THE CHARACTERISATION OF NOISE LEVELS IN VARIOUS THROUGHPUT ABATTOIRS DURING THE SLAUGHTERING OF DIFFERENT SPECIES

MAHALI AMELIA HLASA

Dissertation submitted in fulfilment of the requirements for the Degree

MAGISTER TECHNOLOGIAE

ENVIRONMENTAL HEALTH

in the

School of Agriculture and Environmental Sciences
Faculty of Health and Environmental Sciences

at the

Central University of Technology, Free State

Supervisor: **Dr Carien Weyers, D. Tech. (Environmental Health)**
Co-supervisor: **Prof C. Van Der Westhuizen, Ph.D. (Agricultural Economics)**

BLOEMFONTEIN
October 2006

DECLARATION OF INDEPENDENT WORK

I, MAHALI AMELIA HLASA, passport number RA067877 and student number 9900764, do hereby declare that this research project submitted to the Central University of Technology, Free State for the Degree MAGISTER TECHNOLOGIAE: ENVIRONMENTAL HEALTH, is my own independent work; and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State; and has not been submitted before to any institution by myself of any other person in fulfilment of the requirements for the attainment of any qualification.

_____ _____

SIGNATURE OF STUDENT DATE

SUMMARY

Occupational noise affects industries in many countries around the world, and there is strong evidence from previous research linking it to noise-induced hearing loss (NIHL). More than 30 million workers in the United States of America alone were exposed to hazardous noise at the workplace before 1998. In South Africa, workers are not supposed to be exposed to a noise rating limit at or above 85dB(A). Abattoir employees are subjected to high noise levels when compared to the occupational noise rating limit of 85dB(A). Noise is generated from various mechanised and manual processes and activities in the abattoir during the slaughter of different animal species. Noise sources include conveyers, circular saws, air conditioners and pumps, pneumatic and other mechanical equipment. The aim of this study was to characterise noise exposure in different grades of abattoirs during the slaughter of cattle and sheep. The grading of abattoirs was previously done according to Grade A-E. Grade A-C is now referred to as high throughput abattoirs while Grade D and E are referred to as low throughput abattoirs. Personal and environmental noise exposure levels of workers in Grade A, C and D abattoirs in the Free State were therefore investigated. Noise measurements were done in accordance with the methods stipulated in the South African National Standards (SANS) Code of Practice 10083. Environmental and personal sampling were conducted with a calibrated Type 1 Quest integrated sound level meter (ISLM) and a Quest noise dosimeter respectively. Calibration was checked before and after taking measurements to ensure reliability and validity of results. The average noise exposure level in the high throughput abattoirs was above the recommended standard of 85dB(A). In the low throughput abattoirs the noise exposure levels were below this level. There were no statistically significant differences between the noise exposure levels during the slaughter of different species ($P>0.05$), or between Grade A and Grade C ($P>0.05$). There was a statistically significant difference ($P<0.05$) however between Grade A and Grade D noise exposure levels. The results indicate that workers in Grade A and C abattoirs are exposed to unacceptable noise levels. Further research is recommended to include all categories of abattoirs and to determine the impact of noise exposure on the worker's hearing in order to

develop strategies to protect employees from the effects of excessive exposure to noise.

OPSOMMING

Beroepsgeraas affekteer industrië in baie lande in die wêreld, en daar is sterk bewyse vanuit vorige navorsing wat geraas geïnduseerde gehoorverlies (GIGV) hiermee verbind. Meer as 30 miljoen werkers net in die Verenigde State van Amerika is aan gevaarlike geraas in die werkplek voor 1998 blootgestel. In Suid-Afrika is werkers nie veronderstel om aan ‘n geraas-limiet van gelyk aan of bo 85dB(A) blootgestel te word nie. Abattoir werknemers word aan hoë geraasvlakke blootgestel, as dit vergelyk word met die beroepsgeraaslimiet van 85dB(A). Verskeie gemeganiseerde prosesse en aktiwiteite asook hande-arbeid in die abattoir genereer geraas tydens die slagting van verskillende dierespesies. Geraasbronne sluit vervoertoestelle, sirkulêre sae, lugreëlings en pompe, pneumatiese and ander meganiese toerusting in. Die doel van die studie was om die geraasblootstelling in verskillende deurset abattoirs gedurende die slagting van beeste en skape te bepaal. Die gradering van abattoirs is voorheen volgens Graad A-E gedoen. Graad A-C word nou as hoë deurset abattoirs verwys terwyl Graad D en E as lae deurset abattoirs verwys word. Persoonlike- en omgewingsgeraasblootstellingsvlakke van werkers in Graad A, C en D abattoirs in die Vrystaat is ondersoek. Geraasmetings is in ooreenstemming met die metodes wat in die Suid-Afrikaanse Nasionale Standaarde (SANS) gebruikskode 10083 gestipuleer word, uitgevoer. Omgewings- en persoonlike monsterneming is onderskeidelik met ‘n gekalibreerde Tipe 1 Quest geïntegreerde klankpeilmeter en ‘n Quest geraasdosismeter gedoen. Kalibrasie is voor en na die monsterneming nagegaan om die betroubaarheid en die geldigheid van die resultate te verseker. Die gemiddelde geraasblootstellingsvlak in Graad A en C abattoirs was bo die aanbevole standaard van 85dB(A). Die geraasblootstellingsvlak in Graad D abattoirs was onder hierdie vlak. Daar was geen statisties betekenisvolle verskille tussen die geraasblootstellingsvlakke gedurende die slagting van verskillende spesies ($P>0.05$) of tussen Graad A en C ($P>0.05$) nie. Daar was wel ‘n statisties betekenisvolle verskil tussen die geraasblootstellingsvlak in Graad A en Graad D. Die resultate toon dat die werkers in Graad A en C abattoirs aan onaanvaarbare geraasvlakke blootgestel is. Verdere navorsing, wat alle kategorië abattoirs insluit, word aanbeveel om die impak van geraasblootstelling op die werker se gehoor vas te stel sodat strategië ontwikkel kan word om die werknemer te beskerm teen die effekte van oormatige geraasblootstelling.

DEDICATION

This piece of work is dedicated to my son Christopher Ombasa Wani and to my husband, Napoleon Lubang Wani for the unconditional love, tireless devotion and constant support they offered me throughout the course of my studies. Without their sacrifice this dissertation would not have been possible.

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to the following:

- My father in heaven for giving me life and good health to see me through my studies;
- My husband for all the sacrifice, inspiration and support;
- My son for his understanding and support;
- My sisters for taking care of my child while I was studying;
- Dr. C Weyers for her expertise, help, and guidance;
- Prof. C Van Der Westhuizen for his expertise and guidance;
- The Innovation Fund of the Central University of Technology for granting funding for the study;
- The Government of Lesotho for financial support and encouragement;
- The abattoirs used as sampling sites during the study;
- Mrs. A Du Toit from the Library and Information Centre at the Central University of Technology Free State for her willingness to help;
- Mrs. NJ Lötter for the editorial assistance that she provided.

TABLE OF CONTENTS

CHAPTER 2

LITERATURE REVIEW

CHAPTER 3

ENVIRONMENTAL NOISE IN DIFFERENT THROUGHPUT FREE STATE ABATTOIRS DURING THE SLAUGHTER OF CATTLE AND SHEEP

CHAPTER 5

COMPARISON OF NOISE EXPOSURE LEVELS IN DIFFERENT THROUGHPUT ABATTOIRS DURING THE SLAUGHTER OF CATTLE AND SHEEP

CHAPTER 6

CONCLUSION AND REFLECTIONS OF THE STUDY

LIST OF TABLES

CHAPTER 2

CHAPTER 4

CHAPTER 5

LIST OF FIGURES

CHAPTER 2

CHAPTER 1

GENERAL INTRODUCTION

1.1 BACKGROUND

Noise is one of the most common occupational hazards and can be found in many industries (Rabinowitz, 2000). The National Institute for Occupational Safety and Health (NIOSH) confirmed in 1998 that noise-induced hearing loss (NIHL) is one of the most reported and common occupational illnesses at present (NIOSH, 1998; Toran, 2002). In 2001 there were approximately 120 million people in the world with hearing problems (Goeltzer, Hansen and Sehrndt, 2001), and many countries are currently developing guidelines to ensure that employees are protected from excessive noise in their working environment (MacMillan, 1999; World Health Organisation, 1997).

In 1997, the World Health Organisation (WHO) declared that noise is a significant threat to hearing in particular and human health in general (World Health Organisation, 1997). The noise centre at the League for the Hard of Hearing in the United States of America (USA) confirmed this in 1998 (Blanchard, 1998). The same report mentioned that continuous exposure to noise levels at or above 85dB(A) for a period of 8 hours could lead to permanent hearing loss (Blanchard, 1998; Denniston, 2000).

The South African Occupational Health and Safety Act, Act 85 of 1993, states that no employer shall allow any employee to work in an environment with an equivalent noise level equal to or exceeding 85dB(A) (South Africa, 1993; South Africa, 2003). The Noise-Induced Hearing Loss Regulations (South Africa, 2003), promulgated under this Act, stipulate that the employer shall reduce the equivalent noise level to below 85dB(A) or to levels as low as practicable. Where this is not possible, boundaries and entrances to all identified noise zones must be demarcated. The employer shall prohibit any person from entering this noise zone unless such a person is wearing hearing protectors (South Africa, 1993). Noise-Induced Hearing Loss Regulations (South Africa, 2003) also require that an assessment be done at intervals not exceeding two years (South African National Standard (SANS), 2002).

The assessment will determine if any person is exposed to noise which is at or above the noise-rating limit, regardless of whether hearing protectors are used, and the results should be entered into records as required by this Regulation (South Africa, 2003). Both the South African National Standard SANS: 2002 and 2004 were used in this study. SANS 2004 was only available from beginning of 2005.

One of the first signs of hearing damage is NIHL. Noise-induced hearing loss is a sensory-neural deficit that begins at higher frequencies (3000 Hz to 6000 Hz) and develops gradually as a result of continuous exposure to excessive sound levels, resulting in partial or complete hearing impairment of one or both ears (Rabinowitz; 2000; Schoeman and Schröder, 1994). Metabolic changes in the auditory receptor cells and nerves eventually lead to degenerative damage to the cell structure as well as damage to the inner ear, the organ of Corti and the auditory nerve path (Rabinowitz, 2000). There is no pain involved; therefore, the condition may only be diagnosed when permanent damage has already occurred. Noise can also affect the heart rate and blood pressure (Lusk, Hagerty, Gillespie and Caruso, 2002). Research has recently indicated that it may induce hypertension and cardiovascular disease (Tomei, Fantini, Tamao, Baccolo Paolo and Rosati, 2000).

Excessive noise can interfere with speech communication. Employees cannot communicate with each other while working in noisy environments (Goeltzer, Hansen and Sehrndt 2001) and accidents may increase because warning signals are missed (Rabinowitz, 2000).

There is no reporting system in place regarding the economic impact of occupational hearing loss in abattoirs (Toran, 2002).

1.2 PROBLEM STATEMENT

In South Africa, there is practically no comprehensive data available on NIHL as a result of hazardous exposure at work, especially in abattoirs (Van Zyl, 1995). Therefore, there is a possibility that workers in abattoirs may be subjected to high levels of noise. An increase in productivity necessitates process mechanisation that may emit high noise levels (Blanchard 1998). Noise is emitted from many processes

and activities in the abattoir during the slaughter and processing of different animal species (Environmental Protection Agency (EPA), 1999). The noise levels emitted from these various mechanised and manual processes may be higher than the equivalent noise level (L_{eq}) of 85dB(A) (Blanchard, 1998). Abattoir equipment and machinery includes chain conveyers, stunning boxes, air conditioners, pumps, pneumatic devices and other mechanical equipment (EPA, 1999). Lack of proper maintenance of equipment may also increase noise levels (Bruce, Bommer and Moritz, 1997). The Meat Safety Act (South Africa, 2000) is more concerned with cleaning, disinfection, hygiene, proper handling and storage of meat, among other things, than with the noise exposure of employees. Therefore, this study will determine noise exposure levels in abattoirs in accordance with the requirements of the Occupational Health and Safety Act, Act 85 (South Africa, 1993; South Africa, 2003; South African National Standard (SANS), 2004). The results of this study should provide the necessary information needed to implement initiatives to protect the hearing of abattoir workers.

The researcher is not aware of a similar study that was done recently on noise exposure in abattoirs thus new relevant studies and resources could not be found.

1.2.1 H_0: Hypothesis

Noise levels differ for the slaughter of cattle and sheep

1.2.2 Sub H_0: Hypothesis

Noise levels differ between different throughput abattoirs

1.2.3 H_a: Hypothesis

Noise levels do not differ for the slaughter of cattle and sheep

1.2.4 Sub H_a: Hypothesis

Noise levels do not differ between different throughput abattoirs

1.3 AIM AND OBJECTIVES

1.3.1 Aim

The aim of this study was to characterise noise levels during the slaughter of cattle and sheep in different throughput abattoirs in the Free State.

1.3.2 The objectives of the study were:

- to compare environmental noise levels in different throughput abattoirs during the slaughter of cattle and sheep;
- to compare personal noise levels in different throughput abattoirs during the slaughter process of cattle and sheep; and
- to determine whether the noise levels in abattoirs comply with legislation.

1.4 STRUCTURE OF THE DISSERTATION

Each chapter will be presented as an independent section and the layout of the dissertation is as follows:

- In Chapter 2 the relevant literature is discussed
- Chapter 3 investigates environmental noise exposure levels during the slaughter of cattle and sheep.
- Chapter 4 indicates the difference in the personal noise exposure levels in the different throughput abattoirs.
- Chapter 5 focuses on the noise exposure levels during the slaughter of cattle and sheep with specific emphasis on the differences between the different throughput abattoirs.
- Chapter 6 discusses the conclusions and reflections of the study.

1.5 REFERENCES

Blanchard, N. 1998. The Quietest War: Americans, noise pollution is no joke. *The Environmental Magazine.* March-April. 1-2.

Bruce, R.D., Bommer A.S. and Moritz, C.T. 1997. Noise, vibration and ultrasound. *American Industrial Hygiene Association (AIHA).* Virginia. USA. 438-447, 425.

Denniston, V. 2000. Preventing hearing loss (industrial noise) (Statistical Data Included). *Industrial Distribution.* 1-2.

Environmental Protection Agency (EPA). 1999. Environmental Noise Control: A manual for industrial noise criteria for abattoirs. Australia. 2-3. [Web:] http://www..epa.nsw.gov.au/mao/abattoir.htm#aim. [2004-09-28].

Goeltzer, B.I.F., Hansen, C.H. and Sehrndt, G.A. 2001. *Occupational exposure to noise: Evaluation, prevention and control*. Germany: World Health Organisation.

Lusk, S. L., Hagerty, B.M., Gillespie, B. and Caruso, C. C. 2002. Chronic effects of workplace noise on blood pressure and heart rate. *Archives of Environmental Health.* July-August. 1-4.

MacMillan, R. 1999. Noise Control Management. Australia: The Safetyline Institute. http://www.safetyline.wa.gov.au/institute/level2/course18/lecture137/1137-01.asp. Date of access: 02.06.2003.

National Institute for Occupational Safety and Health. 1998. The Occupational Environment – Its Evaluation and Control. Washington D.C: Government Printing Office.

Rabinowitz, M. P. 2000. Noise–induced hearing loss. *American Family Physician.* May 1. 1-3.

Schoeman, J.J. and Schröder, H.E. 1994. *Occupational Hygiene.* Second edition. South Africa: Juta and Co. 222-228.

South Africa. 1993. Occupational Health and Safety Act (Act no 85 of 1993). Pretoria: Government Printer.

South Africa. 2000. Meat Safety Act, 2000 (Act 40 of 2000). Pretoria: Government Printer.

South African National Standard. 2002. SANS 10083, 2002: Code of Practice for the Measurement and Assessment of Occupational Noise for Hearing Conservation Purposes. Pretoria: Government Printer.

South African National Standard. 2004. SANS 10083: 2004: Code of Practice for the Measurement and Assessment of Occupational Noise for Hearing Conservation Purposes. Pretoria: Government Printer.

South Africa. 2003. Noise-Induced Hearing Loss Regulations. Pretoria: Government Printer.

Tomei, F., Fantini, S., Tomao, E., Baccolo, T.P. and Rosati, M.V. 2000 September. Hypertension and Chronic Exposure to Noise. *Archives of Environmental Health.* 55(5): 19-25.

Toran, M.W. 2002. What did you say? (Special Report: Worker Compensation) USA. 1-2.

Van Zyl, A. P. 1995. Manual for the abattoir industry. First edition. First Impression. South Africa: Red Meat Abattoir Association. South Africa. 3-6, 135.

World Health Organisation. 1997. *Prevention of Noise-Induced Hearing Loss.* Geneva: World Health organisation. 5-6.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

About 530 red meat abattoirs in South Africa are responsible for producing meat that is safe for human consumption. These abattoirs must meet the demand in the country as well as for export purposes (Red Meat Abattoir Association (RMAA), 1999). South African meat abattoirs slaughter approximately 1750 million cattle and 4500 million sheep annually (RMAA, 1999). The abattoirs are classified as high throughput, low throughput or rural red meat abattoirs, depending on the number of slaughter units allowed per day (South Africa, 2004). High throughput abattoirs slaughter more than twenty slaughter units per day and therefore the most animals, compared to Grade C and Grade D (National Department of Agriculture, 2000; South Africa, 2004). Low throughput abattoirs can only slaughter a maximum of twenty slaughter units per day while rural red meat abattoirs may not exceed two slaughter units per day. The maximum slaughter units permitted for each abattoir is determined by the provincial executive officer, based on the capacity of the lairages and hourly throughput potential relative to available equipment and facilities (South Africa, 2000; South Africa, 2004). The abattoir infrastructure determines slaughter units permitted per day (RMAA, 1999; National Department of Agriculture, 2000; South Africa, 2000; South Africa, 2004).

Table 1 illustrates the abattoir classification according to the Abattoir Hygiene Act, Van Zyl, the Meat Safety Act and the Red Meat Regulations (South Africa, 1992; Van Zyl, 1995; South Africa, 2000; South Africa, 2004).

TABLE 2.1: Comparison of the old and new abattoir classification systems

Old classification	**Daily throughput**	**New classification**	**Daily throughput**
Grade A	Own capacity	(A,B and C) High throughput	Determined by the provincial executive officer
Grade B	Up to 100 units per day		

Grade C	Up to 50 units per day		
Grade D	Up to 15 units per day	(Grade D) Low throughput	Not more than 20 units per day
Grade E	Up to 8 units per day	Rural abattoirs	2 units or less per day

2.2 SLAUGHTER PROCESS IN THE ABATTOIR

On arrival, the animals are kept in lairages where they are allowed to rest before slaughter. This makes it possible to conduct an ante-mortem inspection in order to determine the health condition of the animals (South Africa, 2000). The animals are then stunned to render them unconscious before slaughter to prevent pain and suffering. The captive bolt pistol is used for cattle and electric tongs for sheep (National Department of Agriculture, 2000; South Africa, 2000).

A chain is attached just above the hoof and the animal is then hoisted with an electric hoist. The neck arteries are severed within one minute of stunning and the animals are allowed to bleed for approximately six to eight minutes for cattle and three to four minutes for sheep to ensure good quality meat with longer shelf life (National Department of Agriculture, 2000). The Red Meat Regulations of South Africa stipulate eight minutes bleeding time for cattle and six minutes for sheep (South Africa, 2004).

After the animal has been properly bled, the head and feet are removed. In the case of cattle the hide is removed by circular saw blades. Knives and hands are used for removal of sheep hides. During evisceration the viscera are removed from the carcass. The carcasses of cattle are split into two parts for ease of inspection; this also allows proper cooling. The viscera and carcass are inspected and trimmed before final washing. By-products, which include blood, bone dust and marrow, are removed before the carcasses are transported to cold rooms for storage and before they are sent for de-boning or final dispatch to retailers (Gracey, 1986).

Figure 2.1 provides a summary of the processes followed and equipment used in a typical red meat abattoir.

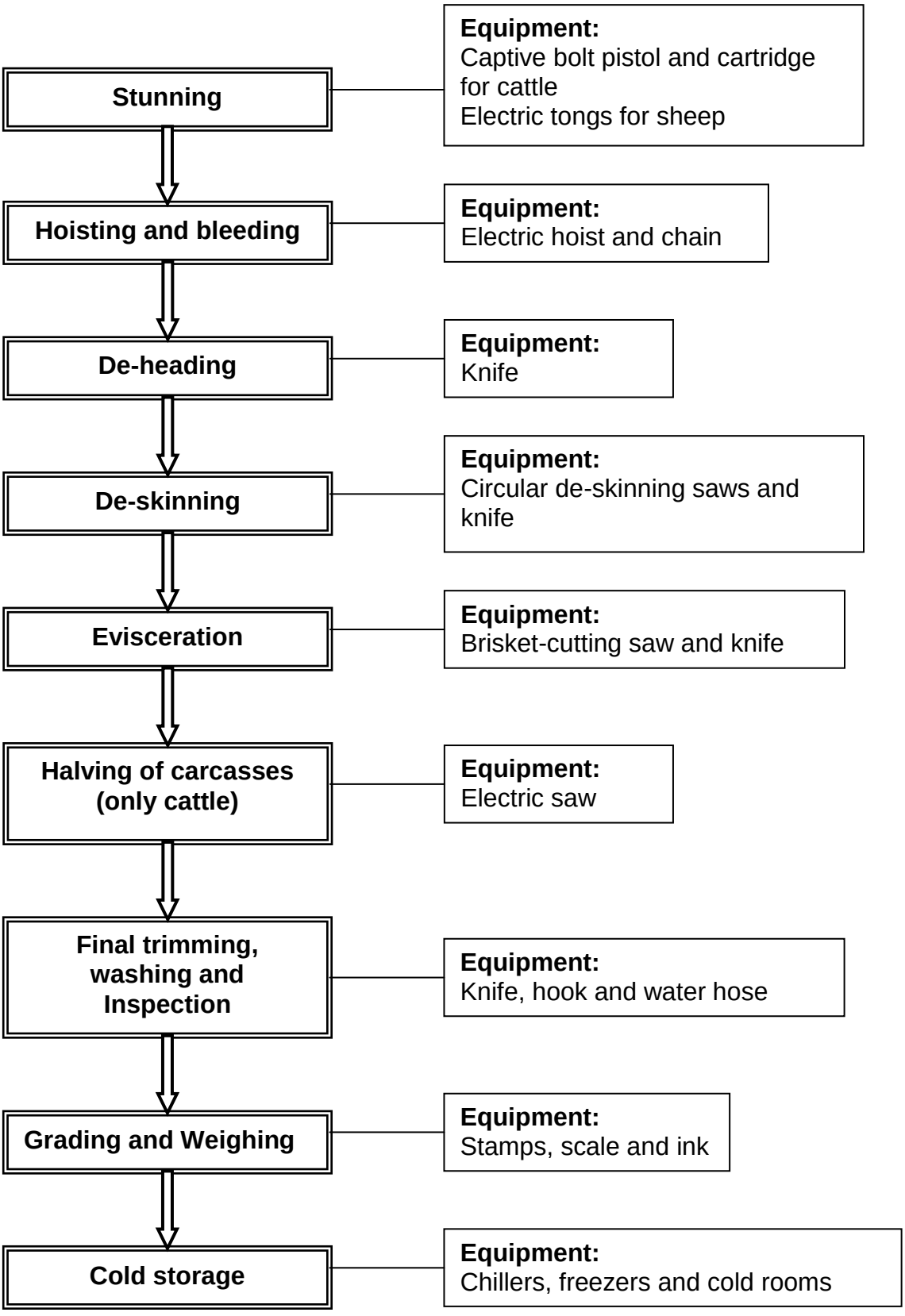

Figure 2.1: General process flow diagram for meat processing operations

The abattoir has a constant supply of hot and cold water available at both normal and high pressure. There are also several machines, tools and types of equipment in the abattoirs that are used to process meat in a hygienic way that is safe for human consumption. The equipment helps workers to process meat at a faster rate in order to keep up with the daily demands of consumers. It includes for example the brisket saw, circular blades/saws, carcass-splitting saws, hock cutters and aitchbone cutters which enable the dressing process to be carried out properly. Although only one individual operates the machine that is used to split the carcasses, this machine can produce noise levels that exceed 85dB(A) and this can affect other workers who are stationed near the source (Peterson, 1991; Health and Safety Executive (HSE), 2002). The circular saws need compressed air and water to function properly and the system is kept running throughout the slaughter process. Circular saws have also been identified as potential sources of noise in the working environment (Peterson, 1991).

The animals are then transported on chain conveyers and surface rails that are either manually or electric motor driven. Noise is emitted from this process since it involves metal against metal and it is assumed that chain conveyors are noisier than rubber roller conveyors. Unfortunately, sound-absorbing and noise-insulating materials that are used in other industries to reduce noise emission cannot be used successfully in abattoirs because of hygiene requirements (Czuchaj, Śliwiński and Środecki, 2001).

Normal working hours that are recommended for the labour force without payment of overtime in South Africa are 8 hours per day (South Africa, 1997). Most abattoirs operate for longer hours at times of high demand and the workers are paid for the extra hours worked. This increases the amount of time that the workers are exposed to noise at the work place. In South Africa slaughtering in most abattoirs depends on the number of animals that farmers bring to the abattoir for slaughter. During high demand periods like Easter and Christmas holidays, slaughtering continues for up to 15 hours per day, although in some bigger abattoirs the workers change shifts.

2.3 NOISE PRODUCTION IN A RED MEAT ABATTOIR

The abattoir industry has increased its mechanisation of equipment, conveyor and ventilation systems, and this has contributed to making the slaughter floor noisy. The

noise levels that are reached are higher than the established limits for noise exposure and the continuous exposure of workers to these high noise levels can cause noise-induced permanent threshold shift (NIPTS) (Sharma, Mohanan and Singh, 1997).

Large modern meat plants like the high throughput abattoirs use the continuous conveyorised method, or the 'Canpack' system (Gracey, 1986). The carcass is suspended by heavy beef trolleys or runners from an overhead rail. This is the most common form of line system used, where the production rate of 50-150 cattle slaughtered per hour is expected as well as 1000 sheep per day (Gracey, 1986). In low throughput abattoirs, however, carcasses are delivered to each station manually. Electricity is available especially in high throughput abattoirs, for air conditioning, to provide power for running different operations as well as to illuminate the working area.

The workers in the abattoirs are exposed to many physical hazards and stressors such as injury, heat, cold and noise (Gomes, Lloyd and Norman, 2002). Many studies have indicated that noise can have adverse effects on health if it is not controlled and kept within safe limits (Blanchard, 1998; World Health Organisation, 2001; Lusk, Hagerty, Gillespie and Caruso, 2002)

Regarding injury, the use of electric circular saws for removal of skin exposes the operators to the danger of cutting themselves accidentally, and the person who operates the electric saw that is used for splitting the carcass is also vulnerable in this regard. There is a covering to protect passers-by from being injured during the splitting, but workers can be hurt by the saw if they pass too close to it (Gomes, Lloyd and Norman, 2002).

Cattle carcasses can sometimes fall from the rails onto the floor and this could injure workers who work in this area. The equipment that is used in the abattoirs requires that people operating them and or working near them be alert at all times to avoid being injured while performing duties. Most workers in the abattoirs are not aware of the dangers associated with overexposure to noise (Gomes, Lloyd and Norman, 2002), accepting the noise from the equipment they use as normal. Therefore they

fail to demand proper hygiene measures and personal protection (Gomes, Lloyd and Norman, 2002).

Noise is undesired sound that causes unwarranted disturbance within a useful frequency band (Schoeman and Schröder, 1994; South African National Standard, 2002; South Africa, 2004). It can have both auditory and non-auditory effects on workers in the workplace, which may affect their safety and their productivity (Heggings, 1998). It interferes with and disrupts communication if excessive in the workplace, and it is one of the most prevalent occupational hazards in industry today, leading to noise-induced hearing loss (NIHL) (Hatting and Acutt, 2003; Schoeman and Schröder, 1994), or noise-induced permanent threshold shift (NIPTS).

NIHL is a sensory-neural permanent shift in the hearing threshold of the ears due to exposure to noise and is therefore irreversible (Schoeman and Schröder, 1994). It can result from a single exposure to high intensity impulsive noise or from longer exposures to lower noise levels. The hair cells in the cochlea become damaged (National Institute of Occupational Health and Safety (NIOSH), 1998). This type of hearing loss occurs first at higher frequencies (around 4000Hz) (NIOSH, 1998). Repeated exposures to noise without enough time for recovery between exposures also influence vulnerability of individuals to hearing loss (Environmental Protection Agency (EPA), 1981).

2.4 TYPES OF NOISE IN THE ABATTOIRS

Impulse noise is characterised by a very sharp instant rise in sound pressure and can result in increased blood pressure, pulse rate and headaches (Petiot, Parrot, Lobreau and Smolik, 1992; Tomei, Fantini, Tamao, Baccolo and Rosati, 2000). This type of noise is dangerous and can cause instantaneous damage to the ear (Clark and Bohne, 1999). It is common practice in abattoirs for machinery to be repaired while slaughtering is in progress. In some abattoirs the falling of animals and the banging of the gate used to control entry of stunned animals into the abattoir produce this kind of noise.

The most common type of noise in most abattoirs is continuous noise from the electric motor that runs throughout the process of slaughtering for all species, to keep the conveyors moving. The intensity of continuous noise remains constant for a considerable period of time.

The switching on and off of equipment in the abattoir due to the different processes that are undertaken at different times, produces great variations in sound intensity and results in an interrupted form of noise. This includes electric de-skinning machines, equipment that is used for splitting the carcasses, as well as the switching off of the control that moves the rails if there is a problem in the production line (Gracey, 1986).

Fluctuating noise is noise whose intensity varies over a given period, such as in the case of a machine running continually at different speeds depending on the type of work it has to perform (Schoeman and Schröder, 1994). This type of noise is not common in abattoirs.

2.5 NOISY EQUIPMENT IN THE ABATTOIRS

The predominant source of noise or noise-generating processes on the slaughter floor includes the hand-operated electric de-hiding machine that uses compressed air and water and emits noise when in operation. It is used to remove skin for both cattle and sheep, although in some abattoirs only knives and hands are used. In addition to this, noise generated by the air conditioning equipment and exhaust fans has been studied extensively and shown to produce noise levels of up to 95dB(A) (Romeu, Jimenez and Capdevila, 2003; Health and Safety Executive (HSE), 2002).

Other equipment such as the conveyers, both overhead and surface, that are used to transport carcasses, are made of steel and noise is emitted when products are being pushed around for further processing. Eventually all the meat is transported and kept in the chillers. The brushing and bumping of metal as the hooks are being pulled over the metal rail also contributes to the level of ambient noise that is produced.

In smaller abattoirs, the stunning area is situated on the same floor level as the slaughter floor. The animals knock against the metal gate that opens to the bleeding area while trying to run away or when they fall down just after stunning. The electric saw that is used to split the cattle carcasses also produces noise when in use (Peterson, 1991). One man operates it, and this area is not separated from the rest of the slaughter floor.

The workers sometimes become excited and sing as they work or shout at each other either in conversation or argument. They have to raise their voices above normal conversation levels if they want to be heard, as there is a lot of noise from different sources on the slaughter floor.

Heads and feet are thrown into the metal containers and pulled in trolleys for further processing. Impulse noise is generated as they bang against these containers, normally stainless steel. This type of noise is different from continuous noise that is caused by the electric motor that is left on throughout the slaughter process, which helps to provide power for heating the water, to operate equipment and for illumination. This motor is left on until all slaughtering for the day is completed and therefore continuously emits noise. Unfortunately, there are no acoustic adaptations in abattoirs because of the nature of operations undertaken in this environment as well as for hygienic purposes.

Figures 2.2 to 2.15 illustrate the machinery, equipment, fittings and finishing of the floors, walls and the ceiling as conceived as contributory factors in the overall noise produced on the slaughter floor during the slaughter of cattle and sheep.

Figure 2.2: Wall and floor on the abattoir slaughter floor as sound-reflecting surfaces

Figure 2.3 illustrates the fittings and some of the equipment used on the slaughter floor during the slaughter of cattle and sheep.

Figure 2.3: Fittings and equipment used on the slaughter floor as sound-reflecting surfaces on the slaughter floor

Figure 2.4 illustrates the type of ceiling used in most high throughput abattoirs.

Figure 2.4: Underside of a parapet roof/ceiling

Figure 2.5 indicates furnishings on the floor and walls and the stainless steel equipment that is used on the slaughter floor.

Figure 2.5: Wall, floor and equipment as sound-reflecting surfaces on the slaughter floor

Figure 2.6 shows the conveyor and trolley system used on the slaughter floor.

Figure 2.6: The conveyor system, trolley and conveyor shafts used to transport offal from one station to another for further processing

Figure 2.7 illustrates the heads and feet being transported on the slaughter floor.

Figure 2.7: Heads and feet being transported on the slaughter floor

Figure 2.8 indicates feet being thrown on to the conveyor shaft to be conveyed to another floor for further processing.

Figure 2.8: Feet thrown into the conveyor shaft

Figure 2.9 shows an employee using a circular saw to de-skin a cattle carcass.

Figure 2.9: An employee using circular saw blade to de-skin a cattle carcass

Figure 2.10 illustrates a worker using a brisket cutter to open the chest of a cattle carcass.

Figure 2.10: Brisket cutter in use

Figure 2.11 shows a worker using a saw to split a cattle carcass.

Figure 2.11: Carcass-splitting saw used to divide the carcass into two parts

Figure 2.12 illustrates the conveyor system that is used as transport mechanism for the carcasses on the slaughter floor.

Figure 2.12: Motor-driven conveyor system

Figure 2.13 shows a motor that is used to drive the conveyors on the slaughter floor.

Figure 2.13: Motor used to operate the conveyors

Figure 2.14 illustrates an air conditioning device used in most abattoirs for ventilation purposes.

Figure 2.14: Air conditioning device situated below the ceiling

Figure 2.15 indicates the extractor fan on the ceiling used to remove humidity and odours from the slaughter floor.

Figure 2.15: Extractor fan situated in the ceiling

2.6 LEGISLATION

There are regulations worldwide intended to limit the noise exposure of workers in the workplace (Eleftheriou, 2002), and many countries have introduced legal obligations and guidelines requiring employers to protect their employees and others from exposure to excessive noise (MacMillan, 1999).

The EPA defines hazardous noise levels as time-weighted average levels of 85dB(A) and above, although more susceptible individuals may suffer hearing loss at levels lower than this (EPA, 1990). On the other hand, the Occupational Noise Exposure Regulations in the United States of America state that industrial employers must limit noise exposure of their employees to 90dBA for an 8-hour period (United States of America Department of Labor, 1996), and the Greeks suggest 85 and 90dB(A) standard as the permitted maximum noise exposure dose, although these only serve as guide figures which are considered adequate for the protection of the worker's hearing (Greek Standardisation Organisation (ELOT), 1985). The Australian Occupational Health and Safety Noise Regulations of 1996 limit the peak noise level to 140dB linear or an 8-hour equivalent continuous A-weighted sound pressure level to 85dB(A) (Australia,1996).

At the same time, the United States of America Occupational Health and Safety Administration (OSHA) has mandated that general industry employers must establish a hearing conservation programme for workers exposed to noise levels having a time-weighted average (TWA) of 85dB(A) or higher (OSHA, 1983), and in 1998, the NIOSH recommended exposure limit (REL) for occupational noise exposure was 85dB(A), which was regarded as less risky than the 90dB(A) permissible exposure level (PEL) which was enforced by OSHA and the Mine Safety and Health Administration (MSHA) (NIOSH, 1998). Most nations and international consensus firmly supported the 3dB exchange rate (NIOSH, 1998). The exchange rate is used to calculate the amount by which the permitted sound level may increase if the exposure time is halved. In this case, for each halving of the duration of exposure the limit is increased by 3dB(A) (Schoeman and Schröder, 1994).

In South Africa, the Noise-Induced Hearing Loss Regulations, 2003, section 3, promulgated under the Occupational Health and Safety Act, 1993, stipulate that “No employer or self–employed person shall require or permit any person to enter any workplace under his or her control where such person will be exposed to noise at or above the 85dB(A) noise rating limit” ($L_{Ar,\ 8h}$) (South Africa, 2003). The hearing damage risk is assessed using the SANS Code of Practice for Measuring and Evaluating Noise for the purpose of Conserving Hearing (SANS 10083, 2004).

2.7 EFFECTS AND IMPLICATIONS OF OVER-EXPOSURE

In an abattoir, excessive noise can make it impossible to hear warning signals for workers to act accordingly, thus endangering the lives of workers (Reich, 1995). It is difficult to converse on important instructional matters, which leads to misunderstandings and many mistakes by workers as well as their supervisors. This can in turn affect production and increase losses. Equipment such as knives, hooks, saws and de-hiding machines are dangerous, and require users to be alert at all times to avoid acting irresponsibly and hurting themselves or others.

Non-auditory effects of noise include an increase in the secretion of adrenal hormones that result in a wide range of influences in the human body. The heart and cardiovascular system can be adversely affected (Schoeman and Schröder, 1994), and this may result in increased heart rate, of both systolic and diastolic blood pressure, which may also lead to adverse chronic and acute effects (Lusk *et al.,* 2002*)*. Most importantly, it leads to distraction and lowered work productivity. Industrial losses due to absenteeism and decreased efficiency due industrial noise is estimated at $2.5 billion in the United States of America every year (Miller, 1973)

The intensity and duration of noise determine its potential to cause damage to the hair cells in the inner ear (Rabinowitz, 2000). Exposure to noise for a long time may cause a temporary change or ringing in the ears. This is a short-term effect and may disappear some time after leaving the source of noise (NIOSH, 1998). Repeated exposure to loud noise, however, causes permanent, incurable hearing loss known as noise-induced hearing loss (NIHL) (NIOSH, 1998; Park, 2003). NIHL is a critical health problem that leads to withdrawal from social situations and dependency on

friends and family for communication. This results in depression, low self-esteem, loneliness and isolation (Suter, 1994).

2.8 RATIONALE

In the abattoir industry, workers are subjected to a variety of noise sources. High noise levels from the electric motor, circular electric saws and conveyers, among other things, which are used daily during the slaughtering and dressing process, are capable of causing damage to the hearing. The frequent use of this equipment causes high levels of noise which consist of mostly high-pitched components. All these noise sources combine to cause high levels of ambient noise that require some form of protection to be used. The problem is worsened by hygiene requirements in the abattoirs which rule out the use of sound-absorbing and insulating materials and systems used in other industries to reduce the emission of noise, since they are usually porous and fibrous materials which are not resistant to humidity and can encourage the growth of micro-organisms (Czuchaj, Śliwiński and Środecki, 2001).

Occupational hearing loss is a problem that has been recognised since the industrial revolution and it contributes to economic costs estimated at billions of dollars (NIOSH, 1998). According to The American Family Physician, more than 10 million Americans have hearing loss due to excessive noise exposure in the workplace (Rabinowitz, 2000). NIHL is a major health risk worldwide with more than 35 million people exposed to detrimental noise levels (above 85dB(A)) in industrial plants (Sulkowski, Szymczak, Kowalska and Sward-Matyja, 2004)

Incidentally, the World Health Organisation (WHO) declared noise a significant health threat in 1996 (Blanchard, 1998). Research has indicated, however, that avoiding exposure to noise can stop progression of the damage to the hair cells in the cochlea (Rabinowitz, 2000).

Therefore, the purpose of this study was to determine whether the workers in the different throughput abattoirs in the Free State region are overexposed to noise in the workplace, and whether these abattoirs comply with legislation. This was done by determining the extent of the possible hazard as well as the possible sources of

noise on the slaughter floor, in order to recommend measurers to protect the health and well-being of people working in this industry, and to save the abattoirs from having to pay compensation in the event that it could be proven that people's hearing was affected negatively due to exposure at work.

This study focuses on high and low throughput red meat abattoirs according to the new classification, within a 150 km radius of Bloemfontein.

2.9 REFERENCES

Australia. 1996. Australian Occupational Health and Safety Noise Regulations Australia.

Blanchard, N. 1998. The Quietest War: for Americans, noise pollution is no joke. *The Environmental Magazine.* New York 1-2.

Clark, W.W. and Bohne, B.A. 1999. Effects of noise on hearing. *JAMA.* 281:1658-1659.

Czuchaj, J., Śliwiński A. and Środecki K. 2001. Noise Sources and Acoustic properties of workrooms in the plants of food processing and pharmaceutical industry. *Applied Acoustics.* Poland. 1141-1156.

Eleftheriou, P.C. 2002. Industrial noise and its effects on human hearing. *Applied Acoustics 63*. 35-42.

Environmental Protection Agency (EPA). I981. Noise Effects Handbook. United States of America:. EPA 5000-9-82-106.

Gomes, J., Lloyd, O. and Norman, N. 2002. The health of the workers in a rapidly developing country: effects of occupational exposure to noise and heat. Vol. 52 no. 3. *Occupational Medicine*. Great Britain. 121-128.

Gracey, F. 1986. Meat Hygiene. Eighteenth edition. Great Britain: British Library Cataloguing in Publication Data. 76-79.

Greek Standardisation Organisation (ELOT), 413. 1985. Acoustics-assessment of occupational noise exposure for hearing conservation purposes. Greece: Greek Organization for Standards.

Hatting, S. and Acutt J. 2003. Occupational Health, Management and Practice for Health Practitioners. Third edition. Pretoria. 139-145, 495-496.

Health and Safety Executive (HSE). 2002. Reducing noise exposure in the food and drink industries. United Kingdom: Health and Safety Executive Information Sheet No. 32.

Heggins J. 1998. Effects of Industrial Noise on Hearing. 1-5. http://hubel.sfasu.ed/courseinfo/sl98/hearing.html. Date of access: 2004.07.08.

Lusk S.L., Hagerty, B.M., Gillespie, B. and Caruso, C.C. 2002. Chronic Effects of workplace noise on blood pressure and heart rate. *Archives of Environmental Heath.* New York. 1-2.

MacMillan, R. 1999. Noise Control Management. The Safetyline Institute. Australia. http://www.safetyline.wa.gov.au/institute/level2/course18/lecture137/1137-01.asp. Date of access: 02.06.2003.

Miller R.K. 1973. You can reduce plant noise. K. Miller & Associates. Atlanta, GA. 133-137.

National Institute for Occupational Safety and Health (NIOSH). 1998. Criteria for a Recommended Standard: Occupational noise exposure. Publication No. 98-126. Ohio. 2-11.

National Department of Agriculture. 2000. Meat Inspectors Manual: Red Meat. South Africa: Directorate Veterinary Services. 2-9.

Occupational Safety and Health Administration [OSHA]. 1983. Occupational Noise Exposure. Hearing Conservation Amendment; Final Rule Federal Register Vol. 48. Washington DC. 9738-9785.

Park, M. 2003. Assessment of potential noise-induced hearing loss with commercial "Karaoke" noise. *International Journal of Industrial Ergonomics.* South Korea.

Peterson, J.E. 1991. Industrial Health. Second revised edition. American Conference of Governmental Industrial Hygienists, Inc. Ohio. USA. 196-200, 202-210.

Petiot, J.C., Parrot, J., Lobreau, J.P. and Smolik H.J. 1992. Cardiovascular effects of impulse noise, road traffic noise, and intermittent pink noise at LAeq = 75dB, as a function of sex, age, and level of anxiety: a comparative study. Heidelberg; Springer, Berlin. *International Archives of Occupational and Environmental Health*. Volume 63. Number 7. 485-493.

Rabinowitz, **P.M.** 2000. Noise-induced hearing loss. *American Family Physician.* Volume 61, No. 9. USA: The American Academy of Family Physicians.

Red Meat Abattoir Association (RMAA). 1999. Red Meat Industry Status Report. South Africa.

Reich, R.B. U.S. 1995. Department of Labour. Occupational Safety and Health Administration. 3074. Hearing Conservation. US.

Romeu, J., Jimenez, S. and Capdevila, R. 2003. Noise emitted by water supply installations. *Applied Acoustics.* Vol 65, Issue 4. Acoustics and Mechanical Engineering Laboratory, Technical University of Catalonia. Spain. 401-419.

Schoeman, J.J. and Schröder, H.H. 1994. Occupational Hygiene. Cape Town: Juta. 195-200, 222-229.

Sharma, O., Mohanan, V. and Singh, M. 1997. Noise Emission in Coal Industry. *Applied Acoustics,* Vol. 54, No. 1. National Physical Laboratory, New Dehli. India. 1-7.

South Africa. Department of Agriculture. 1992. Abattoir Hygiene Act, 1992 (Act 121 of 1992). South Africa: Government Printer.

South Africa. Department of Labour. 1993. Occupational Health and Safety Act, 1993 (Act 85 of 1993). South Africa: Government Printer.

South Africa. Department of Labour. 1997. Basic Conditions of Employment Act, 1997 (Act 75 of 1997). South Africa: Government Printer.

South Africa. Department of Agriculture. 2000. Meat Safety Act, 2000 (Act 40 of 2000). South Africa: Government Printer. Section 8, 8-18, 19-29.

South Africa. Department of Labour. 2003. Noise-induced Hearing Loss Regulations. South Africa: Government Printer.

South Africa. Department of Agriculture. 2004. Red Meat Regulations, 2004. (Meat Safety Act, 2000 (Act 40 of 2000)). South Africa: Government Printer.

South African National Standard. 2002. SANS 10083, 2002: Code of Practice for the Measurement and Assessment of Occupational Noise for Hearing Conservation Purposes. Pretoria: Government Printer.

South African National Standard. 2004. SANS 10083: 2004: Code of Practice for the Measurement and Assessment of Occupational Noise for Hearing Conservation Purposes. Pretoria: Government Printer.

Sulkowski, W.J., Szymczak, W., Kowalska, S. and Sward-Matyja, M. 2004. Epidemiology of Occupational Noise-Induced Hearing Loss (ONIHL) in Poland. Otolaryngol Pol. 58(1). Institut Medycyny UL. SW. Teresy 8 90-950 Lodz. 233-6.

Suter, A.H. 1994. Comments on Occupational Noise to the Occupational Safety and Administration Standards Planning Committee. Docket No. C-04. November. USA.

Tomei, F., Fantini, S., Tomao, E., Baccolo, T.P. and Rosati, M.V. 2000 September. Hypertension and Chronic Exposure to Noise. *Archives of Environmental Health.* 55(5): 19-25.

United States of America Department of Labor. 1996. Occupational Noise Exposure. Department of Labour. 29 CFR 1910.95.

Van Zyl, A. P. 1995. Manual for the Abattoir Industry. First edition. The Red Meat Abattoir Association. South Africa. 56-61, 20-37.

World Health Organisation. 2001. Occupational and community noise. Media centre: fact sheet no. 258. http:www.who.int/mediacentre/factsheets/fs258/en/. Date of access 05. 09. 2005.

CHAPTER 3

ENVIRONMENTAL NOISE IN DIFFERENT THROUGHPUT FREE STATE ABATTOIRS DURING THE SLAUGHTER OF CATTLE AND SHEEP

3.1 INTRODUCTION

According to the report that was compiled for the World Health Organisation (WHO) in 2004, noise was one of the most prevalent occupational hazards in industry worldwide (Concha-Barrientos, Campbell-Lendrum and Steenland, 2004). The Health and Safety Executive (Health and Safety Executive, 1998) in the United Kingdom (UK), as well as researchers in South Africa reported that exposure to noise can cause irreversible hearing damage (Schoeman and Schröder, 1994; Health and Safety Executive, 1998; Blanchard, 1998; Macmillan, 1999).

On the abattoir slaughter floor, several factors influence the noise exposure level. These factors include the type of walls and finishing on the roof and floor, machinery and tools used as well as the type of protection available (Walsh, 1999).

The measurements showed that the noise level exceeded the South African threshold limit of 85dB(A), indicating that the abattoir industry may pose a serious threat in terms of noise-induced hearing loss. Hearing conservation programmes are therefore recommended. Since no prior information was available, this assessment was made to establish whether noise exposure levels are acceptable or not. According to the Health and Safety Executive, if noise levels exceed 85dB(A), the workers need to be informed about the risks to their hearing and provided with hearing protectors (Health and Safety Executive, 2002). The type of noise that is produced in the abattoirs is highly variable in terms of intensity and consistency, and selection of the right instrument was therefore critical in this study.

The concrete walls of the abattoirs were plastered and covered with ceramic tiles from the bottom up to a height of 1.5 to 3 meters, depending on the size and type of the slaughter hall. The windows were situated high up in the wall just below the roof, and they were kept closed throughout the slaughtering time. Air conditioners and

extractor fans were used to ventilate the area, although the doors were open all the time during sampling. The floors were covered with cement screed which was smoothed for ease of cleaning but non-slippery. There were no acoustic adaptations in place. The roof consisted of corrugated iron sheets in most cases although in one multi-storey abattoir it consisted of parapet roofing.

3.2 THE PROBLEM STATEMENT

Noise is a common health hazard in the workplace (MacMillan, 1999), and exposure to excessive noise can lead to noise-induced hearing loss (NIHL) (Macmillan, 1999; Environmental Protection Agency (EPA), 1999).

Noise exposure in abattoirs is one area that has been overlooked for a long time, because of the emphasis placed on cleaning, disinfection and hygiene (Van Zyl, 1995).

3.3 AIM AND OBJECTIVES

3.3.1 Aim of this chapter

This part of the study was therefore conducted to investigate the compliance of environmental noise exposure levels in the different throughput abattoirs during the slaughter of cattle and sheep, in terms of the Noise-induced Hearing Loss Regulations and the South African National Standard (South Africa, 2003; South African National Standard, 2004).

3.3.2 The main objectives of this chapter were:

- to measure environmental noise exposure levels on the slaughter floor;
- to compare noise levels during the slaughter of cattle and sheep respectively;
- to compare maximum noise exposure levels for the selected throughput abattoirs during the slaughter of cattle and sheep; and
- to compare the respective noise levels of selected throughput abattoirs.

3.4 MATERIALS AND METHODS

3.4.1 Sampling

The Public Health section of the Veterinary Laboratory in Bloemfontein (Department of Agriculture) was contacted and this body provided a list of all the abattoirs in the Free State. The list comprised of abattoirs with various throughput levels, and included Grade A, B, C, D and E abattoirs. The categories referred to vary from rural and low to high throughput abattoirs, depending on the number of slaughter units allowable per day.

All the abattoirs that fell within a radius of 150 km of Bloemfontein were included as the population of the study. From this population nine abattoirs were randomly selected from the list: three in grade A, three in grade C and three in grade D. Each abattoir was visited at least three times during the slaughter of cattle and sheep. The distance (150 km) was decided on for ease of access, time limitations and financial constraints. Grades B and E were left out because of the very slight difference in the slaughter units between Grades A and B and Grades D and E. Grade E abattoirs in most cases slaughter for own consumption, to use on the farm or for few people. Sometimes there is no slaughtering for three consecutive months, and when they do slaughter, it may be one or two animals. There was not enough time to wait for this period to collect samples. Only one or two people are involved in these abattoirs and the exposure time is not more than one hour at the most.

Noise level measurements were taken on the slaughter floor during the slaughter and dressing process of cattle and sheep at different sampling points. Four sampling points were identified in each of the abattoirs. These included the bleeding area, the area for cutting and removal of feet, heads and skin, evisceration, splitting of the carcass in the case of cattle, inspection, final trimming and washing as well as the washing area just before the animals are taken to the chillers for storage. Figure 3.1 illustrates the abattoir slaughter floor with some of the equipment that is used for the slaughter and dressing process of cattle and sheep (Gracey, 1986). The position of the sound level meter is indicated by a star ().

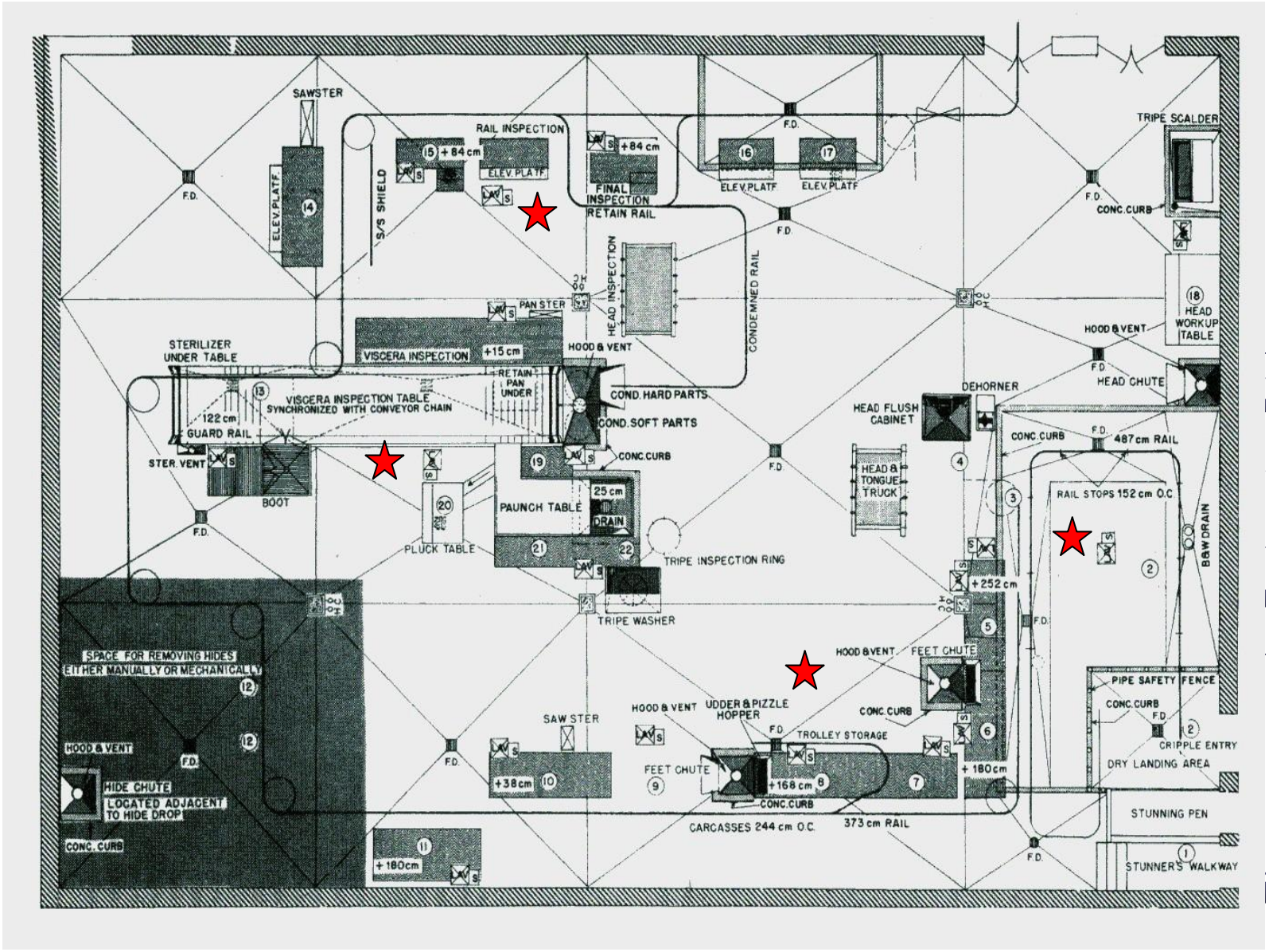

Figure 3.1: Typical abattoir floor plan also indicating the general sampling points

As illustrated in Figure 3.1, the first sampling position was near the area where the neck arteries are severed and animals are carried on overhead rails to the slaughter floor, which is close to the bleeding area. The sound level meter was placed carefully where workers could not easily knock it down when moving. Next to this area is the area where the feet and heads are removed and where the removal of the skin from the carcasses is begun. The second position was between the skin removal area and the evisceration area. The third position was the area where the cattle carcasses are split, or where the offal is inspected in sheep. The last sampling position was near the place where carcass inspection takes place and there is final trimming and washing of the carcass. It is also the area where the carcasses are lined up for weighing as the final stage before being loaded into the cold storage facilities. Positioning of the sound level meter (SLM) was dependent upon the size of the abattoir and the availability of space. The sampling points selected covered areas that were representative of all the operations on the slaughter floor, and samples were collected for the entire slaughter operation.

Noise exposure measurements were taken in each abattoir, three times during the slaughter of each species, in order to reduce the risk of biased measurements. The position of the SLM was changed at hourly intervals for each sampling session, and the average was determined. The SLM was reset before changing its position.

3.4.2 Instruments

Environmental monitoring was carried out using two calibrated Type 1 QUEST 1800 precision integrating sound level meters. The occupational noise rating limit of 85dB(A) per 8-hour period was used (South Africa, 2003; Eleftheriou, 2001). The instruments were set on impulse response as recommended by the SANS 10083 and the National Institute for Occupational Safety and Health (NIOSH) (NIOSH, 1998 (a) and (b); South African National Standards (SANS), 2004). Calibration was checked with the Quest CA-22 calibrator before and after measurement to ensure accuracy of results.

Noise exposure measurements were made using standard procedures as stipulated by the South African National Standards (SANS 10083, 2002, “Code of Practice for

measuring and evaluating noise for the purpose of conserving hearing"). The A-weighted sound pressure level was selected as this is used for most industrial measurements (Walsh, 1999). A self-cling plastic (Glad-wrap) was used to cover the sound level meter during sampling as most microphones are sensitive to moisture (Anderson and Anderson, 1993). Windshields were used to cover microphones of the instruments to prevent the results from being influenced by humidity, air flow turbulence and fans and blowers used inside the abattoirs (Bell and Bell, 1994). Whenever possible, care was taken to avoid exposing the instruments to any form of excessive vibration while transporting them and during sampling.

A computer programme sigma plot was used for analysing statistical data and for the graphical display of results. The variables of concern included maximum, minimum, equivalent noise level (L_{eq}), and duration of exposure in minutes. The average was used to determine noise exposure level and the standard deviation was used to characterise and describe the distribution of data for the different noise level parameters.

3.5 RESULTS AND DISCUSSION

The measurements (144) taken in Grades A, C and D abattoirs at different positions during the slaughter of cattle and sheep were processed and the average noise exposure levels (L_{eq}) calculated (see Figure 3.2).

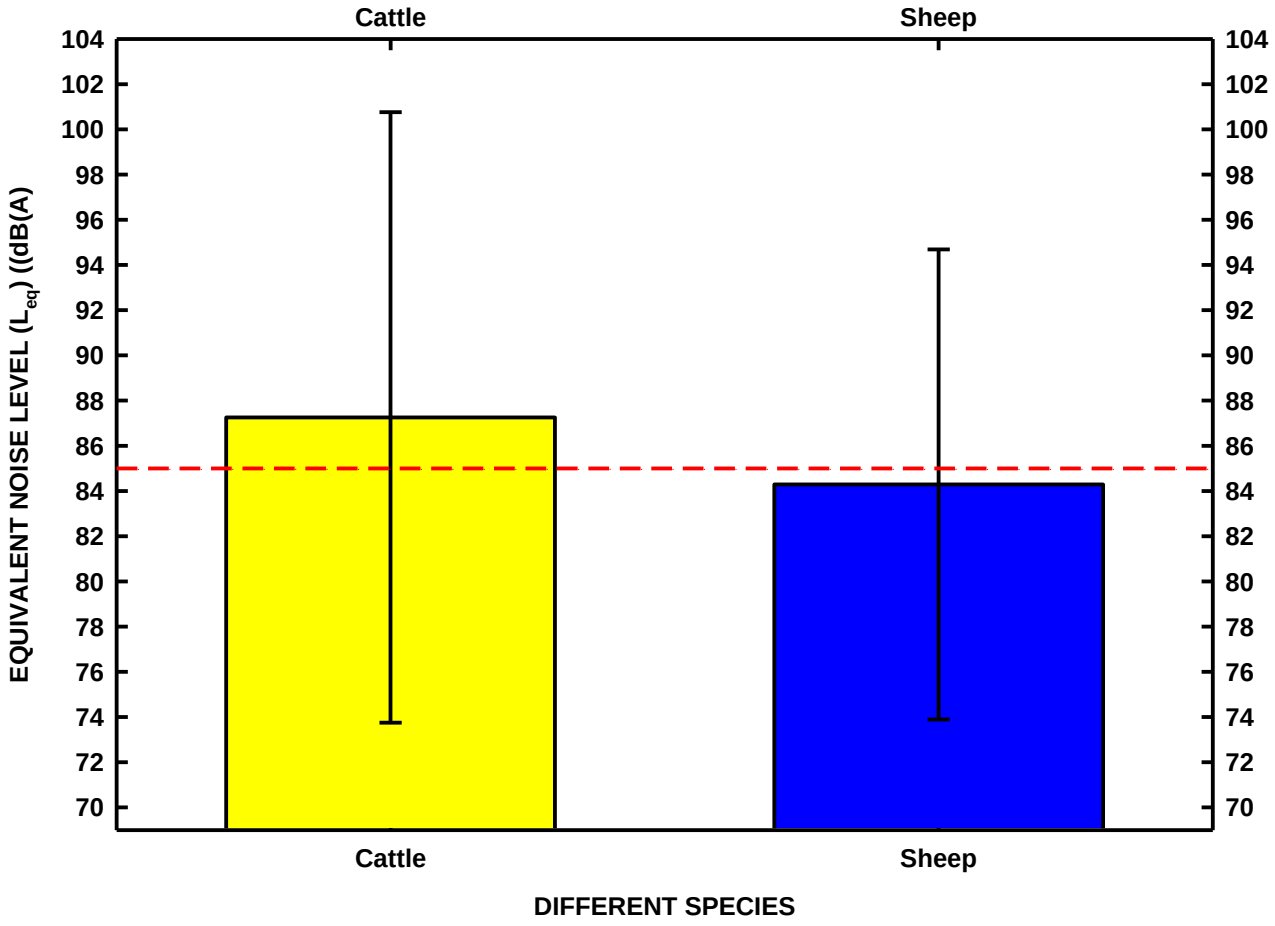

FIGURE 3.2: Average environmental noise exposure levels (L_{eq}) (dB(A)) during the slaughter of cattle and sheep

Figure 3.2 illustrates the average noise exposure levels during the slaughter of cattle and sheep respectively. The red line represents the noise rating limit for hearing conservation in South Africa (85dB(A)) (South Africa, 2003; South Africa, 2004). The average noise level recorded during the slaughter of cattle (±87dB(A)) is above this noise rating limit and the highest value recorded was more than 100dB(A). The lowest value recorded for both cattle and sheep was 74dB(A) although the overall average for sheep was 84.5dB(A). This value for sheep is slightly under 85dB(A) noise rating limit for South Africa while the average for cattle exceeds the limit by 2.1dB(A). The above results indicate the overall average for the selected Grades A, C and D abattoirs.

The average noise exposure level during the slaughter of sheep was 0.05dB(A) below the noise exposure standard of South Africa. However, figure 3.2 clearly indicates that noise levels above this limit were recorded. Noise-induced hearing loss develops gradually from continuous exposure to noise levels at or above 85dB(A) (Macmillan, 1999; Rabinowitz, 2000; Lusk, Hagerty, Gillespie and Caruso, 2002) and according to Suter (1994), susceptible workers will incur hearing losses at levels below this level (Suter, 1994). The Department of Minerals and Energy in South Africa also passed guidelines in 2002 of ≥82dB(A) in order to ensure the safety of miners (South Africa, 2002). Therefore, measures should be taken to ensure that this limit is not exceeded at all or that the length of exposure time is reduced because abattoir workers normally work longer than the 40 hour work-week standard.

Normal conversation is not possible on the slaughter floor and people have to get very close to each other and still shout in order to be heard. This might be the first indication that the level of noise on the slaughter floor is above normal.

The number of equipment, their proximity to each other and the processes involved in the slaughter and dressing process of both cattle and sheep made it difficult to distinguish noise emission from a particular source and thus the contribution of different equipment. Therefore, the measured noise came from several sources. It is assumed that noise generated was also from the electric motors, equipment and processes apart from noise being reflected by the structures and vibration of equipment.

Apart from this, the abattoir slaughter floor has a lot of stationary and mobile equipment which is used during the processing of carcasses. This equipment acts as reflecting surfaces in the propagation of sound, and also results in the echoing of sounds (Leech and Squires, 1999). It takes longer for this echo to die away than the original sound, and this exposes the worker to noise from the original source as well as from the reflection (Leech and Squires, 1999; Walsh, 1999).

From Figure 3.2 it is clear that the noise levels related to the slaughter of cattle and sheep differ. This might occur because of the highly mechanised processes used during the slaughter of cattle. For example, circular saw blades are used to remove

skin from cattle carcasses while fists and knives are used to remove the skin from sheep carcasses. It has been proven in the past that circular saws alone can produce noise levels of up to 100dB(A) (Bell and Bell, 1994). This value corresponds to the highest value recorded during the slaughter of cattle as indicated in Figure 3.2. On the other hand, a carcass splitting saw is used to half a beef carcass and this is not the case with a sheep carcass. As mentioned earlier, it is known how much noise is contributed by this instrument alone to make any difference in the overall noise level measured. However, the Health and Safety Executive (2002) mentioned in their report that powered saws can emit noise levels of about 100dB(A).

It can be argued that the same slaughter floor is used for the slaughter of both species, which might suggest that the same reflecting surfaces will be present whether cattle or sheep are being slaughtered. However, equipment that is not used during the slaughter of sheep is shut down and therefore it was assumed that this would contribute less to the overall noise level generated. It has also been proven that the amount of ambient noise produced by equipment in operation is more than when the same equipment is not operational (Bruce, Bommer and Moritz, 1997). Normal wear and tear of machinery as well as malfunction can change the normal sound of equipment (Bruce, Bommer and Moritz, 1997) and can affect the level of noise produced by specific machines.

Figure 3.3 illustrates the maximum average environmental noise exposure levels in the different categories of abattoirs during the slaughter of cattle and sheep.

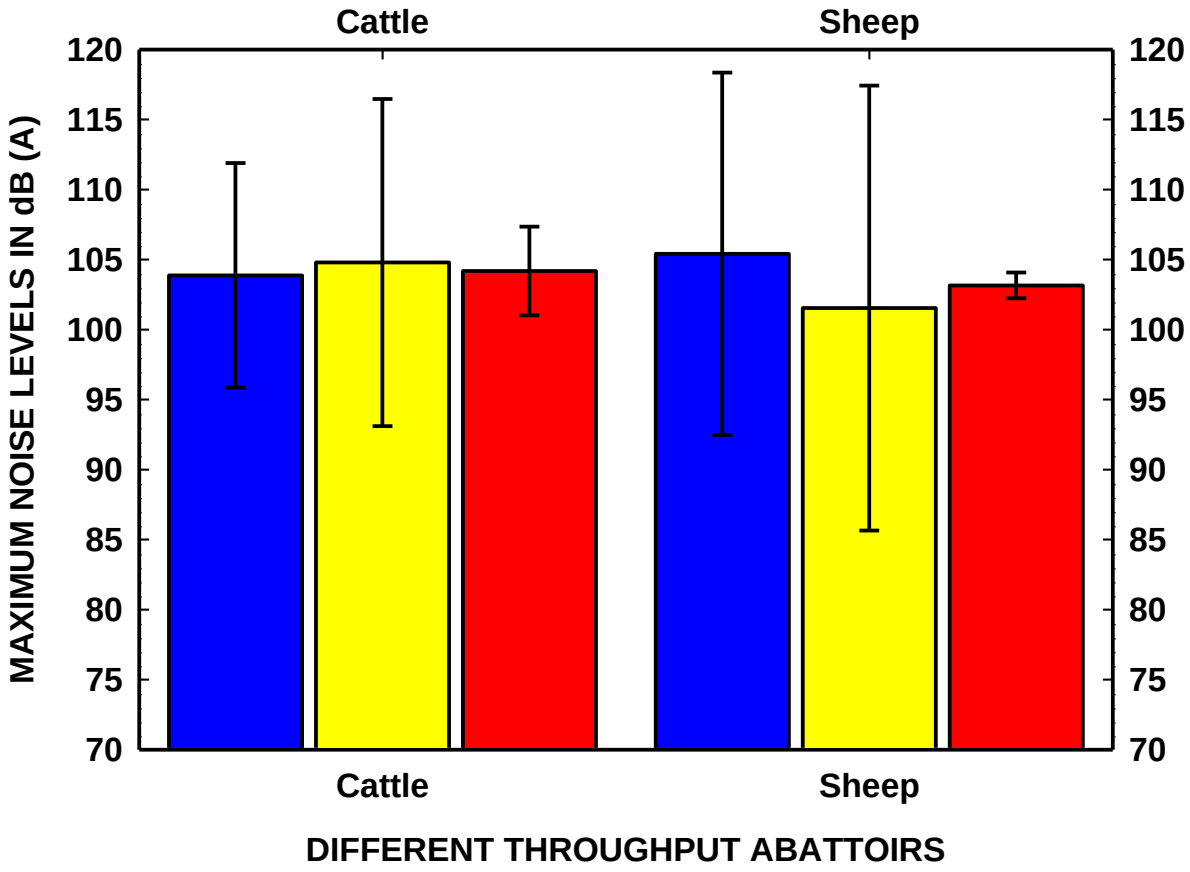

FIGURE 3.3: Maximum average environmental noise level (dB(A)) in different throughput abattoirs

Figure 3.3 illustrates the respective maximum average values for Grade A, C and D during the slaughter of cattle and sheep respectively. The average noise level for both species in the different categories of abattoirs is above 100dB(A). The highest value was recorded during the slaughter of cattle in Grade C abattoirs and during the slaughter of sheep in Grade A abattoirs. It seems therefore, that the level of noise can rise or drop regardless of the species that is being slaughtered and the type of equipment that is used. In some cases noise levels recorded in Grade C were higher than those found in Grade A, i.e. higher values were found during the slaughter of sheep than of cattle. This makes it very difficult to safely conclude whether the species or the grade of abattoir influences the level of noise on the abattoir slaughter floor.

In South Africa, it is required by law that no employer shall permit or require any person to enter any workplace under his control to be exposed to noise at or above the 85dB(A) noise rating limit (South Africa, 1993; South Africa, 2003) and according to the Department of Labour in the US (International Standards Organisation,1999), the maximum allowable noise level for four hours exposure per day is 95dB(A), 100dB(A) for two hours and 115dB(A) for 15 minutes or less per day (Mine Safety and Health Administration (MSHA), 1999). In Canada the maximum allowable noise exposure limits at 85dB(A) criterion level is 94dB(A) for 1 hour and 97dB(A) for 30 minutes (Canadian Centre for Occupational Health and Safety (CCOHS), 2005). Barker (1993) warned that ears should not be exposed for any length of time to noise levels above 115dB(A). The United States Department of Labour also stipulates in their Compliance Guide that no workers should be exposed at any time to sound levels exceeding 115dB(A), even when wearing hearing protectors (United States, 2000). Barker (1993) based most of his conclusions on the Occupational Health and Safety Administration (OSHA) standards and also mentioned that if the sound level is at 100dB(A) the maximum exposure time should be two hours (Barker, 1993; OSHA, 1992). The United States of America OSHA however stipulates 115dB(A) as the non-permissible level (OSHA, 1992).

According to Schoeman and Schröder, a person will experience discomfort at sound pressure of 120dB and pain at 130dB (Schoeman and Schröder, 1994). Although according to figure 3.3, levels as high as 118dB were recorded during the slaughter of sheep, the highest average is not more than 105dB. Although it would be tempting to assume that in terms of the statement mentioned above the abattoir employees might not be exposed to levels of noise that might result in negative effects. Plog (1995) on the other hand believed that any exposure above 115dB(A) without protection is hazardous (Plog, Nilland and Quinlan, 1995). In 1997, Bruce however, mentioned that exposure to noise level of 95dB(A) for an 8hour day for the working lifetime could result in high-frequency hearing losses of greater than 30dB (Bruce, Bommer and Moritz, 1997). Bhaskar (1999) on the other hand indicated 115dB as a non-permissible level that workers should never be exposed to (Bhaskar, Hens, Compton and Devuyst, 1999).

The length of time that these excursions above 115dB were experienced was not monitored, therefore, the workers might to some extend still be overexposed if these noise levels continue for longer periods. Time of exposure is important because the limit can be reduced by 3db(A) if the duration of exposure is halved Schoeman and Schröder, 1994).

Therefore, according to Figures 3.2 and 3.3, the overall noise level to which the abattoir workers are exposed is well above the South African as well as the international safe exposure limit. A study done in Korea in 2002 to assess the degree of potential noise-induced hearing loss due to commercial Karaoke noise was able to indicate that intense noise poses a serious threat to potential hearing loss (Park, 2003). Results from this study showed that noise levels in these environments were higher than 95dB(A) and the hearing threshold level revealed that up to 8dB of significant hearing loss was found (Park, 2003).

3.6 RECOMMENDATIONS AND CONCLUSION

Based on the results emanating from this study, it can be safely assumed that abattoir workers are overexposed to unacceptable noise levels. Therefore, it would be advisable to adopt the “Control Banding” concept in the abattoir industry according to which the control measures are put in place even before the hazards are measured to prevent further exposure and possibly more damage to the workers’ hearing. Hermann (1976) suggested that it would be advisable to assign “noisy tasks” to the deaf, upon the understanding that they have got nothing to lose, but this is a very controversial and irresponsible statement as these employees would still miss the warning signals that could endanger their lives. Over-exposure of employees to noise should be avoided to protect the workers in their work environment.

As already mentioned, many problems were experienced during the investigations conducted for this study. This might have negatively influenced the outcome and possibly exaggerated the potential noise hazard on the abattoir slaughter floor. Further research is therefore necessary in this area in order to include the grades of abattoirs that were not included in the study.

The impact of these noise levels on the workers' hearing was not measured. It would be interesting to determine the threshold shift of these workers in order to quantify the magnitude of the problem.

A comprehensive hearing conservation programme is highly recommended, that should monitor the working environment as well as the workers on a continuous basis, in order to create an environment that is less harmful to the workers (Occupational Safety and Health Administration (OSHA), 1992). This could also save the abattoirs a great deal of money that might otherwise be lost to compensation claims as well as through absenteeism.

Abattoir owners can employ engineering control measures by requesting manufactures to develop equipment that emit less noise.

As is required by law in South Africa, abattoir owners need to inform their employees about the noise levels to which they are exposed and what the negative effects of this to their health could be. They have to inform them about the choices they have and how they can help themselves to avoid over-exposure. This could be achieved by regular intensive training of employees.

The workers could be rotated to perform different tasks during one shift to reduce the continuity of exposure to high level of noise. This will give the ears time to recuperate before being over-exposed again.

When the other control measure are in place and the levels of noise are still above the limit, protective equipment in the form of ear plugs or ear muffs can be provided to reduce the amount of noise that is actually received by the ear.

The history of workers was not established in order to determine their exposures outside the work place as well as their age, health status and length of service at that particular abattoir. This information could have helped to determine in case of noise-induced hearing loss whether the loss was mainly due to their present work.

It would be very difficult to compare this study with others that were done previously since the author could not identify similar studies in South Africa and elsewhere.
The researcher is not aware of any similar study conducted previously in South Africa with the aim of evaluating the potential hazard to hearing because of over- exposure in abattoirs, and therefore recommends that this study be viewed as a sensitisation tool to stimulate interest in this industry so that further investigations may be undertaken and safety guidelines developed.

3.7 REFERENCES

Anderson, J.S. and Anderson M.B. 1993. Noise its measurement, analysis, rating and control. Great Britain: Ashgate Publishing Limited. 95-107.

Barker, D.E. 1993. Noise: The invisible hazard. National Ag Safety Database. University of Missouri. Columbia.

Bell, L.H. and Bell, D.H. 1994. Industrial noise control fundamentals and applications. Second edition. New York, USA: Marcel Dekker, Inc. 151-190**.**

Bhaskar, N., Hens, L., Compton, P. and Devuyst, D. 1999. Environmental Management in Practice. United Kingdom: Rouledge.

Blanchard, N. 1998. The Quietest War: for Americans, noise pollution is no joke. *The Environmental Magazine*. 1-2.

Bruce, R.D., Bommer, A.S. and Moritz C.T. 1997. Noise, vibration and ultrasound: The occupational environment - its evaluation and control. The American Industrial Hygiene Association (AIHA). Virginia. USA. 425-488.

Canadian Centre for Occupational Health and Safety (CCOHS). 2005. Canada :Noise – Occupational Exposure Limits in Canada.

Concha-Barrientos, M., Campbell-Lendrum, D. **and Steenland, K.** 2004. Occupational Noise: Assessing the burden of disease from work-related hearing

impairment at national and local levels. Protection of Human Environment. World Health Organisation. Environmental Burden of Disease Series, No. 9. Geneva.

Eleftheriou, P.C. 2001. Industrial noise and its effects on human hearing. *Applied Acoustics 63.* Cyprus. 20 March, 2001. 35-42.

Environmental Protection Agency (EPA). 1999. Environmental noise control: A manual for industrial noise criteria for abattoir. Australia. 2-3 [http://www..epa.nsw.gov.au/mao/abattoir.htm#aim]. Date of access: 20.04.2005.

Gracey, J.F. 1986. *Meat Hygiene.* Eighth edition. Great Britain: British Library Cataloguing in Publication Data. 82-90.

Health and Safety Executive (HSE). 2002. Reducing noise exposure in the food and drink industries: Guidance on the noise at work regulations UK.

Hermann, E.R. 1976. Biomechanics of human hearing. Noise Control Engineering. USA. 6: 9-12.

International Standards Organisation. R1999. 1971. Assessment of occupational noise exposure for hearing conservation purposes. Geneva, Switzerland: International Organisation for Standardization.

Leech J.F. and Squires M. 1999. Noise. Clays handbook of environmental health. Eighteenth edition. London: E & FN Spon. 705-726.

Lusk, L.S., Hagerty, B.M., Gillespie, B and Caruso, C.C. 2002. Chronic Effects of Workplace Noise on Blood Pressure and Heart-rate. Archives of Environmental Health.

MacMillan, R. 1999. Noise Control Management. Australia: The Safetyline Institute. http://www.safetyline.wa.gov.au/institute/level2/course18/lecture137/1137-01.asp. [Date of access] 02.06.2003.

Mine Safety and Health Administration (MSHA). 1999. Health Standards for occupational noise exposure: Health standards to protect miners from hearing loss. United States Department of Labour.

National Institute for Occupational Safety and Health (NIOSH). 1998 (a). Criteria for a recommended standard; instrumentation for noise measurement. Ohio: National Institute for Occupational Safety and Health. 33-35.

National Institute for Occupational Safety and Health (NIOSH). 1998 (b). Criteria for recommended standards: occupational noise exposure. Revised criteria. Cincinnati. OH: National Institute for Occupational Safety and Health.

Occupational Safety and Health Administration (OSHA). 1992. Occupational Noise Exposure. 29 Code of Federal Regulations, 1910.95. Occupational Health and Safety Administration, US. Washington D.C: Government Printing Office.

Park, M. 2003. Assessment of potential noise-induced hearing loss with commercial "Karaoke" noise. *International Journal of Industrial Ergonomics.* South Korea. 30 January, 2003. 375-385.

Plog, B.A., Nilland, J. and Quinlan, P.J. 1995. Fundamentals of industrial hygiene. Fourth Edition. United States of America: National Safety Council.

Rabinowitz, **P.M.** 2000. Noise-induced hearing loss. *American Family Physician.* Volume 61, No. 9. USA: The American Academy of Family Physicians.

Schoeman, J.J. and Schröder, H.E. 1994. Occupational Hygiene. Second Edition. Juta and Co. South Africa. 205-216.

South Africa. 1993. Occupational Health and Safety Act, Act 85 of 1993. South Africa Republic. Pretoria: Government Printer.

South Africa. 2003. Noise-Induced Hearing Loss Regulations, 2003. South Africa Government. Pretoria: Government Printer.

South African National Standards (SANS). 2002. SANS 10083, 2002. Code of Practice: Measurement and Assessment of Occupational Noise for Hearing Conservation. South Africa Government. Pretoria: Government Printer.

South African National Standards (SANS). 2004. SANS 10083, 2004. Code of Practice: Measurement and Assessment of Occupational Noise for Hearing Conservation. South Africa Government. Pretoria: Government Printer.

Suter, A.H. 1994. Comments on Occupational Noise to the Occupational Safety and Administration Standards Planning Committee. Docket No. C-04. November. USA.

United States. 2000. Compliance Guide: Occupational Noise Exposure Standard. Mine Safety and Health Administration. United States Department of Labour.

Van Zyl A. P. 1995. *Manual for the abattoir Industry.* First edition. The Red Meat Abattoir Association. South Africa. 56-61, 20-37.

Walsh, P. 1999. Noise and air pollution in the food industry: Sources, control, and cost implications. Food Industry and the Environment in the European Union. (Practical issues and cost implications). Second edition. UK: Aspen Publication. 79-85.

CHAPTER 4

CHARACTERISATION AND COMPARISON OF PERSONAL NOISE EXPOSURE LEVELS DURING THE SLAUGHTER OF CATTLE AND SHEEP IN THE FREE STATE ABATTOIRS

4.1 INTRODUCTION

People were exposed to noise even before the industrial revolution. The problem was exacerbated by an increase in the mechanisation of processes in industries (Standard, 1996; Concha-Barrientos, Campbell-Lendrum and Steenland, 2004). The most important health effect of occupational noise is hearing impairment (Concha-Barrientos, Campbell-Lendrum and Steenland**,** 2004). Hearing loss in developing countries has increased due to occupational and non-occupational noise exposure (Park, 2003; WHO, 1999). However, previous studies have indicated that regular exposure to high noise levels often results in some form of hearing loss due to damage of the delicate cells in the inner ear (Standard, 1995; Sharma, Mohanan and Singh, 1997; Bruce, Bommer and Moritz, 1997; Rabinowitz, 2000; Mine Safety and Health Administration, 2000; Eleftheriou, 2001). The National Institute for Occupational Safety and Health (NIOSH) has confirmed that repeated exposure to noise levels that can damage hair cells eventually leads to permanent hearing loss (NIOSH, 1998). It can cause damage to the employee's hearing immediately if the noise level exceeds the standard, and regular continuous exposure to excessive noise levels may result in permanent and incurable hearing loss (Leech and Squires, 1999). According to legislation, it is necessary for employers to ensure a safe work environment (South Africa, 1993).

Noise exposure of 85dB(A) for 8 hours per day is not recommended in the work environment because it has been scientifically proven that noise exposures at or even below the above mentioned rating level can cause disturbance, reduce performance and can cause hearing threshold shifts (Walsh, 1999). The Noise-Induced Hearing Loss (NIHL) regulations require that a noise assessment be done. This assessment should be done at intervals not exceeding two years, to determine whether any person is exposed to noise which is at or above the noise rating limit of

85dB(A), regardless of whether any personal hearing protectors are used (South Africa, 2003).

4.2 THE PROBLEM STATEMENT

Excessive noise levels can produce a hazardous work environment and may also mask warning signals. This problem is common, especially in industries that utilise many different types of machinery (World Health Organisation, 1997). The noise level increases with the horsepower incensement of pneumatic machines (World Health Organisation, 1997).

Noise at work poses a potential risk to the hearing of workers and is usually neglected especially in the abattoir industry (Standard, 1996; Health and Safety Executive, 2002). There is a combination of both continuous and impulse noise present in the abattoir and abattoir workers are subjected to a variety of noise sources on the slaughter floor. Prominent noise sources that were identified on the slaughter floor include electric motors, circular saw blades used for de-skinning the carcasses, conveyors, trolleys, compressed air and air conditioners. The noise generated by these identified noise sources contributed significantly to the overall noise level (Sharma, Mohanan and Singh, 1997) recorded on the slaughter floor. There is a possibility that the noise exposure levels in abattoirs may exceed the recommended levels and therefore threaten the hearing, health and general well-being of workers (Gracey, 1986).

4.3 AIM AND OBJECTIVES

4.3.1 Aim of this section of the study

The aim of this section of the study was to characterise and compare personal noise exposure levels of different throughput Free State abattoir workers during the slaughter of cattle and sheep.

4.3.2 Objectives of the study

The specific objectives for this part of the study included:

- the determination of the personal noise exposure level during the slaughter of cattle and sheep in different throughput abattoirs;
- a comparison of the results with the noise rating limit of 85dB(A); and
- a recommendation to the abattoir industry regarding control measures to protect the workers' hearing.

4.4 MATERIALS AND METHODS

A list of abattoirs was obtained from the Public Health section of the Bloemfontein Veterinary Laboratory, Department of Agriculture. Due to financial and time constraints, only those Grade A, C, and D abattoirs situated within a radius of 150 km of Bloemfontein were selected. From this population, three abattoirs in each category were then randomly selected.

In this study a sample of 12 employees, two from each abattoir, were selected, depending on the type of work they performed. The floor supervisor and an employee who transports heads and feet from the slaughter floor to the conveyor shafts were selected. They wore the Micro-18 QUEST (Amtronix (PTY) Ltd. South Africa) noise dosimeters for an entire work shift. They were selected because they were not stationed at one working station but moved among the different noise sources on the slaughter floor. It was assumed that they would represent employees at different work stations.

Personal noise exposure for each subject was determined using the standard procedure as stipulated in the South African National Standards 10083: 2002, Code of Practice for measuring and evaluating noise for the purposes of hearing conservation (South African National Standards, 2002). Personal noise exposure was measured with the two calibrated personal QUEST Micro-18 noise dosimeters (Amtronix (PTY) Ltd. South Africa) that complied with the requirements of SABS IEC 804 and with accuracy performance requirements of SABS IEC 651. The equipment

was calibrated beforehand by the CSIR using specifications in IEC 942 for type 1 calibrators, and calibration was checked before and after measurement to ensure accuracy of results using the QUEST CA-22 calibrator. The noise dosimeter was carried by the employee with the microphone attached to his collar as close as possible to the ear, for the entire work shift (Schoeman and Schröder, 1994).

Windshields were used to cover microphones to prevent the results from being influenced by wind noise. Although there are no published corrections for dealing with meter or microphone vibration (Bell and Bell, 1994), care was taken to avoid exposing the instruments to any form of excessive vibration during transportation whenever possible.

The sampling time depended on the number of animals slaughtered per day and it varied for each day and also according to species. The average personal noise exposure level in each abattoir was calculated.

Noise exposure levels were recorded for the entire work shift during the slaughter of each species. The measurements were taken at least three times in each abattoir during the slaughter of both cattle and sheep.

4.5 RESULTS AND DISCUSSION

The average personal noise exposure levels for Free State abattoir employees in Grade A, C and D abattoirs during the slaughter of cattle and sheep are illustrated in Figure 4.1. A total of 12 employees, six from Grade A, four from Grade C and two from Grade D abattoirs, were included in the sample.

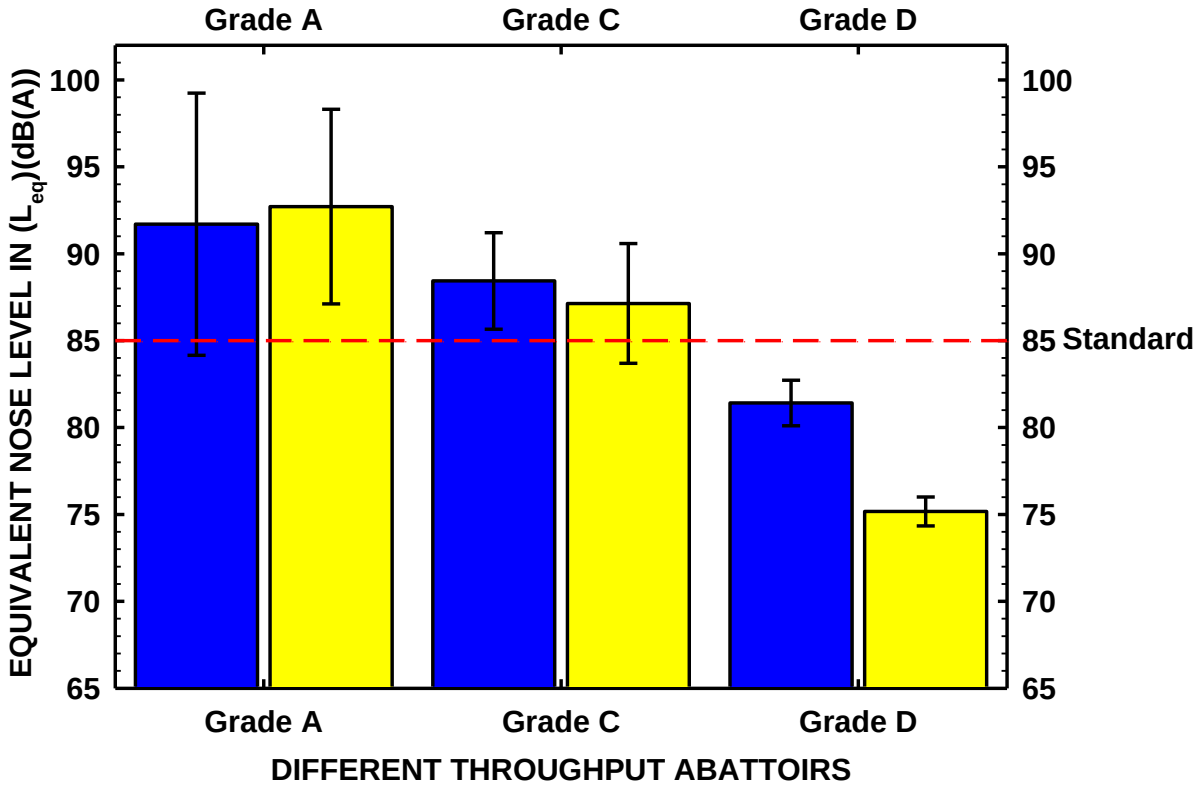

FIGURE 4.1: Personal noise exposure level (L_{eq})(dB(A)) for different throughput abattoirs

The average personal noise exposure levels of abattoir workers in Grade A and Grade C abattoirs exceeded the South African exposure limit of 85dB(A) (South Africa, 1993; South Africa, 2003; South African National Standards, 2004). The workers in these categories of abattoirs are overexposed. Lower noise exposures were observed in Grade D although in these abattoir levels are higher than 80dB(A) during the slaughter of cattle, which is above the international First Action Level for noise exposures in the workplace (Concha-Barrientos, Campbell-Lendrum and Steenland, 2004). Although the noise exposure levels in Grade D abattoirs seem to be low, they could still disguise warning signals and therefore put the workers at risk of becoming injured (Occupational Safety and Health Administration, 1992).

There appears to be some difference in the average exposure level between cattle and sheep during the slaughter process, though there were no statistically significant differences (P>0.05).

The highest average personal noise exposure level (L_{eq}) recorded during sheep slaughter was 99.78dB(A) while 99.74dB(A) was recorded during cattle slaughter. The same slaughter floor is used for the slaughter and dressing process of both species, but each species follows a different production line because different equipment is used during the slaughter of cattle and sheep (Gracey, 1986). For instance, in most cases a sheep skin is removed using a knife while circular saws are used to remove skin from cattle carcasses. More items of equipment and machinery are used during the slaughter and dressing process of cattle than sheep, yet the noise exposure levels are higher for sheep than for cattle. This may suggest that the amount of noise produced on the slaughter floor cannot be solely attributed to the nature and number of items of machinery and equipment used on the slaughter floor. However, it has been proven in previous studies that the circular saw blades alone can produce a noise level of up to 100dB(A) (Health and Safety Executive, 2002; Peterson, 1991; Czuchaj, Śliwiński and Środecki, 2001 and World Health Organisation, 2001). Individual equipment and machinery were not monitored in this study and therefore the contribution of each could not be determined to identify which ones contributed more towards the high noise levels on the slaughter floor, especially in the Grade A category of abattoirs.

The number of cattle and sheep slaughtered per day might be the same, but it takes more time to slaughter and dress cattle than sheep, because of the processes involved as well as the different sizes of these species. As a result, the hourly throughput for sheep is higher than for cattle. This may suggest that the workers will still be exposed for longer periods to unacceptable noise levels during the slaughter of cattle and therefore the slight difference in the highest levels recorded does not reduce the noise dose that the worker receives and therefore the negative effects that these noise levels might have on the worker's hearing (Clark and Bohne, 1999). There is a high degree of variability in the time that individuals spend performing different tasks per day and this may expose them to different noise levels (Bruce,

Bommer and Moritz, 1997), which is why the average noise exposure for the work - shift was determined.

The type of noise generated on the slaughter floor is highly variable, and depends on the area in which the worker spends most of his time. A number of factors which determine the noise levels in and around an area include the number and relative position of machines as well as the level of noise emitted by each, their size and the size of the area where they are situated as well as the type of surroundings (Leech and Squires,1999). The workers might contribute to the noise level because of their actions, for example dropping tools and equipment on the floor or pulling carriages for long distances across the floor. Faulty equipment may cause the sound to change and either increase or decrease the level of noise recorded.

It is required by law in South Africa that whenever employees are exposed to a noise rating limit at or above 85dB(A) in the workplace, a hearing conservation programme must be in place (South African National Standard, 2002). Through observation it was determined that only one abattoir included in the study provided hearing protection devices to their employees. The employees however, either did not wear hearing protectors at all or not for the entire work shift. This could suggest a lack of training and education of employees. Generally, it seems as though there was no hearing conservation programme in any of the abattoirs investigated although provision of the hearing protection devices in one abattoir would suggest that the employer was aware of a possible noise hazard.

According to the World Health Organisation (WHO), (1997), noise levels below 80dB(A) are considered less harmful to human hearing although they may have some non-auditory effects on the human body (World Health Organisation, 1997). Section 21 of the Occupational Health and Safety Administration also states that noise levels above the exposure limit may still be hazardous since they may cause fatigue, stress and communication problems (OSHA, 1992; Mine Health and Safety Inspectorate, 2003). If the calculated dose exceeds 85dB(A), however, employees must be part of a comprehensive hearing conservation programme (Bruce, Bommer and Moritz, 1997). Peterson (1991) however, argued that the safe continuous noise exposure level is not known for man (Peterson, 1991), because the length of

exposure plays a significant role to human health and hearing, at any level (Peterson, 1991). Therefore, employers should protect workers from being exposed to noise levels above those recommended by both national and international agencies as safe exposure limits.

In this study two individuals were monitored simultaneously in every abattoir. Their overall exposure was determined by calculating the average exposure for the entire work shift.

Generally Grade A abattoirs emit noise levels exceeding 85dB(A), and therefore exceed national standards applicable to noise generated at the workplace, as well as the levels set by OSHA (Occupational Safety and Health Administration, 1992). The Health and Safety Executive also reported that compressed air equipment could emit noise levels of 85-95dB(A), while other saws, cutting machinery, blast chillers, freezers and manually wheeled trolleys which are used intensively in abattoirs produce between 85 and 107dB(A) (Health & Safety Executive, 2002). The World Health Organisation also state that noise levels of saws can be as high as 106dB(A) (World Health Organisation, 2001).

The exposure time of workers differed depending on the number of animals slaughtered each day. Therefore the shift duration varied between 2 and 10 hours. This was an unforeseen problem as some animals were slaughtered for longer periods than others and it might have influenced the outcome and therefore the potential impact on the employee's hearing. According to the World Health Organisation, both the amount of noise and the exposure time determine the amount of damage to the inner ear (World Health Organisation, 2001). There was an unexpected large variation in dose measurements even with the same worker because of continuous movement to different places on the slaughter floor.

It is very difficult to detect health problems associated with exposure to noise as the effects build up gradually over time. Therefore, it would be advisable to monitor noise exposure at all levels because previous studies have indicated that even if noise exposures do not exceed the legal ratings, it could cause annoyance, reduce

performance and still cause hearing threshold shift of about 20 to 25dBA (Irle, Hesse and Strasser, 1996; Rabinowitz, 2000).

According to a review study done by Heggings (Heggings, 1998) on previous research done (Sataloff and Sataloff, 1987), there was no real evidence of a difference between noise-exposed workers and their controls with respect to the changes in hearing level during the course of their follow-up audiograms one and two years after the initial audiograms.

Noise Dosimeters had to be worn for the entire work shift during the slaughter of the species of interest. The performance of noise dosimeters can be affected largely by the working habits and job assignments of the individual (Eleftheriou, 2001) and this accounts for the large variation in the figures that were recorded daily.

Table 4.1 illustrates the average maximum noise exposure levels in different grade abattoirs during the slaughter and dressing process of cattle and sheep. The highest values were recorded in the Grade A abattoir category during the slaughter of cattle and sheep while the lowest values were found in Grade D abattoirs.

TABLE 4.1: Maximum personal noise exposure levels (dB(A)) of employees in different throughput abattoirs

GRADE A		GRADE C		GRADE D	
CATTLE	**SHEEP**	**CATTLE**	**SHEEP**	**CATTLE**	**SHEEP**
115.69±4.63	115.70±4.99	110.78±5.14	110.69±4.35	99.98±10.03	93.55±0.21

The results indicate that workers in different throughput abattoirs are exposed different noise levels. The statutory threshold limit in South Africa is 85dB(A) (South African National Standard, 2004). Therefore workers are not supposed to be exposed for any length of time to levels at or above this limit without a proper hearing conservation programme in place to protect the workers from damaging their hearing (South African National Standard, 2004).

4.6 RECOMMENDATIONS AND CONCLUSION

This part of the study revealed that workers in the abattoirs are exposed to high noise levels; therefore, it is recommended that noise should be regularly monitored to create awareness of the possibility of hazardous exposure at work and the effects associated with overexposure. While it is evident that occupational exposures to noise in abattoirs is unavoidable because of the type of equipment used and specific processes, these exposures could be minimised by the proper use of personal protective equipment and by engineering control measures.

Concha-Barrientos, Campbell-Lendrum and Steenland confirmed in their report to the WHO report that occupational noise remains a problem in all regions of the world and it is only through appreciating noise as a hazard and providing the necessary protection that the incidence of NIHL could be reduced (Concha-Barrientos, Campbell-Lendrum and Steenland, 2004).

Noise monitoring agencies worldwide recommend that whenever workers are likely to be exposed to noise levels at or above the 85dB(A), they should be provided with information, education and training (South Africa, 2003; United Kingdom, 2005). The education and training should include noise exposure levels, the risk associated with this exposure and preventative measures (Suter, 1994; Merry and Franks, 1995; Sollberger, Tubbs, McCleery and Achutan, 2004; Smith, 1998). Workers need to be involved in the decision- making processes that involve their health.

In the United Kingdom, the Control of Noise at Work Regulations (2005) and the management of Health and Safety at Work Regulations (1999) require that workers that are exposed to noise levels above the noise rating limit should be provided with appropriate health surveillance in order to detect early signs of hearing damage in order to reduce the risk of NIHL (United Kingdom, 1999; United Kingdom, 2005). Thus a more comprehensive investigation is required to determine the contribution of each type of machinery and equipment as well as other factors that might influence the overall noise level on the slaughter floor.

Engineering and administrative control measures to reduce the level of noise at the source and reducing the amount of time that the workers are exposed to

unacceptable levels of noise appear to be the most effective means of hearing conservation (Bruce, Bommer and Moritz, 1997).

Manufacturers need to notify users of the potential dangers associated with the use of equipment and provide information on how workers can be protected, if they cannot design equipment that does not impact on the health and safety of the workers (Bruce, Bommer and Moritz, 1997). The Noise-induced Hearing Loss Regulations (2003) and the Noise at Work Regulations (1989) also require that whenever an employer suspects that workers are likely to be exposed to unacceptable noise levels, he should ensure that a competent person carries out an investigation and informs the workers about the noise level that they are exposed in order to facilitate compliance with the regulations (United Kingdom, 1989; South Africa, 2003).

The abattoir industry is a workplace with multiple sources of noise and workers travel among these sources to perform a variety of operations during the day. It is assumed that they are subjected to different noise levels. It would be advisable to focus control efforts more on equipment and machinery than on personal protection equipment. Therefore, a more comprehensive study is recommended to measure the contribution of each machine so that sources that emit high noise levels can be identified and where possible engineering control measures applied with regard to the particular machinery or equipment.

4.7 REFERENCES

Bell, L.H. and Bell D.H. 1994. Industrial Noise Control Fundamentals and Applications. Second edition. Marcel Dekker, inc. New York, USA. 151-190.

Bruce, R.D., Bommer, A.S. and Moritz C.T. 1997. Noise Vibration and Ultrasound: The Occupational Environment - Its Evaluation and Control. A*merican Industrial Hygiene Association (AIHA).* Virginia. USA. 425-488.

Clark, W.W. and Bohne, B.A. 1999. Effects of Noise on Hearing. *JAMA.* 281: 1659-9.

Concha-Barrientos, M., Campbell-Lendrum, D. **and Steenland, K.** 2004. Occupational Noise: Assessing the burden of disease from work-related hearing impairment at national and local levels. Protection of Human Environment. World Health Organisation (WHO). Environmental Burden of Disease Series, No. 9. Geneva.

Czuchaj, J., Sliwinski, A. and Srodecki, K. 2001. Noise sources and acoustic properties of workrooms in the plants of food-processing and pharmaceutical industry. *Applied Acoustics.* Poland. 1141-1156.

Eleftheriou, P.C. 2001. Industrial Noise and its Effects on Human Hearing. *Applied Acoustics. Cyprus.* 35-42.

Gracey, **J.F.** 1986. Meat Hygiene. Eighth edition. British Library Cataloguing in Publication Data. London. 129-152, 185-194, 197-190.

Health and Safety Executive (HSE). 1989. Reducing noise exposure in the food and drink industries: Gudance on the noise at work regulations 1989. United Kingdom.

Heggins J. 1998. Effects of Industrial Noise on Hearing. 1-5. Http://hubel.sfasu.ed/courseinfo/sl98/hearing.html. [2004/07/08].

Irle, H., Hesse, J.M. and Strasser, H. 1996. Physiological cost of energy-equivalent noise exposures with a rating level of 85 dB(A): Hearing threshold shifts associated with energetically negligible continuous and impulse noise. *International Journal of Industrial Ergonomics 21.* Germany. 451-463.

Leech, J.F. and Squires M. 1999. Environmental Health: Noise. Eighteenth edition. E & FN Spon. London and New York. 705-726.

Merry, C.J. and Franks, J.R. 1995. Historical assessment and future directions in the prevention of occupational hearing loss. *Occupational Medicine.* July. 10 (3): 669-681.

Mine Safety and Health Administration. 2000. Occupational Noise Exposure Standard. United States Department of Labor. United States.

Mine Health and Safety Inspectorate. 2003. Guideline for the Compilation of a Mandatory Code of Practice for and Occupational Health Programme for Noise. Department of Minerals and Energy. South Africa.

National Institute for Occupational Safety and Health (NIOSH). 1998. Criteria for Recommended Standards: Occupational Noise Exposure. Revised criteria. Cincinnati. OH. National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 98-126. United States. 11-38.

Occupational Safety and Health Administration (OSHA). 1992. Occupational Noise Exposure. 29 Code of Federal Regulations, 191095. Occupational Health and Safety Administration, US. Government Printing Office. Washington D.C.

Park, M. 2003. Assessment of potential noise-induced hearing loss with commercial “Karaoke” noise. *International Journal of Industrial Ergonomics.* South Korea. 375-385.

Peterson, J.E. 1991. Industrial Health. Second revised edition. American Conference of Governmental Industrial Hygienists, Inc. Cincinnati, Ohio. 194-197, 206-207, 215-216.

Rabinowitz, P. M. 2000. Noise-Induced Hearing Loss. *American Family Physician.* Volume 61 No. 9. May 1, 2000. New York. USA.

Sataloff, R.T. and Sataloff, J. 1993. Occupational Hearing Loss. Second edition. Marcel Dekker Inc: New York.

Schoeman, J.J. and Schröder, H.E. 1994. Occupational Hygiene. Second edition. South Africa: Juta and Co. 222-228.

Sharma, O., Mohanan, V. and Singh, M. 1997. Noise Emmision Levels in a Coal Industry. New Delhi, India: National Physical Laboratory.

Smith, A.W. 1998. Noise and Health: The World Health Organisation and the Prevention of Deafness and Hearing Impairment Caused by Noise. *nRn Publications.* Volume 1. No. 1. 6-12 (7*).*

Sollberger, R., Tubbs, R., McCleery, R. and Achutan, C. 2004. Occupational exposure during cement tile cutting with portable saws. *American Industrial Hygiene Association.* May: 74.

South Africa. Department of labour. 1993. Occupational Health and Safety Act (Act 85 of 1993). Pretoria: Government printer.

South Africa. Department of Labour. 2003. Noise-Induced Hearing Loss Regulations. Pretoria: Government Printer.

South African National Standards. 2002. SANS 10083: 2002. Code of Practice: Measurement and Assessment of Occupational Noise for Hearing Conservation Purposes. South Africa. Pretoria: Government Printer.

South African National Standards. 2004. SANS 10083: 2004. Code of Practice: Measurement and Assessment of Occupational Noise for Hearing Conservation Purposes. Pretoria: Government printer.

Standard, J.J. 1996. Fundamentals of Industrial Hygiene: Industrial Noise. Fourth edition. National Safety Council. USA. 197-245.

Suter, A.H. 1994. Comments on Occupational Noise to the Occupational Safety and Administration Standards Planning Committee. Docket No. C-04. November. USA.

United Kingdom, 1989. The Noise at Work Regulations, 1989. Statutory Instrument 1989 No, 1790. Restormel Borough Council. United Kingdom.

United Kingdom. 1999. The Management of Health and Safety at Work Regulations, 1999. Health and Safety Executive (HSE). United Kingdom.

United Kingdom. 2005. The Control of Noise at Work Regulations, 2005. Statutory Instrument 2005 No. 1643. United Kingdom.

Walsh, P. 1999. Noise and Air Pollution in the Food Industry: Sources, Control, and Cost Implications. Second edition. United Kingdom: Aspen Publication 79- 85.

World Health Organisation. 1997. Prevention of Noise-Induced Hearing Loss. Report of a WHO-PDH informal consultation. Geneva.

World Health Organisation. 1999. Guidelines to Community Noise: Adverse Health Effects of Noise. London. UK.

World Health Organisation. 2001. Occupational and Community Noise. Fact Sheet No 258. Media Centre. Geneva.

CHAPTER 5

COMPARISON OF NOISE EXPOSURE LEVELS IN DIFFERENT THROUGHPUT ABATTOIRS DURING THE SLAUGHTER OF CATTLE AND SHEEP

5.1 INTRODUCTION

Noise is not a new hazard, especially in industry. It has been declared as one of the most common occupational hazards in many industries (Rabinowitz, 2000). A report issued by the World Health Organisation (WHO) in 2001 pointed out that globally about 120 million people had problems associated with work-related hearing loss (WHO, 2001). This information was further confirmed in 2002, and it was added that noise induced hearing loss (NIHL) is one of the most reported and common occupational illnesses at present (Toran, 2002).

Noise can affect heart rate and blood pressure. Research has recently indicated that it may induce hypertension and cardiovascular disease (Tomei, Fantini, Tamao, Baccolo and Rosati, 2000). Continuous exposure to high levels of noise can cause hearing loss (Sharma, Mohanan and Singh, 1997). Excessive noise can also interfere with speech communication (Schoeman and Schröder, 1994; Bruce, Bommer and Moritz, 1997). Employees cannot communicate with each other while working in noisy environments (Goeltzer, Hansen and Sehrndt, 2001), and the possibility of accidents increases because warning signals may be missed (Rabinowitz, 2000).

Many countries have developed guidelines and legislation to ensure that employees are protected from excessive noise in their working environment (MacMillan, 1999; World Health Organisation, 1997). The South African Occupational Health and Safety Act, Act 85 of 1993, states that no employer shall allow any employee to work in an environment with an equivalent noise level equal to (L_{eq}) or exceeding 85dB(A) (South Africa, 1993). The Noise-Induced Hearing Loss Regulations, (2003) require an employer to ensure that an assessment be done at intervals not exceeding two years to determine whether any person is exposed to noise which is at or above the noise-rating limit, regardless of whether hearing protectors are used. The results must be recorded as required by the regulation (South Africa, 2003).

In South Africa, there is little or no comprehensive data available on noise induced hearing loss (NIHL) as a result of excessive exposure at work, especially in abattoirs (Van Zyl, 1995). There is generally no reporting system in place regarding the economic impact of occupational hearing loss in abattoirs (Toran, 2002). Therefore, this study was conducted to categorise the noise exposure of employees in the different throughput abattoirs during the slaughter of cattle and sheep.

5.2 AIM AND OBJECTIVES

5.2.1 Aim of this section of the study

The aim of this section of the study was to characterise noise exposure in different throughput abattoirs in the Free State.

5.2.2 The objectives of this section of the study include:

- a comparison of noise exposure levels in the different throughput abattoirs during the slaughter of cattle and sheep;
- a comparison of the results with the South African National Standard for noise exposure at work; and
- recommending to the abattoirs that they acknowledge noise exposure as an existing hazard in their industry and duly take precautionary measures against unacceptable exposure levels.

5.3 MATERIALS AND METHODS

A list of all Free State abattoirs was obtained from the Public Health Department of the Veterinary Services in Department of Agriculture, Bloemfontein. Grade A, C, and D abattoirs within a radius of 150 km of Bloemfontein were selected to represent the study area. Three abattoirs in each category were included in the sample.

Environmental monitoring was conducted with two calibrated Type 1 Quest 1800 precision integrating sound level meters while a QUEST Micro-15 noise dosimeter was used for personal monitoring. The instruments complied with the requirements of IEC 804 and the accuracy performance requirements of IEC 651. The calibration

was checked with a QUEST CA-22 sound source before and after measurements to ensure validity and reliability of results.

The noise measurements were made using standard procedures as stipulated in the SANS 10083: 2002, Code of Practice for measuring and evaluating noise for the purposes of hearing conservation (South African National Standard, 2002). The recommended standard is 85dB(A) (South Africa, 1993; South African National Standard, 2004; Eleftheriou, 2001).

The averages and standard deviations were used to characterise the noise exposure in different throughput abattoirs during the slaughter of cattle and sheep.

5.4 RESULTS AND DISCUSSION

Figure 5.1 illustrates the equivalent noise level in different throughput abattoirs during the slaughter of cattle and sheep. The actual values measured in the different throughput abattoirs are shown in Table 5.1below.

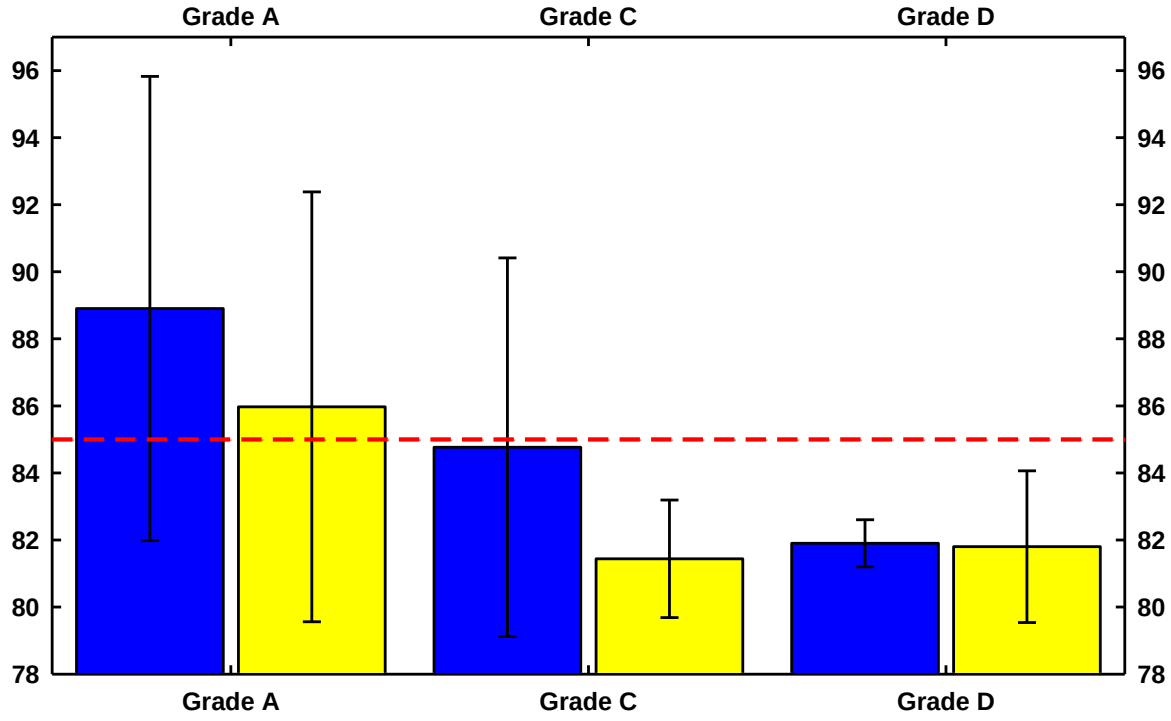

FIGURE 5.1: The environmental equivalent noise levels (L_{eq_j}) (dB(A)) in different throughput abattoirs for the slaugther of cattle and sheep

TABLE 5.1: The environmental equivalent noise levels (Leq) (dB(A)) in different throughput abattoirs during the slaughter of cattle and sheep

Grade A		Grade C		Grade D	
Cattle	**Sheep**	**Cattle**	**Sheep**	**Cattle**	**Sheep**
88.90±6.9231	85.97±6.4094	84.77±5.6471	81.44±1.7536	81.90±0.7014	81.80±2.2627

In figure 5.1, the equivalent environmental noise exposure levels are indicated for the selected Grade A, C and D abattoirs. The red line as in previous chapters indicates the South African noise rating limit for hearing conservation purposes. The highest value was recorded in Grade A abattoir during the slaughter of cattle and the lowest value was recorded in Grade C abattoir during the slaughter of sheep.

According to figure 5.1 the average noise exposure levels in Grade A abattoirs is above 85dB(A) irrespective of the species although the average for cattle was 2.93dB(A) higher than the average for sheep. In Grade C and Grade D the average noise exposure level is below the standard. The average for cattle in Grade C abattoirs was just 0.33dB(A) below the noise rating limit. The actual values (averages) are illustrated in table 5.1.

TABLE 5.2: Average noise exposure levels for personal sampling in different throughput abattoirs during the slaughter of cattle and sheep

	L_{eq} (dB A)	
	Cattle	**Sheep**
Average	88.6895 ± 6.7143	88.2186 ± 7.4634
P- value	0.8487	

Table 5.2 illustrates the equivalent noise levels (dB(A)) for the slaughter of the different animal species. According to these results there is no statistically significant difference ($P > 0.05$) between the noise exposures during the slaughter of the two species. However, there were differences in noise levels that were observed during the slaughter of these species and the noise exposure was high for cattle and lower for sheep in different categories of abattoirs, as well as for abattoirs within the same Grade.

According to the South African National Standard 10083: 2002, the L_{eq}, 8-hour is 85dB(A) for continuous and composite measurements (South African National Standard, 2002). This level was also used as a reference to measure compliance with the South African and Occupational Safety and Health Administration permissible noise exposure level.

Workers in Grade A abattoirs seem to be overexposed to noise, which exceeds the national and international standards applicable to noise generated in the workplace, as well as the levels set by Occupational Safety and Health Administration. The highest value was measured in this category of abattoirs during the slaughter of cattle, and the second highest value was recorded during the slaughter of sheep. The lowest value was recorded in Grade C abattoirs during the slaughter of sheep, although physically it appears that there is only a slight difference between the values recorded in Grade C and D abattoirs.

The highest levels in Grade A abattoirs might be because of the type of equipment that is used as well as the number of animals slaughtered per hour. Some Grade A abattoirs slaughter ± 900 cattle and more than 800 sheep per day during high demand periods. This depends a great deal on the capacity and size as well as the daily throughput of the abattoirs in this category. Most of the processes are mechanised in order to speed up the process and to meet daily demands or targets. Electrified and motor-driven equipment is used extensively. For example, powered electric saws which use compressed air and water to remove skin from the carcass are believed to produce much noise when in operation. Individual equipment was not monitored to determine the contribution of each towards the overall noise level on the slaughter floor.

The noise levels indicate that the noise generated by all prominent sources like electric motors, circular saw blades during de-skinning, chain conveyors, trolleys, compressed air, air conditioners and many others that were identified on the slaughter floor during the slaughter and dressing process is above the recommended standards. Regardless of the category of the abattoir, most of them emit noise levels exceeding 85dB(A), and therefore exceed international standards applicable to noise generated the workplace, as well as the levels set by Occupational Safety and Health

Administration. Although individual machines were not monitored, the Health and Safety Executive reported that powered saws can emit up to 100dB(A), compressed air equipment 85-95dB(A), other saws, cutting machinery, blast chillers and freezers as well as manually pushed wheeled trolleys which are used intensively in abattoirs, between 85 and 107dB(A) (Health and Safety Executive, 2002).

These measurements also confirm that environmental noise levels normally found in abattoirs exceed the allowable exposure values. For example, the minimum noise level measured for high throughput abattoirs was 74.55dB(A) for cattle and 74.25dB(A) for sheep, which is well above the minimum noise level set by international standards applicable to noise at work (OSHA, 1983).

Even within the same class, abattoirs differed greatly in size, type of equipment used and number of animals slaughtered per hour/day. For example, some abattoirs used two circular saws for de-skinning while others in the same category used about 10 at the same time. Therefore, it cannot be said with certainty that these saws were the sole reason for the high levels of noise recorded on a daily basis. Studies done by the Health and Safety Executive (HSE) indicated that electric (powered) saw blades can produce noise levels of up to 100dB(A) while other meat cutting equipment can produce between 85 and 107dB(A) (Health and Safety Executive, 2002). These are used on a daily basis either to split the carcass in two or to cut open the brisket.

To remove the skin from a sheep carcass, hands and knives are used in almost all the abattoirs sampled. This might be the reason for the lower measurements observed during the slaughter and dressing process of sheep which is evident not only in Grade A abattoirs, but in all three categories of abattoirs. This also supports the contention that electric saw blades used to de-skin cattle carcasses might be responsible for higher noise levels. Grade A abattoirs however still showed noise levels above the recommended standard during the slaughter of sheep. This might be because there are more sheep slaughtered per hour than cattle in Grades C and D abattoirs. The line therefore moves faster and requires the use of electric overhead conveyers and air conditioning systems.

The same trend was observed in Grades A, C and D categories, where higher values were observed during the slaughter of cattle than sheep. This might be because the electric saw blades are used in all the abattoirs to remove the skin from the cattle carcasses while only fists and knives are used to remove skin from the sheep.

The air conditioning systems and extractor fans used in Grade A abattoirs are generally situated on the roof or on the walls within 1 m of the roof. The slaughter floor is relatively quiet when there are no operations in process, but the moment the air conditioners are switched on, even before slaughter can begin, the sound level meter already records sound pressure level between 75 and 85 dB (A). Earlier American research indicated that noise levels produced by air conditioning systems could reach 86.9 dB (A) (Bell and Bell, 1994).

The high noise levels could also be caused by the “Canpack System” employed in these abattoirs, where the overhead conveyor system that is electrically operated is used to transport carcasses from one station to another to complete the slaughter and dressing process. Every time it is switched off during breaks, there is a difference in the noise level audible to the ear. It has been proven that when equipment is switched off, there is reduction in the noise level; therefore the equipment contributes significantly to the total noise level that is produced in the area (Anderson and Anderson, 1993).

The number of workers employed in Grade A abattoirs is higher than the number working in lower graded abattoirs. This might suggest that more people in Grade A abattoirs are exposed to high levels of noise than those in Grades C and D abattoirs. Some Grade D abattoirs slaughter fewer than 10 sheep per day while a Grade C abattoir could slaughter between ten and 100 or sometimes even more, depending on demand and the size of the abattoir, facilities available and the capacity of the abattoir. Abattoirs do not necessarily stick to the slaughter units allowable per day as stipulated in the regulations: these numbers are much lower however than the 300 to 1000 sheep that Grade A abattoirs slaughter per day. Section 8 of the Meat Safety Act, 2000, indicates that the maximum throughput of Grade A (high throughput) abattoirs is determined by the Provincial Executive Officer depending on the hourly

throughput potential, equipment and facilities available (South Africa, 2000). Therefore, the number of slaughter units per day is highly variable.

Although most processes in higher grade abattoirs are mechanised, the time it takes to slaughter 400 or 700 sheep or cattle is still longer than the time it takes to slaughter 7 or 20 animals per day. This could mean that the time of exposure to high levels of noise in Grade A abattoirs is longer than in lower grade abattoirs. Previous studies have indicated that continuous exposure to noise for longer periods increases the risk of noise-induced hearing loss (MacMillan, 1999; Lusk, Hagerty, Gillespie and Caruso, 2002). During this study it was apparent that the times varied from 30 minutes in Grade D abattoirs to more than 4 hours in Grade A abattoirs per day to slaughter the same species.

Generally, there is more equipment on the slaughter floor in Grade A abattoirs than in the other two grades, and the area is bigger. There is a possibility that the sound that is produced is reflected on more surfaces and ends up affecting the level of noise that is actually produced by the equipment (South African National Standard, 2002; Bell and Bell, 1994). There is a great deal of fixed and movable equipment and many fittings in the abattoir which might affect the propagation of sound on the slaughter floor. This differs according to the size of the abattoir and it might have affected the consistency of results as every abattoir is arranged differently. Individual machines were not monitored to quantify the contribution of each to the overall noise level recorded in the particular building.

Although it may seem that the workers in Grades C and D abattoirs are exposed to levels of noise below 85dB(A), this still does not rule out the fact that they might be over-exposed and therefore be at risk of losing their hearing or suffering from other noise-related illnesses that might affect their performance at work and eventually their health in general. It has been proven that exposure to noise on a continuous basis, even at low levels (80dB(A)), could bring about metabolic changes in the body which might eventually result in the threshold shift in the hearing of the individual (Reich, 1995).

There seems to be a physical difference in the noise level in different throughput abattoirs during the slaughter of cattle and sheep. Scientifically, there is no statistically significant difference between the Grade A and the Grade C abattoir ($P > 0.05$), although there is a statistically significant difference between Grade A and D ($P < 0.05$).

5.5 RECOMMENDATIONS AND CONCLUSION

Occupational noise exposures in abattoirs are unavoidable because of the type of equipment and specific processes used. Exposures could be minimised, however, through engineering control measures and the proper use of personal protective equipment (Romeu, Jimenez and Capdevila, 2004).

It is therefore recommended that abattoirs implement hearing conservation programmes to preserve the hearing of workers.

The overall noise level in the abattoir industry is above 85dB(A). Only one abattoir provided ear plugs for the workers, although not all of them wore or used them properly. They just hung them over their shoulders. This indicates a lack of proper user education before issuing protective devices. The workers therefore exceeded the threshold limit value (TLV). Unfortunately screening audiometric tests were not done to quantify the impact.

This study was also able to identify that very little attention is given to protecting the hearing of abattoir workers because, of the nine abattoirs included in the study, only one abattoir provided earplugs for all the workers in noisy zones. The employers are partly responsible because they fail to provide workers with education and protective equipment to preserve their hearing in circumstances where they fail to reduce the noise generated to levels that are regarded as harmless to individuals working in these areas.

Noise dosimeters had to be worn for the entire work shift during the slaughter of the species of interest. It was therefore impossible to get repeated readings, as was the case with the SLMs. This allowed for large variations during daily measurements.

The performance of noise dosimeters was affected largely by the working habits and job assignments of the individuals (Eleftheriou, 2001) and this accounts for the large variation in the figures recorded daily.

This is the first consistent study made in terms of characterisation of noise levels in abattoirs. There were many unforeseen problems encountered during execution of the study. It is therefore strongly believed that this work should be viewed as a pilot study to indicate the need for more comprehensive work in future. It is very important to pay particular attention to the category of the abattoirs to be included in the study, the number of people exposed to excessive levels of noise on a daily basis, the length of time the workers carry the noise dosimeter and whether they leave it on or put it on pause during tea and lunch breaks. Audiometric testing should be included to quantify the extent of damage and the impact on the hearing of workers in the abattoirs.

In order to reduce variability and fully quantify hearing problems in the abattoir, repeated and more measurements are encouraged in future. The number of samples collected and workers who carry noise dosimeters should also be increased, as should the length of time taken for sampling (sampling period). Sampling during peak periods could provide more accurate results since the shifts are busier and longer. The information could then be used to develop guidelines even for the rest of the time when there is normal production.

Section 6 of Noise-Induced Hearing Loss Regulations, 2003, requires from employers that assessment be done at intervals not exceeding two years to determine if any person may be exposed to noise which is at or above the noise-rating limit, regardless of whether any personal hearing protectors are used, and the records of such results be entered into the records as required by the regulation (South Africa, 1993; South Africa, 2003). Therefore, workers should be regularly monitored to determine the effects of overexposure at the earliest possible time (NIOSH, 1998).

Government and international monitoring agencies should require that workers be educated and trained on appropriate working conditions, and could introduce a reward system for acknowledging complying workers.

Noise is not a life-threatening occupational hazard, but it is a costly one to the industry (Peterson, 1991; Sound research Laboratories Ltd., 1991) as well as to the workers, and it needs to be dealt with accordingly.

The most reliable method however would be to reduce noise to levels that would not be harmful to workers or cause injury: this is very complicated and expensive however, and expertise is required to design more effective machinery and equipment with a reduced noise level.

5.6 REFERENCES

Anderson, J.S. and Anderson, M.B. 1993. Noise, its measurement, analysis, rating and control. Great Britain: Ashgate Publishing Limited. 95-107, 135-139.

Bell, L.H. and Bell, D.H. 1994. Industrial noise control fundamentals and applications. Second edition. New York, USA: Marcel Dekker, inc. 60-66, 135-156, 151-190, 175-189, 405-417.

Bruce, R.D., Bommer, A.S. and Moritz C.T. 1997. Noise, vibration and ultrasound: The occupational environment - its evaluation and control. Virginia. USA: *The American Industrial Hygiene Association (AIHA).* 425-488.

Eleftheriou, P.C. 2001. Industrial noise and its effects on human hearing. Cyprus: *Applied Acoustics.* 35-42.

Goeltzer, B.I.F., Hansen, C.H. and Sehrndt G.A. 2001. Occupational exposure to noise: evaluation, prevention and control. Germany: World Health Organisation.

Health and Safety Executive. 2002. Information Sheet. Reducing exposure in the food and drink Industry. United Kingdom.

Lusk, L.S., Hagerty, B.M., Gillespie, B and Caruso, C.C. 2002. Chronic Effects of Workplace Noise on Blood Pressure and Heart-rate. Archives of Environmental Health.

MacMillan, R. 1999. Noise Control Management. Australia: The Safetyline Institute. http://www.safetyline.wa.gov.au/institute/level2/course18/lecture137/1137-01.asp. Date of access: 02.06.2003.

National Institute for Occupational Safety and Health (NIOSH). 1998. Criteria for a recommended standard; instrumentation for noise measurement. Ohio: National Institute for Occupational Safety and Health. 33-35.

Occupational Safety and Health Administration (OSHA). 1983. Occupational Noise Exposure. Hearing Conservation. Amendment. Final Federal Register Vol. 48. Washington D.C. 9738-9785.

Peterson, J.E. 1991. Industrial Health. Second revised edition. Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists, Inc. 206-207, 215-216.

Rabinowitz, P.M. 2000. Noise-Induced Hearing Loss. May 1. Volume 61. No. 9. *American Family Physician.*

Reich, R.B. 1995. Occupational safety and health administration 3074. US Department of Labour: Hearing conservation. United States of America.

Romeu, J., Jiménez, S. and Capdevila, R. 2004. Noise emitted by noise installations. April. Vol. 65, Issue 4. Spain: *Applied Acoustics.* 401-419.

Schoeman, J.J. and Schröder, H.E. 1994. Occupational Hygiene. Second edition. South Africa: Juta and Co. 205-216.

Sharma, O., Mohanan, V. and Singh, M. 1997. Noise emission in coal industry. *Applied Acoustics*, Vol. 54. No. 1. 1-7

Sound Research Laboratories Ltd. 1991. Noise control in industry. Third edition. Great Britain: Sound Research Laboratories. 19-62.

South Africa. 1993. Occupational Health and Safety Act (Act 85 of 1993). Pretoria: Government Printer.

South Africa. 2000. Meat Safety Act (Act 40 of 2000). Pretoria: Government Printer.

South Africa. 2003. Noise-Induced Hearing Loss Regulations, Pretoria: Government Printer.

South African National Standard. 2002. SANS 10083, 2002: Code of Practice for the Measurement and Assessment of Occupational Noise for Hearing Conservation Purposes. Pretoria: Government Printer.

South African National Standard. 2004. SANS 10083: 2004: Code of Practice for the Measurement and Assessment of Occupational Noise for Hearing Conservation Purposes. Pretoria: Government Printer.

Tomei, F., Fantini, S., Tamao, E., Baccolo, T.P. and Rosati, M.V. 2000. Hypertension and chronic exposure to noise. September. *Archives of Environmental Health.* 55(5): 19-25.

Toran, M.W. 2002. What did you say? (Special Report: Worker Compensation). USA: Risk and Insurance. 1-2.

Van Zyl, A.P. 1995. Manual for the Abattoir Industry. First edition. The Red Meat Abattoir Association. South Africa. 56-61, 20-37.

World Health Organisation. 1997. The prevention of deafness and hearing impairment caused by noise. Geneva.

World Health Organisation. 2001. Occupational and community noise. Media centre: fact sheet no. 258. http:www.who.int/mediacentre/factsheets/fs258/en/. Date of access: 05. 09. 2005.

CHAPTER 6

CONCLUSION AND REFLECTIONS OF THE STUDY

6.1 CONCLUSION AND REFLECTIONS

Occupational noise exposure is the most common cause of hearing loss worldwide. It is preventable but not reversible. If no measures are in place to protect the hearing of workers that are exposed to noise levels above the recommended standards the number of people with noise-induced hearing loss will increase and irrespective of the negative influence on the health of employees, industries may also face increased claims due to hearing loss by employees.

There is little information available in literature about the noise exposure levels in abattoirs. Different categories of Free State abattoirs were therefore investigated to determine both the environmental and personal noise exposure levels of employees.

The results indicated that abattoir employees are exposed to unacceptable noise levels at work. It was also evident that in all the abattoirs investigated there were no measures in place to reduce the level of exposure either at source or through personal protective equipment. The employees were not aware that a noise hazard exists at the work place and that it might affect their hearing in future. This might suggest that employees are not informed. It is the responsibility of employers to inform their employees about the negative effects of over-exposure to noise in order to make informed decisions concerning their health.

6.2 CONCLUSIONS

This investigation has demonstrated that:

- environmental noise levels in Grades A and C abattoirs is above the recommended 85dB(A). Therefore, the workers in these abattoirs are exposed to unacceptable noise levels which might damage their hearing permanently;

- workers in Grade D abattoirs are not over-exposed.
- personal noise exposure levels indicate that workers in Grades A and C abattoirs are exposed to unacceptable noise levels;
- Grades A and C abattoirs do not comply with national standards with regard to noise exposure in the work environment;
- there is no hearing conservation programme in place in the included abattoirs investigated;
- the workers are not educated about the noise levels they are exposed to, or about the long term effects thereof or protective measures that should be taken; and
- in most cases hearing protection devices are not issued to workers. Where hearing protection devices are issued, employees do not receive training on proper use and maintenance of the devices.

6.3 RECOMMENDATIONS TO INDUSTRY

The results have indicated that there is a crisis in the abattoir industry regarding workers' exposure to unacceptable noise levels at work. Therefore:

- the abattoirs must comply with the Noise Induced Hearing Loss Regulations and hearing conservation programmes should be implemented in red meat abattoirs. The South African National Standards recommends that noise measurements be conducted at least once a year and records of such measurements and of screening audiometric testing should be kept safely in order to compare results and to have the baseline audiogram;
- information sessions with workers regarding hazardous noise levels and the effects of over-exposure should be conducted;
- regular monitoring of the noise levels on the slaughter floor is recommended to ensure that any abnormal levels which might be due to malfunctioning of equipment will be investigated;
- exposure time can be reduced if employees work in shifts and rotate between different processes and operations;
- manufacturing industries can develop less noisy equipment that the abattoirs can purchase and use because the nature of operations on the slaughter floor

does not allow for sound-absorbing material to be installed on the walls, floor or roof without hygiene and sanitation problems. The Red Meat Regulations (2004) require that fittings, equipment and furnishing of rooms should not compromise hygiene and should be made of material that is smooth, impervious, washable and light coloured, among other things;

- providing all the workers in the noise zone with hearing protection devices as a last resort would also reduce the exposure level; and
- workers should be advised to seek medical treatment for any hearing problems in order to reduce the incidence of noise induced hearing loss.

6.4 REFLECTION OF THE STUDY

This study opened the researcher's eyes to the various hazards that workers are exposed to on a daily basis without their realisation. Researchers are needed in every area of life to investigate hazardous conditions; not only in abattoirs, but everywhere where a human being works because hazards may be found everywhere. If nobody knows about the hazards, however, it will be difficult to comprehend the magnitude of the problem.

There is need to investigate more deeply into the subject of noise in abattoirs in order to draw valid conclusions about the findings, so that authorities can act on comprehensive information. Noise exposure at work is not only a problem in South Africa but in the world as a whole; therefore, countries of the world should work together to reduce the incidence of hearing loss due to over-exposure to noise at work.

Abattoir owners need to be informed of the results of this study so that they can be aware of the situation and can act on the results.

Slaughter times differed from abattoir to abattoir. Some abattoirs slaughtered cattle and sheep for one or a few hours per day, and some slaughtered one species for the whole day. This also depended on the number of animals brought for slaughter by the farmers and on the time the animals arrived at the abattoir. Measurements were

done at hourly intervals to accommodate these conditions and the instruments that were used were able to calculate exposure levels for the exact amount of time.
In cases of emergency slaughter, the slaughter floor would be cleared to avoid possible contamination so that only that one carcass was processed at that time as quickly as possible. The instruments were not switched off during this time and those measurements were included in the final calculation of the average exposure levels. It is not known to what extent this might have affected the results, but this was regarded as part of the exercise since the workers were still on the slaughter floor and slaughter was in progress.

The same procedure was followed when certain equipment broke down during the slaughter process and repairs had to be carried out immediately. Production did not stop completely and the workers continued working.

Self-clinging plastic was used to protect the sound level meters from getting wet from water and blood during the process. This might have affected some results as it covered the windshield as well, but this was the only way to protect the instrument from damage and it could not have been avoided.

6.5 FURTHER RESEARCH

Further research to measure the actual hearing threshold shift of the employees with audiometric tests is recommended. This would give a clear picture of the impact of this exposure to noise on a daily basis.

All abattoirs in the Free State should be included instead of selecting only some abattoirs. This would reduce bias and provide more accurate measurements.

Sampling during peak periods and for more than one day at a time will be more comprehensive. Peak periods will represent the worst case scenario thus; conclusions can be drawn for less active times at the abattoirs.