FACTORS THAT CONTRIBUTE TO NOISE-INDUCED HEARING LOSS AMONGST EMPLOYEES AT THE BOKONI PLATINUM MINE IN THE SEKHUKHUNE DISTRICT OF THE LIMPOPO PROVINCE, SOUTH AFRICA

by

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DECLARATION

I declare that this dissertation/ thesis "Factors that contribute to noise-induced hearing loss amongst employees at the Bokoni platinum mine in the Sekhukhune District of the Limpopo Province, South Africa", hereby submitted to the University of Limpopo for the degree of Master of Nursing Sciences has not previously been submitted by me for a degree at this or any University, and that it is my own work in design and in execution. All material contained has been duly acknowledged.

Signature

24.03.2017

Date

DEDICATION

The study is dedicated to all employees who were diagnosed with Noise-Induced Hearing Loss, and those who are continuously exposed to excessive noise in their work environment at the Bokoni Platinum mine.

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ABSTRACT

Background: Noise-induced hearing loss has been reported amongst the top three occupational diseases within the platinum mines in South Africa. Occupational noise is a widespread risk factor, with strong evidence linking it to a significant health outcome of hearing loss.

Purpose: The purpose of this study was to investigate the factors that contribute to noise-induced hearing loss amongst employees at the Bokoni Platinum mine in the Sekhukhune District, Limpopo Province, South Africa.

Study method: A qualitative, phenomenological, exploratory, descriptive and contextual design was applied in order to explore and describe the factors that contribute to noise-induced hearing loss. Participants were selected using a purposive sampling method. Data were collected from 7 employees diagnosed with noise-induced hearing loss in the year 2013 and 6 Hearing Conservation Programme managers using semi-structured interview guide. Data were analysed using Tesch's approach to data analysis.

Trustworthiness was ensured by applying Lincoln and Guba's four criteria i.e. credibility, transferability, dependability and confirmability. Ethical clearance was obtained from the Medunsa Research Ethics Committee (MREC/HS/292/2014: PG), and permission to collect data was granted by the Bokoni Platinum mine management. The details of the study were explained to potential participants who then agreed to be part of the study and signed a consent form.

Results: The following themes emerged: experiences and challenges faced by employees in the work environment, noise hazards and the health of employees, hearing protective device factors and management and leadership factors.

Conclusion: The results of this study indicated that noise-induced hearing loss was caused by a combination of different contributory factors. Failure to apply the guidelines, policies and procedures from the Department of Minerals and Energy in full resulted in employees developing noise-induced hearing loss. Employees also reported that the employer takes time to repair broken hearing protective devices.

Key concepts: Factors, noise-induced hearing loss, noise exposure, employees

DEFINITION OF CONCEPTS

Audiogram

A graph of hearing sensitivity in which various test frequencies are plotted on the horizontal axis from 250 Hz to 800 Hz, with the vertical axis showing the degree of hearing loss in Decibels (dB) (Work place safety & insurance board, 2003).

In this study, an audiogram is the graph of the results of an employee who was tested for hearing at the Bokoni Platinum mine.

Contribute

To help cause something (Oxford dictionary, 2012).

For the purpose of this study, to contribute refers to the risks that employees are exposed to in their working environment that might cause noise-induced hearing loss.

Employee

Any person who in any manner assists in carrying or conducting the business of the employer (Acutt & Hatting, 2009).

In this study, an employee is any person who was working at the Bokoni Platinum mine.

Factors

Facts or situations that influence the results of something (Oxford dictionary, 2012).

For the purpose of this study, factors refer to the meaning, opinions, trends and noisy working environment that contribute to noise-induced hearing loss at the Bokoni Platinum mine.

Hearing Conservation Programme Managers

Edwards and Kritzinger (2012) describe the Hearing Conservation Programme as the programme that co-ordinates activities with noise control and prevention.

For the purpose of this study, Hearing Conservation Programme managers are managers who are involved in the hearing conservation programme who co-ordinate activities concerning noise control and prevention of noise at the Bokoni Platinum mine.

Noise

An unwanted sound that causes serious psychological, physiological and social effects (Paunovic, Jakovljević & Belojević, 2009).

In this study, noise refers to excessive sound at the Bokoni Platinum mine, above 85 decibels.

Noise-Induced Hearing Loss

The acquired loss of hearing that occurs due to excessive noise exposure (Acutt & Hatting, 2009).

In this study, noise-induced hearing loss refers to the hearing loss acquired by employees while on duty at the Bokoni Platinum mine due to excessive noise.

LIST OF ABBREVIATIONS

COP - Code of Practice

COIDA - Compensation for Injuries and Diseases Act

dB - Decibel

DME - Department of Minerals and Energy

HPDs - Hearing Protection Devices

HCP - Hearing Conservation Programme

MHS - Mine Health and Safety Act

NIHL - Noise-Induced Hearing Loss

NIOSH - National Institute for Occupational Safety and Health

OEL - Occupational Exposure Limit

PHL - Percentage of Hearing Loss

SA - South Africa

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CHAPTER 1:
OVERVIEW OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND

Noise is an unwanted sound that causes serious psychological, physiological and social effects, a feeling of disturbance, stress reactions, sleep disorders, some hormonal changes, increased blood pressure, increased risk of myocardial infarction, impairment of well-being, and negative impact on the general quality of life (Paunovic, Jakovljević & Belojević, 2009). Noise exposure is a wide spread problem in mining due to the use of heavy equipment, drilling, rock breaking, transferring, sorting and milling of rocks, as well as a confined working environments (Edwards, Dekker, Franz, Van Dyk & Banyini, 2011). Excessive noise exposure in the workplace can limit a worker's ability to communicate and hear signals, which can impact on their safety and productivity (Edwards & Kritzinger, 2012). Long term noise exposure increases the risk of hearing loss, with implications for workers' health, employment prospects and overall quality of life (Edwards et al., 2011). The damages that result from excessive (harmful) noise manifest as noise-induced hearing loss (NIHL).

NIHL is defined as a sensorineural type of hearing loss caused by exposure to intense impulses or continuous sound (Win, Balalla, Lwin & Lai, 2015). The audio logic profile of NIHL is the presence of sensorineural hearing loss that is often pronounced in the higher frequency, between 3,000 Hz and 6000 Hz of the audiogram (Win et al., 2015). Beyond the workplace, the risk of NIHL arises from environmental exposure, like hard-rock concerts, listening to loud music, using a personal music player (PMP), shooting or being in earshot of shooting, military service, and fireworks (Pawlaczyk-Luszczynska, Dudarewicz, Zaborowski, Zamojska & Sliwinska-Kowalska, 2013). In the work place, NIHL arises from industrial or other occupations with exposure to high levels of noise over 85 dB over an 8 hour working shift for 40 hours per week (Ntlhakana, 2014). NIHL is irreversible but preventable, and may present as partial or total hearing loss. Its severity depends primarily on the duration of noise exposure and sound intensity (Azizi, 2010). Hearing loss may affect one or both ears, although not always to the same extent, and because it occurs gradually, one may not realise it until it is too late (Timmins & Granger, 2010).

Noise-induced hearing loss is the number one sensory disability in the world, and the World Health Organisation (WHO) estimates that 16% of hearing loss is attributable to occupational exposure (WHO, 2004). Globally, the European Union, Asia, and the South American countries list NIHL as one of the most common occupational diseases (Wells & Khoo, 2013). A global analysis indicates that 16% of deafness is due to occupational noise, with a higher proportion in males at 22%, and females at 11%, owing to differences in occupational categories, economic sectors of employment, and working lifetime (WHO, 2004). The United States of America (USA) National Institute for Occupational Safety and Health (NIOSH) reports that 80% of USA miners work in an environment in which noise levels exceed the legislated permissible exposure limit of 85 dB (Edwards et al., 2011). About 22 million workers are exposed to hazardous noise each year, and 18% of these workers have hearing loss (Edwards et al., 2011). In Germany, 4–5 million people (12–15% of the workforce) are exposed to noise levels above 41 dB, which is defined by WHO as hazardous (WHO, 2004). In Australia, occupational noise-induced hearing loss (ONIHL) is a significant health and economic problem (Timmins & Granger, 2010). In the same country, there were about 16 500 successful workers' compensation claims between July 2002 and June 2007, for industrial deafness involving permanent impairment due to noise (Timmins & Granger, 2010).

According to the annual report by the chamber of mines (2011/2012), NIHL in South Africa (SA) is one of the top three occupational diseases in the platinum mines. Furthermore, about 367 cases of NIHL were reported in the year 2011. In SA mining, industry noise levels range from 63.9 to 113.5 dB, and approximately 73.2% of miners in this industry are exposed to noise levels above the legislated occupational exposure limit of 85 dB (Strauss, Swanepoel, Becker, Eloff & Hall, 2012). The South African mining industry has also been listed amongst the developing countries with high levels of noise exposure. This was reported in 17 studies that were conducted recently in 12 countries (Chambanduka, Musasa & Muteti, 2013). These studies were carried out in a wide range of workplaces, including manufacturers of foods, fabrics, printed materials, metal products, drugs, watches, and the mining industry (Chambanduka et al., 2013).

In 2005, the Mine Health and Safety Council of South Africa (MHSA), comprised of representatives of the state, labour, and employers, signed an agreement that there should not be deterioration in hearing that is greater than 10% amongst occupationally exposed individuals by 2008 in the mining industry (Strauss et al., 2012). Regardless of this agreement, 367 incidences of NIHL were reported in the annual medical report by the Department of Minerals and Energy (DME) to the chamber of mines in 2011 (Chamber of Mines, 2011/2012), hence the need to investigate factors that contribute to NIHL within the mining industry. This study was conducted in the Bokoni Platinum mine, Sekhukhune district, Limpopo Province.

1.2 PROBLEM STATEMENT

Despite the guidelines and preventative measures that were issued by the DME in 2003 to guide all mines on occupational health noise control, 18 employees in (2009), 28 in (2010), 29 in (2012) and 37 in (2013) out of 4230 employees of the Bokoni Platinum mine were diagnosed with NIHL respectively (Bokoni Annual Medical Report, 2009/2010/2012/2013). All these employees were exposed to noise on a daily basis as they carried their duties. This shows an increase in the number of employees diagnosed with NIHL in this mine over this period. It would seem that there are underlying factors that contribute to this problem. This study, therefore, sought to investigate factors that contribute to the observed increase in NIHL incidences in the Bokoni Platinum mine, in the Sekhukhune district, Limpopo Province, South Africa.

1.3 PURPOSE OF THE STUDY

The purpose of this study was to investigate the factors that contribute to NIHL at the Bokoni Platinum mine, in the Sekhukhune District, Limpopo Province, South Africa.

1.4 THE OBJECTIVES OF THIS STUDY

The objectives of this study were:

- To explore the factors that contributes to NIHL at the Bokoni Platinum mine.
- To describe the factors that contributes to NHIL at the Bokoni Platinum mine.
- To describe the recommendations to Bokoni Platinum mine to prevent the factors contributing to NIHL.

1.5 RESEARCH QUESTIONS

The following research question guided the researcher throughout the study:

- What are the factors contributing to NIHL at the Bokoni Platinum mine?

1.6 RESEARCH METHODOLOGY

A qualitative research approach was followed to conduct this study. A qualitative research approach is concerned with meanings, attitudes and behaviours best understood within their natural settings (Neutens & Rubison, 2010; Babbie & Mouton, 2011). Since the objective of the study was to explore and describe the factors that contribute to NIHL, semi structured one-on-one interviews were conducted to enable the researcher to acquire an in-depth understanding of the factors that contribute to NIHL. This was followed by asking probing questions to obtain more information. More details on the research methodology will be discussed in Chapter 3 of this report.

1.6.1 Study site

The study was conducted at the Bokoni Platinum mine, which is located in the Sekhukhune district on the R37 road from Polokwane to Burgersfort. The Bokoni Platinum mine is 70 kilometres from the city of Polokwane.

1.6.2 Research design

A phenomenological, exploratory, descriptive, contextual design was applied in conducting this study. Phenomenology is concerned with people's lived experiences

with regard to the phenomenon under study and how they interpret their experience (Creswell, 2013). In this study, the phenomenon is noise and the workers were asked to relate their lived experiences with regard to noise exposure at their workplace, which may have caused NIHL. An explorative design was used to explore the factors that contribute to NIHL. Through a descriptive and contextual design, the participants were asked to describe the factors that contribute to NIHL as they occur at Bokoni platinum mine. Research design will be discussed in detail in Chapter 3.

1.6.3 Population and Sampling

The population is the entire group of persons or subjects that meets the criteria that the researcher is interested in (Brink, Van der Walt & Van Rensburg, 2012). The population for this study consisted of 37 employees diagnosed with NIHL and 14 hearing conservation programme (HCP) managers who worked in four of the five mine shafts at the Bokoni Platinum mine.

The fifth shaft was not included because it had only recently been opened at the time that this study was conducted and did not have employees who had developed NIHL. The employees diagnosed with NIHL were identified on the spread sheet with the names of employees diagnosed with NIHL which was available in the mine clinic.

A purposive and convenience sampling method was used to select the participants in this study. A total number of 16 employees diagnosed with NIHL and 12 hearing conservation managers were purposively and conveniently selected from the 4 shafts. Of the 16 employees diagnosed with NIHL 6 and 2 hearing conservation managers participated in the pilot study and they were excluded in the main study. However, data saturation with employees was reached at participant number 7 and with the HCP manager's data saturation was reached at participant number 6. Therefore, the total number of participants for this study is 13.

1.6.4 Data collection

Data collection is a process involving the selection of subjects and gathering of data, which is dependent on the design and measurement methods (Grove, Gray & Burns, 2015). Data were collected from employees and HCP managers by conducting semi-structured one-on-one interviews with one central question "**Can you describe the**

factors contributing to NIHL in your workplace?" This was asked in the same manner to all the participants at the beginning of interview. The interview guide was also used to obtain more information. Probing questions were asked to follolw-up,seek clarity and obtain more information. All the interviews were captured on a voice recorder and field notes were taken on observable behaviours. The data collection will be discussed further in Chapter 3.

1.6.5 Data analysis

Tesch's method of data analysis, which is comprised of eight integrated steps, was used to analyse the data (Creswell, 2009; de Vos, Strydom, Fouche and Delport (2011). The researcher transcribed all the data verbatim from the tapes. The eight steps of Tesch's open coding method, as described by Cresswell (2009), were used to analyse the transcribed data. The eight steps will be discussed in detail in Chapter 3 of this report.

1.7 MEASURES TO ENSURE TRUSTWORTHINESS

Trustworthiness refers to the applicability, consistency, and the neutrality of the findings (Babbie & Mouton, 2011). Lincon and Guba (as cited in de Vos et al., 2011) recommend four strategies, namely: credibility, transferability, dependability and confirmability be applied to ensure trustworthiness in this study. The four strategies will be discussed in full in Chapter 3.

1.8 BIAS

To prevent bias the language spoken and understood by the participants was used to conduct the interviews to ensure that all participants understands and are able to express their views and ideas on the factors that contribute to NIHL. Bias will be discussed in detail in chapter 3 of this report.

1.9 SIGNIFICANCE OF THE STUDY

Bokoni Platinum mine management and the hearing conservation managers may also benefit from the results of study by using the findings to develop new measures of preventing the factors leading to NIHL or to put more emphasis on applying preventive guidelines.The employees would also benefit because management will purchase quality hearing protective devices. Alternative hearing protective devices will be used while the broken ones are sent for repairs. Awareness campaigns on the dangers of noise and the use of hearing protective devices will be intensified.

1.10 ETHICAL CONSIDERATIONS

De Vos et al. (2011) describe ethics as a set of moral principles that are suggested by an individual or a group, which offers rules and behavioural expectations. The following ethical standards were adhered to while conducting the study: Permission to conduct the study, informed consent, confidentiality and anonymity, the principle of justice and protection and the principle of non-maleficence. More details on the ethical considerations will be discussed in Chapter 3 of this report.

1.11 CHAPTER SUMMARY

Chapter 1 has provided an introduction and background, the problem statement, the purpose of the study, the research questions, the objectives of the study, research methodology, the study site, the population and sampling, data collection, data analysis, measures to ensure trustworthiness, bias, the significance the study and ethical considerations.

1.12 OUTLINE OF THE DISSERTATION

The chapters in this dissertation are organised as follows:

Chapter 1: Overview of the study.

Chapter 2: Literature review and theoretical framework.

Chapter 3: Research design and methodology.

Chapter 4: Discussion of research results and literature control.

Chapter 5: Summary, conclusions, limitations and recommendations.

CHAPTER 2:
LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION

A literature review is a process that involves finding, reading, understanding and forming conclusions about the published research and theory on a particular topic (Brink et al., 2012). The aim of a literature review is to determine what is already known about the topic to be studied, and to minimise the possibility of duplicating previous studies (Brink et al., 2012). This chapter discusses the research findings by other reseachers regarding NIHL, as well as the theory adopted to determine the factors that contribute to NIHL amongst employees at the Bokoni Platinum mine, in the Sekhukhune District, Limpopo Province, South Africa.

2.2 HEARING LOSS PROCESS

Hearing loss is the gradual decrease in sensitivity to sounds or inability to hear sounds, either partially or totally (Shemesh, 2010). Excessive repeated exposure to noise and a single exposure to an extremely intense sound may cause damage to the auditory system and result in hearing loss (WHO, 2015). The hearing loss is usually slow in onset but progresses relentlessly for as long as the exposure continues. The harmful effects of noise may manifest long after exposure has ceased (WHO, 2015). When describing hearing impairment, three attributes are considered: type of hearing loss (part of the hearing mechanism that is affected), degree of hearing loss (range and volume of sounds that are not heard) and configuration (range of pitches or frequencies at which the loss has occurred) (Shemesh, 2010).

The American Speech-Language-Hearing Association (2014) (ASHA) categorises hearing loss in three different groups based on the part of the auditory system affected, namely conductive, sensorineural and mixed hearing loss. Conductive hearing loss occurs when sound is not conducted efficiently through the outer ear canal to the eardrum and the tiny bones of the middle ear. In this type of hearing loss, the damage can often be reversed with interventions, including surgery. The most common type of

NIHL is sensorineural hearing loss which results from damage to the microscopic hair cells of the inner ear involved in converting sound waves into the nerve impulses that humans perceive as sound (American Speech-Language-Hearing Association, 2014). Sensorineural hearing loss can be temporal or permanent, and is usually bilateral and non-reversible (WHO, 2015). Exposure to loud sounds for a length of time causes fatigue of the ears sensory cells, resulting in temporary hearing loss or tinnitus (a ringing sensation in the ear). In this type of hearing loss, hearing usually recovers within a few hours or a day and it has been reported following attendance of discotheques, rock concerts and sporting events. Temporary hearing loss is a good predictor of the early development of irreversible or permanent hearing loss (WHO, 2015). Permanent hearing loss results from regular and prolonged noise exposure, which causes gradual, irreversible damage to the sensory cells and other structures (Sayapathi, Ting Su & Koh, 2014). The last type of hearing loss, mixed hearing loss, is when conductive hearing loss occurs in combination with sensorineural hearing loss (SNHL). In other words, there may be damage to the outer or middle ear and the inner ear (cochlea) or auditory nerve (American Speech-Language-Hearing Association, 2014).

2.3 PREDISPOSING FACTORS TO NIHL

Certain people may be more susceptible to NIHL than others, meaning that individuals who experience identical noise exposure may develop different degrees of hearing damage (WHO, 2015). Genetic predisposition, chronic conditions such as diabetes and hypertension, diseases such as otosclerosis and Meniere's disease, drugs and ototoxic medications, otitis media, trauma, tumours, aging and exposure to cigarette smoke, exposure to certain chemicals and pharmaceuticals (ototoxins) and exposure to loud noise can increase the risk of acquiring NIHL (Timmins & Granger, 2010; WHO, 2015). Exposure to loud noises from all sources accounts for about 20% of adult-onset hearing loss, although some research suggests that this proportion may be considerably higher. About 75% of moderate or greater hearing loss worldwide is adult-onset (Timmins & Granger 2010).

There are several factors that specifically influence the onset and development of NIHL: frequency, intensity and duration of the exposure (Sayapathi, Ting Su, & Koh, 2014). Chronic exposure and repetitive exposure to high-intensity noise and long duration of contact with noise greater than 85 dB may aggravate the development of this occupational disease (Sayapathi, Ting Su, & Koh, 2014).

Data suggest that males are most affected by the condition and that age is an important confounder for hearing loss (Musiba, 2015). A global analysis indicates that males are 16% at risk of developing NIHL than females owing to differences in occupational categories, economic sectors of employment, and working lifetime (WHO, 2004). Furthermore, in Zimbabwe, the prevalence of NIHL is 27% and 60% of the NIHL cases are 50 years and above old. The lowest prevalence of 5% is amongst those who were between the ages of 20 to 29 years. Lastly but not least, most workers who were diagnosed with NIHL had 20 years of service. In South Africa, 22% of the workers who were diagnosed with NIHL were 58 years old and an increase in hearing deterioration was associated with a longer service (Musiba, 2015).

2.4 DIFFERENT TYPES OF NOISE (OCCUPATIONAL AND NON-OCCUPATIONAL

Noise pollution has become a more severe and widespread problem world-wide due to population growth, fast urbanisation, migration of people from rural to urban areas, expansion and industrialisation of cities and infrastructure development (Onder & Akay, 2015). After air and water pollution, noise pollution is considered to be the third most serious kind of pollution in metropolises (WHO, 2015). Generally, noise pollution is recognised in three categories, which are: community/environmental noise, industrial noise and airport noise (Onyango, Kanali & Kaluli, 2015). Environmental/community noise was described by Onyango et al. (2015) as noise emanating from human activities such as transportation, recreation, entertainment and internal domestic activities. Statistically, environmental noise from non-occupational activities is estimated at 1-1,6 million in western union countries. World-wide 1,1 billion young people could be at risk of hearing loss due to unsafe listening practice (WHO, 2015). South African adolescents were also found to be at risk of hearing loss due to

recreational activities, where 96% of them visit nightclubs or watch movies, while 86% play and listen to personal music players through headphones (Keppler, Dhooge & Vinck, 2015). Community/environmental sound pollution can be significantly reduced by changing personal behaviour, life style, and controlling the quality of automobiles (Rauf, Hossieni, Ahmad, Jamal & Hussien, 2015).

2.5 SOURCES OF NOISE

The sources of artificial noise pollution are from industrial machinery and processes, heavy automobile traffic, trains, airplanes, electrical appliances, public address systems, and generators used for both commercial and residential purposes. Construction activities like mining, construction of bridges, dams, buildings, stations, roads, flyovers and noise from social events make the environment unfriendly and perhaps uninhabitable (Aluko & Nna, 2015).

While mining of minerals has always been a gruelling and forceful task whether it is underground or on the surface, it is strongly associated with excessive noise (Strauss, 2012). Additionally, the mining process has been described as the physical breaking of rocks with iron hammers, applying no skill to the task, but force (Strauss, 2012). In a survey studying NIHL among USA mine workers, the investigators found that certain pieces of equipment in coal primary plants were the loudest sources of noise production (Azizi, 2010). In South Africa, Ntlhakana (2014) reported drilling machines, ventilation fans and crushers, diesel operated locos, winches, air compressors, and conveyer belts as the most common sources of noise in the platinum mines.

2.6 EPIDEMIOLOGY OF NIHL

The prevalence of hearing loss among workers in noisy industries has been recognised since ancient times. Occupational NIHL is a major cause of disability throughout the world (Ranga, Yadav, Yadav, Yadav & Ranga, 2014). It has been estimated that, worldwide, as many as 500 million individuals might be at risk of developing NIHL (Pawlaczyk-Luszczynska et al., 2013). In the United States, nearly

20 million workers were regularly exposed to noise and 50% (10 million) suffered from NIHL (Pelegrin, Canuet, Rodriguez & Morales, 2015). In Sweden, about 9% of workers are continuously exposed to hazardous noise levels in the workplace and appropriately 100 million dollars are paid yearly for compensation of NIHL cases (Nkosi, Classen & Voya, 2015). In a Ghanaian gold mine, 23% of the workforce had NIHL; whereas, in SA, 22% of the mining workforces have NIHL (Musiba, 2015).

Clinical observations of NIHL have been reported for more than a century (Timmins & Granger, 2010). The principal characteristics of occupational noise-induced hearing loss are as follows: it is always sensorineural, and affects hair cells in the inner ear. The hearing loss is typically bilateral as most noise exposures are symmetric. The first sign of hearing loss due to noise exposure is a "notching" of the audiogram at 3000, 4000, or 6000 Hz, with recovery at 8000 Hertz (Hz). The exact location of the notch depends on multiple factors, including the frequency of the damaging noise and the length of the ear canal. Therefore, in early noise-induced hearing loss, the average hearing thresholds at 500, 1000, and 2000 Hz are better than the average at 3000, 4000, and 6000 Hz, and the hearing level at 8000 Hz is usually better than the deepest part of the notch (McBride, Gilbert, Baber, Macky, Larking, Zhang & Skaler, 2011).

2.7 NEGATIVE IMPACT OF NOISE (AUDITORY AND NON-AUDITORY HEALTH EFFECTS)

Noise as a pollutant is dangerous to man and the environment and can cause a number of negative health effects. Noise from construction activities, household chores and social events can be excessive. Noise affects humans physically, psychologically and physiologically. Hearing losses (acoustic trauma, temporary hearing loss and permanent hearing loss) are the most common among the physiological effects (Akinkuade & Fasae, 2015). Blood pressure increases, heart beat accelerations, appearance of muscle reflexes, and sleeping disorders are among the other physiological effects (Ranga et al., 2014). Some of the psychological effects of noise are annoyance, stress, anger and concentration disorders as well as difficulties in resting and perception (Akinkuade & Fasae, 2015).

The major challenge facing people with hearing impairment is communication. Hearing-impaired persons vary widely in their communication skills. Among the conditions that affect the development of communication skills by persons with hearing impairments are personality, intelligence, nature and degree of deafness, degree and type of residual hearing, degree of benefit derived from amplification by hearing aid, family environment, and age of onset. Age of onset plays a crucial role in the development of language (Shemesh, 2010). Persons with pre-lingual hearing loss (present at birth or occurring before the acquisition of language and the development of speech patterns) are more functionally disabled than those who loose some degree of hearing after the acquisition of language and speech (Shemesh, 2010).

Exposure to noise in pregnant women at the work place could affect the hearing of their unborn child (Azizi, 2010). Dzhambov, Dimitrova and Dimtrakova (2014) reveal that women exposed to high levels of noise during pregnancy are significantly at risk for having new-borns that are small for their gestational age, gestational hypertension, and infants with congenital malformations. NIHL has other consequences, which include, amongst others, social isolation, impaired communication with co-workers and family, decreased ability to monitor their work environment, lack of ability to hear warning signals or equipment sounds, increased injuries from impaired communication, isolation, anxiety, irritability, decreased self-esteem, lost productivity, expenses for workers' compensation, and hearing aids (WHO, 2004).

2.8 GUIDELINES AND STANDARDS FOR NOISE-INDUCED HEARING LOSS PREVENTION IN THE MINING INDUSTRY

In 2004, WHO established guidelines that outline a method for estimating the disease burden associated with hearing impairment from occupational noise. Therein, the following topics are described:

- Noise characteristics and their relevance to workers' health;
- Criteria for selecting health outcomes for the burden of disease assessment;
- Methods of assessing exposure to workplace noise for all segments of a population;

- Relative risk data for the main health outcomes of occupational noise;
- Procedures for generating a summary measure of the burden of disease resulting from occupational noise; and
- Sources of uncertainty in the disease burden estimates and policy implications (WHO, 2004).

2.8.1 Guidelines for the compilation of a mandatory Code of Practice (COP) for an occupational health programme for noise

In 2003, the Department of Minerals and Energy developed guidelines for different mines on how to control noise in their work place. These guidelines were developed to protect the health and safety of employees. The COP stipulates key elements, which include the noise assessment process, identification of the homogenous exposure group for the purpose of personal exposure monitoring, the education and training of employees on noise preventative measures, co-ordination of the Hearing bbConservation Programme (HCP), measuring methodology, quality control, and medical surveillance (DME, 2003).

The Code of Practice further outlined the following categories of medical examinations that should be conducted with respect to noise hazards:

Baseline audiogram: A baseline audiometry should be conducted on an employee who enters the mining industry for the first time. This is recorded and kept on his record to be used as a reference for future tests.

Periodic audiogram: Periodic audiograms should be conducted annually for all persons exposed to excessive noise.

Exit audiogram: Upon leaving employment at the mine, an exit audiogram should be conducted. The employee will be given an exit medical certificate and a copy will be kept on the employee's file (DME, 2003).

2.8.2 Guidelines for the compilation of a mandatory Code of Practice (COP) on minimum standards of fitness to perform work at the mine

The Department of Minerals and Energy (2000) developed guidelines for mines on the compilation of a mandatory code of practice, which constituted minimum standards of

fitness for employees to perform work at a mine. The objectives of the guidelines were to ensure that, when an employee is certified as fit for a specific category of work, their health is such that the employee will be able to perform that work without an unacceptable health or safety risk. The employer or any other person in authority has to establish a baseline against which to measure subsequent changes in the health status of the employee (DME, 2000).

The guidelines further stipulate specific advice during the initial medical examination regarding conditions such as infectious diseases, endocrine and metabolic disease, diseases of the blood and blood forming organs, mental disorders, diseases of the nervous system, sensory organs, cardiovascular system, respiratory system, diseases of the digestive system, diseases of the genito-urinary system, muscular-skeletal system, skin, heat tolerance, vision, ear, nose and throat (DME, 2000).

The ear examination should be conducted before any audiometric tests. This should include an inspection of the tympanic membrane and the functioning of the Eustachian tubes. There are audiometric standards to be met for different occupations involving changes in barometric pressure and exposure to noise. These are as follows:

Audiometric standards

Pure tone audiometric screening at 0,5 kHz, 1 kHz, 2 kHz and 3 kHz must meet the following criteria:

- Age16-39: pure tone average of 15 dB or less;
- Age 40 and above: Pure tone average of 25 dB or less;
- Irrespective of age: a threshold of 45 dB or less at 3 kHz.

Hearing Aids

The use of a hearing aid by those working in a designated noise zone should not be permitted (Edwards, 2010).

2.9 SOUTH AFRICAN NATIONAL STANDARDS (SANS) 2013 FOR THE MEASUREMENT AND ASSESSMENT OF OCCUPATIONAL NOISE FOR HEARING CONSERVATION PURPOSES

The South African National Standards (SANS) (2013) has outlined the importance of audiometric medical surveillance. The objective of audiometric medical surveillance is to monitor the auditory status of the employees, early identification of auditory damage, prevention of permanent hearing loss and an evaluation of the efficacy of the audiometric test (SANS, 2013).

A baseline audiogram test should be conducted on all employees by a qualified audiometrist. A baseline audiogram can only be conducted on employees working in a noise zone for the first time, or employees working in a newly identified noise zone. The baseline test should be used as a reference for future tests and for compensation claims for an employee's whole working career. Periodic screening audiometry testing should be done annually, after which intervention measures should take place in the case of a Percentage of Hearing Loss (PLH) shift. The first intervention measure should be implemented when there is a shift of 3.2% (Meyer, 2014). The prescribed measures include: an investigation of the reason for the shift, an investigation of the effectiveness of the personal protection (PPE) used (is the attenuation enough?), an investigation of the proper fit and use of the PPE, the training of employees, and documentation and safe-keeping of these investigations (Meyer, 2014). Furthermore, advanced intervention measures must be taken for a PLH shift of 3.4% or more. These measures should include: an investigation of the reason for percentage of hearing loss (PLH) shift, an investigation of the effectiveness of the PPE, the retraining of employees, and referral of employees for diagnostic audiology. When there is a shift of 10% or more, the employee must be regarded as a possible candidate for compensation, and an audiometric retest should be done at a later stage (Meyer, 2014).

2.10 LEGISLATION ON NOISE-INDUCED HEARING LOSS CONTROL AND PREVENTION IN THE MINING INDUSTRY

In the USA, the Noise Control Act of 1972 was established to promote an environment for all Americans that is free from noise that jeopardises their health and welfare (United States of America: 1972). In South Africa, there are various acts that guide both the employer and employee on the control and prevention of noise.

2.10.1 The Occupational Health and Safety Act (OHS Act no 85 0f 1993) on Noise-Induced Hearing Loss Regulation

The aim of this act is to provide for the health and safety of persons at work, especially in connection with the use of machinery. It also provides for the protection of persons against hazards to health and safety arising from, or in connection with the activities of persons at work. This act also established an advisory council on occupational health and safety (South Africa, 1993).

This act should be applied to an employer or self-employed person who, at any workplace under his/her control, carries out work that may expose themselves or their employees to noise at or above the rating limit of 85 dB. An employer or self-employed person should ensure that his or her mandatories or persons other than employers who may be affected by noise in the workplace are given adequate hearing protective devices, information, instruction and training. Any employee who is exposed to noise above the rating limit of 85 dB should obey any lawful order given to him by the employer regarding:

- The use of measures adopted for noise control;
- The immediate reporting of defective, damaged or lost noise control equipment to health and safety representatives or the employer;
- A prohibition to enter or remain in an area where personal hearing protectors are required unless the person is authorised to do so and is wearing hearing protectors; and
- Reporting for medical surveillance and information and training sessions (South Africa, 1993; R307, 2003 paragraph 8(a)).

2.10.2 Mine Health and Safety Act (MHSA, Act no 29 of 1996)

The purpose of this act is to provide for the protection of the health and safety of the employees and other persons in the mine, to provide for the enforcement of health and safety measures, and to provide for appropriate systems of employee, employer and State participation in health and safety matters (South Africa: 1996).

The act stipulates employer-specific obligations regarding noise, which are: risk assessment; noise control engineering; noise monitoring and medical surveillance; hearing and safety training for noise exposed persons to reduce the risk of NIHL; the compilation of a code of practice (COP) for controlling noise and managing the risk of NIHL; and the provision of appropriate hearing protective devices to noise exposed persons (Guild, Ehrlich, Johnston & Roos, 2001).

The act further stipulates employee's specific obligations regarding noise hazards, which are: the proper use and care of hearing protective devices; reporting problems that may preclude or limit the use of hearing protective devices; and reporting noise sources, communication problems or a perceived lack of protection (Guild et al., 2001).

2.10.3 Compensation for Occupational Injuries and Diseases Act (COIDA) no 130 of 1993 with particular reference to Instruction 171

Instruction 171 (2001) of the Compensation of Occupational Injuries and Diseases act (COIDA) clarifies its position regarding claims for the impairment of hearing. This regulation simplifies the compensation mechanism related to NIHL, and is widely believed to bring fairness to the claims procedure for workers who have acquired NIHL in the course of performing their work (Bombela, 2005). The act states that high risk employees must have had a base line audiogram test at the commencement of their employment or at least by November 2003 if they were already employed by that date. After November 2003, all employees with a Percentage Hearing Loss (PLH) amounting to a 10% shift from their baseline (or more) had to undergo a diagnostic audiogram and submit an application form for a compensation claim (on the basis of the COIDA act) (DME, 2000). The act further outlines that all the employees that were found to have already lost 10% of their normal hearing at the time of their baseline audiogram test must automatically submit a claim for compensation, even without having to wait for any further shift of their PLH (DME, 2000).

In the USA, an estimated $242 million is spent annually on workers' compensation for hearing loss (Sutton, 2015). The Health and Safety statistics announcement for South African mines (2014), delivered by Minister Ngoako Ramathlodi, indicated an increase in the number of reported cases of NIHL from 1 075 in 2012, to 1 330 cases in 2013.

2.11 HEARING CONSERVATION PROGRAMME (HCP)

The Hearing Conservation Programme is required when any person in the workplace is exposed to excessive noise, which is defined as an equivalent sound pressure level of 85 dB(A) or more over an eight hour workday (Edwards & Kritzinger, 2012). The Hearing Conservation Programme is an excellent way to co-ordinate activities with noise exposure control and prevention. This programme strives to prevent initial occupational hearing loss, preserve and protect remaining hearing, and equip workers with the knowledge and hearing protection devices necessary to protect them (Edwards & Kritzinger, 2012; Workplace Safety & Insurance Board, 2003). A typical Hearing Conservation Programme should comprise the following elements: noise assessment and control, measuring methodology and quality control, education and training, hierarchy of controls, medical surveillance, and reporting and reviewing (DME, 2003; South Africa 1996:29; SANS 10083: 2013).

2.11.1 Noise assessment and control

The noise assessment process involves the identification and evaluation of noise risk. Site inspections should be carried out to identify noisy work activities and the type of noise generated by such activities. Noise exposure levels should be assessed in a manner that would accurately identify employees exposed to or likely to be exposed to noise above permissible exposure limits (85 dB). Noise zones should be clearly identified in a conspicuous place using the appropriate mandatory symbolic safety sign (DME, 2003). A qualified occupational hygienist must be appointed to conduct noise monitoring, which should be done once every three years or earlier. This should specifically be done when changes in conditions occur, and also when modifications are made to the machinery or processes that may increase noise levels (Workplace Safety & Health guidelines, 2014).

2.11.2 Measuring methodology and quality control

Measuring methodology and quality control includes: noise control engineering, administrative measures, and personal protection. Control engineering mechanisms should be instituted to decrease the number of sources of noise production, and to reduce the level of noise produced (Azizi, 2010). Administrative controls refer to those measures that can be used to reduce the time that is spent by a given worker in high noise areas. This could mean a carefully controlled rotation of the work schedules aimed at reducing the time that each worker spends in high noise areas (Bombela, 2005). The employer must provide suitable personal protection to ensure that the exposed employees are adequately protected from excessive noise (Workplace Safety & Health guidelines, 2014). Personal protective equipment should be regarded as a last resort when engineering and administrative measures fail. Its intended role is to supplement the other risk control elements rather than being used as the primary control measure (Bombela, 2005).

2.11.3 Education and training on noise control preventative measures

Education and training is a fundamental contributor to the success of the Hearing Conservation Programme as training increases employees' awareness of noise hazards, as well as approaches they can adopt to take care of their hearing (Workplace Safety & Health guidelines, 2014). Training must start at induction and continue throughout the employee's stay in the company, and should be targeted at all employees at all levels, not just those who are routinely exposed to noise (Bombela, 2005). HCP training should be carried out annually for employees exposed to excessive noise, as well as new employees (Bombela, 2005).

The training programme should cover: the adverse effects of noise on hearing; the purpose and benefits of the HCP; HCP policies; the purpose of hearing protectors; instructions on the proper selection, fitting, use, care and maintenance of hearing protectors; the importance of the consistent wearing of hearing protectors; the purpose and procedures involved in audiometric testing, including pre-test instructions; and an explanation of the audiometric results and preventive measures (Bokoni Hearing Conservation Programme, 2013). During the annual training sessions, employees should be encouraged to provide suggestions and comments on the suitability of

available hearing protectors in relation to their job, possible ways to further reduce noise levels, and ways to motivate the wearing of hearing protectors (Bokoni Hearing Conservation Programme, 2013).

2.11.4 Hierarchy of noise control

The control of noise hazards can be accomplished through the hierarchy of control, which should include: elimination, substitution, engineering, administration and personal protective equipment (PPE).

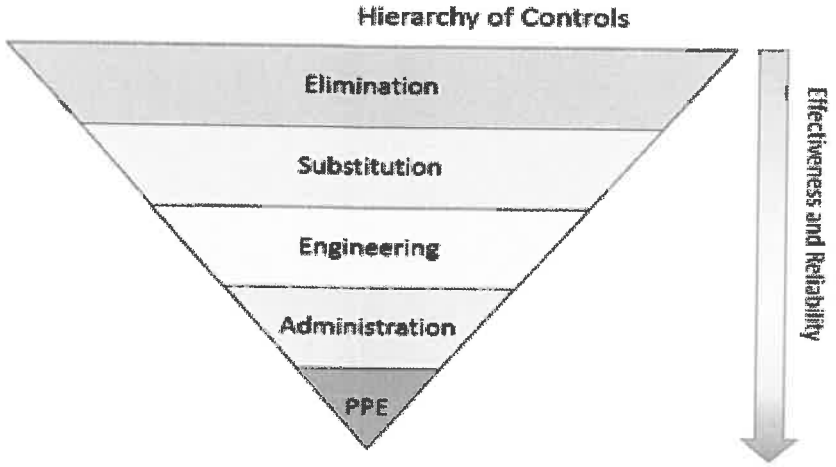


Figure 1: Hierarchy of noise control (Workplace Safety & Health guidelines, 2014 & Bokoni Hearing Conservation Programme, 2013)

Under the MHSA Regulations, reasonably practicable steps should be taken to eliminate any measurable safety and health risk at the workplace. Such risks include excessive noise from equipment and machinery (Bokoni Hearing Conservation Programme, 2013). Where it is not reasonably practicable to eliminate the risk, the option of replacing noisy machines with quieter ones should be considered. Intrinsically, quieter machinery is often more efficient, easier to maintain, and less costly (Workplace Safety & Health guidelines, 2014).

Engineering noise control is another measure that can be taken to minimise risk. It involves the application of physical means to reduce the noise level at the source, along the path, and in the hearing zone of the employees. Noise control can be implemented at the source through the installation of intake silencers on the booster fans. Noise control at the path can be implemented by reducing noise transmitted in

the air through complete enclosure of noise sources. Furthermore, noise control can be executed at the receiver through the provision and use of hearing protective devices (Bokoni Hearing Conservation Programme, 2013).

Administrative controls refer to any arrangements or procedures that limit the daily noise exposure of employees by controlling the work or production schedule. An example of an administrative method would be shortening of the length of time an employee is exposed to excessive noise by job rotation for a significant proportion of time. This would make an appreciable difference to their daily exposure. Scheduling machine operating times to reduce the number of employees exposed to noise would also impact employees' exposure (Workplace Safety & Health guidelines, 2014).

Personal Protective Equipment (PPE) can be used to provide added protection, in addition to engineering and administrative controls. Employees who are exposed to noise should be provided with suitable hearing protectors. The purpose of hearing protection is to ensure that the exposed employees are adequately protected from excessive noise. Before hearing protectors are issued to the affected employees, the following important factors should be considered: individual fitting is necessary to ensure optimum performance; the hearing protectors selected should be suitable for the working environment and the type of job involved; the selected hearing protectors should be able to reduce the noise level to below 85 dB at the ear; and employees should be examined to determine if they are suffering from any medical conditions related to the ear, such as irritation of the ear canal. Furthermore, education and training should be provided on the proper wearing of hearing protectors; the maintenance of hearing protectors, the importance of the consistent wearing of hearing, the adverse effects of noise on hearing; the purpose and benefits of the hearing protective devices; and the need for their use and limitations (Workplace Safety & Health guidelines, 2014 & Bokoni Hearing Conservation Programme, 2013).

2.11.5 Medical surveillance

According to the MHSA, Act no 29 of 1996, medical surveillance programs should be designed to provide the employer with information that enables the elimination, control or minimisation of the hazard and its associated risks. There is a requirement for linkages to be established between the results of noise exposure determinations and

the records of medical surveillance. Medical surveillance should include pre-employment (baseline), periodic and exit audiograms; ensuring the effectiveness of the Hearing Protection Device (HPD); the education and training of employees on the ear; and record keeping to track employees' audiological results for the early identification of NIHL (Ntlhakana, 2014).

2.11.6 Reporting and reviewing

Records and reports related to Hearing Conservation Programme activities must be kept at the mine for at least 5 years (DME, 2003; Workplace Safety & Health Guidelines, 2014). These records should include major noise sources and factors leading to the over exposure of employees; the noise control plan; and the events of factors that have influenced the results of the assessments. The hierarchy of controls that have been initiated, the elimination of hazards by rotating workers in high risk areas, engineering controls to improve noise levels of machinery and equipment, safety practices implemented and adhered to, approved personal protective equipment issued, and workers being educated and counselled regarding their proper use should also be included in the records kept at the mine (DME, 2003).

2.12 THEORETICAL FRAMEWORK

A theory is the organised, coherent and systematic articulation of a set of statements. These statements relate to significant questions in a discipline that are communicated in a meaningful whole (Masters, 2012). According de Vos et al. (2011), a theory has a logical statement that explains the relationship between two or more objects, or characteristics of humans. Betty Neuman's Health Care System theory has been adopted in this study to determine the factors that contribute to NIHL amongst workers. This theory was also used to revise and recommend the application of guidelines that were used to control and prevent NIHL at Bokoni Platinum mine.

Neuman identifies three stressors that alter a person's wellness: the intrapersonal (occurring within a person), interpersonal (occurring between individuals) and extra personal (occurring outside the person) (Leddy & Pepper, 1998). This theory is concerned with how stress and reactions to stress affect the development and

maintenance of health (Leddy & Pepper, 1998). Furthermore, Leddy and Pepper (1998) describe these stressors as tension-producing stimuli that have the potential to disturb a person's equilibrium or normal line of defence.

This theory was designed to guide nurses to properly assess the effects and possible effects of environmental stressors, and treat patients holistically considering five variables, namely physiological, psychological, developmental, sociocultural and spiritual (Miyerkules, 2012). Neuman further emphasises that nurses should not only view patients holistically, but should also consider their family, friends and the community (Miyerkules, 2012). This theory places responsibility on nursing to develop interventions to prevent or reduce stressors on the patient's well being or to make those stressors bearable for the patient (Miyerkules, 2012). Stressors disrupt the patient's systems, sometimes causing physical illness or emotional and social crises (Miyerkules, 2012). Neuman further explains that a nurse can also intervene by providing primary prevention as, during this level, a reaction has not yet occurred, but the degree of risk is known. This prevention focuses on identifying risk factors, attempting to eliminate the stressor, protecting the normal line of defense, and strengthening the flexible line of defense. Secondary prevention focuses on strengthening internal lines of resistance, reducing the reaction to a stressor, increasing resistance factors and tertiary prevention, offers support to the patient, and attempts to add energy to the well being in order to facilitate reconstitution (Lowry, 2011).

In this study, the environmental stressor is the level of excessive noise in the mine to which employees were exposed. An employee's continuous exposure to excessive noise may result in a change in wellness as the lines of defence become weakened or broken. Excessive noise has a negative effect on the hearing mechanism of the body, which results in the development of noise-induced hearing loss (NIHL) (Lowry, 2011). Furthermore, loss of hearing has other health implications such as isolation, anxiety, irritability, and decreased self-esteem (WHO, 2004).

Employees with NIHL may have multiple stressors that could negatively impact their well-being and overall health (Lowry, 2011). This study proposed to determine the factors contributing to NIHL and to recommend the application of the guidelines to ideally strengthen the lines of resistance, and to reduce the impact of stressors on the

employees at the mine. Thus, by utilising this preventative model, the nurse, as a caring professional, could act to protect mining employees from the detrimental effects of these stressors (Lowry, 2011). The concepts of Neuman's Theory were used to frame and guide this study.

2.13 CHAPTER SUMMARY

Chapter 2 discussed the hearing loss process, predisposing factors to NIHL, different types of noise, sources of noise, the epidemiology of NIHL, and the guidelines and standards related to NIHL. This chapter also presented factors related to prevention, such as guidelines for the compilation of a mandatory Code of Practice (COP) for an occupational health programme to reduce noise. A discussion was also presented on the Department of Minerals and Energy's (DME, 2003) guidelines for the compilation of a mandatory Code of Practice with minimum standards of fitness to perform work at a mine. The Department of Minerals and Energy (DME, 2000) and the South African National Standards' (SANS, 2013) 10083:2013: legislation on NIHL control and prevention was also clarified, as well as the Occupational Health and Safety Act (OHS Act no 85 of 1993), the NIHL regulation no. R. 307:2003, the Mine Health and Safety Act 29 of 1996, and the Machinery and Occupational Act no 6 of 1983. This was followed by a discussion on the Compensation for Occupational Injuries and Diseases Act (COIDA) no 130 of 1993, with particular reference to Instruction 171, the measurement and assessment of occupational noise for hearing conservation purposes, the Hearing Conservation Programme (HCP), and the effects of NIHL. Lastly, the theoretical framework that was used to frame and guide this study was examined. The next chapter will focus on the methodology of this study.

CHAPTER 3:
RESEARCH METHODOLOGY

3.1 INTRODUCTION

In this chapter, the research methodology will be presented in detail. The research approach, the study site, research design, population to be studied, sampling method and sample size, data collection and analysis, measures taken to ensure trustworthiness and ethical considerations will be discussed.

3.2 RESEARCH APPROACH

A qualitative research approach was adopted in this study. Qualitative research is a systematic approach used to describe the experiences and situations from the perspective of the person in the situation (Grove, Gray & Burns, 2015). The aim of qualitative research is to uncover meaning, feelings, opinions, and trends and describe the situation in its natural setting (Denzin & Lincoln, 2005; Creswell, 2014). Qualitative approach was more appropriate in order to explore the depth, richness and complexity of the factors contributing to NIHL while interacting with the participants at the Bokoni Platinum mine were the employees are exposed to noise.

Hancock, Ockledford and Windridge (2009) outlined that qualitative research is concerned with the social aspects of our world and seeks to answer questions about:

- Why people behave the way they do;
- How opinions are formed; and
- How people are affected by the events that go on around them.

Through qualitative approach, participants' behaviour, their perceptions, meanings attached to noise and how they are affected by this noise at their work place were captured. According to Creswell (2014), in qualitative research the researchers are key instruments; they collect data themselves and try to develop a complex picture of the problem under study. Data were collected by the researcher through one-on-one interviews in order to explore the multiple factors that contribute to NIHL.

3.3 STUDY SITE

Berg and Lune (2012) state that the study site should be in a location where entry or access is possible and where the target population is likely to be available. This study was conducted at the Bokoni Platinum mine, which is located in the Sekhukhune district on the R37 road from Polokwane to Burgersfort. The Bokoni Platinum mine is 70 kilometres from the city of Polokwane. Mining operations began there in 1963 and have been ongoing for almost 52 years. The mine has about 6 300 employees, including contractors.

The Bokoni Platinum mine has four shafts (underground) and one open cast area where mining activities such as drilling, rock breaking, stopping, and the processing of mining products is conducted. All the workers in these areas are exposed to noise with decibels that are between 85 to 125 dB.

3.4 RESEARCH DESIGN

Babbie and Mouton (2011) define a research design as a plan or blue print of how the researcher intends conducting the research. Berg and Lune (2012) outlined that the purpose of research design is to specify exactly who or what is to be studied, as well as when, how and for what purpose the study is being carried out. Grove, Grey and Burns (2015) described that the type of research design directs the selection of population, sampling process and a plan of data collection and analysis. The phenomological, explorative, descriptive and contextual research designs were used in order to achieve the objectives of this study and to explore and describe the lived experiences of employees diagnosed with NIHL and hearing conservation managers regarding the factors contributing to NIHL at the Bokoni Platinum mine.

3.4.1 Phenomenological design

Phenomenology is a research design which describes the common meaning attached to a concept by several individuals through their lived experience (Creswell, 2014). Babbie and Mouton (2011) outlined that phenomenology focus on continuously interpreting, creating, justifying, giving meaning to and rationalising the action of

people in everyday life. According to Welman et al. (2005), the main focus of phenomenological design is to understand the social and psychological phenomena from the views of the people who are part of the phenomena under study. In this study, through phenomenological design, the researcher described the factors that contribute to NIHL through the participants' lived experiences in their work environment. Phenomenological design enabled the researcher to interpret and understand NIHL as described by the participants who were affected by NIHL.

3.4.2 Exploratory research design

Exploratory research explores the circumstances in a community, how people get along in their setting, what meanings they give to their actions and what concerns them within their setting or environment (Engel & Schutt, 2013). Semi-structured one-on-one interviews with a central question followed by probing questions, as indicated in the interview guide (see Appendix A, Page 92), were conducted. These enabled the researcher to explore how the employees ended up with NIHL, and what meaning they gave to their actions, experiences and their concerns at Bokoni Platinum mine. Through an exploratory research design, the researcher was able to explore and understand the circumstances in which employees were exposed to noise, as well as the meaning and the effects of this noise to their level of hearing.

3.4.3 Descriptive research design

Descriptive design refers to an intensive examination of a phenomenon and its deeper meaning (de Vos et al., 2011). Gravetter and Forzano (2012) and Mertens (2009) outlined that in descriptive research, the researcher attempts to discover facts or to accurately, describe reality as it exists naturally, in order to gain an overview of the current status of a situation. The descriptive approach enabled the researcher to gain insight into the contributing factors of NIHL, as described by the participants, based on their experiences at the Bokoni Platinum mine.

3.4.4 Contextual research design

Contextual research design aims to describe and understand events within a concrete, natural setting or the immediate context in which they occur (Babbie & Mouton, 2011). Streubert–Speziale and Carpenter (2011) argue that carrying out research in a natural

setting refers to an enquiry done in an environment that is free from manipulation.Through this contextual design, the researcher was able to understand events and actions as they occurred in an everyday, real life setting at the Bokoni Platinum mine. This was achieved by conducting one-on-one interviews with employees diagnosed with NIHL and the managers, who were involved in the Hearing Conservation Programme, which co-ordinates activities geared towards the control and prevention of noise at Bokoni Platinum mine. The contextual design was applicable for this study because the employees have experienced NIHL at the Bokoni Platinum mine.

3.5 POPULATION

A population is the aggregation of elements from which the sample is actually selected (Babbie, 2013). De Vos et al. (2011) describe population as the totality of persons, events and case records with which the research problem is concerned. The population consisted of all employees who have experienced NIHL in the year 2013 at the Bokoni Platinum mine.The accessible population is the portion of the target population to which the researcher has reasonable access (Grove et al., 2015). The researcher used the spread sheet with the names of employees diagnosed with NIHL which was available in the mine clinic to identify the population. The accessable population consisted of 37 employees who were diagnosed with NIHL in the year 2013 in all four shafts, and the 14 Hearing Conservation Programme managers at the Bokoni Platinum mine.

3.6 SAMPLING

Sampling is the process of selecting a sample from a variety of people, objects, textual materials and audio-visual and electronic records (Leedy & Ormrod, 2010). Neuman (2011) defines a sample as a smaller selection of individuals from the population. A purposive and convenience non-probabilty, sampling method was used to select the participants in this study.

During purposive sampling, the researchers use their knowledge about the population to select relevant sample members with knowledge about the problem being studied (Polit & Beck, 2012). De Vos et al. (2011) and Neuman (2011) argue that purposive sampling is based on the researcher's judgment, or on selected cases with a specific purpose in mind as the sample is composed of elements that contain the most representative characteristics or typical attributes of the population.

Convenience sampling involves choosing readily available people for the study (Brink et al., 2012). The researcher explained the aim of the study to the nursing manager and the mine management. The researcher in conjunction with the nursing manager used the spread sheet with the names of employees diagnosed with NIHL in 2013 at the mine clinic to select employees for the study. A maximum of 4 employees and 3 hearing conservation managers were selected from each shaft based on their availability and consent to participate in the study. A total number of 16 employees and 12 hearing conservation managers were purposively and conveniently selected from the four shafts. Of this number, 6 employees and 2 hearing conservation managers were used for a pilot study which was conducted at the Bokoni Platinum mine.

3.6.1 Sample size

According to Grove et al. (2015) in a qualitative study, the sample size is guided by data saturation which will be reached when no additional information is obtained from participants. In this study, the sample size was determined by the information from the participants collected during one-on-one interviews. Out of the 16 employees and 12 HCP managers who were purposively and conveniently selected, 6 employees and 2 HCP managers were interviewd during the pilot study. From the 10 employees who remained for the main study data saturation was reached at participant number 7 and from the 10 HCP managers data saturation was reached at participant number 6.

3.7 INCLUSION AND EXCLUSION CRITERIA

3.7.1 Inclusion criteria

Polit and Beck (2012) describe inclusion criteria as a set of conditions that need to be met in order to participate in a research study. All employees who were diagnosed with NIHL in 2013 and all HCP managers were included. The employees diagnosed with NIHL were included because they had experienced NIHL, allowing for exploration of the contributing factors. The HCP managers were included because they are the ones who co-ordinate activities on noise exposure control and prevention at the Bokoni Platinum mine.

3.7.2 Exclusion criteria

Exclusion criteria are explained as characteristics that are not relevant to the study (Polit & Beck, 2012). Since the objective of the study was to explore the contributing factors to NIHL, the employees who were not diagnosed with NIHL were excluded from the study. The managers who were not involved in co-ordinating the noise control and prevention activities were also excluded from the study.

3.8 DATA COLLECTION

Data collection is a series of interrelated activities aimed at gathering relevant information to answer research questions and objectives of the study (Creswell, 2013). A qualitative researcher uses various approaches in data collection such as interviews, observations, documentations and visual materials (Creswell, 2014; Polit & Beck, 2012).

3.8.1 Pilot study

A pilot study is a small scale version or trial run of the research, which is designed to test the methods to be used in a larger study (Polit & Beck, 2012). Additionally De Vos et al. (2011); Creswell (2013) specify that a pilot study is a brief study conducted prior to a larger research, which helps the researcher to refine data collection plans, develop relevant lines of questions and adapt to reseach procedures.

A pilot study was conducted at the Bokoni Platinum mine in order to determine the feasibility of the study. It also created an opportunity for the researcher to refine and improve the interview guide and her interviewing technique. Six employees who were diagnosed with NIHL in 2013, and two managers who were involved in the Hearing Conservation Programme, were interviewed using the central question and the semi-structured interview guide. The employees and managers who participated in the pilot study were excluded in the main study to avoid bias as they would already know the questions to be asked. The results of the pilot study indicated the need for the researcher to avoid asking leading questions, as well as the need for more probing in order to have and understanding and obtain more information on the contributing factors of NIHL.

3.8.2 Preparation for data collection

According to de Vos et al. (2011), it is very important to gain permission from the relevant authority to begin research in a chosen field. Ethical clearance to conduct the study was obtained in writing from the Medunsa Research Ethics Committee; permission to conduct the study was also granted by the Bokoni Platinum mine management (see Appendices B & C, Page 95 - 96). The researcher then contacted the nursing service manager at the clinic. The aim and objectives of the study, the type of participants to be interviewed and how the interviews were to be conducted was explained to the nursing service manager. The nursing service manager then introduced the researcher to the hearing conservation manager's team and the other staff members and explained the purpose of the study. With the help of the manager, a well-ventilated room where there was no noise or other disturbances was identified as suitable to conduct the interview sessions. The employees who met the criteria set out for this study were identified through the spread sheet which had the names of employees who were diagnosed with NIHL and were available in the mine clinic. The date, time and place of the interviews were then arranged.

3.8.3 Data collection method

Data were collected by the researcher who was guided by the supervisors who are skilled qualitative researchers for a period of three months. The researcher started by

collecting demographic data to put employees at ease, create rapport and to understand the social back ground.

Semi-structured one-on-one interviews using an interview guide (see Appendix A, Page 92), was used to collect data. According to de Vos et al. (2011), one-on-one interviews using a semi-structured interview guide encourages participants to give a fuller picture of their situation and to respond to probes. Polit and Beck (2012) describe a written interview guide as logically sequenced, self-prepared questions to be covered with each participant during the interview process. Semi-structured, one-on-one interviews using an interview guide enabled the participants to describe their experiences in their work environment, and how they made sense of what happened to them in terms of the factors contributing to NIHL at their work place. The one-on-one interviews were conducted using languages spoken and understood by the participants at the Bokoni Platinum mine, English, Sepedi and Xhosa, Fanagalo (words and expressions used by miners) was also used by the researcher to explain or ask questions to gain more clarity on issues. All the participants were asked the central question at the beginning of the interview in the same manner. **"Can you describe the factors contributing to NIHL in your workplace?"** The interview guide was used to obtain more information. Probing questions were also asked to generate further explanation, gain a better understanding and and a follow-up on interesting information regarding factors leading to NIHL. According to Polit and Beck (2012), probing is a research technique used by interviewers to generate further explanation from the participants. The interviews for the employees were conducted at the clinic in a well ventilated room and the manager's were interviewed in their offices located in different shafts.

All the interviews were captured on a voice recorder. De Vos et al. (2011) outline that in a semi-structured one-on-one interview, a voice recorder enables the researcher to capture verbatim all the information said by the participants. The researcher obtained permission to use the voice recorder during the interview and all interviews were recorded. Field notes are a written account of the things the researcher sees and observe during the course of interviewing participants (de Vos et al., 2011). Field notes were wriiten to capture non-verbal communication such as mannerisms displayed by

the participants. Field notes were analysed together with the verbatim transcriptions to develop themes and sub-themes.

The participants were allowed to describe their situation freely with little interruption, in order to obtain data in full. The researcher asked one question at a time and gave participants a chance to think about what they wanted to add before proceeding to the next question. The physical or psychological effects of the interviews were monitored throughout the study. Participants were monitored and they were observed for any signs of distress. Data were collected until saturation was reached, where no new information emerged (Polit & Back, 2012).

3.8.4 Interviewing and Communication Techniques

The following interviewing communication techniques were applied during the semi-structured one-on-one interviews, as indicated by de Vos et al. (2011):

- **Minimal verbal response:** the researcher adopted verbal responses such as "ok", "mm-mm", "I see" during the interviews in order to assure the participants that she was listening and had interest in what they were saying.
- **Paraphrasing:** in order to verify the meaning of what the participants had said, the researcher repeated what the participant said in her own words.
- **Clarification:** during the interview, the researcher asked for clarification on statements that were not clear, e.g. "you seem to be saying."
- **Reflection:** the researcher reflected on the important ideas provided by the participants in order to get them to provide more information, e.g. "Do you believe that NIHL is preventable?"
- **Encouragement:** during the course of the interview, the researcher complimented the participants to give them the courage to carry on, for example, "That is interesting."
- **Reflective summary:** The researcher summarised the participants' ideas, thoughts and feelings that were verbalised to confirm that she understood what the participants were saying. This was also done to stimulate the participants to give more information, for example, "Are you saying that there is training available, please explain more?"

3.9 DATA ANALYSIS

The purpose of data analysis is to organise, provide structure to and elicit meaning from the research data (Polit & Beck, 2012). This research followed Tesch's approach to data analysis, which comprises eight integrated steps (Creswell, 2009):

- The researcher got a sense of the research as a whole by reading through the transcriptions of each interview carefully and jotting down ideas as they came to her;
- The researcher analysed the transcriptions of the interview and the field notes that were taken during the interview and selected those that were the most interesting. While going through the data, the researcher continuously asked: "What is this about?" in an attempt to find the underlying the meaning. All thoughts that came to mind were written in the margin;
- The researcher compiled a list of all topics. Similar topics were clustered together and formed into columns, which were arranged into major topics, unique topics and irrelevant issues;
- The researcher abbreviated topics as codes and wrote them next to the appropriate segments of text. This was done to establish whether new categories and codes emerged;
- The researcher reduced the total list of categories by grouping together the topics that related to each other. Thereafter, she drew lines between the categories to show the relationship between them;
- The researcher finally decided on the abbreviations for each code, and arranged these alphabetically. Data belonging to each category were assembled in one place and a preliminary data analysis was performed;
- The analysed data were grouped in themes and sub-themes.

3.10 MEASURES TO ENSURE TRUSTWORTHINESS

Barbie and Mouton (2011) clarify that the trustworthiness of a study refers to its applicability, consistency, and the neutrality of its findings or decisions. Lincon and

Guba (cited in de Vos et al., 2011) propose four strategies: credibility, transferability, dependability, and confirmability. These were followed in this study.

3.10.1 Credibility

Credibility refers to confidence in the truth and interpretation of data (Polit & Beck, 2012). Credibility aims to demonstrate that the research was conducted in a manner that ensures that the subjects of the study were accurately identified and described (de Vos et al., 2011). According to Babbie and Mouton (2011), credibility could be achieved through prolonged engagement and triangulation. The researcher had a prolonged engagement with the participants in the field. Three months was spent in the field and each interview lasted 30 to 45 minutes. This prolonged engagement assisted the researcher with establishing a trusting relationship with the participants and were able to communicate freely. Follow-up interviews were also conducted to verify the information collected from the participants.

Triangulation of data was achieved through using various methods of collecting data. The central question was asked in the same manner, followed by probing questions to seek clariy. All the interviews were captured on a voice recorder and field notes were written to capture non- verbal cues. Data were collected until data saturation was reached.

3.10.2 Dependability

Dependability refers to whether the findings of a study would be similar if it were to be repeated with the same or similar subjects, or if it was replicated in the same context (Babbie & Mouton, 2011). Dependability was ensured by giving a detailed description of the research methods that were used in the study so that if there were a need to replicate the study with the same participants in a similar context, another researcher would obtain the same results. An inquiry audit was conducted to determine whether the processes and procedures used were acceptable by submitting the voice recoded data, transcribed notes and field notes to the supervisors who have extensive experience in qualitative research (de Vos et al., 2011).

3.10.3 Transferability

Transferability refers to the extent to which the findings from the data can be transferred to or have applicability in other settings or groups. The researcher's responsibility is to provide sufficient descriptive data that would enable another researcher to apply this information to a different setting (Polit & Beck, 2012). The researcher ensured transferability by providing a detailed description of the context of the study and the reseach methodology in chapter 3. Purposive sampling was also used to ensure transferability.

3.10.4 Confirmability

According to Polit and Beck (2012), confirmability refers to objectivity, the potential for congruence between two or more independent people about the accuracy of the data, relevance, or meaning. Babbie and Mouton (2011) outlined that confirmability can only be achieved if the findings are the product of a focus on the enquiry and not the biases of the researcher. Confirmability was ensured by including direct quotes from the participants to demonstrate that the findings emerged from the data and not from the researcher's own biases. The proposal, voice recorded data, copies of the transcribed data, and field notes were sent to an independent coder who is an experienced qualitative researcher for analysis and co-coding. Thereafter, the researcher and the independent coder had a meeting to compare and discuss the themes and sub-themes identified by both. Where there were differences the raw data was revisited and a consensus was reached.

3.11 BIAS

Bias is any influence that produces a distortion of the results of a study, or that strongly favours the outcome of a particular finding in a research study (Brink et al., 2012). Bias was avoided by selecting the sample population using purposive and convenience sampling method and bracketing. Purposive sampling technique allowed the researcher to carefully select the sample based on elements that are related to and would most aptly be able to answer the research questions and provide relevant

information (de Vos et al., 2011). Open-ended questions were asked and the participants were allowed to talk freely without interruption by the researcher. Tufford and Neuman (2010) describe bracketing as a scientific process in which the researchers suspends or holds in abeyance his or her presuppositions, biases, assumptions, theories or previous experiences regarding the phenomenon studied. To ensure bracketing and prevent bias the researcher wrote down all the preconceived ideas before beginning with data collection. Data were collected as if nothing was known about the phenomenon.

3.12 ETHICAL CONSIDERATIONS

De Vos et al. (2011) describe ethics as a set of moral principles that are suggested by an individual or a group, which offers rules and behavioural expectations. Leedy and Ormrod (2010) argue that whenever human beings or other creatures with the potential to think, feel and experience physical or psychological distress are the focus of the investigation, the researcher needs to be sensitive to ethical issues in order to ensure correct conduct. Due to the fact that human beings participated in this study, the following ethical standards were adhered to during the course of the study:

3.12.1 Permission to conduct the study

The proposal was submitted to the University of Limpopo Medunsa Research Ethics Committee (MREC) for ethical clearance (see Appendices B, Page 95). Permission to conduct the study was given by the Bokoni Platinum mine management (see Appendix C, Page 96).

3.12.2 Informed consent

According to Flick (2014), informed consent implies that the subjects know and understand the risks and benefits of their participation in the study. Grove et al. (2015) outlined elements of informed consent, which include: the researcher disclosing essential study information to the participants, competence of the participant to give consent and voluntary consent of the participants to participate in the study. The researcher provided sufficient and comprehesive information to the participants

regarding their participation. The purpose and the objectives of the study were explained to the participants. The researcher explained that the one-on-one interviews, will be conducted, a voice recorder will be used to record the interviews and fieled notes will be written. The researcher made it clear to the participants that participantion is voluntary, they could terminate their participation at any stage without intimidation. The consent form was read to all the participants before they signed it and those who agreed to participate signed. (See Appendices D, E & F page 97 - 99).

3.12.3 Confidentiality and anonymity

Confidentiality is the researcher's safe management of the research information or data shared by the participants to ensure that it is kept private from others (Grove et al., 2015). Assurance was given to the participants that the collected data would not be divulged to unauthorised persons (the employer or any other person not directly involved in the research) without their permission, and that the researcher would publish the results with their identity protected. All of the data collected was kept in a secured place, only assessable to the researcher, the supervisors and the independent coder. Anonymity means that the participant remains nameless in relation to their participation in the research (Berg & Lune, 2012). The participants were allocated numbers and all the results were reported using those numbers.

3.12.4 Principle of justice

According to Flick (2014) justice refers to fairness and equality of treatment received by the participants from the researcher. Brink et al. (2012) outlined that justice refers to the right to fair selection, treatment and privacy. The principle of justice was ensured by purposively and conveniently selecting the participants who met the determined criteria. The researcher also ensured this principle by treating the participants equally and asking them the same questions in their own language. The right to privacy was ensured by conducting the interviews in a private room.

3.12.5 Principle of non-maleficence

Non-maleficence refers to the duty not to inflict any harm on the participants (Flick, 2014). Grove et al. (2015) outlined that in research, discomfort and harm can be physical, emotional, social and economic. The study was conducted in a manner that

allowed the researcher to avoid physical or psychological harm to the participants; this was achieved by carefully structuring the questions and monitoring the participants for any sign of distress. The participants were also informed that they could behave or think as they pleased without fear. They were also ensured that the information which they provided would not be misused to compromise them in any way (Brink et al., 2012).

3.13 CHAPTER SUMMARY

This chapter described and discussed the research methodology, approach, study site and the design used in the study; population, sampling and sample size; inclusion and exclusion criteria; data collection method; data analysis; measures to ensure trustworthiness that include credibility, transferability, dependability, and conformability; bias and ethical considerations including aspects such as permission to conduct the study; informed consent; confidentiality and anonymity; principle of justice and principle of non-maleficence. The next chapter will discuss the research results and implementation of literature control.

CHAPTER 4:
DISCUSSION OF THE RESULTS

4.1 INTRODUCTION

This chapter presents the results of the data collected from the employees who were diagnosed with NIHL in 2014, as well as the Hearing Conservation Programme managers at the Bokoni Platinum mine. The demographic characteristics of the participants are outlined in Table 4.1 and 4.2. Tesch's inductive and descriptive coding technique was adopted for data analysis, as suggested by Creswell (2009). Themes and sub-themes emerged during data analysis. The results are discussed based on factors contributing to NIHL.

A total number of seven employees and six Hearing Conservation Programme managers were interviewed until data saturation was reached. In this study, employees were identified as participants and the HCP managers were identified as 'HCP manager' participants.

Table 1: Demographic characteristics of Hearing Conservation Programme managers

Gender	Age in years	Occupation	Years of experience
Males = 6	21 - 30 = 1 31 - 40 = 2 41 - 50 = 3	Occupational hygiene = 2 Health and Safety = 2 Supervisor = 2	0 - 5 = 2 6 - 15 = 2 16 - 25 = 1 26 - 35 = 1

Table 2: Employees diagnosed with NIHL

Gender	Age	Occupation	Period of employment	No of decibel Exposed	Baseline percentage of hearing loss	Percentage of hearing loss
Males = 7	41 - 50 = 2 51 – 60 = 5	Change house attendant = 2 Winch operator = 3 Rock drill operator = 2	6 - 15 = 1 26 - 35 = 1 36 – 45 = 5	85 dB and below = 2 85 - 95 dB = 3 96 - 105 dB = 2	0 - 5% = 1 6 - 10% = 4 11 - 20% =2	10 - 20% = 4 21 - 30% = 3

4.2 THEMES AND SUB-THEMES

Flick (2014) describes a theme as an umbrella construct relevant to the research question, which can be seen on some level of patterned response or meaning within the data set. A sub-theme is a specific theme within a large theme (Flick, 2014). In this study four themes and their sub-themes emerged during data analysis, as outlined in Table 4.3. The themes and their sub-theme are discussed below. Direct quotes from participants are presented to support the study findings. Literature is also presented to support the findings.

Table 3: Summary of the themes and sub-themes reflecting the factors contributing to NIHL

Themes	Sub-themes
1. Expiriences and challenges faced by employees in the work environment	1.1 The existence of noise hazards 1.2 Implementation of screening tests 1.3 Maintenance and repair of faulty equipment
2. Noise hazards and the health of employees	2.1 Hearing loss acquired in the line of duty 2.2 Knowledge related to the source of noise and prevention of NIHL 2.3 Employees' perception of noise
3. The hearing protective device factors	3.1 Availability and quality 3.2 Knowledge and adherence 3.3 Replacement process
4. Management and leadership factors	4.1 Enforcement and implementation of policies, guidelines and regulations 4.2 Precautions taken to minimise noise hazards 4.3 Educational health programme for noise control 4.4 Recommendations to employees following NIHL

THEME 1: EXPIRIENCES AND CHALLENGES FACED BY EMPLOYEES IN THE WORK ENVIRONMENT

Although mining has important economic, labour and social effects in our country, it is a demanding environment where the employees are faced with a number of challenges such as excessive noise, which has a significant impact on their health, social life, families, the community and the society surrounding them (Ware, 2014). Participants shared their views on the challenges that emerged in the following sub-themes:

Themes	Sub-themes
1. Expiriences and challenges faced by employees in the work environment	1.1 The existence of noise hazards 1.2 Implementation of screening tests 1.3 Maintenance and repair of faulty equipment

Sub-theme 1.1: The existence of noise hazards

The participants shared similar views on the existence of excessive noise in their work environment, which was perceived as the cause of their hearing problems. This is reflected in the following extracts from a participant who said:

"I'm working as a driller and there is a lot of noise coming from the machine that we use to drill and also from the fans. This noise is there every day and I've been working in this noisy area since 1996 till today. Even now I cannot hear well because of this noise".

The HCP manager participant added by saying:

"In the mining environment underground there is a lot of noise because we are using different machines which emit a lot of noise. The other things especially in the mining can be like the difference in sound pressure levels, like when you are in the cages. When we go down underground with the cage (lift) the pressure increases the level of noise and when you get out you have temporary hearing loss."

The findings are in agreement with a study conducted by Reddy, Welch, Thorne and Ameratunga (2012) on the use of hearing protection in manufacturing workers. They reported the existence of constant noise in the work place as one of the causes of health problems such as hearing loss. Amponsah-Talwiah, Leka, Jain, Hollis and Cox (2013) carried out a study on the impact of physical and psychosocial risks on employee well-being and quality of life in the mining industry in Ghana. Their study indicated that the outrageous noise created by the machines used in the mines, combined with the enclosed workspace that characterises underground mines, increased the likelihood of hearing loss. Strauss (2012) outlined that mining of minerals is associated with excessive noise exposure due to the use of machines which involves gruelling and forceful task.

Sub- theme 1.2: Implementation of screening tests

One of the ways to assess the effectiveness of preventive noise control measures and to detect and monitor hearing loss over time is to assess workers' hearing through the conduction of audiometric tests (SANS, 2013). It is also a legislated requirement that the employer must comply with DME (2003) guidelines. The audiometric tests must include pre-employment (baseline), periodic and exit audiograms. Findings of this study revealed that audiometry screening tests such as baseline, periodic and exit are being conducted. One participant said:

"They check us in the clinic and test us, they also check our lungs. I mean they test our ears in the machine every year when we come back from leave you cannot go back to work without going to the clinic they will return you back from the shaft."

In support of the employee the HCP manager said:

"We do medicals, audiometric test and other tests such as X-rays. These tests are done annually, when they leave the mine and when we hire them. The results of the audiometric test are compared with the baseline results and if there is hearing deterioration we send a person to the specialist for further test."

These findings concur with that of a study conducted by Mizan, Abrahams, Sekobe, Kgalamono, Ndaba, Manganyi, Renton and Wilson (2014) in the iron and steel industry in SA, from eight companies. They reported that all companies had medical

surveillance programmes in the form of audiometric testing at baseline, periodically, and at exit medical assessment. In support of these findings, the Mine Health and Safety Act (1996) indicate that audiometric screening tests must be done during employment, annually and when the employee leaves the company. Ntlhakana (2014) reported that medical examinations which included audiometric test and the overall medical assessment were done to all the employees when they return from leave.

However, in the context of this study, the Bokoni Hearing Conservation Programme (2013) outlines that audiometric screening testing must be done every six months for the early detection of NIHL. These tests must be conducted on the employees who are working in high risk occupations such as winch and rock drill operators.

One HCP manager participant said:

"There is a procedure available for early detection of hearing loss. We have now moved away from the annual to 6 months audiometric test medicals; But currently the six months audiometric tests are not done to everyone is only for certain categories such as rock drillers and winch operators. We are in the process of reviewing to see if there is a need to add some categories."

Another HCP manager participant added:

"The medical that we do is initial and periodic. Periodic audiometric screening test is done annually. We have also introduced 6 months interval for the high exposed categories such as operators, loco drivers, rock drill and the compressor house attendants".

On the contrary, 2 participants who work in the high risk occupations responded differently by outlining that:

First participant: *"They only test our ears in the clinic when we start to work and again when we come back from leave every year during our stay in this employment. When we leave the employment for another company the ear test is done to check if the ears are damaged by the machine."*

Second participant said: *"When we came back from leave, they test our ears with the machine every year. Our ear plugs (which are personalised) are washed in the machine to check if they are still functional."*

In a study conducted by Ware (2014) on the epidemiology, mechanisms, and interventions of human hearing loss it is outlined that early detection and intervention thorough hearing screening programmes is crucial to minimising the impact of hearing loss. WHO (2004) outlined that due to the fact that NIHL can develop rapidly in workers exposed to high noise levels on a daily basis, it may be a good practice to conduct audiometry testing twice a year for workers exposed to noise levels that equal or exceed 100 dB.

Sub- theme 1.3: Maintenance and repair of faulty equipment

Engineering control is one of the essential components of noise management programs. This mean control of noise from the source, which includes buying of quieter machinery, replacement and maintenance of machines (Work Place Safety & Health Guidelines, 2014). In this study, the HCP managers indicated that there are policies with regards to maintenance and repair of machines. This statement is supported by the following extract from an HCPM participant;

"The machines are serviced by the manufacturing companies quarterly. If there is breakdown we call them they come and fix them. We also have a policy in place on the service and maintenance of machines where they also check if the noise silencers in the machines are still effective this is done quarterly. The employees also have a responsibility to check the machines before they beginning of the shift should there be a problem they must report immediately."

However, participants indicated that there are work areas where there is no noise or the noise level is minimal, but they constantly experience malfunctioning of equipment.

This is reflected in the following extracts:

"I'm now working in change house where there is no noise. Only if the washing machine is not in good condition that's when there is noise. This happens most of the time and they give us ear plugs so we can use when the machine start to make noise."

Another participant added by saying: *"The cage also makes a lot of noise if the pipes inside are not in good condition. A cage is something like an elevator which transports us to underground and inside there are pipes for smoke. The pipes sometimes are broken and they make a lot of noise like Waa."*

Occupational Safety and Health Administration (2011) indicate that proper maintenance of equipment and replacing faulty or warn out ones can significantly reduce noise levels on the job site. A study done by Kulkarni (2015) in India reviewing the effects, and monitoring and control of noise pollution revealed that there was poor implementation of technical measures such as poor maintenance of roads, vehicles and machines.

THEME 2: NOISE HAZARDS AND THE HEALTH OF EMPLOYEES

Noise is an unwanted sound which degrades quality of life and contributes to several health hazards. It affects human beings physically, psychologically and physiologically (Akinkuade & Fasae, 2015). The most common health hazard is hearing loss, which occurs gradually, and can be temporary, or irreversible/permanent (Akinkuade & Fasae, 2015). The following sub-themes emerged from this theme:

Themes	Sub-themes
2. Noise hazards and the health of employees	2.1 Hearing loss acquired in the line of duty 2.2 Knowledge related to the source of noise and prevention of NIHL 2.3 Employees' perception of noise

Sub-theme 2.1: Hearing loss acquired in the line of duty

Exposure to high levels of noise has both auditory and non-auditory negative health effects on employees. These effects do not only affect them but also affects how they relate with others their safety and can cause disability (deafness) (Shemesh, 2010). In this study, employees reported that their present hearing status, which is poor, was caused by the noise they have been exposed to in their working environment. This was supported by a participant who said:

"I think the reason why I cannot hear well is because of the noise from the machines. I've been working underground for a long time. I also think it is their time not to hear well (the ears) [you see am getting old]. Most of the people with hearing problem are us the old ones, the younger ones do not have these problems. I think is also because years ago when we started to work the mines did not have hearing protective devices."

Another participant said:

""Hee (changing facial expression and moving forward) I think my ears were damaged by the work that I was doing. I used to work as winch operator before they remove me from underground because my ears are damaged. I have worked as a winch operator for many years and those machines used to make a lot of noise. The machines I'm referring are the fans and drilling machines. My ears were damaged by the noise from those machines, even now I cannot hear well because of that noise."

A study by Ware (2014) on the epidemiology, mechanisms, and interventions of human hearing loss revealed that prolonged high-intensity noise exposure in the work place can damage hair cells, producing a permanent hearing threshold shift and reduced speech-from-noise distinction. Ware (2014) further outlined that the main impacts of hearing loss is on the individual's ability to communicate with others, which affects them in all aspects of their lives (socially, emotionally and economically). Edwards and Kritzinger (2012) reported that excessive noise exposure can lead to permanent hearing loss and poor verbal communication which leads to socal isolation and disruption of lives.

Sub-theme 2.2: Knowledge related to the source of noise and prevention of NIHL

Insight and knowledge of the employees on the sources of noise and the available preventative measures can result in more positive attitudes towards participation and compliance on noise control and hearing loss prevention (Azman et al., 2011). In this study, participants seemed to be knowledgeable about the sources of noise in their different work areas. The findings are supported by the following extracts:

"I think now is better because they used to blast when we were still inside the mine (underground). The noise which came from the blasting of rocks was too loud, but

currently they only started to blast after we knock off and everyone is out of underground not so long. Blasting is like they break the rocks into small pieces and you will hear loud sounds like boom. I think it was in 2014 when they started to blast when we are outside. The other thing is that you as an employee must take responsibly of using the ear plugs and know that if you are not using them you are killing yourself."

Another participant said:

"*There is noise from the drilling machine because when you bore it is not possible that the machine cannot make noise. I don't want to lie they tell us every day before we start to work about protecting our ears and they give us personalised ear plugs."*

One HCP manager supported the above extracts by saying:

"*In the mining industry, we are using different machinery and most of them release a lot of sound pressure which contribute to NIHL. For example, we have the haulages compressors, fans, rock drill and the winches. In those machines we have silencers which reduce the noise. The other initiative is that we have now reduced noise exposure time. Meaning that they must not work in noise areas for more than 8 hours."*

The results of this study concur with the results of a study done by Ntlhakana (2014) on the knowledge, attitude and views of South African mine workers regarding noise-induced hearing loss and the use of hearing protective devices in the gold and non-ferrous mining industries. The participants revealed having knowledge on the sources of noise. They further demonstrated that drilling and ventilation machines, diesel operated winches and crushers produce the highest level of noise in the workplace. The study by Ntlhakana (2014) further revealed that the participants also displayed knowledge on the preventative measures for deafness, such as proper use of hearing protective devices when using noisy machine. A study conducted by Azizi (2010) on the sources of noise outlined that different equipments used in coal primary plants were the loudest sources of noise production.

Sub-theme 2.3: Employees' perception of noise

Participants seemed to view noise as normal and part of their daily working life, as reflected in the following verbatim statements:

"Underground when you bore it is not possible that the driller machine cannot make noise it makes noise continuously. There are also other machines that make a lot of noise like fans, winch and compressors."

In addition, another participant said:

"Here in the mine there is a lot of noise from the machines that we are using, so it is not possible that you can prevent this noise, this noise has been there for long time since I started to work in the mine even now it is still there."

In a study carried out in New Zealand by Reddy et al. (2012) on the use of hearing protection by manufacturing workers, employees accepted noise as something that is natural, inevitable and part of their work environment. According to the results of a study done in USA by Balanay and Kearney (2015) on the attitude toward noise among college students, their attitude towards noise prevention strategies was poor and negative. A positive attitude was only seen in the students who had started to develop NIHL symptoms.

THEME 3: THE HEARING PROTECTIVE DEVICE FACTORS

The last essential component of the hierarchy of control in the hearing conservation programme is the provision and use of HPDs which was enforced in South African mining industry in 1988 and became compulsory for all mines (Guild et al., 2001). The following sub-themes emerged from this theme:

Themes	Sub-themes
3. The hearing protective device factors	3.1. Availability and quality 3.2. Knowledge and adherence 3.3. Replacement process

Sub-theme 3.1: Availability and quality of HPDs

In this study, participants acknowledged that presently they were provided with different hearing protective devices, such as personal protective hearing devices

custome made (noise X), disposable ear plugs and ear muffs. However, they also raised the concern that the personalised HPDs were introduced late when their hearing ability was already compromised. The quality of the custom made device was found to be questionable. This is reflected in the following extracts from the participants:

"Now they provide us with different hearing protective devices, I'm using the personal made custom ones (that they measure our ears and fit them) before they give us and they are better in protecting noise. The problem is that they gave them to us late when our ears were already damaged. We have started using the custom made ones in 2005. All along we have been using the plastic ones which are not effective because you can still hear lot of noise even when you wear them."

An HCP manager participant added:

"All the employees are now using the custom made hearing protection devices. With the custom hearing protective devices, it was proven that they protect the ears better than other ones. The roll out is not 100% complete, some are still using the old hearing protective devices such as disposable ear plugs and ear muffs which are available in our stores."

Another HCP manager participant added by saying:

"*We are now using customised hearing protective devices which are called Noise X. They are actually giving much protection than plastic ones. The other good thing about the Noise X is that they are personalised, even when they are lost no one can wear another ones' protective devices, is only the owner who can use them."*

In support of this study, Ntlhakana (2014) reported that South African mine workers indicated that they preferred personal custom made HPDs (Noise X) because they protect the ears more efficiently. A study by Steenkamp (2008) on a personal approach to hearing conservation reports that personal, custom made HPDs have more advantages as they are physically sized for comfort. They provide enough attenuation for the specific working zone and over protection is minimised to optimise communication so that employees can hear warning signals. Work place safety guidelines (2014) outline that employees who are exposed to excessive noise should

be provided with suitable HPDs which must be suitable for the working enviroment and the type of job involved.

However, in this study, the quality of the customised Noise X devices was reported to be questionable by the participants. This was supported by the following extracts:

"The personalised hearing protective devices are like bones sometimes they fall and break. Unlike the plastic ear plugs which are like rubber they do not brake easily. The other thing with the personalised hearing protective devices is that if they brake it takes more than a month to be fixed.

In adition another Participant said:

"*Mm-mm with Noise X problem is that they brake easily. When they brake they tell you to bring them to clinic. They are not like those old ones (ear plugs) which are like tyres even if they fall they do not brake. The Noise X if you have a problem you return them to the clinic. They tell you to use the old ones while they are still fixing the damaged ones."*

There are similarities between the findings of this study and those of Bruek (2009), on the real world use and performance of hearing protection. In the study by Bruek (2009) some users of custom-moulded earplugs reported that they did not find them comfortable, and the devices were sometimes found to be defective during the annual service check. In contrary Timmins and Granger (2010) study stated that some of the HPDs got damaged due to negligence by the workers and being worn out.

Sub- theme 3.2: Knowledge and adherence

Hearing protection devices are used to provide added protection in addition to engineering and administrative controls, which ensure that the exposed employees are adequately protected from excessive noise (Workplace Safety & Health Guidelines, 2014). Barriers, such as lack of knowledge, might contribute to poor adherence. In this study, the participants seemed to have knowledge about the importance of using hearing protective devices in their workplace. This was confirmed by the following statements from the participants:

"We only use earplugs to protect your ears from the noise. There is nothing else that I am using. I only know the rubber ear plugs and the personalised Noise X which are issued to us to protect our ears when we go underground."

Additionally another participant said: *"Nodding, Jaa they give us different ear plugs like noise bans and ear plugs, you cannot operate machine without hearing protection. Should the supervisors or safety officers find you working without protecting your ears they will stop you and take you to the office, they are very strict."*

In the study by Ntlhakana (2014), all participants, regardless of their experience, were aware of the importance of using HPDs for the whole shift, and owned personal HPDs. Ntlhakana (2014) further revealed that even though employees were knowledgable about the use of HPDS, the participants displayed lack of knowledge on other noise reduction measures which are practiced by the mine. Reddy et al. (2012) reported that, employees acknowledged that they used HPDs to prevent damage to their hearing.

However, in the current study, some participants and HCP managers argued that even though the employees are knowledgeable on the use of HPDs, compliance and adherence on their use was still a challenge with some of the employees.

One participant said: *"People are not the same, some are new, they don't think like us who have been there for a long time. Some they don't use them properly as shown, sometimes they don't use them at all."*

An HCP manager participant added: *"What I have realised is that the employees remove the ear plugs when they are busy working, when they see safety officers or someone from the management they wear them and remove them when they leave."*

Another HCP manager participant supported by saying: *"Because of poor compliance of employees regarding wearing protective devices, what we do is that we have an incident reporting system so if any of the supervisors or safety representatives or management go underground and find the employees not wearing their PPE they are reprimanded and that goes to the report system."*

Chambanduka et al. (2013) reported that the prevalence of noise-induced hearing loss among employees at a mining industry in Zimbabwe is due to lack of use of protective

devices. Additionally, this is due to the workers' attitudes and forgetfulness. Wells and Khoo (2013) indicated that it is an ongoing struggle for many employers to ensure that workers wear protection at all times on the job. A study by Sayapathi, Ting Su and Koh (2014) on the impact of different permissible exposure limits on hearing threshold levels reported that employees were supervised consciously to ensure continuous usage of HPDs.

Sub-theme 3.3: The replacement process

Eventualities such as replacement of damaged HPDs can comprise the hearing of the employees if not well managed. Participants revealed that the process of replacement of broken HPDs is a challenge as they take long to repair them. The following extracts from the participants support the statement above:

"If you report that the noise ban is broken, they take them for repair in the clinic. The problem is that after take them they just let us back to work without protection. What I mean is that when they said we must go and work they must give us plastic earplugs so we can use them, for now they just let us go without saying anything. But we the old ones we go to our supervisors who send us to the store room to collect plastic ones. If it is new persons they just go and work and wait for a month without protecting their ears and when they come back already the ears are damaged."

In addition, another participant said: "*Eee if the noise bans are broken they must provide us with temporary ear plugs. Because they take more than a month to fix the broken ones."*

In agreement with these findings, the study conducted by Bruek (2009) found that inadequate provision and replacement of damaged earmuffs was one the barriers identified and experienced by the participants. A study by Timmins and Granger (2010) on overcoming barriers to effective noise control and hearing loss prevention in Australia, reported that some of the HPDs used by workers got damaged due to misuse and being worn out.

THEME 4: MANAGEMENT AND LEADERSHIP FACTORS

Mining leaders and managers are guided by The Mine Health and Safety Act (MHSA, Act No. 29 of 1996), which stipulates employer-specific obligations regarding noise in order to protect the health and safety of the employees. Management commitment is the most important factor governing achievements in hearing conservation. The following sub-themes emerged from this theme:

Themes	Sub-themes
4. Management and leadership factors	4.1 Enforcement and implementation of policies, guidelines and regulations 4.2 Precautions taken to minimise noise hazards 4.3 Educational health programme for noise control 4.4 Recommendations to employees following NIHL

Sub-theme 4.1: Enforcement and Implementation of Policies, Guidelines and Regulations

The South African mining industry is regulated by legislations, guidelines and standards that regulate and guide all mines on the control and prevention of NIHL. However, even though the regulations and guidelines are available, the implementation can be a challenging process for both the employer and employees (Edwards, 2010). In this study, the participants and the HCP managers were in agreement that the mine had policies, guidelines and regulations in place that were implemented through a Hearing Conservation Programme. This programme guided the employer and the employees in relation to the control and prevention of NIHL.

One HCP manager participant said:

"We *have NIHL investigation procedure available and Code of Practice, which is like a constitution to guide the mines on how to deal with noise. We also have legislations, guidelines, policies and operating procedures available for different departments."*

Another HCP manager added by saying: "*The contents of the HCP include: Risk assessment and occupational hygiene monitoring, Noise control engineering, education and training, Medical surveillance, which includes audiometric test, investigation of hearing loss, hearing protection devices, availability and implementation of policies and guidelines in relation to noise prevention to the process of compensation and record keeping."*

The results of this study concur with the results of a study done by Edwards et al. (2011), in relation to meeting the milestones set by the industry to prevent NIHL in SA. The findings revealed that these standards, legislations, guidelines and hearing conservation programmes relating to NIHL prevention are available, but that there was poor compliance in their implementation within the mines. A study by Edwards & Kritzinger (2012) on noise-induced hearing loss milestones: past and future, revealed that hearing conservation programmes was an excellent way to co-ordinate activities with noise exposure control and prevention but a need for improvements to current programmes prevention strategies was identified.

Sub-theme 4.2: Precautions taken to minimise noise hazards

The HCP managers outlined that the precautionary measures fall under the Hearing Conservation Programme (HCP), which is the main umbrella were all activities for noise control and prevention are implemented.

An HCP manager participant said: "*The management is implementing all the programmes; we have the occupational hygiene and medicine, training centre and couple of initiatives. Like we are buying quieter machines with noise silencers, we have the HCP programme, we have hearing loss investigations, and we have full time safety representatives available in all the shafts. We are also now issuing the custom made hearing protective devices which have better protection. With all the initiatives*

that were introduced now is up to the role player who is the employee to start using what is being provided to him."

Another HCP manager participant added:

"We have the Hearing Conservation Programme, which is available for early detection of NIHL. Ook the Hearing Conservation Programme is like this: we are monitoring the hearing loss, actually from the start I just said when the person come to this mine we do baseline, once baseline is done, the person goes to work for one year and we do personal monitoring using dosimeter on their herc, we do spot checking, after the spot check we identify high noise area that's where we will give dosimeter for personal monitoring."

On the same issue, Amponsah-Talwan et al. (2013) highlighted that the managerial support, initiatives to minimise hazards, and the reinforcement of safe practices provides workers with social cues and enables employees to understand expectations about their behaviour in relation to safety. The results also concur with the MHSA, Act No. 29 of 1996 and OHS Act no 85 of 1993, which stipulates that the employer should take reasonably practicable steps to eliminate any measurable safety and health risks. Such risks include excessive noise from equipment and machinery and, where it is not reasonably practicable to eliminate the risk the option of replacing noisy machines with quieter ones should be considered.

Sub-theme 4.3: Educational health programme for noise control

Training and education is one of the fundamental aspects of the Hearing Conservation Programme. The current study revealed that the implementation of education and training programmes was an important aspect in the safety of employees. This statement was supported by the following response from a participant:

"When we go underground everyday there is mass meeting where we talk about safety and protective devices and also our work material how we must handle them. This is done to ensure that everything you do at work must be done according to safety standard. Even with rock drill machine when you operate you must follow the standards, so that you don't get injured."

Additionally, an HCP manager participant said:

"We do training in different places like training centre by the accredited facility and in the clinic when they do medicals initial and periodic. Even when we are doing hearing investigations if we found that the employee does not know how to use the HPDs we re-train them."

In support of the findings of this study, Reddy et al. (2012) reported that regular training encourages workers to wear HPDs and increases workers' awareness of issues around noise and hearing protection. The Occupational Health and Safety Act no 83 of 1993 states that it is the responsibility of the employer to provide adequate information, instruction and training on noise control and prevention to the employees who are exposed to noise at or above the rating limit of 85 dB. Furthermore, an investigation of hearing loss by the HCP committee was also identified by HCP managers as part of the available training programme.

"When the person goes for his medical and the results of the audiometric test indicate the hearing loss of greater than 5%, that person get paraded to be investigated by investigation committee. The investigations are done on weekly basis every Thursday. The committee investigate the person by asking questions on what could have caused the hearing loss, we re-train them on the use of hearing protective devices and make recommendations."

In addition, another HCP manager participant said:

"In the investigation, we are trying to find the cause of what happened, is he working in noisy environment and if not, what are the contributory factors, is actually making us aware of what is happening in our work environment and we are trying to help the employee."

The results of this study are consistent with the findings of Mizan et al. (2014), where four companies reported that they conducted investigations and re-trained their employees on the early identification of hearing loss, starting from a PHL shift of 5%. They further revealed that the investigations also provided an opportunity to assess whether companies could translate policy intentions into good governance and practices. The new changes from the Noise-Induced Hearing Regulations (SANS,

2004) to the SANS 10083 were highlighted by Meyer (2014). These measures include: investigation of the reason for the shift, investigation of the effectiveness of the personal protective equipment (PPE) used (is the attenuation enough?), investigation of the proper fit and use of the PPE, and the documentation and safe-keeping of these investigations.

However, the HCP managers highlighted that even though training is available and implemented, there is a need for more training on how hearing loss occurs because it occurs gradually and is not visible.

"Awareness must be an ongoing thing which must happen every time when safety talks are done on noise. What I have realised that is not like people know much about noise most of people don't know more about noise. They must know what noise is and how hearing loss occurs. It is important for them to understand that hearing loss occurs after some years. It is not like this other sickness that you will start to see them early."

And another HCP manager said:

"First lead training for the supervisors and technologist must be done. They need to be trained on what is actually noise, how people lose hearing and emphasis actually on what they should do."

Timmins and Granger (2010) report that greater awareness is needed on how hearing loss occurs. That is, people need to understand that it can begin gradually and accumulate over extended periods of time. Mizan et al. (2014) reveal that, although companies provide training to workers on noise control and prevention, the quality of this training could be improved and should be properly evaluated. Kulkarn (2015) study reviewing the effects, monitoring and control of noise pollution reported that there is a need for public enlightenment and improvement on education emphasising on the hazards, dangers and human problems associated with noise pollution.

Sub-theme 4.3: Recommendations to employees following NIHL

The HCP managers and participants revealed that part of the recommendations following NIHL diagnosis depending on the extent of the illness, was redeployment

from underground to a noise-free work area. This is supported by the following extracts:

One participant said: *"I am now working as a change house attendant and I only stopped operating the winch machine underground the previous year when they moved me from underground. Where I'm working now there is no noise but because of the hearing problem, even after they have changed me I still cannot hear well."*

An HCP manager participant added by saying:

"The investigation committee (occupational hygiene, safety officer, occupational medical practitioner, the representative from the supplier of hearing protective devices and union representatives), we investigate the person with the hearing loss and make recommendations. The recommendations are made based on the results of the audiometry test, the specifications from the mine health and safety acts and depending on the extent of hearing loss we move them to noise free areas such as change house where they do laundry."

In support of this study, Occupational Health in the Gold sector (2013) indicates that employees diagnosed with early NIHL should receive counselling and, where possible, they may be redeployed. The South African National Standards (SANS) (2013) outline that, in case of identification of hearing loss, advanced intervention measures such as hearing investigations must be taken by the employer to prevent permanent hearing loss. The Code of Practice (DME, 200) outlines that hearing impaired employees should be redeployed to noise free zones.

4.3 DISCUSSION OF FIELD NOTES

Field notes are generally written notations about what the researcher observes during data collection, which are included during data analysis (De Vos et al., 2011). The researcher may include observations, what was heard, seen or said and the experiences as narrated by the researcher (Streubert-Speziale & Carpenter, 2011). In this study, field notes assisted the researcher to capture the non-verbal cues as well as facial expressions. The following were observed during data collection:

Nodding, Jaa they give us different earplugs like noise bans and earplugs, you cannot operate machine without hearing protection. Should the supervisors or safety officers find you working without protecting your ears they will stop you and take you to the office, they are very strict."

"Hee (changing facial expression and moving forward) *I think my ears were damaged by the work that I was doing because I was operating the machine before they change me from underground two years ago. There was lot of noise there and operated the machine for many years. Even now I cannot hear well."* The researcher had to repeat herself several times.

The researcher also observed that participants were relaxed and comfortable during the interviews. Only one interview was disturbed even though there was a 'do not disturb' sign hung on the door.

4.4 CHAPTER SUMMARY

In this study, themes and subthemes were developed from the data analysis. The sub-themes were literature controlled and found to be supported by the literature.

Theme 1: Expiriences and challenges faced by employees in the work enviroment; the existence of excessive noise in the work enviroment, implementation of the 6 months audiometric test and poor maintanace of the faulty equipments was identified as the contributory factors.

Theme 2: Noise hazards and the health of employees; the study revealed that the presence of excessive noise is a heath hazard that contributed to NIHL, the use of different machinery and blasting was indentified as sources of noise and the employee's belief that noise is normal and difficult to control.

Theme 3: The hearing protective device factors; the participants were concerned that the custom made hearing protective devices were introduced late when their hearing

was already affected, they HCP managers were worried that there was poor adherence by some employees with the use of HPDs and the long period of replacement of damaged custom made hearing protective devices was identified as a challenge.

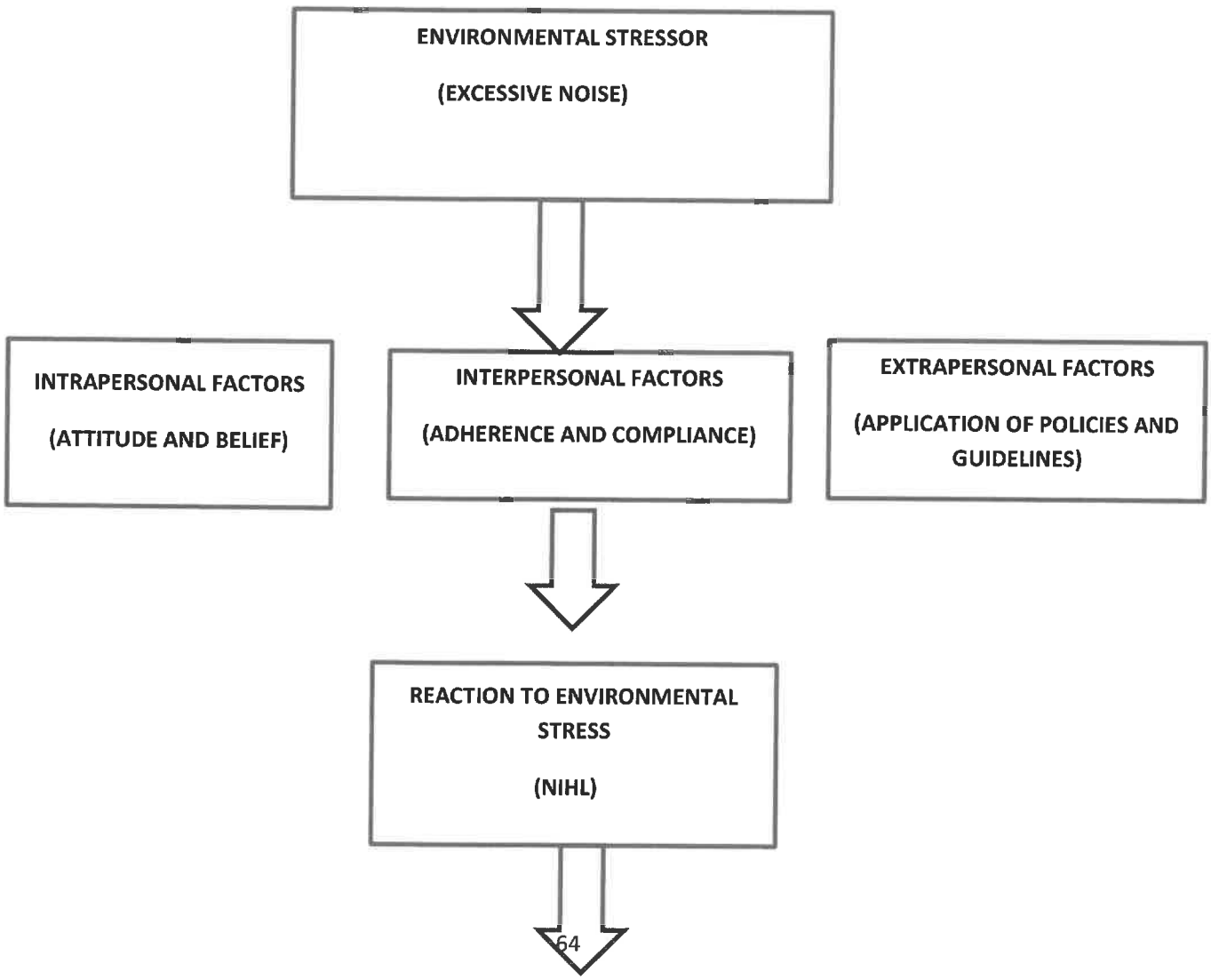
Theme 4: Management and leadership factors; the study revealed that there are policies, guidelines and reguolations are available but there are shortcomings in the implementations of some elements, currently there is training provided on noise control and prevention but the HCP managers suggested that the need for improvement in the training to be more detailed and it was also revealed that the affected employees were redeployed to noise freee areas. The next chapter will present the application of theory in relation to the findings.

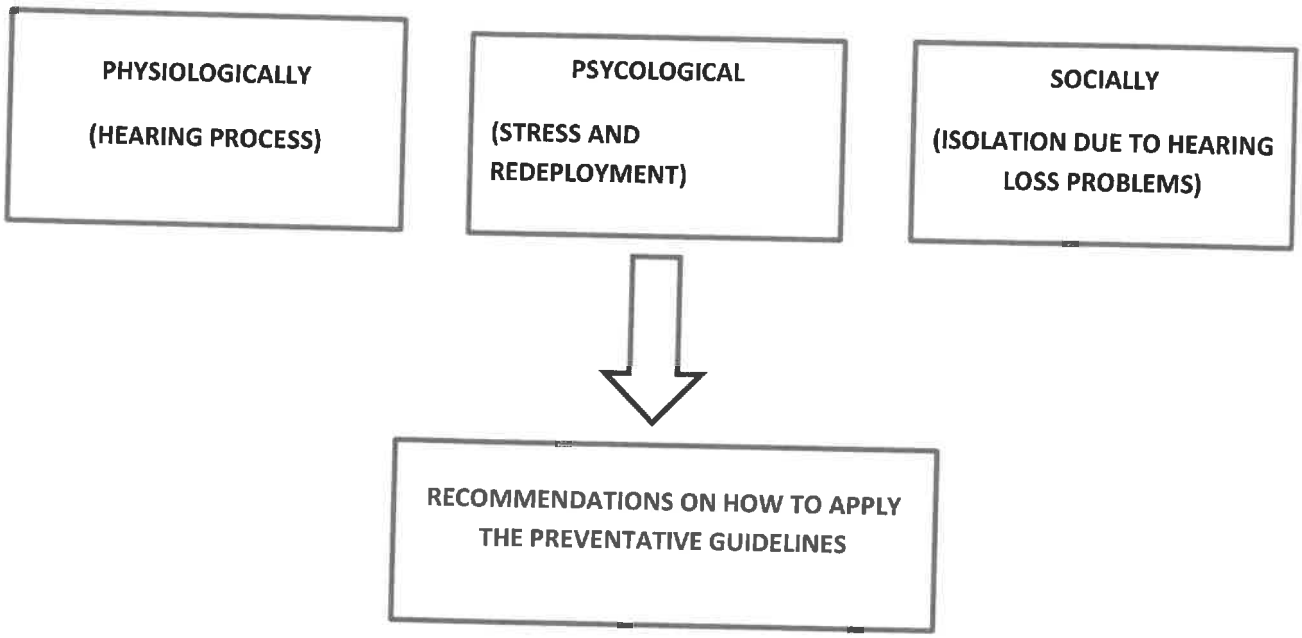
CHAPTER 5:
APPLICATION OF THE THEORY IN LINE WITH THE FINDINGS PRESENTED IN CHAPTER 4

5.1 INTRODUCTION

In this chapter, the findings of the research study in relation to the theory are presented. Betty Neuman's theory focuses on the client system in relation to the environmental stressors and the reaction to stressors (Lowry, 2011). The theory was designed to guide nurses to properly asses the effects of environmental stressors and to develop interventions to prevent or reduce the stressor to the client system (Miyerkules, 2012).

Figure 2: Schematic representation of the relationship between theories and findings of this study





5.2 ENVIROMENTAL STRESSOR IN RELATION TO NIHL

The findings of this study identified the existence of excessive noise above the legislated level in South Africa of 85 dB, at the Bokoni Platinum mine as the main environmental stressor. Exposure to excessive noise has negative effects on the hearing process of the employees, with the end result of gradually developing NIHL. The participants affected by NIHL revealed that they are currently experiencing hearing problems as a result of their exposure to a noisy environment for some years.

This was reflected in the following quote from Sub-theme 1.1: The existence of noise hazards. "*I think the reason why I cannot hear well is because of the noise from the machines. I've been working underground for a long time. I also think it is their time not to hear well (the ears) [you see am getting old]. Most of the people with hearing problem are us the old ones, the younger ones do not have these problems. I think is also because years ago when we started to work the mines did not have hearing protective devices.*"

The findings are in agreement with Betty Neuman's theory that outlined that environmental stressors have the potential to disturb a person's equilibrium or normal line of defence with regards to development and maintenance of health (Leddy &

Pepper, 1998). The theory further indicates that within each environmental stressor there are intrapersonal, interpersonal and extrapersonal factors that can alter a person's wellbeing (Leddy & Pepper, 1998).

5.2.1 The intrapersonal contributory factors

In theme number two, data revealed that there are intrapersonal factors that might have contributed to NIHL amongst employees at the Bokoni Platinum mine. Although the employees displayed knowledge related to sources and prevention of NIHL, they seem to be of the belief that noise is difficult to control. They further revealed that they had been exposed to this excessive noise for a long time and it now appeared to have formed part of their daily working life. The findings are supported by the following statement from one of the participants under Sub-theme 2.3: Employees perception about noise: "*Here in the mine there is a lot of noise from the machines that we are using, so it is not possible that you can prevent this noise, this noise has been there for long time since I started to work in the mine even now it is still there.*"

The findings are in agreement with the Betty Neuman theory, which views an intrapersonal factor as something occurring within a person. Azman et al. (2011) outlined that the belief that noise that they already have poor hearing, might reduce their commitment to the control and prevention of NIHL.

5.2.2 Interpersonal contributory factors

Theme three of this study revealed that compliance and adherence to the use of hearing protective devices by some of the employees was a serious challenge to both employee and the employer. The employees and HCP managers revealed that even though the mine has strategies and discipline in place to monitor and discipline non-compliant employees, adherence is still a serious challenge in the control and prevention of NIHL. This is reflected in the following quote in Sub-theme 3.2: Knowledge and adherence: "*What I have realised is that the employees remove the ear plugs when they are busy working, when they see safety officers or someone from the management they wear them and remove them when they leave.*" These findings concur with Neuman's theory, which outlines that the interpersonal factors occur between individuals (Leddy & Pepper, 1998).

5.2.3 Extra-personal contributory factors

Data in theme one and four revealed that there are shortcomings in the application of some elements of the available guidelines, policies and procedures such as: conducting the proposed six month audiometric tests for high risk occupations and proper maintenance and repair of faulty or worn out equipment.

The following quote in Sub-theme 1.3: Maintenance and repair of faulty equipment supports the above statement: *"I'm now working in change house where there is no noise. Only if the washing machine is not in good condition that's when there is noise. This happens most of the time and they give us ear plugs so we can use when the machine start to make noise."*

The findings are in agreement with the theory that describes extra personal factors as something occurring outside the person. It is something that the client has no control over but can be controlled by external stakeholders (Miyerkules, 2012).

5.3 REACTION TO ENVIROMENTAL STRESS (NOISE-INDUCED HEARING LOSS)

The Betty Neuman theory views a person as a holistic system influenced by environmental stressors. The theory further indicates the effect of environmental stressors and the reaction to these stressors on the development and maintenance of health (Leddy & Pepper, 1998). Neuman emphasises the relationship between the three stressors as they interact with each other to complete the holistic system of a human being. Failure to adhere to one or more of the three stressors is likely to alter the system's stability and diminish health (Miyerkules, 2012). Neuman further outlines that, once the system reacts to the stressor, there are other health consequences that might occur physiologically, psychologically and socially.

Data revealed that that there are shortcomings in the application of the three stressors which were found within and between the employees and also within the management (see 5.1.1 for details). In this case, data revealed that the hearing conservation managers failed to enforce the application of the proposed guidelines and procedures, such as the implementation of the 6 months audiometric test for early detection of

NIHL in high risk jobs and proper service and repair of malfunctioning machines. As a result, the hearing process of the employees was gradually affected, resulting in the development of NIHL.

Furthermore, NIHL had other health implications on the affected employees, such as the inability to hear well and redeployment to noise free work areas. This is reflected in the following quote in Sub-theme 4.3: Recommendations to employees following NIHL: "*I am now working as a change house attendant and I only stopped operating the winch machine underground the previous year when they moved me from underground because of the hearing problem.*"

It is clear from the extract that NIHL does not only have implications for the health of employees, but also psychological, socialisation and work-related effects, such as safety.

5.4 DEVELOPMENT OF RECOMENDATIONS FOR APPLICATION OF PREVENTATIVE GUIDELINES IN RELATION TO THEORY

The Betty Neuman theory is useful in nursing, since it emphasises responsibility on nurses to develop preventative interventions at the primary level, secondary level and tertiary level (Lowry, 2011).

5.4.1 Primary prevention level

The Neuman theory outlines the primary level as crucial because the reaction has not yet occurred, but the degree of risk is known (Lowry, 2011). The study results revealed that the mine has the Hearing Conservation Programme that co-ordinates activities associated with noise exposure control and prevention of NIHL. Data revealed that primarily the mine is doing risk assessment and occupational hygiene monitoring, noise control engineering, provision of personal protective clothing and conduction of audiogram screening tests, buying machines with noise silencers, reduction of exposure time, and education and training on employment. These were conducted daily during briefing meetings and annually.

However, it was also revealed that even though there are policies and procedures in place for implementation of this level of prevention, there is a need for improvement in relation to the content of the training. Such improvements should include the hearing loss process and its effect on the employees. Reddy et al. (2012) recommended that training needs to go further and stimulate thinking about why hearing is precious and how it would affect the different aspects of a worker's life.

5.4.2 Secondary prevention level

The Neuman theory describes the secondary level as a focus on strengthening internal lines of resistance, reducing the reaction to a stressor and increasing resistance factors (Lowry, 2011). Data revealed that secondarily, the mine is replacing noisy machines with silent ones, that there is continuous monitoring and medical surveillance of employees (annually and when they leave the company), there is availability of safety officers on site to train and supervise compliance with safety standards, there is investigation of hearing loss at an early stage, from a PLH shift of 5%, and referral of employees with a percentage of hearing loss shift above 10% to an audiologist for further tests.

There were shortcomings identified in the implementation of some elements in this level (see 5.2 paragraph 2). There is a need for proper implementation of rules and regulations as one of the important strategies to overcome the burden of NIHL (Kulkarn, 2015). This includes, adaption to the SANS changes in terms of the PLH shift; according to the new changes the hearing investigation should take place when there is shift of 3.2%. This might help in the early intervention and prevention of further hearing loss (Meyer, 2014).

5.4.3 Tertiary level of prevention

Betty Neuman describes tertiary prevention as the level of offering support to the patient, and attempting to add energy to the system in order to facilitate reconstitution (Lowry. 2011). Data revealed that, at this level, the mine is re-engineering the work environment, re-training affected employees on the use of HPDs, referring employees with PHL above 10% to the audiologist, and redeploying employees to noise-free work areas.

To offer support and follow-up to the affected employees, it is recommended that attention be focused on the need for evaluation of HCP with regards to the special needs of hearing impaired workers (Morata, Themann, Randolf, Verbsky, Byrne & Reeves, 2005).

5.5 CHAPTER SUMMARY

In this chapter the Neuman theory was applied to better understand the factors that contribute to NIHL. The theory also guided the study in the development of the recommendations for application of the guidelines and policies in order to strengthen the employees hearing system. The Neuman theory can also be utilised to guide nurses to properly assess the stressors and how these stressors interact with each other and to treat patients holistically by applying and implementing all levels of prevention. By adopting this preventative theory, nursing as a caring profession could protect the mining employees from the burden

CHAPTER 6:
SUMMARY, RECOMMENDATIONS, LIMITATIONS AND CONCLUSION

6.1 INTRODUCTION

The results of chapter 4 pointed to a combination of different factors that contribute to NIHL amongst the Bokoni Platinum mine employees in the Sekhukhune District of the Limpopo Province, South Africa. This chapter presents a summary of the research report, limitations of this study, the conclusions that were drawn from the research findings and the themes and sub-themes in Chapter 4 are formulated. The recommendations are given to enable mines and the relevant stakeholders, to revise the application, implementation and evaluation of all the elements available in the legislations, guidelines, and Hearing Conservation Programmes for noise control and the prevention of NIHL.

6.2 RESTATEMENT OF THE PROBLEM

Despite the guidelines and preventative measures that were issued by the DME in 2003 to guide all mines on occupational health noise control, 18 employees in (2009), 28 in (2010), 29 in (2012) and 37 in (2013) out of 4230 employees of the Bokoni Platinum mine were diagnosed with NIHL respectively (Bokoni Annual Medical Report, 2009/2010/2012/2013). All these employees were exposed to noise on a daily basis as they carried their duties. This shows an increase in the number of employees diagnosed with NIHL in this mine over this period. It would seem that there are underlying factors that contribute to this problem. This study, therefore, sought to investigate factors that contribute to the observed increase in NIHL incidences in the Bokoni Platinum mine, in the Sekhukhune district, Limpopo Province, South Africa.

6.3 RESTATEMENT OF THE OBJECTIVES

The objectives of this study were:

- To explore the factors that contributes to NIHL at the Bokoni Platinum mine.

- To describe the factors that contributes to NHIL at the Bokoni Platinum mine.
- To make recommendations to address the factors contributing to NIHL at the Bokoni Platinum mine based on the findings of the research study.

6.4 SUMMARY OF THE MAIN FINDINGS

The findings of the study are based on the following four themes:

Theme 1: Experiences and challenges faced by employees in the work environment

The study revealed that employees were faced with different challenges in their work environment. These challenges included the existence of noise hazards, implementation of screening tests and maintenance and repair of faulty equipment. Such challenges were perceived to be some of the contributory factors to NIHL at the Bokoni Platinum mine.

The existence of excessive noise in the work environment was perceived as one of the main contributing factors. This was evidenced by participants indicating that exposure to noise from different machines, such as drillers, winch machines and from the fans, in their daily working environment might have contributed to their current hearing problems. These findings are in agreement with those of Edwards et al. (2011), who identified noise exposure as a wide-spread problem in the mining sector, due to the use of heavy equipment, drilling, rock breaking, transferring, sorting and milling of rocks, as well as a confined working environment.

Implementation of the audiometric screening tests, pre-employment, periodically and on exit, were identified as a positive initiative conducted by the mine to monitor the hearing status of employees, as indicated in the OHS Act no 85 of 1993. Although the HCP managers indicated that one of the initiatives was to conduct six monthly audiometric tests on all employees in high risk occupations, the implementation of this initiative appeared to be a challenge. None of the participants working in those high risk occupations, such as rock drillers and winch operators, indicated that those tests were being conducted. They mentioned, instead, that audiometric tests are done once a year when they come back from leave. Conducting regular ear tests for the highly

exposed employees is important for early identification of auditory damage and prevention of permanent hearing loss. Thus, more frequent audiometric testing (e.g. every six months) may be needed if exposures are equal to or greater than 100 dB (SANS, 2013).

Participants in this study associated their current hearing status with poor maintenance and repair of faulty equipment. They indicated that that there is work areas were the noise is minimal, below 85 dB, like change house; however, due to recurrent malfunctioning of machines these areas end up being noisy. They also mentioned that the pipes in the cage (lift), which transports them underground, emits a lot of noise if they are not functional.

Theme 2: Noise hazards and the health of employees

The present study revealed that excessive noise in different work environments is a health hazard and that a number of employees had acquired NIHL. This affected their safety and how they relate to other people, due to poor communication. This was evidenced by some of the participants indicating their inability to hear properly during the interview process by repeating words, such as "Hee", resulting in the need for the researcher to repeat questions several times. Excessive noise exposure can lead to permanent hearing loss and poor verbal communication, which leads to social isolation and disruption of the lives of those directly impacted, as well as their families, friends, and co-workers (Edwards & Kritzinger, 2012).

The participants had insight and knowledge related to the sources of noise. They identified sources of noise, such as different machinery, blasting and fans, as some of the major sources of noise. A study conducted by Nthlaikana (2014) reported that participants displayed knowledge about the sources of noise. The rock drill, winch, loco machines, compressors and ventilation fans were identified as the main sources of noise (Nthlaikana, 2014).

The current study revealed that participants seemed to view noise as normal and as something that cannot be preventable. Azman, Randolf and Hundak (2011) reported the belief that noise control is difficult, and that the perception of workers' that they are used to noise might reduce their commitment and compliance to noise control and preventative measures.

Theme 3: The hearing protective device factors

The hearing protective device factors identified in this study were: availability and quality of hearing devices, knowledge of and adherence to regulations and guidelines, and the replacement process of the HPDs. The participants acknowledged that presently the mine provides them with custom made HPDs. According to their experience, these HPDs are more effective in terms of protecting their ears than the previous ones, which were ear plugs. However, the affected participants were concerned that the custom made devices (Noise X) were introduced too late, once their hearing had already been affected. They believed that if the custom made HPDs were introduced earlier, their hearing status would have been better.

The current study revealed that participants had knowledge about the importance and use of HPDs. The HCP managers raised the concern that, even though employees were aware of the importance of the use of HPDs, adherence was poor. It was revealed that some employees only use them if they see safety officers and managers. A study done by Musiba (2015) on the prevalence of NIHL among Tanzanian miners also found that, although the employees were provided with different HPDs, compliance was poor.

The quality and replacement of damaged HDPs (custom made) was identified as a problematic process that took long (more than a month). It was also revealed that these HPDs were easily damaged. Timmins and Granger (2010) reported that some of the HPDs used by workers got damaged due to misuse and being worn out.

Theme 4: Management and leadership factors

The present study revealed that enforcement and implementation of policies, guidelines and regulations; precautions taken to minimise noise hazards; educational health programmes for noise control and recommendations to employees following NIHL; are some of the factors affecting leadership and management.

Although there were policies, guidelines and regulations available, the current study revealed shortcomings in the implementation of some elements. These included, conducting the proposed six month audiometric tests for high risk jobs, and the proper maintenance and repair of faulty or worn out equipment. In India a study done by

Kulkarn (2015) reviewing the effects, monitoring and control of noise pollution identified the need for proper implementation of rules and regulations as one of the important strategies to overcome the burden of NIHL.

The present study revealed that training on the use and maintenance of HPDs and other health and safety issues was facilitated by the accredited training facility and the relevant medical personnel in the training centre and in the clinic upon commencement of employment, annually and daily in different departments. HCP managers also indicated that one of the methods used to train employees during hearing loss investigations by the HCP committee, was re-training of the affected employees on the importance and use of HPDs.

However, the HCP managers suggested that the content of training should be more detailed and should include how hearing loss occurs; employees should be made to understand that it occurs gradually and is not reversible. It was further suggested that it will be more effective if this process starts from top management and feeds down to the employees in the lower level. In agreement with these findings, Reddy et al. (2012) underline that training must be intense and stimulate an understanding that hearing is precious and a loss of hearing can affect different aspects of the life of employees. In addition, there is a need for public enlightenment, education and sensitisation on the hazards, dangers and human health problems associated with noise pollution (Kulkarn, 2015).

This study indicated that redeployment of employees with NIHL to noise-free work areas was done based on the severity and according to the available guidelines and standards. Such noise-free areas include the change house where the noise level is below 85 dB. However, due to recurrent malfunctioning of the washing machines, employees in this areas end up being exposed to noise above 85 dB. The guidelines (COP) (DME, 2000) state that hearing-impaired employees using hearing aids should be redeployed to noise-free zones.

6.5 RECOMMENDATIONS

The following recommendations are based on the four themes that had emerged during the one-on-one interviews with the employees and the Hearing Conservation Programme managers at the Bokoni Platinum mine.

6.5.1 Recommendations for Theme 1: Expiriences and challenges faced by employees the in work environment

The three sub-themes that emerged from this theme are: the existence of noise hazards, implementation of screening tests, and maintenance and repair of faulty equipment.

6.5.1.1 Recommendations to management and practice

- The Hearing Conservation Programme is the main domain which co-ordinates actives to control and prevent NIHL in this mine. Therefore, the HCP managers must constantly monitor and review the effectiveness of all the elements in this programme. This might help to identify gaps in the implementation of this programme. Failure of the implementation of one element has an affect on the effectiveness of the whole programme. It is necessary to identify, standardise, and apply effective and efficient programs for the prevention and control of NIHL.

6.5.1.2 Recommendations for education and training

- In-service training for both the employees and management on the maintenance and repair of machines might encourage them to immediately report to the relevant department when they observe malfunctioning machines.

6.5.1.3 Recommendations to research

- Further research should be undertaken on the experiences and challenges faced by employees on noise control and prevention in the mining industry.

6.5.2 Recommendations for Theme 2: Noise hazards and the health of employees

Recommendations on this theme have emerged from three sub-themes: Hearing loss acquired in the line of duty, knowledge related to the sources of noise, and prevention of NIHL.

6.5.2.1 Recommendations to management and practice

It is recommended that there should be thorough explanation of the baseline audiogram results to all employees upon commencement of employment as they are used as a reference for subsequent tests. The information given should be specific, should emphasise the specific noise hazards in different occupations, and should include the methods employed to control these hazards.

6.5.2.2 Recommendations on education and training

- Occupational NIHL is a major cause of disability throughout the world. Therefore, public awareness campaigns; which addresses what noise is, risk factors, long term effects (physiological, social, psychological and economical), available preventive services and potential treatments, might assist to overcome the barrier of attitudes and beliefs (Ware, 2014).

- There is a need for the training department to introduce a risk/hazard-based training programme. This might equip the employees with specific different hazards in the work environment, depending on their occupation and adaptation of measures, to prevent NIHL in those areas.

6.5.2.3 Recommendations to research

- Further research should be undertaken to develop more strategies to minimise excessive noise in the mines.

6.5.3 Recommendations for Theme 3: The hearing protective device factors

Recommendations related to this theme were based on the following three sub-themes, which emerged from during data collection: Availability and quality, knowledge and adherence, and replacement process.

6.5.3.1 Recommendations to management and practice

- More emphasis should be placed on adherence to the use of HPDs by encouraging the employees to take ownership of their health by involving them during training, meetings and in the clinic during medical examinations. This could be achieved thorough explanation of their baseline audiogram results as they are used as a reference for subsequent tests. However, the information given should be specific, should emphasise the specific noise hazards in different occupations and the methods employed to control these hazards.

6.5.3.2 Recommendations to education and training

- The educational programme provided on the use of HPDs needs to go further than the fact that HPDs help to protect hearing. It should also emphasise the fact that hearing is precious and how hearing loss would affect different aspects of the employees' life.

6.5.3.3 Recommendations to research

- Further research should be conducted on the causes of non-adherence to the use of HPDs. The results could possibly improve the current challenges faced with non-compliance.

6.5.4 Recommendations for Theme 4: Management and leadership factors

The recommendations from this theme were made based on the following sub-themes: enforcement and implementation of policies, guidelines and regulations, precautions taken to minimise noise hazards, educational health programmes for noise control, and recommendations to employees following NIHL.

6.5.4.1 Recommendations to management and practice

- The mine management should develop strategies to evaluate and monitor whether the available procedures, guidelines and policies are well implemented. Ware (2014) suggested that adequate policy support structure and effectual leadership may overcome the challenge of poor implementation of guidelines.

- The HCP should be integrated with the rehabilitation of the employees affected by NIHL to adopt coping strategies as they experience many challenges. This could be achieved by providing accessible follow-up services to identify and address the challenges they are facing daily and how they are coping.

6.5.4.2 Recommendations to education and training

- Revision of the available content of the training programme for the employees at all levels, and more awareness campaigns on noise (what is noise, long term effects and the available preventative measures) should be implemented. This may help the employees to change their attitude and perception that noise is normal and part of working life.

- Employees with NIHL should be encouraged to form support groups to share their experiences and their coping strategies.

6.5.4.3 Recommendations to research

- Further research should be undertaken to develop strategies to address the needs of hearing-impaired employees. These should be included in the HCP programme, which may help to protect the remaining hearing.

- Further research should be undertaken on the shortcomings to effective application and implementation of the acts, guidelines, policies and procedures and should include the development of strategies to overcome any shortcomings.

6.6 LIMITATIONS OF THE STUDY

The study was conducted at the Bokoni Platinum mine in the Sekhukhune District, Limpopo Province, South Africa. Therefore, the findings of this study cannot be generalised to other Platinum mines in this Province or in the country. The study was conducted on a smaller scale.

6.7 CONCLUSION

The results of this study indicated that noise-induced hearing loss was caused by a combination of different contributory factors. Failure to apply the guidelines, policies and procedures from the Department of Minerals and Energy in full resulted in employees developing noise-induced hearing loss. Employees also reported that the employer takes time to repair broken hearing protective devices

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APPENDICES

Appendix A: Interview guide

Part 1: Demographic information

1. Age

18-28	1
29-38	2
39-48	3
49-58	4
59-65	5

2. Highest level of education

Never went to school	1
Primary school	2
High school	3
College	4
University	5

3. Occupation

Occupational hygienist	1
Shift boss	2
Team leader	3
Stopper	4
Driller	5
Mechanical	6
Miner	7
Shift boss	8
Loco driver	9
Winch operator	10
Other(specify)	11

4. Number of years employed

0-5	1
6-15	2
16-25	3
26-35	4
36- 45	5
46 and more	6

5. Number of decibel exposed to

85 and below	1
85-95	2
96-105	3
106 and above	4

6. Previous employment

Administrative	1
Electrical	2
Driving	3
Security	4
Plumber	5
Mechanical	6
Mining	7
Other (specify)	8

7. Pre-placement baseline PLH (Percentage of hearing loss)

0.1 to 5%	1
5 to 10%	2
10 to 20%	3
Other (specify)	4

Part 2: **Interview guide**

1. What do you think could have contributed to NIHL?

2. Describe the preventative measures for noise exposure at your work place?

3. Describe the programmes available at your workplace to address issues concerning NIHL?

4. What do you think can be done to prevent a continuous increase of NIHL at your work place?

Appendix B: Ethical clearance certificate from MREC

UNIVERSITY OF LIMPOPO
Medunsa Campus

MEDUNSA RESEARCH & ETHICS COMMITTEE

CLEARANCE CERTIFICATE

MEETING:	**08/2014**
PROJECT NUMBER:	**MREC/HS/292/2014: PG**
PROJECT:	
Title:	Factors that contribute to noise induced hearing loss amongst employees at the Bokoni Platinum Mine in the Sekhukhune district of the Limpopo province, South Africa.
Researcher:	Mrs I Muthelo
Supervisor:	Prof Malema
Co-supervisor:	Dr TM Mothiba
Department:	Nursing & Human Nutrition
Degree:	Masters of Nursing Science

DECISION OF THE COMMITTEE:

MREC approved the project.

DATE: 02 October 2014

UNIVERSITY OF LIMPOPO
Medunsa Campus
2014 -10- 02
MEDUNSA RESEARCH ETHICS COMMITTEE
MREC CHAIRPERSON

DR C BAKER
DEPUTY CHAIRPERSON MREC

The Medunsa Research Ethics Committee (MREC) for Health Research is registered with the US Department of Health and Human Services as an International Organisation (**IORG0004319**), as an Institutional Review Board (**IRB00005122**), and functions under a Federal Wide Assurance (**FWA00009419**)
Expiry date: **11 October 2016**

Note:
i) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.**
ii) **The budget for the research will be considered separately from the protocol.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

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PROUDLY SOUTH AFRICAN

Appendix C: Permission Letter

Date : **24/11/2014**

To: Univercity of Limpopo – Ethics Research Council
Re: Livhuwani Muthelo

From: SHE Manager Bokoni Platinum Mines

Study/ Research at Bokoni Mines

The application for an opportunity to do research at Bokoni Platinum Mines with regards to Hearing Conservation:

We do not have any objection with the study you require to conduct
However it must be noted that the information is related to health and the necessary confidentiality requirement need to be observed.
Requested that this study/ research also be done so that the Mine will also benefit from such study in particular in terms of our continuous improvement program to our goal of reaching Zero harm

Regards

Pierre Labuschagne
SHE Manager
015 -620-0106

Appendix D: Consent form (English)

UNIVERSITY OF LIMPOPO (Turfloop Campus) ENGLISH CONSENT FORM

Statement concerning participation in a Research Project*.

Name of Study: Factors that contribute to noise induced hearing loss amongst employees at the Bokoni Platinum mine in the Sekhukhune district of the Limpopo Province, South Africa.

I have read the information and heard the aims and objectives of the proposed study and was provided the opportunity to ask questions and given adequate time to rethink the issue. The aim and objectives of the study are sufficiently clear to me. I have not been pressurized to participate in any way.

I know that sound recordings will be taken of me. I am aware that this material may be used in scientific publications which will be electronically available throughout the world. I consent to this provided that my name is not revealed.

I understand that participation in this Study is completely voluntary and that I may withdraw from it at any time and without supplying reasons.

I know that this Study has been approved by the Medunsa Research Ethics Committee (MREC), University of Limpopo. I am fully aware that the results of this Study will be used for scientific purposes and may be published. I agree to this, provided my privacy is guaranteed.

I hereby give consent to participate in this Study.

.....	.....	.....
Name of employee	Signature of employee	Witness
.....	.....	
Place.	Date.	

Statement by the Researcher

I provided verbal and/or written* information regarding this Study / Project*
I agree to answer any future questions concerning the Study / Project* as best as I am able.
I will adhere to the approved protocol.

L.Muthelo.....	.....	.....	.....
Name of Researcher	Signature	Date	Place

Appendix E: Consent form (Sepedi)

UNIVERSITY OF LIMPOPO (Turfloop Campus) SEPEDI CONSENT FORM

Setatamente mabapi le go tšea karolo ka go ya Dinyakišišo.

Leina la Dinyakišišo: Bokoni Platinum mine mo Distriking ya Sekhukhune, provinseng ya Limpopo.

Ke kwele ka ga tshedimošo mabapi le maikemišetšo le morero wa dinyakišišo tšeo di šišintšwego gomme ke ile ka fiwa monyetla wa go botšiša dipotšišo gomme ka fiwa nako yeo e lekanego gore ke naganišiše ka ga taba ye. Ke tloga ke kwešiša maikemišetšo le morero wa dinyakišišo tše gabotse. Ga se ka gapeletšwa go kgatha tema ka tsela efe goba efe.

Ke a kwešiša gore go kgatha tema Dinyakišišong tše ke ga boithaopo gomme nka tlogela go kgatha tema nakong efe goba efe ntle le gore ke fe mabaka.

Ke a tseba gore Dinyakišišo tše di dumeletšwe ke Medunsa Research Ethics Committee (MREC), Yunibesithi ya Limpopo (Khamphase ya Turfloop) .Ke tseba gabotse gore dipoelo tša Dinyakišišo tše di tla dirišetšwa merero ya saense gomme di ka phatlalatšwa. Ke dumelelana le se, ge fela bosephiri bja ka bo ka tiišetšwa.

Mo ke fa tumelelo ya go kgatha tema Dinyakišišong.

Leina la moithaopi	Lefelo.	Tlhatse	Letšatšikgwedi.
.....	.....	.....	.....

Setatamente ka Monyakišiši

Ke fana ka tshedimošo ka molomo le/goba yeo e ngwadilwego mabapi le Dinyakišišo tse Ke dumela go araba dipotšišo dife goba dife tša ka moso mabapi le Dinyakišišo ka bokgoni ka moo nka kgonago ka gona.

Ke tla latela melao yeo e dumeletšwego.

L Muthelo.....	.....	.....	.....
Leina la Monyakišiši	Mosaeno	Letšatšikgwedi	Lefelo

Appendix F: Consent form (Xhosa)

UNIVERSITY OF LIMPOPO(Turfloop Campus) XHOSA CONSENT FORM

Ingxelo malunga nokuthatha inxaxheba kwi Research Project

Igama lesifundo: Izinto ezidlala indima enkulu ekuphulukeni kokuva ngendlebe kubasebenzi base bokoni platinum mines e Sikhukhune district kwiphondo lase Limpopo, emzantsi Africa

Ndiyifundile imininingwane nencazelo ndayiva nenjongo yayo ibithiwe thaca phambi kwam, ndiye ndanikwa nethuba lokuba ndibuze imibuzo ndanikwa nexesha elaneleyo lokucinga ndicingisise ngalomba.Injongo ngezizifundo zicace ngokuthe vetshe kum.Andikhange ndinyanzeliswe ukuba mandibeyinxalenye yalomsebenzi nageyiphi na indlela.

Ndiyazi ukuba ingxelo ngedlela endive ngayo zizakuthathwa kum.Ndiyazi nokuba Lo material ingasentyenziswa kusasaso oluyakushicilelwa kumacwecwe lufumaneke kwizwe lonke Jikelele. Ndikuvuma okuba Igamalam alisokuze livezwe.

Ndiyakuzwisisa ukuba ukuthatha kwam inxaxheba kwezizifundo kungokuthanda kwam kwaye ndingaziyeka nangeliphina ithuba ngaphandle kokunikezela izizizathu zokuyeka .

Ndiyazi ezizifundo ziye zangqinwa ngabe Medunsa Research Ethics Committee(MREC) kumaziko emfundo ephakamileyo kwiPhondo Lase Limpopo.Ndazi ngokupheleleyo ukuba iziphumo zezizifundo ziyakusetyenzisa kokwenjongo se Sience kwaye singahle zisasazwe .Ndiyavumelana noku ,ukubana niyaqinisekisa incukacha ngam azinakuvezwa.

Ndiyavuma ukuba ndizothata inxaxheba kwezizifundo.

....

Igama lomfundi Signiture Yomfundi.

....

INdawo Usuku Ingqina

Ndinikezela ngokuthetha/ngokubhaliweyo * imininingwane malunga nezizifundo.

Ndiyangqina ukuphendula neyiphina imibuzo eyokuthi ivele malunga nezizifundo ngokolwazi lwam.

...Muthelo L..... ....

Igama Signiture Usuku Ingqina

Appendix G: Requisition letter

6774 Sargasso Street 5

Polokwane Ext 29

0699

Managing Director

Bokoni mine

Atok

Letter of requisition to conduct a research study at the Bokoni Platinum mine

I, Livhuwani Muthelo, who is currently registered at the University of Limpopo for a Master's Programme hereby request permission to conduct research study at the Bokoni Platinum mine. The study will investigate factors that contribute to Noise Induced Hearing Loss amongst employees who work at the Bokoni Platinum mine, in the Sekhukhune district of the Limpopo Province, South Africa.

The study will not in any way cause harm to the employees or employer, but may help to improve the available measures/programmes to prevent excessive noise exposure that results in NIHL.

Please find attached an ethical clearance letter from the University of Limpopo ethical clearance committee, and the plan (proposal) on how the study will be conducted.

Regards

L. Muthelo

Appendix H: Certificate from independent coder

Qualitative data analysis

Master's degree in Nursing Science

MS L MUTHELO

THIS IS TO CERTIFY THAT:

Professor Maria Sonto Maputle has co-coded the following qualitative data:

Individual interviews and field notes

For the study:

Factors that contribute to noise induced hearing loss amongst employees at the Bokoni Platinum mine in the Sekhukhune District of the Limpopo Province, South Africa

I declare that the candidate and I have reached consensus on the major themes reflected by the data during a consensus discussion. I further declare that adequate data saturation was achieved as evidenced by repeating themes and their sub-themes.

Appendix I: Certificate from the editor

PROFESSIONAL EDITING SERVICES

EDITING CERTIFICATE

Master's Degree in Nursing Science

MS L MUTHELO

THIS IS TO CERTIFY THAT

Dr Kathrine Elizabeth Scholtz has edited the MSc thesis titled:

"Factors that contribute to noise-induced hearing loss amongst employees at the Bokoni Platinum mine in the Sekhukhune District of the Limpopo Province, South Africa"

K Scholtz

Dr KE Scholtz

Appendix J: Interview transcripts with one of the participants

Researcher = R

Hearing conservation programme Manager = HCM Participant

R = What do you think are the contributory factors of NIHL in this mine?

HCM Participant = In the mining industry, we are using different machinery, which most of them release a lot of sound pressure which contribute to NIHL, mostly, for example, that on the haulages we have the compressors, we have fans in the stopping, the rock drill and the winch machines.

R = What are the other contributory factors, except the machinery that you think might be the contributory factor?

HCM Participant = The other things, especially in the mining can be like the different in sound pressure levels, like the sound in the cages which transport employees to underground in Vertical shaft.

R = Can you explain further on the pressure levels?

HCM Participant = The pressure level is like when you change the BP.

R = The BP you are referring to...?

HCM Participant = The Barometric pressure (BP), when we go down with the cage the pressure inside increase the noise, when you get out you have temporary hearing loss.

R = Mmm. Do you have anything to add on the contributory factors?

HCM Participant = I think I have said it all.

R = Describe the preventative measures to prevent and control noise in your work place?

HCM Participant = For example, the compressors we don't open them the whole day, to reduce the exposure time, actually we release it during off peak hours, especially in the afternoon when there are few people underground, again on the fans we have the silencers, if it does not have silencers we buy them and do install them, on the

machines we use electricity, which is different from the one which use catalic pressure, which emit a lot of noise.

R = Can you explain more on the helt machines

HCM Participant = The helt machines are the ones using electricity, it does not make a lot of noise even though they are not that effective.

R = Can you explain when did you start using this new machinery in this mine?

HCM Participant = It was in 2005 to 2006 is then that they start introducing them. Another thing is the exposure time, those ones are the engineering controls that we have, we are trying to reduce the exposure.

R = Can you explain more on the exposure time, how are you implementing that?

HCM Participant = We have different shifts where we allow people to work less than 8 hours but even though some work more than that, that's what we are pushing so that people cannot be exposed for a long time.

R = Ok, describe the programmes available at your work place to address issues concerning NIHL

HCM Participant = We have different programme, firstly NIHL we consider it as a safety thing. We have the awareness, monthly safety topics were we discuss, with the supervisors, informing them about the importance of wearing hearing protection devices, we do have presentation, this is one of the presentation, because most of the people think like with noise you have to see blood, actually it explains how the noise affects the hearing.

R = Ok.

HCM Participant = Another with is we do hearing investigations which is part of awareness as we are actually trying to investigate the cause and make recommendations , in the investigation we have the full times, Occupational medical Practitioner and unions.

R = Can you explain more about full time, what are you referring to?

HCM Participant = Full time health and safety representatives, they do the surveys in underground to see if people are wearing hearing protection devices, if they are not wearing them, is non-conformance and that thing is actually being filled.

R = Ok, can you explain how often are the surveys being done by safety representatives?

HCM Participant = Actually is done monthly, their main work every day they make a schedule.

R = You have mentioned that you have investigation with the Occupational Medical Practioners (OMP), can you explain what is happening during this investigation?

HCM Participant = The investigation is actually based on the audiometric test, we actually bench mark from the baseline we take the difference, every year if more than 5% per cent, we start to investigate. Actually, what we are investigating we are trying to find the cause of what happened, is he working in the noisy environment and if not what are the contributory factors, is actually making us aware of what is happening in our work place and we are trying to help the employees.

R = How often are you having this investigations?

HCM Participant = Usually every Thursday

R = Describe the type of hearing devices used in this mine.

HCM Participant = We use the disposable which are in different patterns, but is it fine, can I describe them?

R = It's ok, you can describe them.

HCM Participant = Actually, they are blue and is a blue rubber, even the ear muffs and the customized ones, but we are now using customised ones because they are actually giving much protection than plastic ones and no one can wear another ones protective devices only yourself can use them.

R = How are workers trained to use the hearing protective device?

HCM Participant = We do training in different places like training centre when they do medicals, the initial, and the other one, which I forgot.

R = Which one are you referring to?

HCM Participant = The one that they do every year

R = Ok.

HCM Participant = The periodic even in the clinic on the customised hearing protective devices they train them and even when we are doing investigation if we find out that the employee does not actually know how to use them, we train them.

R = Ok, can you add more on training?

HCM Participant = That's all, I have nothing to add.

R = How are the employees supervised regarding the use of hearing protection devices in this mine?

HCM Participant = This is actually what we have on the presentation that we did to the supervisors just to actually make them aware because those are they are the people who are actually monitoring that they are wearing them, and again the safety representative's, they also try to check the compliance and even the ventilation office, when they are doing the survey, they check them.

R = I wanted to ask, as you said the ventilation and safety are doing survey, can you explain how often do they do them?

HCM Participant = Surveys are done monthly.

R = Ok, describe the procedure available in this mine to investigate noise.

HCM Participant = Every time the ventilation officer when they do surveys, they actually measure on different pattern and when we want to zone or when we want to do normal survey, we do zoning.

R= Can you explain zoning?

HCM Participant = Zoning, you find out that we have a compressor which is making a lot of noise, we are going to measure, like when you are one meter away from the machine, how much is the noise and we indicate when you are in this area you must wear hearing protection, even the individual machines like the machines we

demarcate them with signs such that when you are maybe five meters away you need to wear hearing protection and actually like every source in the mine, we demarcate.

R = Ok, you wanted to say something again under the procedure available to investigate noise, initially so said ventilation when they do survey you wanted to add there...

HCM Participant = Under the procedure used to investigate noise, what I can actually add is that there is that we do not only the ventilation officer, but also the occupational hygiene are actually the people who are monitoring the noise, this one they do measuring in different ways, like they are doing zoning, demarcating, but again, they are also doing individual monitoring.

R = Ok, can you explain further on individual monitoring?

HCM Participant = This is where actually give the person dosimeter and measure the noise for 8 hours.

R = How often are the occupational hygiene technologist doing that?

HCM Participant = They do 25% of the whole mine, we actually do that on exposure group and in different categories, the people in the developing and in the stopping are doing different jobs, stopping is another hertz. On those hertz, we measure 5% in all the shafts. From that 5%, which is eight hour monitoring, we can actually say maybe 95% is exposed to this noise.

R = How is noise practically controlled in the work environment?

HCM Participant = practically, what actually is happening is that one is managerial thing from us as occupational hygiene and ventilation from managerial part, we do engineering control, as I have explained earlier.

R = Describe the procedure available for early detection of NIHL in this mine, especially for those who are exposed to severe noise

HCM Participant = Which procedure?

R = I'm referring to the one available for early detection in this mine.

HCM Participant = We have Hearing conservation programme (HCP).

R = Can you explain more on the HCP?

HCM Participant = This the one in which we are monitoring the hearing loss, actually from the start I just said when the person come to this mine we do baseline, once the baseline is done, the person go to work for one year and we do personal monitoring using dosimeter and we do spot checking, after the spot check, we identify high noise area that's where we will give dosimeter for personal monitoring, we measure TWA

R = Can you explain what is TWA?

HCP Participant = Time waiting average, we are measuring for 8 hours, because we cannot say that this machine has lot of noise without measuring, after that we can say here people are exposed to high noise, once the person go the medical then we can see the shift using the machinery. It means he is exposed to noise, meaning there is something wrong.

R = Ok.

HCM Participant = we also check on the sources if we can engineer them, if we can't engineer them, we look at the other alternative, can we reduce the exposure time, if still there is noise, we look for alternative of giving him customised hearing protection, after that that is our HCP, from that based on the audiometric results we can make decision, like mostly our winch operators, who are exposed to high noise we check their ears six month so we can monitor them.

R = What do you think can be done to prevent continuous increase of noise at your workplace?

HCM Participant = There is a need of first lead training.

R = Can you explain more on that training?

HCM Participant = The training, like occupational hygiene and supervisors need to be trained on what is actually noise and how sound is being formed because in mostly is not actually the source is the sound from source, so that the occupational hygienist can come with hearing protection. Actually the supervisors need to be trained on what should they do.

R = kindly explain further on What else can be done?

HCM Participant = The awareness, which is actually an ongoing thing which is happening every time when we do safety talks there is noise, when we go underground there is noise because is not like people know much about noise most of people don't know, they just know is noise but does not know if I get hearing loss, what happens.

R = Ok, explain how the management is involving the employees in the initiation of policies and procedures regarding NIHL.

HCM Participant = What we actually do is we have safety campaign like road shows, in those road shows we have dramas which are performed by employees we are trying to say if they are working according to the law like with the ear test results if the person has 2% shift this year next year he remains with 2%, we give them incentives or the mine compensate.

R = Can you explain how are they compensated?

HCM Participant = They are compensated in terms of money

R = Ok.

HCM Participant = There is also Mohlabane wa Bokoni where people are introducing different songs. The better song on safety issues is the one which win.

R = Can you explain more about Mohlabane wa Bokoni, what is it all about?

HCM Participant = Is all about the care, actually they are producing different songs and the better song win R5000, it is all about caring for each other like wearing hearing protection devices.

R = Describe the procedure used in this mine to investigate and report NIHL.

HCM Participant = On the compensation, I don't know more, but during investigation, employees with a shift of a more than 10 %, we send them to the audiologist to compare. If is still more than 10%, they submit for compensation, that is actually done by OMP, to the Department of mineral and energy we report on quarterly basis on how many people did we investigate and what were the findings. The main purpose of the investigation is to find out if there is something and make recommendations.

R = Describe the training programme available in this mine regarding noise control?

HCM Participant= Training programme, like I said before, we have two. One in the training centre, which is the main one if new employee come to the mine they train them on hearing protection. If periodic, we do refresher and also in the clinic they do the general one on the sources and hearing protection.

R = Explain the policies, procedures and guidelines available in this mine regarding noise control.

HCM Participant = Policies, I explained the HCP first, we also have the COP.

R = Can you explain what is the COP?

HCM Participant = COP is the code of practice which guide us on what to do, like what are we going to do ventilation office will first detect and measure noise, again what are the managers supposed to do, and also what is the OMP is supposed to do they have to test the ear and report to occupational hygiene, occupational hygiene they do measuring, the managers are making sure that employees are wearing protective devices.

R = Do you have anything to add on the policies and guidelines?

HCM Participant = On the hearing conservation from procurement, they are not allowed to buy machines which are more than 110 dB and also from DME, they don't allow them to buy those machines.

R = Thank you very much for your participation.