing loss among maintenance workers. This shows that there is still lacking of awareness among the workers and the management regarding to this issues. Hopefully, this research can create not only awareness but to increase knowledge to the workers, management and related government such as DOSH to overcome this problem.

Workers are very important asset to the industries and employer especially. Noisy workplace environment will affect the workers' health such as noise-induced hearing loss. Increasing numbers of workers that get the disease will increase the compensation of SOCSO. This cause management to have bad reputation if there is a lot of compensation. Therefore, this study attempt to create an awareness and increase knowledge not only to the workers but also to the management or the employers itself regarding to this very serious hazard.

## 1.4 Conceptual Framework

From Figure 1.1, aircraft maintenance workers are exposed to three (3) types of hazards. They are exposed to physical, chemical and biological hazard. The physical hazard is noise either directly to the aircraft or tools used during maintenance work such as hammering or riveting. While for chemical, they are exposed to several solvents such as paint, jet fuel and some of solvent used to clean the aircraft body. Both factors can cause hearing impairment whether directly or indirectly. For biological hazard, they might exposed to mold in the aircraft itself. This study focuses on physical and chemical hazard only.

There are two (2) main factors that contribute to hearing impairment other than noise and chemical which are occupational and non-occupational factors.

Risk factors of hearing impairment from occupational factors are: (1) Sound Intensity, (2) Years of employment, (3) Period of exposure and (4) Distance from sources. In a meanwhile, the causes of hearing impairment from non-occupational factors are : (1) Age, (2) Lifestyle, (3) Medication, (4) Coexisting of hearing loss and ear disease, and (5) Hearing protective devices.

Among of those factors, the main factors that are studied in this research are: (1) Sound intensity, (2) Age, (3) Smoking, (4) Ototoxic Medication and (5) Chemical exposure

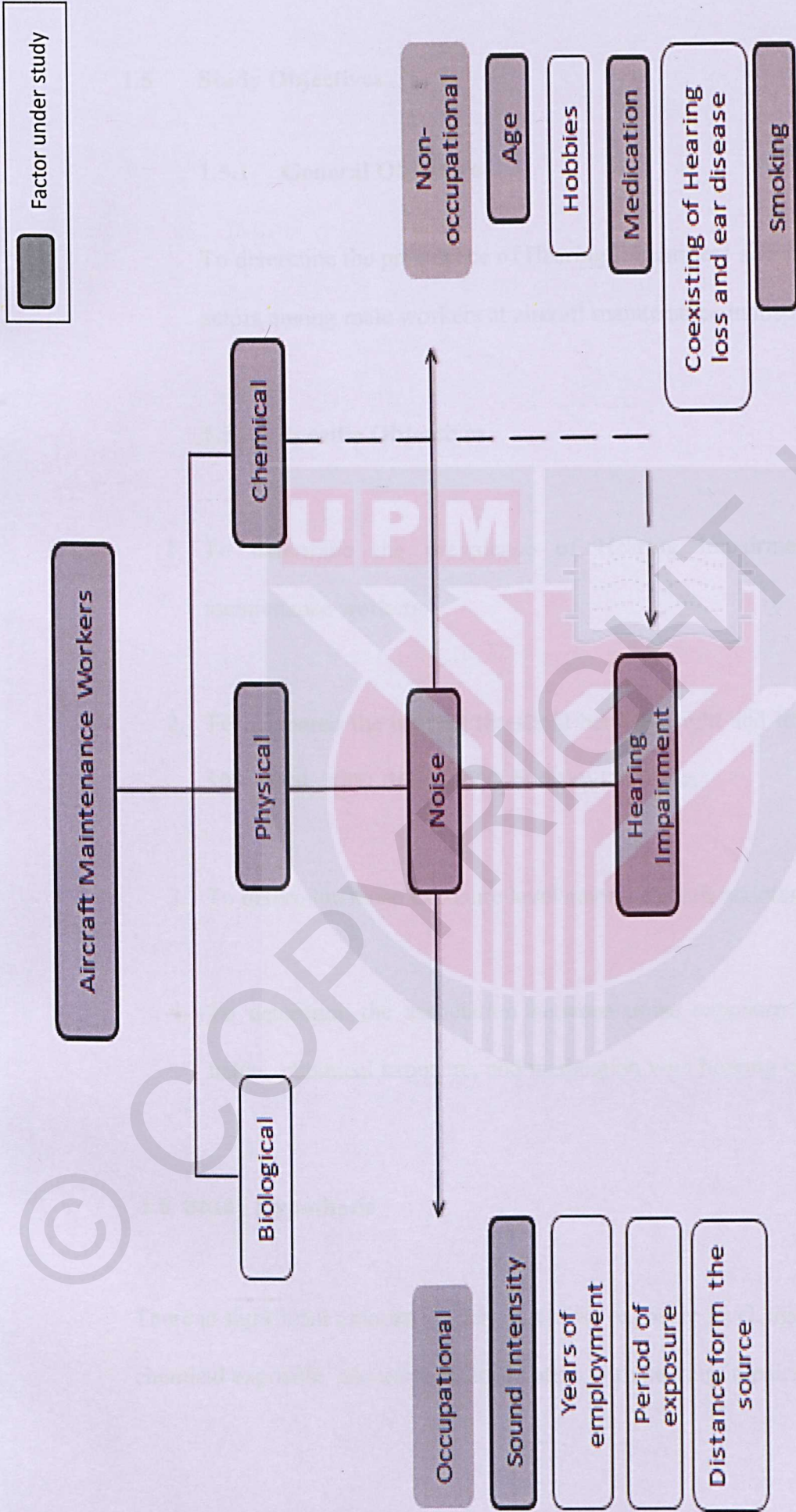


Figure 1.1: Conceptual Framework of Prevalence of Hearing Impairment and Its Associated Factors Among Male Workers at Aircraft Industry

## **1.5 Study Objectives**

### **1.5.1 General Objective**

To determine the prevalence of Hearing Impairment and its associated risk actors among male workers at aircraft maintenance industry.

### **1.5.2 Specific Objectives**

1. To determine the prevalence of Hearing impairment among aircraft maintenance workers
2. To compared the hearing threshold between right and left ear at frequencies 500, 1000, 2000, 3000, 4000, 6000 and 8000Hz.
3. To determine noise exposure level among aircraft maintenance workers
4. To determine the association between noise exposure level, age, smoking habits, chemical exposure, and medication with hearing impairment

## **1.6 Study Hypothesis**

There is significant association between noise exposure level, age, smoking habits, chemical exposure, and ototoxic medication with hearing impairment

## 1.7 Terminology

### Sound

#### Conceptual Definition

Vibrations which travel through the air or another medium and are sensed by the ear or anything that can be heard. (Pearsall, 2002)

#### Operational Definition

Velocity of sound in the air is approximately 340m/s at ground level and the wavelength of the audible sounds will range from 23 m (5Hz) to 19 m (18 kHz). Since sound is pressure changes in the air, it is normally measured in Newton per square meter or Pascal (pa). The quietest sound that can be heard is about 0.000002 Pa. (Ashton and Gill, 1992)

### Noise

#### Conceptual Definition

A sound, especially one that is loud or unpleasant or that causes disturbance. (Oxforddictionaries.com, 2013)

#### Operational Definition

Noise is combination of sound intensity and frequencies from several sources. The sound level meter is used to measure decibel reading which the frequencies from 1kHz to 6kHz which is known as A-weighted scale. (Asfahl,1999).

## **Hearing Loss**

### **Conceptual Definition**

Hearing loss is a common problem that often develops with age or is caused by repeated exposure to loud noises. (Pearsall, 2002)

### **Operational Definition**

Hearing loss is average hearing level at 0.5, 1.0, 2.0 and 3.0 kHz is greater than 25dB in either ear or difference in hearing level between the ears of more than 15dB at 0.5,1.0 and 2.0 kHz or more than 20dB at 3.0,4.0 and 6.0 kHz. (Plog, 1988)

## **Hearing Impairment**

### **Conceptual Definition**

Hearing impairment is hearing loss that prevents a person from totally receiving sounds through the ear. (Kentucky Education and Workforce Development Cabinet, 2013)

### **Operational Definition**

Hearing impairment is the arithmetic average of the permanent hearing threshold level of an employee at 0.5, 1.0, 2.0 and 3.0kHz which shifted by 25dB or more compared to the standard audiometric reference level. (Factories and Machinery Act, 1989)

## **Noise induced Hearing Loss**

### **Conceptual Definition**

Exposure to loud noise, or chronic unprotected exposure to  $> 90$  dBA daily which likely to lead to bilateral, symmetrical hearing and diplacusis may be present. (Sataloff, 2005)

### **Operational Definition**

Noise induced hearing loss define as audiometric threshold notch is present when one or more of the thresholds at 3, 4, or 6 kHz exceeds the pure-tone average of the 0.5 and 1 kHz thresholds by 15 dB or more, and the 8 kHz threshold is at least 5 dB lower (better) than the highest threshold in the 3 to 6 kHz range. (Healthy People 2010 Criteria for Data Suppression Statistical Notes No. 24. Hyattsville, MD, 2013)

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Anatomy of Ear

The organ of hearing is divided into three parts, which are the external, the middle and the inner ear (Plog, 1988)

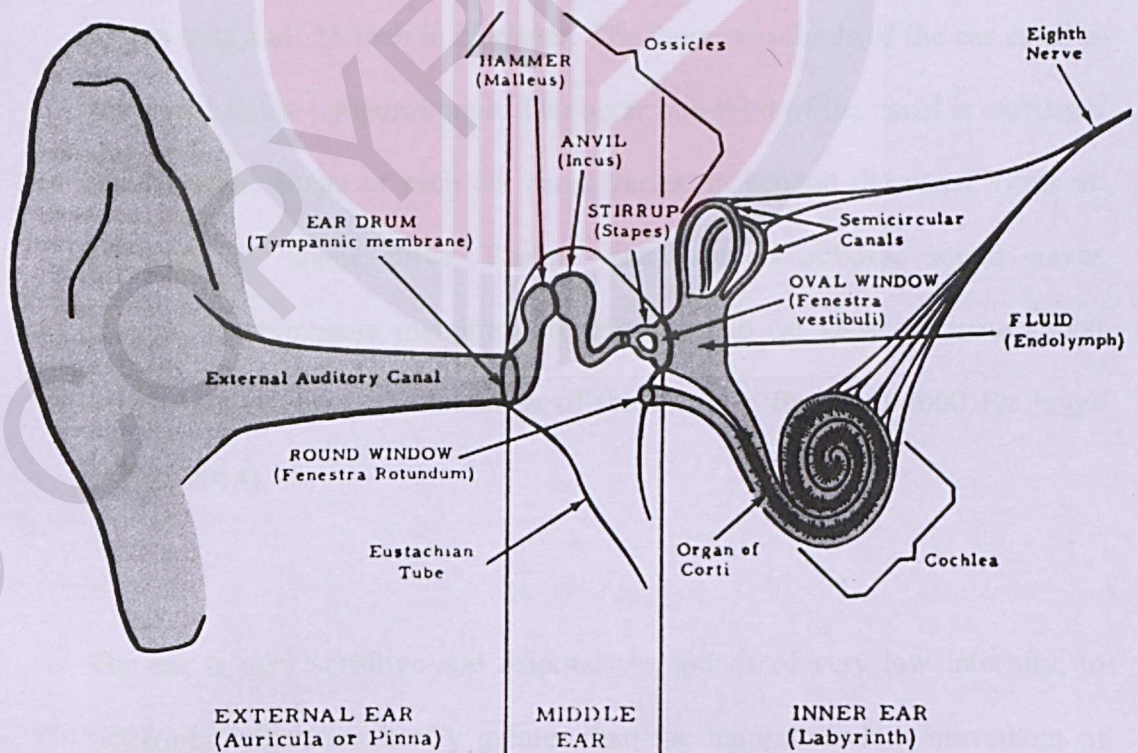


Figure 2.1 Anatomy of ear

## 2.11 External Ear

The external ear includes ear pinna/auricle and the ear canal (Plog, 1988).

### Pinna

The pinna or auricle is a concave cartilaginous structure, which collects and directs sound waves traveling in air into the ear canal or external auditory meatus (Elvin, 2014).

### Ear Canal

The ear canal or external auditory meatus is approximately 1.25 inches long and .25 inch in diameter. The inner two-thirds of the ear canal is imbedded in the temporal bone. The outer one-third of the canal is cartilage. Although the shape of each ear canal varies, in general the canal forms an elongated "s" shape curve. The ear canal directs airborne sound waves towards the tympanic membrane (eardrum). The ear canal resonate sound waves and increases the loudness of the tones in the 3000-4000 Hz range (Elvin, 2014).

The ear is very sensitive and responds to sounds of very low intensity, to vibrations which are hardly greater than the natural random movement of molecules of air (Hallowell *et al.*, 1970).

## 2.12 Middle ear

The primary anatomy of the middle ear consists of the tympanic membrane (ear drum), the middle ear ossicles (bones), and the eustachian tube. Middle ear systems are designed to convert (or “transduce”) sound vibrations in the air into mechanical energy which is then passed on to the inner ear fluid (Keifer, 2014).

### Ossicular Chain

The middle ear space houses three little bones, the hammer, anvil and stirrup (malleus, incus and stapes) which conduct sound from the tympanic membrane to the inner ear (Silverman *et al.* 1970). The stapes is the smallest bone in the human body and attaches to a very small membrane opening to the inner ear, called the oval window (Keifer, 2014).

### Eustachian Tube

The eustachian tube serves to equalize pressure on either side of the tympanic membrane (Plog, 1988). When the eustachian tube opens, the air pressure between the outer and middle ear is equalized. The transmission of sound through the eardrum is optimal when the air pressure is equalized between the outer and middle ear. When the air pressure between the outer and middle ear is unequal, the eardrum is forced outward or inward causing discomfort and the ability of the eardrum to transmit sound is reduced (Ervin, 2014).

## **Eardrum**

The eardrum or tympanic membrane serves as a divider between the outer ear and the middle ear structures (Ervin, 2014). It consists of an inner layer of mucous membrane, a middle layer of fibrous tissue, and an outer layer of squamous epithelium. It is shaped like a spider web, with radial and circular fibers for structural support (Plog, 1988).

### **2.13 Inner ear**

The inner ear is typically discussed as having three main parts which are the cochlea, vestibule, and semicircular canals (Plog, 1988).

#### **Cochlea**

The cochlea is a tubular snail-shaped structure lined with the basilar membrane, which contains thousands of feathery hair cells tuned to vibrate to different sound frequencies. Nerve endings are contained in a complex, slightly elevated structure over the floor of the tube forming the cochlea (Plog, 1988).

The cochlear duct contains the Basilar membrane upon which lies the Organ of Corti. The Organ of Corti is a sensory organ essential to hearing. It consists of approximately 30,000 finger-like projections of cilia that are

arranged in rows. These cilia are referred to as hair cells (Ervin, 2014). Haircell damage and/or dysfunction (both inner and outer hair cells) will lead to sensory hearing loss, while damage to the fibers of auditory nerve will lead to neural hearing loss (Keifer, 2014).

### **Vestibular System**

The balance part of the ear is referred to as the vestibular apparatus. It is composed, in part, of three semicircular canals located within the inner ear. The vestibular system helps to maintain balance, regardless of head position or gravity, in conjunction with eye movement and somato sensory input (Keifer, 2014).

Our sense of balance is dependent not on hearing, but on organs of equilibrium. Near the cochlea are three semicircular canals lying in planes perpendicular to each other the canals contain endolymph fluid that responds to movement of the head. Additional positional information is provided by receptors located in the vestibule. The vestibular branch of the auditory nerve (combined, called the eighth cranial nerve) transmits these impulses to the cerebral cortex and we recognize the position of our head in space as it relates to the pull of gravity (Plog, 1988).

## 2.2 Hearing Loss

Based on baseline audiogram, hearing loss is defined as average hearing level at 500, 1,000, 2,000, and 3,000 Hz is greater than 25 dB in either ear. Each ear must have an average hearing shift of more than 25 dB for the frequencies measured to be ranked as impaired (Plog, 1988).

### 2.21 Types of hearing loss

#### Conductive Hearing Loss

It is a result of a blockage of ear canal that interferes with normal transmission of vibration to the inner ear. These can be:

- a. Wax or foreign object in the ear canal
- b. Middle ear infection
- c. Malfunction of ossicles
- d. Trauma to the ear drum
- e. Blockage of the Eustachian tube

This type of hearing loss is seldom industrial in origin, is not caused by noise exposure and may be identified in an otological examination (Stern and Mandsdorf, 1998). The hair cell did not receive as much stimulation, so that the perception of the hearing is lowered. In addition, exposure to very loud noises such as explosions can damage the ear drum due to the rapid change in

pressure occurs and also some drugs as well as some infections disease can damage the structure of middle ear (Nims, 1999).

### **Sensorineural Hearing Loss**

Sensorineural hearing loss is the hearing difficulty caused by inner ear damage (Plog, 1988). It is caused by damage to tissues of the inner ear, such as hair cell. Exposure to loud noise will cause this type of hearing loss. Besides, the hair cell is swelling and twisting which resulting in less efficient transfer of sound energy which take stronger stimuli to cause the hair cell to react. After repeated exposure to noise, it will damage hair cells permanently (Nims, 1999).

## **2.3 Noise and Noise Exposure**

Noise is often used to mean unpleasant sound that the listener does not want to hear (Plog, 1988). It is an occupational hazard which loud sound produces hearing loss has been recognized for thousands of years. It has been recognized as a problem, both environmentally and occupationally, since the early days of aviation (Nair and Kasyap, 2009).

Noise is similar to light which it is also energy in form of waves. However, sound is the results of cyclic pressure changes that are produced by a source. This cyclic pressure creates sound pressure which can be measured by portable field instrument. The most common and convenient unit for

expressing sound pressure levels (SPLs) is the decibel (dB). It is common to see decibels with an added designation of A, B or C in parentheses, as in 85 dB (A). These letters refer to weighting scales for measuring sound. The human ear is more sensitive to higher frequencies, Therefore, it takes less sound pressure for the noise to be perceived as loud as a noise with lower frequencies. This scale is the one that is specified by OSHA for use in evaluating occupational noise exposure. A reading 85 dB (A) means that the sound pressure level was measured at 85 dB on A scale (Nims, 1999).

### **2.31 Aircraft Noise**

Aircraft noise which is produced by aircraft or its component causes noise pollution during on the ground while park such as auxiliary power units, during takeoff, on run up propeller and jet exhaust, during landing, or underneath and lateral to departure and arrival paths. A moving aircraft including jet engine or propeller causes compression and rarefaction of air, which produce motion of air molecules. This movement propagates through air as pressure waves. If these pressure waves are strong enough and are within the audible frequency spectrum, a sensation of hearing is produced. Mainly, the noise comes from three (3) main sources including aerodynamic noise, engine and other mechanical noise. In addition, different aircraft have different noise levels and frequencies (Kyter, 1994).

Aircraft maintenance involving with noisy operations such as aircraft movement, engine testing, maintenance equipment and powered tools and

other maintenance and repair activities Operation and/or equipment in hangars included run of auxiliary power unit, air compressor, Combo unit (for lubricating aircraft components), Mule unit (for testing the hydraulic part of aircraft) and riveting gun, which all producing impulsive high-level sound (Noweir and Zytoon, 2013).

### **2.32 Regulation and Guidelines on noise**

#### **Occupational Safety and Health Act 1994**

Based on Section 15 of Occupational and Safety Act 1994, all employers and self employed person has to ensure, so far as is practicable, the safety, health and welfare at work of all his employees (OSHA, 1994).

#### **Factory and Machinery Act 1967**

There is specific law which regulate the noise exposure which is Factories and Machinery (Noise Exposure) Regulations 1989. According to the law, no employee shall be exposed to noise level exceeding 90 dB (A) over 8 hour for continuous noise or 115 dB (A) at any time (FMA, 1967).

## **American Conference of Governmental Industrial Hygienists (ACGIH)**

It is an organisation devoted to the administration and technical aspects of occupational and environmental health. In their handbook of Threshold Limit Values (TLVs) they provide guideline for practice of Industrial Hygiene. The ACGIH recommend TLV for noise provides more protection standard. The ACGIH method is used to calculate noise exposure (Stern and Mansdorft, 1998).

### **2.4 Regulation on aircraft noise**

The International Civil Aviation Organization (ICAO) is a convention of States that are under treaty to ensure safety oversight of the airports and airspaces. The Organization has put together regulations and documents that are supposed to aid States in ensuring that aviation industry all over the world is safe (ICAO, 2006).

With respect to aircraft noise and its debilitating effects on hearing abilities of people, ICAO has put together directives and procedures that regulate operations at airports to help minimize the noise. Much of ICAO's effort to address aircraft noise over the past 40 years has been aimed at reducing noise at source. Aeroplanes and helicopters built today are required to meet the noise certification standards adopted by the Council of ICAO (ICAO, 2001).

## **2.5 Factors related to hearing impairment among Aircraft Maintenance Workers**

### **2.51 Association between Hearing Impairment and Noise Intensity**

In other occupational setting, equivalent noise levels above 85 dB (A) during 8 hours have been shown to increase the risk for hearing loss (National Board of Occupational Safety and Health, 2005).

All operations involved in aircraft maintenance hangars produced noise of level higher than the recommended 85 dB (A) level. The measures noise levels in hangar are higher than those in workshop (Noweir and Zytoon, 2013). Aircraft maintenance workers are exposed to noise varies on different occasions depending on whether aircraft engine are running, location on, or near the flight line and activities undertaken in the maintenance hangars such as grif blasting, riveting, grinding and hammering (Guest *et al.*, 2010). The maximum noise level during technical works in the hangar is riveting which the noise level is measured inside the ear muff which indicate the reading was 119 dB (A) (Smeje *et al.*,2011). Besides, in civilian aircraft maintenance workers, the measured peak noise exposure was 115dB (A).

### **2.52 Association between Hearing Impairment and Chemical Exposure**

Recently, solvent either alone or interacting with noise have emerged as a major cause of occupational hearing loss. Simultaneous exposure to noise and solvents has worsened hearing loss in occupational settings

(Johnson, 1993). It has been suggested that organic solvent can injure the sensory cells and peripheral nerve endings of the cochlea which can affect the auditory pathways in the brain (Crofton *et al.*, 1993, 1997, 1998). There are several studies showed that hearing loss worsened with exposure to solvent and noise compared with exposure to noise only (Morata *et al.*, 1994).

Recently, aircraft technician that are exposed to aircraft noise, jet fuel and other chemical have come into focus (Kaufman *et al.*, 2005). Some of the workers were exposed to mixed organic solvent during cleaning, paint removal and painting task (J Kim *et al.*, 2005). There is study conducted which is Study of Health Outcomes in Aircraft Maintenance Personnel (SHOAMP) General Health and Medical Study among military f-11 aircraft maintenance personnel showed that workers that exposed to both noise and solvents, and thus at potentially increased risk of hearing loss are among f-11 fuel tank maintenance workers (Guest *et al.*, 2010). The workers are exposed to high levels of jet fuels, paint and strippers as well as epoxy resins (Guest *et al.*, 2010).

### **2.53 Association between Hearing Impairment and Smoking**

Smoking is a cause of various cancers, respiratory and cardiovascular diseases. Recent studies have shown that it also has detrimental effect on hearing function and the endocrine system (Tweed *et al.*, 2012). In addition, there is study that examined the relationship between smoking and noise-induced hearing loss which reported that the incidence of noise-induced

hearing loss is significantly higher in smokers (Palmer *et al.*, 2004). This is because there is a synergistic effect between the two factors (Mizou *et al.*, 2003).

The interaction mechanism of noise and chemical substances on hearing damage involves changes such as an increased cochlear vulnerability to noise and noise-related intensification of cochlear damage from chemical agents that have ototoxic effects (Fechter, 1995). The carbon monoxide present in the mainstream smoke reduces cochlear blood oxygen levels as a result of capillary vasoconstriction, increased blood viscosity, reduction of transported oxygen and difficulties in oxyhaemoglobin dissociation. Thus, noise exposure will induce hypoxia in the cochlea which causing direct lesions or interacting with mechanical noise-induced impairments (Chen, 2002).

#### **2.54 Association between Hearing Impairment and Age**

The hearing impairment in aircraft maintenance workers was found to be rapid within the first 20 years of employment (Hong, 2005). There is also report that showed similar trend which mentioned that rapid impairment happened within the first 10-15 years of exposure, followed by slowing rate of growth with additional exposure to noise (Leensen *et al.*, 2011).

However, there is younger in commercial airline company had a higher rate of hearing loss in the worse ear than a non-noise exposed reference population in that country. The higher hearing loss is among the younger, especially the 35-40 years old (Smeje *et al.*, 2011).

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Study design**

This study was done from 23<sup>rd</sup> January 2014 till 1<sup>st</sup> March 2014. The study comprised of 30 male aircraft maintenance workers of a Company X. The respondent for this research is taken from production workers at hangar which directly exposed towards the aircraft noise. The study involved in interviewing the respondent using questionnaires, initial noise monitoring by using Sound Level Meter (SLM) and personal noise assessment by using noise dosimeter. (Appendix 1).

#### **3.2 Study Location**

The location of the study is at Sepang, Selangor. It is an aircraft maintenance company which have in-house workshops that provide complete services in airframe, component, engine, and cabin refurbishment to all Airbus aircraft. This location had been chosen based on walkthrough survey during previous visit. The main criteria for choosing this place is the hangar

especially exposed their workers to the noise hazards which more than 85 dB during certain work task such as during engine run test. They are tend to expose to high noise level as they are contact directly with aircraft itself and also the hangar location is nearby the airstrip.

The 17,000 square meter purpose built hangar is able to accommodate up to four Airbus A320 series aircraft, four ATR 42/72 series or two A330/340 series aircraft. The hangar is divided into four lines which Line 1, Line 2, Line 3 and Line 4. Each of every line can suit one airbus.

### **3.3 Study Design**

This is a cross sectional study to determine the prevalence of hearing impairment and its associated factors among male workers at aircraft industry. Finally, the measurement was used to propose a recommendation to the owner of the company.

### **3.4 Sampling Method**

#### **3.4.1 Sampling Population**

The study population for this study was fulltime workers from different ethnic group employed inside the hangar section except the office

workers which exposed to occupational noise >85 dB based on Factory and Machinery Act 1967 (FMA-Noise Exposure Reg.1989).

### **3.4.2 Study Sample**

Study samples include male aircraft maintenance workers that had been selected to participated in this study from different lines and shift (night crew) from the hangar section.

### **3.4.3 Sampling Frame**

The sampling frame was obtained from the human resource department of each line workers. The sampling frame consists of aircraft maintenance workers that fit the inclusive criteria's of this study.

### **3.4.4 Sampling Unit**

Sampling units only involved maintenance workers who complied with the inclusive criteria's.

### **3.4.5 Inclusive Criteria**

Each respondent should meet the inclusive criteria's: (1) male aircraft maintenance workers (2) did not had any history of head injury and (3) coexisting of ear diseases.

### 3.46 Sampling Methods

The sampling method applied for this study is purposive sampling method. Workers will be chosen from all jobs with exposure to noise, until the required number of workers achieved. Those workers that will be chosen are based on the inclusion criteria as specified below :

1. Current registered staff of the company for at least 1 month.
2. Production workers ( Hangar )
3. Work directly with aircraft
4. Male
5. Have not been exposed to significant noise in the last 12 hours (for audiometric testing).

The list name of the workers will be obtained from the Human Resource of the Company X. Sample population will be selected using random sampling method. Fishbowl technique will be used to choose the respondent based on the list name that will provided by the company. The total number of respondent that will be selected are 87 workers who exposed to high level of noise (>85 dB).

### 3.47 Sample size

The sample size for this study is calculated based on (Kirkwood, 1998). The formula is given below :

$$N = \frac{p(1-p)}{e^2}$$

where,

N = sample size

p = 26% (prevalence for hearing loss according to (Morata *et al.*, 1993) on

workers exposed to noise)

= 0.26

e = standard error (0.05)

Therefore, the sample size is:

$$N = \frac{p(1-p)}{e^2}$$

$$= \frac{0.26(1-0.26)}{0.05^2}$$

$$= 76.96$$

The calculated sample size was increased by a 13% margin, thus only eighty seven workers are required from study population

### **3.5 Instrumentation**

#### **3.51 Measurement for hearing threshold**

Audiometer which a frequency-controlled audio-signal generator is used which produce pure tone signal, the frequency and intensity of which are varied for use in hearing measurement. The initial baseline audiogram is obtained and compared with the results that will be obtained after audiometric test. The equipment is calibrated according to American national Standards Institute (ANSI) standards Specification for Audiometers (ANSI S3.43-1992).

### 3.52 Noise logging dosimeter Model Q 300



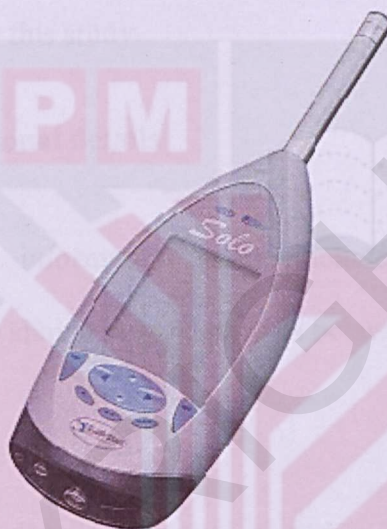
**Figure 3.1 Noise Dosimeter**

The Q 300 noise dosimeter provides both exponential averaged and time integrated measurements and the result logged in internal memory. This dosimeter are designed to be socially acceptable and cause minimal interference when clipped on a belt or worn in a shirt pocket. The small microphone is simply clipped to the shirt near the ear, as they are light in weight and small.

The meter is housed in cast aluminium case to protect against physical abuse as well as electrical interference. When connected to computer, the Quest Noise Manager software will allow the user to analyse and print out pre-

recorded data in detail. The dosimeter also can print the detailed report of noise events. It can be connected to printer by using a Quest “Parallel Printer Interface” or “Serial Computer Interface”. This dosimeter need to be calibrated well before each used.

### 3.53 Sound level meter Solo



**Figure 3.2 Sound Level Meter Solo**

Sound level meter consist of a microphone which converts the sound wave to electrical impulse. This model is general purpose designed for sound pressure level measurements with or without the use of optional band-pass filter. It is friendly hand held meter with LCD display that provide a numerical and bar graph readout. It is housed in moulded plastic case with internal shielding is function to protect against external electromagnetic interference. The meter is operated with easy to used slide switches and push buttons. If sound measurements need to be made from a distance, the microphone can be removed and the extension cable will be inserted. This

instrument must be calibrated using Quest Standard Calibrator. The calibration is done according to Sound Level Meter Model 2700 manual.

### **3.54 Questionnaire form**

A self-constructed questionnaire was developed and will be used in this study. The questionnaires are divided into four (4) categories to gather important related to this study.

#### **Respondent's Personal details**

The detailed information asked includes ages, race, gender and educational level as shown in the details as below :

##### **1. Personal details**

The workers are asked on the age and which section in the hangar they are.

##### **2. Working Details**

The workers are asked on history of previous jobs on noise exposure, whether they exposed or not to loud noise, and their duration of work.

##### **3. Hearing Protecting Device**

The respondent is asked on whether their employer provide them the HPD and they are wearing it or not.

#### **4. Lifestyle**

In this section, the respondents need to answer question on hobby that related to loud exposure of noise and smoking habit.

#### **5. Chemical exposure**

The respondent is asked whether they are exposed to chemical during working and stated the type of chemical they exposed to.

#### **6. Medical History**

The respondents are asked on symptoms related hearing problems such as ear infection, tingling ears or hearing loss.

### **3.55 Data collection procedure**

#### **Consent**

The data of this study is collected using a few methods and one of them through self-administered questionnaires. Before the questionnaire is distribute to the respondent, the researcher will explain to the supervisor

about the detail of this study, information sheet, consent letter, the instruction, envelopes security tape, and locked box.

A self-administered questionnaire will be use which all the respondents consent to the study and require to answer a sets of questionnaires . The questionnaires consist of four parts. Part A will use to get the information on Respondent's Personal details, Part B used to collect information on working history, Part C is for the respondent's medical history and lastly Part D is used for the information related to lifestyle.

The respondents were given 15 to 20 minutes to answer the questionnaires given. A token of appreciation were given to them after completing the questionnaires. After the respondent completes the questionnaire, they will be keeps inside envelope and seal the questionnaire with the security tape. Lastly, the workers put the questionnaire inside the lock box for the confidential issues.

The collection of the questionnaire were done consequential in two days for one weeks to ensure good response rate. Each of the questionnaires were checked to ensure all of the questions being answered by the respondent. For the incomplete questionnaire, the respondent were interviewed again to gain the missing information.

### **3.6 Variables**

#### **3.6.1 Independent variable (factor)**

The independent variable of this study is the association risk factors (dose, duration of exposure, age, smoking habits, ototoxic medication and chemical exposure). There are also other risk factors that being measures as co factor such as demographic factor and individual lifestyle.

#### **3.6.2 Dependent variable (Outcome)**

The dependent variable is prevalence of hearing impairment among the male workers at aircraft maintenance industry.

### **3.7 Data Analysis**

Data analysis will is done using “Statistical Package for Social Sciences” (SPSS) Version 21 and Microsoft Office Excel. The data related to the background of workers will be analyzed using Microsoft Office Excel. While, SPSS Software Version 21 will use to determine whether there is association between the independent variable and dependent variable.

### **3.71 Univariate analysis**

Analysis such as mean, standard deviation and percentage is analysed by using SPSS software. The prevalent of hearing status among the respondent was determine using this kind of analysis.

### **3.72 Bivariate analysis**

Analysis such as independent t-test is used to compare the hearing threshold level between right and left ears. In a meanwhile, Pearson chi square correlation test is used to determine the correlation between the studied factors (age, smoking habits, medication and chemical exposure) with the hearing status among the respondents.

## **3.8 Quality control**

### **3.8.1 Questionnaires**

Before the actual questionnaires are given to the respondents that is selected for this study, a pilot questionnaire will give to the 10% of representative population for the pre-test to ensure the respondents are fully understand the questions. The result of the pre-test obtained from Cronbach alpha is 0.70. The distribution of questionnaire is given after the area noise monitoring done.

### **3.82 Noise Dosimeter**

Before and after all of the measurement taken, the noise dosimeter Quest 300 are calibrated using Quest Calibrator to ensure that the measurements are accurate within the specification limits. In addition, measurement of noise dosimeter was based on the Standard Operating Procedure (SOP) of the instrument as below:

SOP was ensured to reduce bias:

- i. When conducting dosimeter measurement, the microphone should properly clip and the body of dosimeter affixes tightly at the waist, so that it would not drop when workers carry it around
- ii. Workers will be explain not to disturb the setting of the dosimeter
- iii. Auto time-off will be set to get the consistency during monitoring
- iv. The respondent need to ask permission of the researcher before going out of the workplace area such as cafe or toilet.

### **3.83 Ethical consideration**

The formal letter from Department of Environmental and Occupational Health was obtained for the application process during the proposal preparation stage. After the methodology of the study was approved by the Medical Research Ethics Committee, FPSK UPM, a written consent was obtained from all respondents prior to data collection (FPSK\_November(13)47) as shown in Appendix 2.

The respondents were provided with Information Letter to get more explanation about the research which include explanation regarding the questionnaire, personal monitoring and audiometric testing. The respondents also assured regarding their confidentiality. They are also be given a Consent Letter to be completed as a prove that they understood the purpose of the research and knew about their right as the respondents. The research was conducted on voluntary basis where all respondents were given a briefings on conducting the experiment. Besides that, the results also be notified to the respondent and the factory management for their records.

### **3.9 Study Limitation**

There is some limitations in this study that cannot be avoided by the researcher such as sample size is too small for this study to be conducted. This is because the restriction number given by the management that do not allow all of the production workers to be involved in this study.

Besides, there is no specific method used to measure the exact chemical exposed among th workers. Therefore, this study only shows the results of the chemical exposure among the workers without specific dose they were exposed to.

## CHAPTER 4

### RESULTS

#### 4.1 Socio-demographic and others information

The company practice 8 hours shift works, which 100% of them have normal working hours which is not more than 8 hours. All of the workers answered 100% that their employer provided them the hearing protective protection device (HPD) such as ear plug or ear muff and they did used those PPE during working. This can be seen in Table 1 below.

**Table 4.1 Socio-demographic and others information**

<b>Variables</b>	<b>N(%)</b>
<b>Age</b>	
20-29	59(67%)
30-39	22(25.3)
40-49	2(2.3%)
50 ≥	4(4.6%)
<b>Working Experience</b>	
Yes	54(62.1%)
No	33(37.9%)
<b>Exposure to loud noise</b>	
Yes	53(60.9%)
No	34(39.1%)

<b>Variables</b>	<b>N(%)</b>
<b>Working hours (8 hours)</b>	87(100%)
<b>Did employer provide HPD</b>	87(100%)
Yes	0 (0%)
No	87(100%)
<b>Did you wear HPD</b>	
<b>Lifestyle</b>	
Loud Music	30(34.5%)
Not applicable	57(65.5%)
<b>Smoking Status</b>	
Yes	6(6.9%)
No	81(93.1%)
<b>Medical History</b>	
Hearing loss	10(11.5%)
Yes	77(88.5%)
No	
Ear Infection	
Yes	1(1.1%)
No	86(98.9%)
Tingling Ears	
Yes	11(12.6%)
No	76(87.4%)
Not applicable	13(14.9%)
Yes	74(85.1%)
No	
<b>Major Operation/Injury (ear, nose and throat)</b>	
Head Injury	4(4.6%)
Ear injury	3(2.3%)
Major ear, nose and throat operation	5(5.7%)

Variables	N(%)
<b>Ototoxic Medication</b>	
<b>Aspirin</b>	
Yes	7(8.0%)
No	80(92.0%)
<b>Quinine</b>	
Yes	1(1.1%)
No	86(98.9%)
<b>Neomycin</b>	
Yes	4(4.6%)
No	83(95.4%)
<b>Chemical Exposure</b>	
Yes	87(100%)
No	0 (0%)

For lifestyle section, 30 (34.5%) of them listened to loud music and 57(65.5%) of them did not involve in such activities that exposed them to loud noise. In medical history section, 10 (11.5%) answered they had hearing loss problems and 11 (12.6%) of them had tingling ears sensation. In addition, there is only 1 (1.1%) respondent answered having ear infection. For overall report on medical history, 85.1% which is 74 of them did not have any problems regarding to ear.

Most of the respondents which are 76 (87.4%) never involved in any ear, nose and throat operation and having injury in ear or head injury. However 4 (4.6%) had previous head injury and 3 (2.3%) had previous ear injury. Regarding the use of ototoxic drugs consumption for Aspirin, Quinine and Neomycin, most of the workers never took the medication but 7 (8.0%) took Aspirin, 1 (1.1%) person took quinine while 4 (4.6%) persons consumed Neomycin. From Table 1, all of the respondent which is 100% of them were exposed to chemical.

## 4.2 Hearing status among maintenance workers

Based on Table 2, the prevalence of hearing impairment among male aircraft maintenance workers at the company is 25.3% of the respondents while 32.2% of them had hearing loss. Nearly half (42.5%) of them had normal hearing.

**Table 4.2 Prevalence of Hearing Impairment and hearing loss among maintenance workers**

<b>Hearing Status</b>	<b>N(%)</b>
<b>Normal</b>	37 (42.5%)
<b>Hearing Impairment</b>	22 (25.3%)
<b>Hearing Loss</b>	28 (32.2%)

Table 3 showed the prevalence of hearing loss at right and left ears. Among of the frequencies tested which is 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz. The study shows that the highest bi lateral hearing loss was found at 6000 Hz compared to other frequencies. The results show that 41.4% of them had hearing loss at 6000Hz.

**Table 4.21 Prevalence of hearing loss at right and left ears**

Frequency (Hz)	Right ear	Left ear
	N = (%)	N = (%)
500	28 (32.2%)	19 (21.8%)
1000	15 (17.2%)	15 (17.2%)
2000	18 (20.7%)	18 (20.7%)
3000	17 (19.5%)	17 (19.5%)
4000	25 (28.7%)	25 (28.7%)
6000	<b>36 (41.4%)</b>	<b>36 (41.4%)</b>
8000	11 (12.6%)	11(12.6%)

To compare the threshold level between the right and left ear, paired t-test was used to determine the differences. The study showed that none of the frequencies (500 Hz to 8000 Hz) except at 6000 Hz. Table 4 below shows the threshold level between right and the left ears.

**Table 4.22 Threshold level between right and left ears**

Frequency (Hz)	Right Ear	Left Ear	t-value	p- value
	Mean± S.D	Mean ± S.D		
500	20.52 ± 7.43	11.09 ± 6.02	1.960	0.053
1000	12.24 ± 5.49	19.37 ± 5.80	-.349	0.728
2000	17.64 ± 7.27	17.64 ± 6.78	0.000	1.000
3000	17.99 ± 10.01	18.9 ± 10.21	-1.278	0.205
4000	19.48 ± 13.77	20.06 ± 12.00	-0.560	0.577
6000	<b>23.10 ± 14.67</b>	<b>20.00 ± 9.97</b>	<b>2.173</b>	<b>0.033</b>
8000	19.20 ± 14.32	19.43 ± 11.85	0.908	0.366

### 4.3 Noise dose of maintenance workers

Table 5, shows the result of the dose and time weighted average value during noise assessment. The maximum dose is exceeding permissible limit (964%) with the TWA exceeding the Action Level (106.21dB (A)). The mean dose was found to be exceeding 100% however, the mean TWA (dB(A)) is lower than 85 dB (A).

**Table 4.3 Dose exposure and Time weighted average (TWA) among all respondents**

<b>Parameter</b>	<b>Mean ± S.d</b>	<b>Min</b>	<b>Max</b>
<b>Dose %</b>	208.19 ±293.25	2%	<b>946%</b>
<b>TWA (dBA)</b>	83.86± 16.19	61.78dBA	<b>106.21dBA</b>

Figure 4.3 below showed the noise exposure level at the hangar. The measurement was conducted by using Sound Level Meter to determine environmental noise level in the hangar.

As can be seen below, line 4 shows high noise level which is more than permissible exposure limit which is more than 90dB. This is because on that time, the aircraft engine was running so it produced high level of noise. Next, there is also high level of noise recorded in the hangar which at line 2 as the sources of the noise is from air conditioner and ground energy produced.

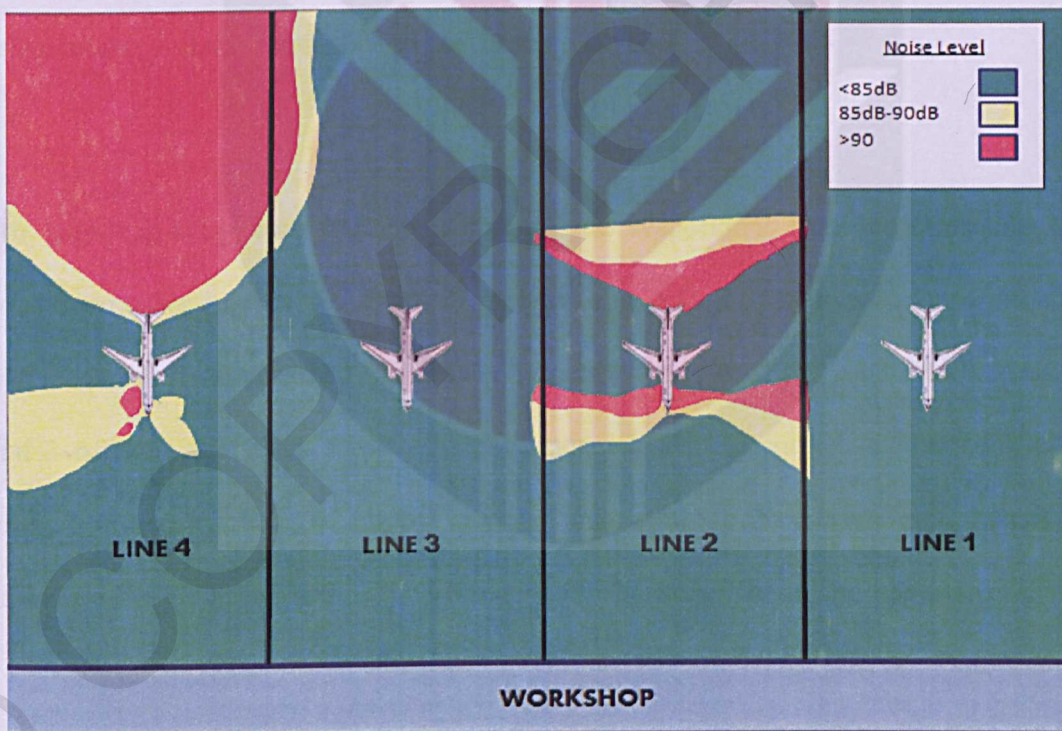


Figure 4.5 The result of noise mapping

#### 4.6 Association between hearing status with selected factors

Based on the Table 6, out of 20 respondents, 4 respondents exposed to noise exceeding the action level (>85dBA) and 3 respondents exposed to noise dose more than 100% had hearing impairment. The results showed there is no significant association between Time Weighted Average (TWA) with hearing status while there is significant relationship between Noise dose with hearing status. Furthermore, in the range age of between 20-29 years old have the highest number of hearing impairment followed by respondents within the range age of 30-39, 40-49 and lastly 50-59 years old. However, for range age between 40-49 years old, none had hearing impairment and only 1 respondent had hearing lost. However there is no significant association ( $p>0.05$ ) between age and hearing status.

For ototoxic drug consumption, none of the respondent that took quinine but consumed other medication. From 87 respondents, only 3 of them took Aspirin and 1 of them took neomycin had hearing impairment while 4 of them who took Aspirin and 3 of them that took Neomycin have normal hearing and none who took both drugs had hearing loss. The study showed that ototoxic drug consumption had no significant association ( $p>0.05$ ) with the hearing status of the maintenance workers.

As all of the respondents were exposed to chemical during working, the analysis results showed that 21 of them were exposed to hydraulic oil had hearing impairment. Only 1 respondent that did not exposed to hydraulic oil, but without hearing impairment. The study indicated that there is no significant association between hydraulic oil with hearing impairment. The study shows that, 22 of those

exposed to MEK, Paint stripper and Jet Fuel had hearing impairment. Those that exposed to epoxy resin, 21 of them had hearing impairment. The finding also indicated that there is no significant association ( $P>0.05$ ) between all types of chemical exposed with hearing status of the workers except form the paint stripper which p value is 0.022 ( $p<0.05$ ). In a meanwhile the study showed that there is no significant association with hearing status with smoking status among the maintenance workers as shown in Table 6.

**Table 4.6 Relationship between studied factors and hearing status**

Variables	Hearing Status		$\chi^2$	P value
	Normal	Abnormal (Hearing Impairment + Hearing Loss)		
Exceed action level (Noise level)	5	4	2.574	0.109
Below action level (Noise level)	2	8		
Above 100% (Noise dose)	5	3	3.909	0.048
Below 100% (Noise dose)	2	9		
Age				
20-29	26	32	5.926	0.115
30-39	6	16		
40-49	0	2		
50-59	0	4		
Smoking				
Yes	1	5	1.165	0.280
No	31	49		
Aspirin				
Yes	3	4	0.104	0.747
No	29	50		

<b>Quinine</b>					
Yes	1	0	1.707	0.191	
No	31	54			
<b>Neomycin</b>					
Yes					
No	3	1	2.564	0.109	
	29	53			
<b>Hydraulic Oil</b>					
Yes					
No	32	53	0.600	0.439	
	0	1			
<b>MEK</b>					
Yes					
No	31	54	1.707	0.191	
	1	0			
<b>Paint Stripper</b>					
Yes		54	5.245	0.022	
No	29	0			
	3				
<b>Jet Fuel</b>					
Yes		54	1.707	0.191	
No	31	0			
	1				
<b>Epoxy Resin</b>					
Yes	29	53	2.546	0.109	
No	3	1			

## CHAPTER 5

### DISCUSSION

#### 5.1 Noise level in hangar

In other occupational setting, equivalent noise levels above 85 dB (A) during 8 hours had been shown to increase the risk for hearing loss (National Board of Occupational Safety and Health, 2005). In this study, it is clearly showed that the workers were exposed to high noise dose and noise level. The finding shows that operation involved in aircraft maintenance hangars produced noise of level higher than the recommended 85 dB (A) level. The measured noise levels in hangar are higher than those in workshop (Noweir and Zytoon, 2013). Aircraft maintenance workers are exposed to noise varies on different occasions depending on whether aircraft engine are running, location on, or near the flight line and activities undertaken in the maintenance hangars such as grif blasting, riveting, grinding and hammering (Guest *et al.*, 2010). Besides, the high noise level might be contributed during engine run test. The minimum noise level measured in this study was 62 dB (A) and the maximum level of noise recorded was 106.21dB (A). The maximum noise level clearly shows the level of noise is exceeded the action level.

## **5.2 Prevalence of Hearing Impairment**

In this study, the percentage of workers having hearing impairment is 25.3% which showed that the workers were having risk to get hearing problems due to maintenance work of aircraft. In spite of high noise levels associated with aircraft maintenance operations, the level of hearing impairment was mild because of the intermittent nature of some of the operations, using hearing protecting devices by most of the workers and job rotation among the operations (Noweir and Zytoon, 2013). This may interpret the this mild auditory effect of noise exposure on auditory performance of many of them when compared with the durations and the levels of noise which they were exposed.

## **5.3 The Association between Risk Factors of Hearing Impairment Among Aircraft Maintenance Workers**

### **5.31 Age**

The occurrence of hearing impairment in aircraft maintenance workers was found to be rapid within the first 20 years of employment (Hong, 2005). In this study, the number of respondent having hearing impairment was the highest in age range between 20-29 years old compared to respondent of more than 30 years old. There is also report that showed similar trend which mentioned that rapid impairment happened within the first 10-15 years of exposure, followed by slowing rate of growth with additional exposure to noise (Leensen *et al.*, 2011). However, the statistical results showed that there is no significant relationship

between age and hearing impairment. This might be due to small number of maintenance workers involved in the study.

### 5.32 Smoking

Smoking is a cause of various cancers, respiratory and cardiovascular diseases. Recent studies have shown that it also has detrimental effect on hearing function and the endocrine system (Tweed *et al.*, 2012). In this study, there was no significant relationship between smoking and the hearing status but there is study that examined the relationship between smoking and noise-induced hearing loss which reported that the incidence of noise-induced hearing loss is significantly higher among smokers (Palmer *et al.*, 2004). This is because there is a synergistic effect between the two factors (Mizouet *et al.*, 2003). The interaction mechanism of noise and chemical substances on hearing damage involves changes such as an increased cochlear vulnerability to noise and noise-related intensification of cochlear damage from chemical agents that have ototoxic effects (Fechter, 1995). The carbon monoxide present in the mainstream smoke reduces cochlear blood oxygen levels as a result of capillary vasoconstriction, increased blood viscosity, reduction of transported oxygen and difficulties in oxyhaemoglobin dissociation. Thus, noise exposure will induce hypoxia in the cochlea which causing direct lesions or interacting with mechanical noise-induced impairments (Chen, 2002).

### 5.33 Chemical Exposure

Recently, solvent either alone or interacting with noise had emerged as a major cause of occupational hearing loss. Simultaneous exposure to noise and solvents had worsened hearing loss in occupational settings (Johnson, 1993). It has been suggested that organic solvent can damage the sensory cells and peripheral nerve endings of the cochlea which can affect the auditory pathways in the brain (Crofton et. al., 1993, 1997, 1998). There is study showed that hearing loss worsened with exposure to solvent and noise compared with exposure to noise only (Morata et. al, 1994). Some of the maintenance workers were exposed to mixed organic solvent during cleaning, paint removal and painting task (Kim *et al.*, 2005). A study conducted by (Guest et al, 2010) among Aircraft Maintenance Personnel (SHOAMP) of among military f-11 aircraft maintenance personnel showed that workers that exposed to both noise and solvents had potential risk of hearing loss. The type of chemical exposed includes high levels of jet fuels, paint and strippers as well as epoxy resins (Guest *et al.*, 2010).

However in this study, the statistical results showed that there was no significant association between all of the chemical exposed except for paint stripper. The study was contradicted with the evidence from other studies. This might be due to several reasons which : (1) the sample size is too small to measure the strength of the relationship between the chemical and hearing impairment, (2) most of the respondent is in age range between 20-29 years old. Therefore their duration of exposure of chemical used is inadequate to cause hearing impairment when simultaneously exposed to the high noise. In

addition, quantitative method such as personal chemical monitoring is needed to establish a significant relationship. Method such as specific method by using conventional integrated sampling method which the air in subject's drawn into glass adsorption tube (SKC), which contained activated charcoal, then the lifetime cumulative exposure, the Cumulative Exposure Index (CEI) can be estimated (J Kim *et al.*, 2005).

#### **5.34 Ototoxic Medication**

The use of certain medications such as anti-malarial and streptomycin can cause hearing problems. Based on the brochure produced by League for Hard of Hearing 2012, they list the most ototoxic drugs such as quinine (anti malaria), aspirin (pain relief) and neomycin (which found mostly in antibiotic ointment). There were also several epidemiological studied and laboratory animal experiments have identified several chemical contaminants that can impair auditory function directly or potentiate the damaging effects of noise on the auditory systems. Animal study had found that exposure to these agents over period generally of 4-16 weeks yields a persistent auditory impairment that is particularly severe between 2 and 16kHz (Fetcher *et al.*, 2007). Indeed, when exposed to both ototoxic substances and noise in the range of 85 dB (A), the combined exposures can produce a synergistic effects.

However, in this study, the statistical result showed that there is no significant relationship between the ototoxic drug and the hearing impairment. This study was not sufficiently to show whether the observed effects are caused by ototoxicity, high level of noise exposure or synergistic relationship between those factors. Further studies would be required in aircraft population using pure-tone-audiometry, otoacoustic emissions and more central hearing test to better distinguish between noise induced hearing loss due to ototoxicity (Fuente and McPherson 2006).

#### **5.4 Recommendation**

Although job rotation might reduce the time-weighted average of noise exposure, it should not be relied on as the only measure for eliminating risk of hearing impairment since the noise exposure level at the hangar exceeds the safe levels.

Usage of noise personal protection by the maintenance workers must be enforced at all operations. If required, during high noise level, the workers should wear both ear plug and ear muff to reduce the sound exposure level. The number of hearing impairment is mild because of the intermittent nature of some operations and the use of the hearing protecting device during the operation.

Since the results of the current study were based on the cross-sectional study in the absence of audiometric baseline records of the workers, it is recommended to conduct a longitudinal study for observing hearing threshold change with time for the

aircraft maintenance workers. As also, the effect of both noise and organic vapours from solvent and fuel is recommended to be studied.

Besides, the occupational hearing conservation programs should have to take up chemical exposures and smoking into consideration. Other things that need to be included in the hearing conservation program included; (1) Regular Hearing Testing: All technicians should be tested, especially workers who do maintenance works directly with the aircraft at the hangar. These tests would measure how loud a sound has to be before the subject barely hears it. Periodical evaluations determine if there has been a deterioration of hearing capabilities. (2) Periodic Noise Measurement assessment: It is done with a sound pressure level meter for measuring continuous noise. In a situation where the noise is intermittent or where the employees are moving in and out of the noise environment, the noise dosimeter might be used. This noise measurement assessment is important to indicate either there is increases in the noise exposure especially in the hangar. (3) Training and Documentation: There is need a continuous training towards the workers so that the workers are aware of their hearing protection during working. In the training, the workers will be provided the information about hearing conservation program they were given opportunity to ask questions and be well informed including the explanation of the test results, informing the employee about normal hearing, hearing loss, how hazardous noise can cause hearing loss, and how hearing protectors work.

## 5.5 Conclusion

Based on this study, we can concluded that: (1) The prevalence of hearing impairment among aircraft maintenance workers is 25.3% which is 22 out of 87 of the workers.(2) There is significant differences of the hearing threshold level between right and left ears at frequencies 6000Hz. (3) The noise level maximum noise level of the workers exposed to is 106.21dB(A) which is exceeding the PEL level of noise. (4) There is significant relationship between hearing status with factors such as noise level and chemical exposed which is paint stripper while others showed no significant relationship.

There is a major limitation of the study especially on the small sample size of the study. Besides, because the short of time during the assessment and the consent from the management, this study unable to include more respondent from the company. Hopefully, the same kind of study can be done with larger sample size so that, the result is more reliable and significant.

PEJABAT TIMBALAN NAIB CANSOLOR (PENYELIDIKAN DAN INOVASI)  
OFFICE OF THE DEPUTY VICE CHANCELLOR (RESEARCH AND INNOVATION)

Ref: UPM/TNCPP/PMC/14181/REKUPAD/03

Date: 7 February 2014

Assoc. Prof. Dr. Shamsul Bahri Mohd Tahir  
Department of Environmental & Occupational Health,  
Faculty of Medicine and Health Sciences,  
Universiti Putra Malaysia,  
Serdang, Selangor

Dear Sir,

RESEARCH PROJECT: THE PREVALENCE OF HEARING LOSS AMONG THOSE WITH THE RISK FACTORS OF HEARING LOSS MAINTENANCE WORKERS

**Appendix 1: Ethical Approval Letter**

The Ethics Committee for Research Involving Human Subjects (ECRHS) of Universiti Putra Malaysia (UPM) has studied the proposal for your research project and has approved the project on the following conditions:

Please find the list of documents required for your research project and the list of research ethics committee members who reviewed the proposal.

Notwithstanding a 'yes' approval, you must ensure that you conduct the research in accordance with the terms and conditions of the approval of carrying out the research.

Thank you.

Yours faithfully,

PROFESSOR DR. NURUL HUDA HUSAIN

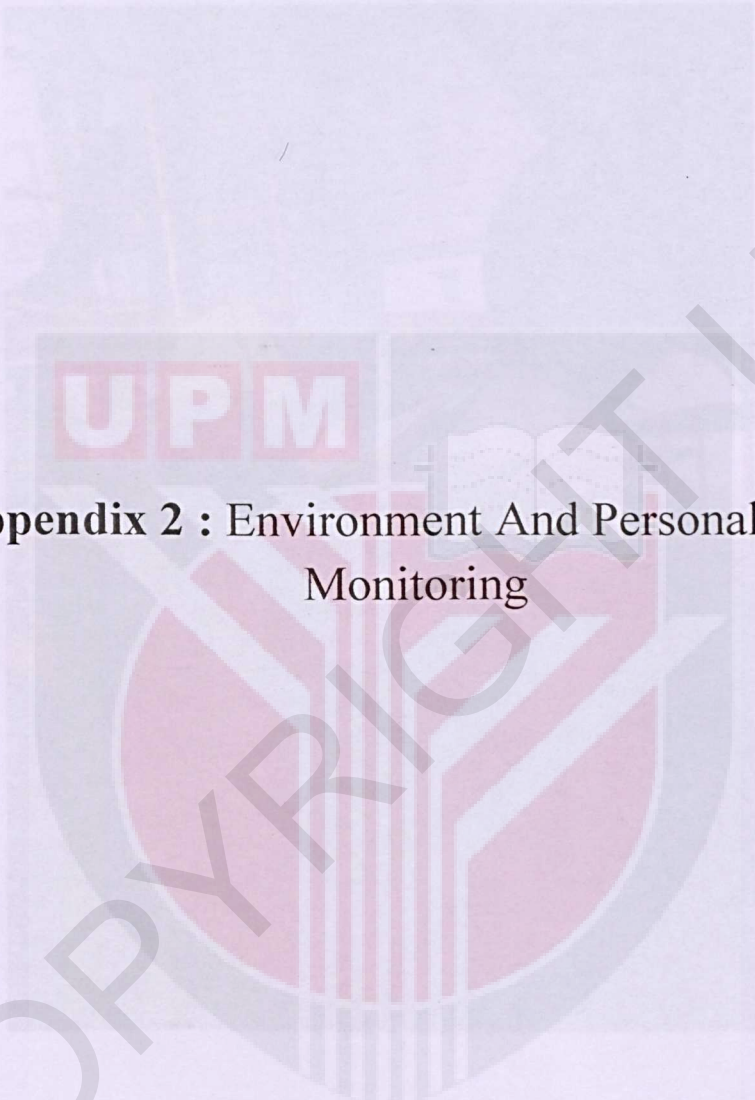
Chairman of Research Involving Human Subjects (RHS) Committee  
Universiti Putra Malaysia

JKEUPM Ref No. : FPSK\_November(13)47

- a) Members of the JKEUPM who reviewed the documents:  
 - Prof. Dato' Dr. Lye Munn Sann
- b) Date of approval: 14/1/2014

Endorsed at JKEUPM Meeting on 7/2/2014, attended by:

NAME	DESIGNATION	GENDER	TICK IF PRESENT
Prof. Dr. Norlijah Othman	Paediatrics & Dean, Faculty of Medicine and Health Sciences	Female	√
Prof. Dr. Zamberi Sekawi	Medical Microbiologist & Deputy Dean of Research and Internationalization, Faculty of Medicine and Health Sciences	Male	√
Prof. Dato' Dr. Lye Munn Sann	Medical Statistician, Dept of Community Health, Faculty of Medicine and Health Sciences	Male	√
Prof. Dr. Tengku Aizan Abd Hamid	Gerontologist & Director, Institute of Gerontology	Female	
Prof. Dr. Lekhraj Rampal	Medical Statistician, Dept of Community Health, Faculty of Medicine and Health Sciences	Male	√
Prof. Dr. Elizabeth George	Pathologist, Dept of Pathology, Faculty of Medicine and Health Sciences	Female	
Prof. Dr. Lim Thiam Aun	Anesthesiologist, Dept of Surgery, Faculty of Medicine and Health Sciences	Male	√
Prof. Dr. Wan Omar Abdullah	Medical Parasitologist, Dept of Medical Microbiology and Parasitology, Faculty of Medicine and Health Sciences	Male	√
Prof. Dr. Patimah Ismail	Professor of Biomedicine, Dept of Biomedical Sciences, Faculty of Medicine and Health Sciences	Female	√
Prof. Dr. Johnson Stanslas	Pharmacologist, Dept of Medicine, Faculty of Medicine and Health Sciences	Male	√
Assoc. Prof. Dr. Mansor Abu Talib	Assoc. Professor of Guidance and Counselling, Dept of Human Development and Family Studies, Faculty of Human Ecology	Male	√
Assoc. Prof. Dr. Azmawani Abd. Rahman	Operations and Technology Management / Deputy Dean of Research and Graduate Studies	Female	
Assoc. Prof. Dr. Noritah Omar (Lay Person)	Assoc. Professor of English Language, Dept of English Language, Faculty of Communication and Modern Languages	Female	
Dr. Rojanah Kahar (Lay Person)	Senior Lecturer of Dept of Human Development and Family Studies, Faculty of Human Ecology	Female	√
Tan Sri Dato' Napsiah Omar (Independent Member)	Chairman, National Population and Family Development Board	Female	

The image features a large, semi-transparent watermark of the Universiti Putra Malaysia (UPM) logo in the background. The logo consists of a shield with a red and white design, topped with a crown and the letters 'UPM' in a red box. A large, diagonal watermark reading 'COPYRIGHT UPM' is overlaid across the entire page.

**Appendix 2 : Environment And Personal Noise  
Monitoring**



**Measurement of environmental noise**



**Measurement of personal noise at the worksite**



FORM BI: RESPONDENT'S INFORMATION SHEET AND CONSENT

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE

The Prevalence of Hearing Impairment and Associated Factors Among Male Aircraft Maintenance Workers

2. INTRODUCTION

Noisy environment is well known to be associated with the accumulation of aircraft maintenance workers in aircraft industry. This study aims to assess the exposure, hearing threshold level and the factors associated with the hearing impairment among aircraft maintenance workers. An audiometric assessment was carried out to identify the prevalence of hearing impairment among the workers.

3. WHAT WILL YOU BE ASKED TO DO?

The respondents are asked to provide the consent to obtain the data information regarding on the study. 10 minutes of the given time to fill a questionnaire. After that, the respondent have to undergo personal noise assessment by wearing noise dosimeter during work and undergo audiometric testing to test the condition of the hearing.

4. WHO SHOULD NOT ENTER THE STUDY?

Female workers at the hangar

**Appendix 3 : Respondent Consent**



**FORM B1: RESPONDENT'S INFORMATION SHEET AND CONSENT**

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

**1. STUDY TITLE**

The Prevalence of Hearing Impairment and Its Associated Factors Among Male Aircraft Maintenance Workers At Aircraft Industry.

**2. INTRODUCTION**

Noisy environment is anticipated to be present in the population of aircraft maintenance workers in aircraft industry. This study aims to measure noise exposure, hearing threshold level and the factors associated with the hearing impairment among aircraft maintenance workers. An audiometric assessment was carried out to analyze the prevalence of hearing impairment among the workers.

**3. WHAT WILL YOU HAVE TO DO?**

The respondents are asked to answer the questionnaire to obtain the data information regarding on the study. 10 minutes will be given to complete the questionnaire. After that, the respondent have to undergo personal noise assessment by wearing noise dosimeter during work and undergo the audiometric testing to test the condition of the hearing.

**4. WHO SHOULD NOT ENTER THE STUDY?**

Female workers at the hangar.

**5. WHAT WILL BE BENEFITS OF THE STUDY:**

**a) TO YOU AS THE SUBJECT?**

It will help the worker to be aware psychosocial and ergonomic risk factors among male aircraft maintenance workers and being more aware in taking several measures to prevent and control the risk of getting the hearing impairment which will give impacts to their daily life.

**b) TO THE INVESTIGATOR?**

It will help the investigator to identify the noise exposure level of the aircraft at the hangar and prevalence of workers having hearing impairment, then studied which associated risk factors would contribute to the problem then suggesting some measures to the management to take control measures to protect the workers from getting hearing problems causing from their works.

**6. ARE THERE ANY RISKS?**

There is no risk available in the study.

**7. WILL THE INFORMATION AND MY IDENTITY REMAIN CONFIDENTIAL?**

Semua All the information and identity given by the respondents this study will remain confidential. No individual description will be made on any part of the study or publication.

**8. WHO SHOULD I CONTACT IF I HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?**

If you have any additional questions, you may contact to Assoc. Prof. Dr. Shamsul Bahri Mohd Tamrin as the Supervisor of the research at 03-89472396 or Afina binti Afandi, the researcher at 014-5121431..

Please sign here if you have read and understood the content of this page

-----

CONSENT

Identity Card No



## 9. CONSENT

I ..... Identity Card No .....  
address.....  
.....hereby voluntarily agree to take part in the research stated above \*(clinical/drug trial/video recording/focus group/interview-based/questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in Respondent's Information Sheet). I understand that i have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I \*wish / do not wish to know the results related to my participation in the research.

I \*agree / do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation.

\*delete where necessary

Signature: .....  
(Respondent)

Signature: .....  
(Witness)

Date: .....

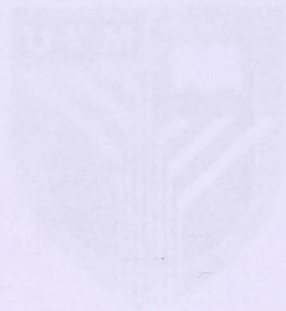
Name: .....

I/C No.: .....

I confirm that i have explained to the respondent the nature and purpose of the above-mentioned research.

Date: .....

Signature: .....  
(Researcher)



**UPM**  
UNIVERSITI PUTRA MALAYSIA  
KAMPUS SEREMBAN

KAJIAN KECACATAN PENDENGARAN DI KALANGAN PEKERJA LELAKI DI DALAM SYARIKAT  
PENYELenggaraAN KAPAL TERBANG

PREVALENCE OF HEARING IMPAIRMENT AMONG MALE WORKERS IN AIRCRAFT MAINTENANCE  
COMPANY

## Appendix 4: Questionnaires

Penyerahan Informed Consent

Kajian ini dijalankan untuk mengenalpasti prevalensi kecacatan pendengaran bunyi serta faktor-faktor yang mempengaruhi kadar keparahan kecacatan pendengaran bunyi dalam kalangan pekerja penyenggaraan kapal terbang.

This study is conducted to identify the prevalence of noise exposure and the factors that contribute to hearing impairment among male workers in aircraft maintenance company.

Segala bujukan maklumat adalah sulit dan rahsia  
All information is private and confidential



BAHAGIAN A : MAKLUMAT

PART A : PERSONAL DET

1. Nama/ Name

2. Umur/ Age

BAHAGIAN B : BUTIRAN PEKERJAAN

KAJIAN KECACATAN PENDENGARAN DI KALANGAN PEKERJA LELAKI DI DALAM SYARIKAT  
PENYELENGGARAAN KAPAL TERBANG

3. You are in which section

**PREVALENCE OF HEARING IMPAIRMENT AMONG MALE WORKERS IN AIRCRAFT MAINTENANCE  
COMPANY**

Line 1

Line 2

Line 3

Line 4

Night Crew

4. Adakah anda mempunyai pengalaman mendengar bunyi yang mengganggu pekerjaan sekarang?

Pengenalan/Introduction

Kajian ini dijalankan untuk mengenal pasti tahap pendedahan bunyi serta faktor-faktor yang mempengaruhi kadar kemerosotan kadar pendengaran dalam kalangan pekerja penyelenggaraan kapal terbang.

*This study is conducted to determine the level of noise exposure and the factors that contribute to hearing impairment among aircraft maintenance workers.*

Yes

No

5. Berapakah jumlah jam anda bekerja sehari? / How many hours you work every day?

8 jam/ 8 hours

7 jam/ 7 hours

6 jam/ 6 hours

Lain-lain. Sila nyatakan / Others. Please state

Segala butiran maklumat adalah sulit dan rahsia  
*All information is private and confidential*



**BAHAGIAN A : MAKLUMAT PERIBADI**

**PART A : PERSONAL DETAILS**

1. Nama/ Name : .....
2. Umur/ Age : .....

**BAHAGIAN B : BUTIRAN PEKERJAAN**

**PART B : WORKING DETAILS**

3. You are in which section? \*Please tick (/)  
*Anda berada di unit manakah ? \*Sila tandakan (/)*

- Line 1
- Line 2
- Line 3
- Line 4
- Night Crew

4. Adakah anda mempunyai pengalaman kerja lain sebelum pekerjaan sekarang?  
*Do you have any other work experience prior to his current job?*

- Ya/ Yes       Tidak/ No

5. Are you exposed to loud noise during the previous job?  
*Adakah anda terdedah kepada kebisingan yang tinggi semasa pekerjaan terdahulu?*

- Ya/ Yes       Tidak/ No

6. Berapakah jangka masa anda bekerja dalam satu hari?  
*How many hours you work per day?*

- 8 jam/ 8 hours
- 7 jam/ 7 hours
- 6 jam / 6 hours
- Lain-lain . Sila nyatakan / Others . Please state: .....

**BAHAGIAN C : ALAT PELINDUNG TELINGA****PART C : HEARING PROTECTING DEVICE**

7. Adakah majikan bekalkan alat pelindung telinga ?  
*Does the employer provide ear protection devices?*

Ya/ Yes

Tidak/ No

8. Adakah anda memakai alat pelindung telinga semasa bekerja?  
*Do you wear ear protection while working?*

Ya/ Yes

Tidak/ No

**BAHAGIAN D : GAYA HIDUP/ HOBI****PART D : LIFESTYLE/ HOBBY**

9. Adakah anda mempunyai hobi berikut ? :  
*Do you have following hobby/hobbies?*

Mendengar muzik yang kuat/ *Listening to loud music*Karaoke / *Karaoke*Menembak/ *Shooting*Menyelam / *Diving*

10. Are you smoking?  
*Adakah anda merokok?*

Ya/ Yes

Tidak/ No

**BAHAGIAN E : SEJARAH PERUBATAN**  
**PART E: MEDICAL HISTORY**

11. Have you ever experienced the following symptoms?  
 Adakah anda pernah mengalami symptom berikut?

- Hearing Loss / Hilang pendengaran
- Ear infection (eg. Puss in ear) / Jangkitan telinga (cth. telinga bernanah)
- Tingling ears / Telinga berdengung
- Not applicable / Tidak berkenaan

12. Have you ever experienced this following :  
 Adakah anda pernah mengalami seperti :

- Head injury / Kecederaan kepala
- Ear injury / Kecederaan telinga
- Major ear, nose and throat operation/  
Pembedahan telinga, hidung dan tekak
- Not applicable / Tidak berkenaan

13. Have you taken the following medication?  
 Pernahkah anda mengambil ubat berikut?

	Ya/ Yes	Tidak/ No
Aspirin (pain relief)	<input type="checkbox"/>	<input type="checkbox"/>
Quinine (Malaria)	<input type="checkbox"/>	<input type="checkbox"/>
Neomycin (Antibiotic)	<input type="checkbox"/>	<input type="checkbox"/>

**BAHAGIAN F : CHEMICAL EXPOSURE**  
**PART F: PENDEDAHAN KIMIA**

14. Adakah anda terdedah kepada bahan kimia semasa bekerja?  
(cth: MEK, Jet Fuel, Epoxy Resin, Paints Stripper, dll....)

*Do you expose with chemical during working?*  
(eg : MEK, Jet Fuel, Epoxy Resin, Paints Stripper, etc....)

Ya/ Yes

Tidak/ No

Jika ya, sila nyatakan jenis bahan kimia tersebut  
*If so, please state the type of chemical you are exposed*

.....

Terima Kasih ^^  
Thank you ^^

Our Ref: UPM/TPSEKIKP/2023-24/004999A  
Date: 25th November 2023

Mr. Ekaal Hisham bin Hj Ismail  
Vice President  
Human Capital Department  
Sepang Aircraft Engineering Sdn. Bhd.  
Lot PT16, Jalan KLIA 57  
Southern Support Zone, KLIA  
64000 Sepang  
SELANGOR DARUL KHASAN

To:

PERMISSION TO COMPLETE RESEARCH FOR THE COURSE ENGINEERING SDN. BHD.

### Appendix 5: Approval Letter

As mention above, I would like to give you a permission to do a research for the mandatory requirement of final year project of Sepang Aircraft Engineering Sdn. Bhd.

The main objective of conducting research is to generate new knowledge through conducting research, interpreting data analysed and finally able to produce a research paper. The detail of the research topic is "OPENX".

In addition, this study will benefit the company in enhancing its product and able to determine the risk factor and the level of risk that is exposed to the environment.

Finally, if there is further information, the research supervisor can be contacted (Name, Prof. Dr. Zarina Hisham, Email: zarina.hisham@upm.edu.my, HP: 017-3134492 or e-mail: zarina.hisham@upm.edu.my). Do contact the research supervisor, Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 UPM Serpong, Selangor or for further information, contact the research supervisor at 017-3134492.

Thank you.

"WITH KNOWLEDGE WE SERVE"



PROFESSOR DR. ZARINA HISHAM  
Head of Department  
Environmental and Occupational Health

cc: Course Coordinator: ECA0209A  
Research Supervisor: ECA0209A



DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH  
FACULTY OF MEDICINE AND HEALTH SCIENCES

TITLE OF PROPOSAL:

# PREVALENCE OF HEARING LOSS AND ITS ASSOCIATION WITH RISK FACTORS AMONG AIRCRAFT MAINTENANCE WORKERS

PREPARED BY:

AFINA BINTI AFANDI  
BSc. ENVIRONMENTAL AND OCCUPATIONAL HEALTH  
UNIVERSITI PUTRA MALAYSIA

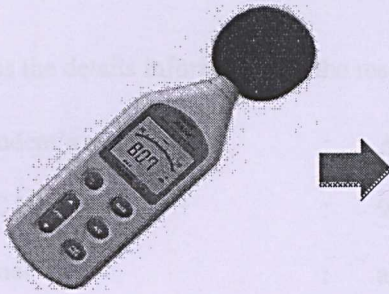


Figure 1.1 : Noise Mapping using Sound Level Meter



Figure 1.2 : Noise dose exposure using Noise Dosimeter



Figure 1.3 : Audiometric Testing

Below is the details information of the researcher:

1. Student's name : **Afina binti Afandi**
2. I/C No. : 910816115066
3. Emel : afina.afandi@gmail.com
4. Tel/HP : 014-5121431
5. Research Title : **Prevalence Of Hearing Loss And Its Association With The Risk Factors Among Aircraft Maintenance Workers**
6. Duration of Research : 01/12/2013 till 01/03/2014
7. No. of Respondent : 80 respondents
8. Research Instrument/Tools : Questionnaires, Noise Dosimeter, Sound Level Meter and Audiometric Services (Mobile booth)

First Schedule  
(Regulation 5(1))

Permissible Exposure Limits

Noise Level (dB (A) - dBS)	Duration of Exposure Permitted per day (hours - minute)
85	10-0
86	17-30
87	12-0
88	10-30
89	9-0
90	7-0
91	5-30
92	4-0
93	3-0
94	2-0
95	1-30
96	1-0
97	0-30
98	0-0
99	0-0
100	0-0
101	0-0
102	0-0
103	0-0
104	0-0
105	0-0
106	0-0
107	0-0
108	0-0
109	0-0
110	0-0
111	0-0
112	0-0
113	0-0
114	0-0
115	0-0
116	0-0
117	0-0
118	0-0
119	0-0
120	0-0

**Appendix 6: First Schedule Of Regulation 5 (1) Factory  
and Machinery Regulation (Noise Exposure)  
1989**

FIRST SCHEDULE  
(Regulation 5(1))

Permissible Exposure Limits

Noise Level (dB (A) — slow)	Duration of Exposure Permitted per day (hours — minute)
85	16-0
86	13-56
87	12-8
88	10-34
89	9-11
90	8-0
91	6-58
92	6-4
93	5-17
94	4-36
95	4-0
96	3-29
97	3-2
98	2-50
99	2-15
100	2-0
101	1-44
102	1-31
103	1-19
104	1-9
105	1-0
106	0-52
107	0-46
108	0-40
109	0-34
110	0-30
111	0-26
112	0-23
113	0-20
114	0-17
115	0-15