KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

KUMASI, GHANA.

NOISE AND HEAT STRESSES ASSOCIATED WITH THE PIONEER FOOD CANNERY LIMITED, A FISH PROCESSING FACTORY

BY

DIANA CRISTAL WILSON (PG6511711)

A THESIS SUBMITTED TO THE DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY IN PARTIAL FUFILLMENT OF THE REQUIREMENT FOR THE AWARD OF A MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL SCIENCE.

NOVEMBER 2015

DECLARATION

I hereby declare that this submission is my own work towards an award of a Master of Science degree in Environmental Science. To the best of my knowledge, it contains no materials previously published by another person nor materials which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

Wilson, Diana Cristal	------------------------------	-----------------
(PG6511711)	Signature	Date
Prof. Kwasi Obiri-Danso	-------------------------------	---------------
(Supervisor)	Signature	Date
Dr. Isaac K. Tetteh	--------------------------------	---------------
(Head of Department)	Signature	Date

DEDICATION

This thesis is dedicated to the Memory of my late mother;
Juliana Kwofie.

ACKNOWLEDGEMENT

For grace and strength from start to finish, I thank God Almighty.

To my supervisor Professor Kwasi Obiri-Danso, Thank you. You have been patient and deeply resourceful. God bless you.

My sincerest gratitude goes to the Environmental Health and Safety (EHS) manager of Pioneer Food Cannery, Mr. Emmanuel Ankomah-Appiah. I am grateful for your time, support and encouragement.

To my husband, Benjamin Cudjoe Selormey, you have been my loudest cheer. You kept me going. God richly bless you.

ABSTRACT

Noise and heat stresses often create intolerable environmental conditions at the work place that could pose very serious health hazards to workers. This study evaluated the physical stresses of heat and noise at a fish processing factory over an 8 hour working shift. Employees' levels of awareness of these stresses were also measured. The study was carried out in five critical sections of the factory. Noise levels were measured using a portable Quest Integrated Sound Level Meter and heat using the HSM 100 CASELLA Heat stress monitor, a modern digital instrument which records Wet-Bulb Globe Temperature (WBGT). The study was done using at least 60% of the workforce (n=188) and 120 structured questionnaires were administered using the proportionate stratified random sampling technique according to the various sections. Results showed that noise levels around the factory were low to moderately high ranging between 82.8 to 89.1dBA although noise levels in some parts of the factory were below the standard tolerable level of 85dBA. All the employees identified noise as an OHS hazard and 89.17% of them were concerned about the noise levels in their section. Four out of the five sections of the factory had mean heat levels above the threshold limit of 28^{o}C and ranged between 27.1 and 31.6^{o}C. Heat levels were highest at the Boiler and Retort sections. Majority (93.3%) of the employees also identified heat to be an OHS hazard and administrative controls were a major approach to heat stress management. The vibrant resident Environmental Health and Safety (EHS) team at the work place were the main facilitators in the increased awareness of the effects of noise and heat stresses as OHS hazards. Heat stress management was inadequate and therefore the need to intensify education and training and also the provision of specialized Personal Protective Equipment, provision of more water fountains and periodic rotation of workers to help minimize the effect of heat and noise stresses.

CONTENTS

DECLARATION ii
DEDICATION iii
ACKNOWLEDGEMENT iv
ABSTRACT v
LIST OF ABBREVIATIONS ix
LIST OF FIGURES xi
LIST OF APPENDICES xii
CHAPTER ONE 1
INTRODUCTION 1
1.1 BACKGROUND TO THE STUDY 1
1.2 PROBLEM STATEMENT 4
1.3 JUSTIFICATION FOR THE STUDY 5
1.4 GENERAL OBJECTIVE 6
1.5 SPECIFIC OBJECTIVES: 6
CHAPTER TWO 7
2.1 NOISE AND OCCUPATIONAL NOISE STRESS 7
2.1.1 Introduction 7
2.1.2 Measurement of Noise 9
2.1.3 Noise Threshold Limit 9
2.1.4 Effects of Occupational Noise 10
2.1.5 Occupational Noise Control 16
2.1.6 Barriers to Noise Control 21
2.2 HEAT AND OCCUPATIONAL HEAT STRESS 22
2.2.1 Introduction 22
2.2.2 Measurement of Heat 23
2.2.3 Heat Threshold Limit 24
2.2.4 Effects of Heat 25
2.2.5 Occupational Heat Control 28
CHAPTER THREE 33

3.1. STUDY AREA..33
3.2. DATA COLLECTION AND ANALYSIS..35
3.2.1 Heat stress monitoring and Sampling 35
3.2.2 Noise stress monitoring and Sampling...37
3.3 QUESTIONNAIRE SURVEY 38
3.4. PRESENTATION AND ANALYSIS OF DATA 39
CHAPTER FOUR...39
4.1 DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS 40
4.1.1 Age Distribution...40
4.1.2 Number of years worked in section 41
4.1.3 Knowledge on OH&S 41
4.2 NOISE LEVELS IN DIFFERENT SECTIONS OF THE FACTORY FLOOR...............................42
4.2.1 Noise stresses at different sections of the factory...42
4.2.2 Workers Perception on Noise stresses as an OH&S hazard 42
4.2.3 Employees' awareness on noise levels within section..43
4.3 HEAT LEVELS IN DIFFERENT SECTIONS OF THE FACTORY FLOOR..................................44
4.3.1 Heat stresses at different sections of the factory 44
4.3.2 Workers Perception on Heat levels as an OH&S hazard 45
4.3.3 Employees' awareness on heat levels within section 45
CHAPTER FIVE..46
5.1 Noise levels in the different sections in the factory..46
5.2 Heat levels in the different sections in the factory 48
5.3 Workers Perception on Noise & Heat stresses as an OH&S hazard..................................49
5.4 Workers Concern about Noise & Heat stresses in their sections.....................................51
6.1 CONCLUSION 53
6.2 RECOMMENDATIONS...54
6.2.1 Strengthened heat stress management..54
REFERENCES..55

LIST OF TABLES

Table 1: Noise limits for various working environments ……………………...............10

Table 2: Permissible Heat Exposure Threshold Limit Value ……………………........25

Table 3: Sections of PFC selected for study …………………………………….......34

Table 4: Questionnaires distribution numbers in the various sections ………………....39

Table 5: Distribution of respondents with respect to age …………………………….…..40

Table 6: Levels of noise within identified areas on the factory floor ………………….…42

Table 7: Employees' awareness on noise levels within section ………………………..43

Table 8: Heat Levels within identified areas on the factory floor ……………………...44

Table 9: Employees' awareness on heat levels within section …...……………………45

LIST OF ABBREVIATIONS

ACGIH	American Conference of Government Industrial Hygienist
ANOVA	Analysis of Variance
CCOHS	Canadian Centre for Occupational Health and Safety
CET	Corrected Effective Temperature
DB	Dry-Bulb Temperature
dBA	Decibel (unit of sound) by the A-weight
EHS	Environmental Health and Safety
EPA	Environmental Protection Agency
GT	Globe Temperature
HPD	Hearing Protection Device
IFC	International Financial Corporation
ILO	International Labour Organization
IPIMAR	Instituto de Investigação das Pescas e do Mar
ISO	International Standard Organization
LAeq8h	Equivalent sound levels, measured over an exposure period of 8 h.
NCDOL	North Carolina Department of Labour
NIOSH	National Institute for Occupational Safety and Health
NIHL	Noise-induced hearing loss
NRR	Noise Reduction Rating
NWB	Nature Wet-Bulb Temperature
OH&S	Organizational Health and Safety
OSHA	Occupational Safety and Health Administration

PFC	Pioneer Food Cannery Limited
PPE	Personal Protective Equipment
QHSSE	Quality Health Safety Security and Environment
REM	Rapid Eye Movement
RFO	Residual Fuel Oil
SPSS	Statistical Package for the Social Sciences
Ta	Dry-bulb Temperature
Tg	Black-globe Temperature
TLV	Threshold Limit Value
Tw	Wet-bulb Temperature
TWA	Time Weighted Average
WBGT	Wet Bulb Globe Temperature Index
WHO	World Health Organization

LIST OF FIGURES

Figure 1: Flow of operational processes at Pioneer Food Cannery……………………….33

Figure 2: Average number of years spent working in each of the sections…………….41

LIST OF APPENDICES

Appendix 1: Questionnaire for employee survey………………..…………………….67

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Noise and heat stresses associated with many work places have been extensively worked on by many research groups (Varca, 1999; Cooper and Cartwright, 1994; Ornelas and Kleiner 2003). Hazards and risks may arise from exposures in the job and work environment and may result from: Physical factors (e.g. noise, vibration, heat); Chemical factors; Biological factors; Safety and ergonomic hazards; Psychosocial and organizational factors; and violence (Lipscomb, 2011). According to Ramsay *et al*. (2006) and Hollmann *et al.* (2001), occupational hazards can be physical, chemical or psychological and can lead to workplace incidents and work-related injury, that impact on organisational productivity and profitability Although the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations is the fundamental goal of the World Health Organization (WHO) and the International Labor Organization (ILO), this is often beyond the reach of many organizations especially those south of the Sahara. Due to globalization and changes in the nature of work, people in developing countries have to deal with increasing work-related stress (WHO, 2007).

According to the WHO (2007), work-related stress is a pattern of reactions that occurs when workers are presented with work demands not matched to their knowledge, skills or abilities and which challenge their ability to cope. The WHO further indicates that

“When there is a perceived imbalance between demands and environmental or personal resources, reactions may include: physiological responses (for example increased heart rate, blood pressure, hyperventilation, as well as secretion of 'stress' hormones such as adrenaline and responses (for example, reduction or narrowing of attention and perception, forgetfulness), and behavioral reactions (for example aggressive, impulsive behavior, making mistakes)”.

In many workplace environments where their operations tend to generate high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities, there is a high potential for causing heat-related illness. Workplaces with these conditions may include iron and steel foundries, nonferrous foundries, brick-firing and ceramic plants, glass products facilities, rubber products factories, electrical utilities (particularly boiler rooms), bakeries, confectioneries, commercial kitchens, laundries, food canneries, chemical plants, mining sites, smelters, and steam tunnels (CCOHS, 2005).

In a typical fish processing factory, there are a myriad of activities that go on daily that generate heat. It is expected that the physiological heat strain experienced by an individual would be related to the total heat stress to which he is exposed (Epstein and Moran, 2006). From cooking of fish to sterilization/retorting of canned fish to loading processes inside shipping containers, many workers find themselves working in areas with indoor temperatures far higher than room temperature, or temperatures tolerable to the body.

Similarly, noise pollution has become problematic yet an unnoticed form of pollution in most developing countries including Ghana (Essandoh *et al*., 2011) The interesting thing about noise is that it need not be excessively loud to cause problems in the workplace. Noise can interact with other workplace hazards to increase risks to workers, for example; increasing the risk of accidents by masking warning signals, interacting with exposure to some chemicals to further increase the risk of hearing loss and being a causal factor in work-related stress (OSHA, 2005). Bahadovi *et al.* (1993) agrees that noise interferes with verbal communications leading to errors and failures to respond to warning signals. According to Essandoh *et al*. (2011), apart from the discomfort and irritation, noise pollution can cause harm depending on its intensity, duration and frequency. Due to industrialization and urbanization, noise pollution has gained attention as an environmental hazard rated third to air and water pollution (Khilman, 2004; Singh and Davier, 2004). In some occupational groups, high noise levels can result in intolerable reactions and negatively impact on job satisfaction and performance (Burns and Robinson, 1970).

1.2 PROBLEM STATEMENT

Noise and heat stresses pose very serious hazards to workers. “To understand why exposure to stress, especially prolonged stress, can cause ill health, it is helpful to know what changes take place in the body during the "fight or flight" response. The heart starts beating faster in order to get more blood to the muscles, adrenaline and other hormones are released to provide more energy, additional stomach acids are secreted, and respiration increases. All these changes are intended to prepare the body for action. When these bodily processes are constantly functioning, however, our bodies are working overtime. Short-lived or infrequent episodes of stress pose little risk. But when stressful situations go unresolved, the body is kept in a constant state of activation, which increases the rate of wear and tear to biological systems. Ultimately, fatigue or damage results, and the ability of the body to repair and defend itself can become seriously compromised. As a result, the risk of injury or disease escalates (NIOSH, 1998). When stress occurs in amounts that individuals cannot cope with, both mental and physical changes may occur (Canadian Centre for Occupational Health and Safety, 2005).

A serious health hazard in most modern plants, especially with canning, is exposure to noise. Putting additional high-speed machines in a limited space continues to drive noise levels up, despite best efforts to keep them below 85 dBA (ILO, 2011). If left uncontrolled, this will lead in many cases to serious conditions such as noise-induced deafness over a working lifetime, moodiness/irritability, inefficiency on the job and lack of attention and concentration. These are undesirable to both organization and individuals.

Heat, often combined with high humidity in cooking and sterilizing, creates environments that are intolerable and unsafe for workers. At times, workers may be required to work in hot environments for long periods. When the human body is unable to maintain a normal temperature, heat-related illnesses can occur and may result in death (OSHA, 2014).

1.3 JUSTIFICATION FOR THE STUDY

It may generally be accepted that there is an effect on the worker from exposure to heat and noise stresses, but there needs to be a scientific understanding of the situation. Industries' response to this problem is inadequate. This is evidenced by for example, the readiness by some industries to pay allowances to workers for working in such hazardous environments. This can be attributed to a lack of understanding of the depth of the problem. This cannot be known until a proper evaluation has been done. The extent of these stresses and the impact on an industry may not be fully known if cosmetic measures continue to be applied.

Until the situation is scientifically evaluated, adequate solutions cannot be found.. According to Almeida (2012), when the cause of the stress can be identified, is of short duration, and can be responded to by a specific set of positive actions that eliminate the cause, this is a healthy stress reaction. However, when the source of the stress is not identifiable, becomes excessive, repeated, prolonged, or continuous, it becomes "distress" and creates unhealthy physiological and psychological reactions.

This study zones in on the physical stressors that are most relevant to a fish processing factory; Heat and Noise. It evaluated the status of the fish processing factory in Ghana with respect to the physical stresses of heat and noise, which are of particular concern to the industry.

1.4 GENERAL OBJECTIVE

The aim of this study was to investigate and establish the prevailing noise and heat levels in the fish processing industry in Ghana, in order that adequate mitigating measures are applied.

1.5 SPECIFIC OBJECTIVES:

1. To measure the noise and heat (temperature) levels at some critical areas of the workplace over an 8hr time period.
2. To assess the adequacy of employee awareness and understanding of the extent and effects of heat and noise stresses in their work environment.

CHAPTER TWO

LITERATURE REVIEW

2.1 NOISE AND OCCUPATIONAL NOISE STRESS

2.1.1 Introduction

Occupational sources of noise are a very significant source of noise which can be harmful to workers. Noise is any unwarranted disturbance within a useful frequency band (NIOSH, 1991). Physically, there is no difference between sound and noise. Sound is a sensory perception and noise corresponds to undesired sound (WHO, 2004).

When sound waves enter the outer ear or pinna, the vibrations impact the ear drum via the auditory canal and are transmitted to the middle and inner ear. In the middle ear three small bones called the malleus (or hammer), the incus (or anvil), and the stapes (or stirrup) amplify and transmit the vibrations generated by the sound to the inner ear. Low frequency sound waves produce slow vibrations and high frequency sounds produce rapid vibrations (Roberts, 2002).The inner ear contains a snail-like structure called the cochlea which is filled with fluid and lined with cells with very fine hairs. These microscopic hairs move with the vibrations and convert the sound waves into nerve impulses– the result is the sound we hear. Exposure to loud noise can destroy these hair cells and cause hearing loss. In Sweden for example, about 9% of the total work force are exposed continuously to a hazardous noise level (Ivarsson *et al.*,1992).

Considerable mechanization in the industry translates into the fact that most food manufacturing plants are noisy (Spellman and Bieber, 2008). In particular, canning factories generate much noise due to the various operations involving the metallic cans (IPIMAR, 2004). OSHA (2005) reports that every year, about 30 million people in the United States are occupationally exposed to hazardous noise levels. The sources of noise in work are several and varied but mainly have a relation to industrial machinery and processes such as gears, turbulent fluid flow, impact processes, electrical machines, internal combustion engine, pneumatic equipment, drilling, crushing, blasting, pumps and compressors (WHO,2001).

Many research works has been conducted in various industries in relation to occupational noise stress. Most industries have a problem with potentially harmful noise levels. A study by Olayinka et al. (2009) within certain manufacturing industries in Nigeria, in which he recorded noise levels between 85.04 – 94.83 dBA. A study conducted by Mulugate (1992) in the wood working industry in Ethiopia for instance also identified that most wood working machines produce potentially hazardous noise levels higher than the permissible level of 85dB (A). Another research study in Saudi Arabia in two manufacturing industries, found that noise levels ranged between 72 and 102 dBA (Ahmed at al., 2001). McMahon and McManus (1988) monitored the noise exposure of 274 printing production workers in 34 establishments in New York City area. Results showed that 43 percent were exposed to 8 hrs time weighted average (TWA) noise exposure of 85 dBA or greater and that 14 percent were exposed to 90 dBA or greater.

2.1.2 Measurement of Noise

Noise is measured in units of sound pressure levels called decibels, named after Alexander Graham Bell, using A-weighted sound levels dBA, (OSHA, 1999a). Because the range of sound pressures that human listeners can detect is very wide, these levels are measured on a logarithmic scale with units of decibels (WHO, 2000).The A-weighted sound levels closely matches the perception of loudness by the human ear.

2.1.3 Noise Threshold Limit

The National Institute for Occupational Safety and Health (NIOSH) has recommended that all worker exposures to noise should be controlled below a level equivalent to 85 dBA for eight hours to minimize occupational noise induced hearing loss. The near-universal adoption of an LAeq,8h value of 85 dBA (or lower) as the limit for unprotected occupational noise exposure, together with requirements for personal hearing protection, has made cases of severe unprotected exposures more rare (WHO, 2000).

The International Financial Corporation (IFC) recommends some standards for noise for various working environments in Table 1 below;

Table 1: Noise limits for various working environments (IFC, 2007)

Table 2.3.1. Noise Limits for Various Working Environments		
Location /activity	Equivalent level LA_{eq},8h	Maximum LA_{max},fast
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light industry (decreasing demand for oral communication)	50-65 dB(A)	110 dB(A)
Open offices, control rooms, service counters or similar	45-50 dB(A)	-
Individual offices (no disturbing noise)	40-45 dB(A)	-
Classrooms, lecture halls	35-40 dB(A)	-
Hospitals	30-35 dB(A)	40 dB(A)

2.1.4 Effects of Occupational Noise

2.1.4.1 Hearing Impairment

Noise that gives rise to hearing impairment is by no means restricted to occupational situations. High noise levels can also occur in open air concerts, discotheques, motor sports, shooting ranges, in dwellings from loudspeakers, or from leisure activities. Other important sources of loud noise are headphones, as well as toys and fireworks which can emit impulse noise.

The ISO standard **(**1999) gives a method for estimating noise-induced hearing impairment in populations exposed to all types of noise (continuous, intermittent, impulse) during working hours. The ISO Standard 1999 (ISO 1990) gives a method for calculating noise-induced hearing impairment in populations exposed to all types of noise (continuous, intermittent, impulse) during working hours. Noise exposure is characterized by LAeq over 8 hours (LAeq, 8h). In the Standard, the relationships between LAeq,8h and noise-induced hearing impairment are given for frequencies of 500–6 000 Hz, and for exposure times of up to 40 years. These relations show that noise-induced hearing impairment occurs predominantly in the high-frequency range of 3000–6 000 Hz, the effect being largest at 4 000 Hz. With increasing LAeq,8h and increasing exposure time, noise-induced hearing impairment also occurs at 2 000 Hz. But at LAeq, 8h levels of 75 dBA and lower, even prolonged occupational noise exposure will not result in noise induced hearing impairment (ISO 1990).

In non-industrial environments in developed countries However, monitoring of compliance and enforcement action for sound pressure levels just over the limits may be weak (Franks 1998). This is also true for occupational and urban environments in developing countries (Smith 1998).

2.1.4.2 Interference with Speech Comprehension.

Speech interference is basically a masking process in which simultaneous, interfering noise renders speech incapable of being understood. The higher the level of the masking noise, and the more energy it contains at the most important speech frequencies, the greater will be the percentage of speech sounds that become indiscernible to the listener (WHO, 2000). Noise interference with speech perception results in a large number of personal disabilities, handicaps and behavioural changes. Particularly vulnerable to these effects are the hearing impaired, the elderly, and children in the process of language and reading acquisition, and individuals who are not familiar with the spoken language (Lazarus 1998). Problems with concentration, fatigue, uncertainty and lack of self-confidence, irritation, misunderstandings, decreased working capacity, problems in human relations, and a number of stress reactions have all been identified (Lazarus 1998). Even slight hearing impairments in the high-frequency range may cause problems with speech perception in a noisy environment.

As the sound pressure level of an interfering noise increases, people automatically raise their voice to overcome the masking effect upon speech (increase of vocal effort). This imposes an additional strain on the speaker (WHO, 200). For complete sentence intelligibility in listeners with normal hearing, the signal-to-noise ratio (i.e. the difference between the speech level and the sound pressure level of the interfering noise) should be 15–18 dBA (Lazarus 1990). Reverberation times below 1 s are also necessary for good speech intelligibility in smaller rooms. For older hearing-handicapped persons for instance, the optimal reverberation time for speech intelligibility is 0.3–0.5 s (Plomp 1986).

2.1.4.3 Sleep Disturbance.

Sleep disturbance manifests primarily in ways such as: difficulty in falling asleep, awakenings; and alterations of sleep stages or depth. Other primary physiological effects can also be induced by noise during sleep, including increased blood pressure; increased heart rate; increased finger pulse amplitude; vasoconstriction; changes in respiration; cardiac arrhythmia; and an increase in body movements (Berglund & Lindvall, 1995). Measurable effects of noise on sleep begin at LAeq levels of about 30 dBA. However, the more intense the background noise, the more disturbing is its effect on sleep. Various studies have also shown that people living in areas exposed to night-time noise have an increased use of sedatives or sleeping pills (WHO, 2000). Other frequently reported behavioural effects of night-time noise include closed bedroom windows and use of personal hearing protection. For a good

sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB LAmax more than 10–15 times per night (Vallet & Vernet 1991). If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30 dBA indoors for continuous noise. If the noise is not continuous, sleep disturbance correlates best with LAmax and effects have been observed at 45 dBA or less (WHO, 2000).

2.1.4.4 Mental Health Effects

Exposure to high levels of occupational noise has been associated with development of neurosis and irritability; and exposure to high levels of environmental noise with deteriorated mental health (Stansfeld 1992). According to WHO (2000), Environmental noise is not believed to be a direct cause of mental illness, but it is assumed that it accelerates and intensifies the development of latent mental disorder. Studies on the adverse effects of environmental noise on mental health cover a variety of symptoms, including anxiety; emotional stress; nervous complaints; nausea; headaches; instability; argumentativeness; sexual impotency; changes in mood; increase in social conflicts, as well as general psychiatric disorders such as neurosis, psychosis and hysteria (WHO, 2000).

2.1.4.5 Cardiovascular and Physiological Effects

Acute noise exposures activate the autonomic and hormonal systems, leading to temporary changes such as increased blood pressure, increased heart rate and vasoconstriction (WHO, 2000). After prolonged exposure, susceptible individuals in the general population may develop permanent effects, such as hypertension and ischaemic heart disease associated with exposures to high sound pressure levels (Berglund & Lindvall 1995). Many studies in occupational settings have indicated that workers exposed to high levels of industrial noise for 5– 30 years have increased blood pressure and statistically significant increases in risk for hypertension, compared to workers in control areas (Passchier-Vermeer 1993). The overall conclusion is that cardiovascular effects are associated with long-term exposure to LAeq, 24h values in the range of 65–70 dBA or more, for both air- and road-traffic noise. However, the associations are weak and the effect is somewhat stronger for ischaemic heart disease than for hypertension. Nevertheless, such small risks are potentially important because a large number of persons are currently exposed to these noise levels, or are likely to be exposed in the future (WHO, 2000).

2.1.4.6 The Effects of Noise on Performance

WHO (2000), acknowledges that in both laboratory subjects and in workers exposed to occupational noise, that noise adversely affects cognitive task performance. The few field studies on the effects of noise on performance and safety showed that noise may produce some task impairment and increase the number of errors in work, but the effects depend on the type of noise and the task being performed (Smith 1990). Laboratory and workplace studies showed that noise can act as a distracting stimulus. Also, impulsive noise events (e.g. sonic booms) may produce disruptive effects as a result of startle responses (WHO, 2000). Among the cognitive effects, reading, attention, problem solving and memory are most strongly affected by noise, and evidence indicates that the longer the exposure, the greater the damage.

2.1.4.7 Annoyance and Interference with Social Behaviors

Lindvall and Radford (1973) define annoyance as “a feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them” Apart from “annoyance”, people may feel a variety of negative emotions when exposed to community noise, and may report anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation, or exhaustion (Fields et al., 1997, 1998). Accroding to WHO (2000), the social and behavioural effects are often complex, subtle and indirect and many of the effects are assumed to be the result of interactions with a number of non-auditory variables. WHO further indicated that Social and behavioural effects include changes in overt everyday behaviour patterns (e.g. closing windows, not using balconies, turning TV and radio to louder levels, writing petitions, complaining to authorities); adverse changes in social behaviour (e.g. aggression, unfriendliness, disengagement, non-participation); adverse changes in social indicators (e.g. residential mobility, hospital admissions, drug consumption, accident rates); and changes in mood (e.g. less happy, more depressed). Although changes in social behaviour, such as a reduction in helpfulness and increased aggressiveness, are associated with noise exposure, noise exposure alone is not believed to be sufficient to produce aggression. However, in combination with provocation or pre-existing anger or hostility, it may trigger aggression (WHO, 2000).

2.1.5 Occupational Noise Control

Noise controls are the first line of defense against excessive noise exposure. A study of hearing conservation programs in small and medium-sized companies in the state of Washington found clinically significant hearing losses in all age brackets over 36 years (Daniell, et al., 2002). Effective noise control is therefore critical. The use of these controls should aim to reduce the hazardous exposure to the point where the risk to hearing is eliminated or minimized. With the reduction of even a few decibels, the hazard to hearing is reduced, communication is improved, and noise-related annoyance is reduced. There are several ways to control and reduce worker exposure to noise in a workplace. According to OSHA (1999a), the following controls can be implemented to reduce worker exposure to noise;

2.1.5.1 Engineering controls

In the hierarchy of control solutions, engineering controls hold the primary place, because they reduce or eliminate hazards in the most reliable manner (Suter, 2012). Engineering controls are “Methods that reduce noise exposure by decreasing the amount of noise reaching the employee through engineering design approaches. Engineering controls isolate the noise from the worker through noise reduction” (NIOSH, 1996). These reduce sound exposure levels are available and technologically feasible for most noise sources. Engineering controls involve modifying or replacing equipment, or making related physical changes at the noise source or along the transmission path to reduce the noise level at the worker's ear. In some instances the application of a relatively simple engineering noise control solution reduces the noise hazard to the extent that further requirements of the OSHA Noise standard (e.g., audiometric testing (hearing tests), hearing conservation program, provision of hearing protectors, etc. are not necessary. Examples of inexpensive, effective engineering controls include some of the following:

- Choose low-noise tools and machinery.
- Maintain and lubricate machinery and equipment.
- Place a barrier between the noise source and employee.
- Enclose or isolate the noise source.

2.1.5.2 Administrative controls

Administrative controls are “Methods that reduce exposure by limiting the time a worker is exposed to noise through administrative approaches. Administrative controls isolate the worker from the noise by reducing exposure” (NIOSH, 1996). These are changes in the workplace that reduce or eliminate the worker exposure to noise. Examples according to OSHA (1999a) include:

- Operating noisy machines during shifts when fewer people are exposed.
- Limiting the amount of time a person spends at a noise source.
- Providing quiet areas where workers can gain relief from hazardous noise sources

- Restricting worker presence to a suitable distance away from noisy equipment.

Controlling noise exposure through distance is often an effective, yet simple and inexpensive administrative control. This control may be applicable when workers are present but are not actually working with a noise source or equipment. Increasing the distance between the noise source and the worker, reduces their exposure. In open space, for every doubling of the distance between the source of noise and the worker, the noise is decreased by 6 dBA (WHO, 2000).

2.1.5.3 Hearing protection devices (HPDs)

Generally however, HPDs such as earmuffs and plugs, are considered an acceptable albeit less desirable option to control exposures to noise and are generally used during the time necessary to implement engineering or administrative controls, when such controls are not feasible, or when worker's hearing tests indicate significant hearing damage. Hearing Protection Devices are often rejected by workers for many reasons, such as discomfort, improper sizing, hygiene, and the inability to hear necessary communication and warning signals (Suter, 2012). One study found that 34% of workers exposed to noise never used hearing protection (Tak, *et al*., 2009). It is therefore important to use hearing protection. Studies have shown that occasional uses of hearing protectors were significantly associated with the risk of injury among agricultural workers (Choi, *et al*., 2005). Proper and consistent usage is therefore very important. Federal regulations issued by the EPA in the United States mandate that hearing protectors be labeled with a noise reduction rating (NRR), which was designed to predict the amount of protection 98% of wearers would achieve by wearing the devices correctly (EPA, 1979). However, research has shown that fewer than 5% of workers actually receive the protection predicted by the NRR (Berger, *et al*., 1994). In instituting use of hearing protection devices, it must be noted that overprotection can cause workers to feel isolated from their environment and can impede communication, with the result that workers will remove their protectors (Williams and Dillon, 2005). A study of the effects of NIHL at work performed at NIOSH (Morata, *et al*., 2005 showed serious concerns about job safety, impaired ability to hear communication and warning signals, especially when using hearing protection devices (HPDs), impaired ability to monitor the sounds of machinery and other environmental sounds.

2.1.5.4 An effective hearing conservation program

According to OSHA, this must be implemented by employers in general industry whenever worker noise exposure is equal to or greater than 85 dBA for an 8 hour exposure (OSHA, 1999a). Hearing conservation programs are particularly lacking in small companies, where resources and health personnel are scarce, and yet noise-induced hearing loss can still be a significant risk (Suter, 2012). This program strives to prevent initial occupational hearing loss, preserve and protect remaining hearing, and equip workers with the knowledge and hearing protection devices necessary to protect them. OSHA (1999a) identifies that key elements of an effective hearing conservation program include:

- Workplace noise sampling including personal noise monitoring which identifies which employees are at risk from hazardous levels of noise.
- Informing workers at risk from hazardous levels of noise exposure of the results of their noise monitoring.
- Providing affected workers or their authorized representatives with an opportunity to observe any noise measurements conducted.
- Maintaining a worker audiometric testing program (hearing tests) which is a professional evaluation of the health effects of noise upon individual worker's hearing.
- Implementing comprehensive hearing protection follow-up procedures for workers who show a loss of hearing (standard threshold shift) after completing baseline (first) and yearly audiometric testing.
- Proper selection of hearing protection based upon individual fit and manufacturer's quality testing indicating the likely protection that they will provide to a properly trained wearer.
- Evaluate the hearing protectors attenuation and effectiveness for the specific workplace noise.
- Training and information that ensures the workers are aware of the hazard from excessive noise exposures and how to properly use the protective equipment that has been provided.
- Data management of and worker access to records regarding monitoring and noise sampling.

Each of these elements is critical to ensure that workers are being protected where noise levels are unable to be reduced below the OSHA required levels. Despite significant advances in hearing protection technology, Hearing Conservation Programs are not an adequate substitute for engineering and administrative controls (Suter, 2012).

2.1.6 Barriers to Noise Control

Occupational noise control needs to be effective for avoidance of health and safety issues. One of the most common barriers is the misperception that noise control is too difficult and too expensive (Suter, 2012). The lack of clear, correct, and comprehensible noise emission information for equipment, lack of trained acoustical engineers is also a barrier to accomplishing the extent of noise control needed in industry and a lack of dissemination of existing noise control information are also measures that go against noise control (Suter, 2012). According to Bruce and Wood (2003), aviation, defense, and mining have all achieved substantial success in reducing noise levels because of the following crucial factors;

- Recognition of the need for control based on the prevalence of noise-induced hearing loss
- Established technologies for reducing noise
- Political will to reduce noise levels
- Demonstration of successful solutions
- Collaboration across interested parties

2.2 HEAT AND OCCUPATIONAL HEAT STRESS

2.2.1 Introduction

Exposure to heat can cause illness and death (OSHA, 2014) and heat stress should be treated with high priority. As industry developed, through industrial revolution to our present highly technological society on- the-job, potential for injury and illness from acute exposure to heat has increased far beyond that known earlier to home-centred craftsmen (Levy *et al*., 2011). Many people are exposed to heat on some jobs, outdoors or in hot indoor environments. This can lead to discomfort, annoyance, subtle and direct effects on performance and productivity, also effects on health and safety of workers (Parson, 2000) or even death. On the average approximately 4000, people die each year in United States from exposure to excessive heat in work, home and community settings (Krake, 2006).

Operations like chemical plants, mining sites, smelters, and steam tunnels involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities have a high potential for inducing heat stress in employees engaged in such operations (OSHA, 1999b).Workplaces with these conditions may include iron and steel foundries, nonferrous foundries, brick-firing and ceramic plants, glass products facilities, rubber products factories, electrical utilities (particularly boiler rooms), bakeries, confectioneries, commercial kitchens, laundries, food canneries, chemical plants, mining sites, smelters, and steam tunnels. Awareness of the impacts of environmental conditions on people is important to improve employee performance and productivity and prevent work accidents. Heat strain is the collective physiological response to heat stress, and represents the individual cost of the heat stress exposure (Golbabaei et. al., 2013).

2.2.2 Measurement of Heat

2.2.2.1 The wet-bulb globe temperature (WBGT) index:

The most widely used heat stress index is the wet-bulb globe temperature (WBGT). It was developed in the US Navy as part of a study on heat related injuries during military training (Yaglou & Minard, 1957). The WBGT index was derived from the "corrected effective temperature" (CET) (Vernon and Warner, 1932). It consists of weighting of dry-bulb temperature (Ta) wet-bulb temperature (Tw) and black-globe temperature (Tg) as follows;

$$WBGT=0.7Tw+0.1Ta+0.2Tg$$

For indoor conditions the index was modified as follows:

$$WBGT=0.7Tw+0.3Tg$$

(For indoor purposes, when $T g \approx T a$, then $WBGT=0.7Tw+0.3Ta$)

This index is recommended by many international organizations for setting criteria for exposing workers to hot environment and was adopted as an ISO standard (ISO, 7243; ACGIH, 2004).

According to OSHA (1999b), for indoor and outdoor conditions with no solar load, WBGT is calculated as:

$$WBGT = 0.7NWB + 0.3GT$$

For outdoors with a solar load, WBGT is calculated as

$$WBGT = 0.7NWB + 0.2GT + 0.1DB$$

where: WBGT = Wet Bulb Globe Temperature Index

NWB = Nature Wet-Bulb Temperature

DB = Dry-Bulb Temperature

GT = Globe Temperature

The determination of WBGT requires the use of a black globe thermometer, a natural (static) wet-bulb thermometer, and a dry-bulb thermometer.

2.2.3 Heat Threshold Limit

OSHA (1999b), in Table 2 recommends some heat exposure Threshold Limit Values (TLVs). These TLV's are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38 °C (100.4 °F). They are also based on the assumption that the WBGT of the resting place is the same or very close to that of the workplace (OSHA, 1999).These Agree with ACGIH (2004) Threshold Limit Values.

	------------ Work Load* ------------		
Work/rest regimen	Light	Moderate	Heavy
Continuous work	30.0°C (86°F)	26.7°C (80°F)	25.0°C (77°F)
75% Work, 25% rest, each hour	30.6°C (87°F)	28.0°C (82°F)	25.9°C (78°F)
50% Work, 50% rest, each hour	31.4°C (89°F)	29.4°C (85°F)	27.9°C (82°F)
25% Work, 75% rest, each hour	32.2°C (90°F)	31.1°C (88°F)	30.0°C (86°F)
*Values are in °C and °F, WBGT.			

Table 2: Permissible Heat Exposure Threshold Limit Value (OSHA, 1999b)

2.2.4 Effects of Heat

Illnesses that may result as a result from heat exposure in the workplace. The physiological strains associated with heat stress are core and skin temperatures and heart rate (Givoni & Goldman, 1973). Increase in deep body core temperature is the most common physiological responses to heat stress. When there is not enough heat exchange with the environment via convection and evaporation, the deep body temperature exceeds the allowable limit 38°C, and so heat is accumulated in the body (Givoni & Goldman, 1972).

Heat related disorders occur when thermoregulatory mechanisms fail to compensate for elevations in core temperature caused by environmental or metabolic heat load (Golbabaei *et. al*., 2013). According to Lee and Brand (2005), investigators have also demonstrated that the perceived quality of the physical environment including temperature influences employee attitudes, behaviors, satisfaction and performance. According to OSHA (2014), the occupational factors that may contribute to heat illness include;

- High temperature and humidity
- Low fluid consumption
- Direct sun exposure (with no shade) or extreme heat
- Limited air movement (no breeze or wind)
- Physical exertion
- Use of bulky protective clothing and equipment.

Specifically, heat stress may cause the following when a person is exposed (OSHA, 2014);

2.2.4.1 Heat Stroke

The most serious heat-related problem is heat stroke, which is life threatening. Heat stroke occurs when the core temperature rises so high that the body’s normal cooling mechanism ceases to function (NCDOL, 2011). Workers experiencing heat stroke exhibit such signs as confusion, loss of consciousness, seizures, have a very high body temperature and may stop sweating. If a worker shows signs of possible heat stroke, medical help must be sought immediately. Until medical help arrives the worker must be moved to a shady, cool area and as much clothing as possible removed. The worker must be wet with cool water and air circulated to speed cooling (OSHA, 2014).

2.2.4.2 Heat Exhaustion

Early symptoms of heat exhaustion can include fatigue, headache and dizziness when you stand up. Profuse sweating, a rapid pulse rate, loss of appetite, nausea and vomiting may also be present (NCDOL, 2011). Workers with heat exhaustion should be removed from the hot area and given liquids to drink. The worker must as well be cooled with cold compresses to the head, neck, and face or having the worker wash his or her head, face and neck with cold water. Frequent sips of cool water should be encouraged (OSHA, 2014). In the absence of any injury, recovery from heat exhaustion is generally quite rapid if the victim is allowed to lie down and rest in a cool area (NCDOL, 2011).

2.2.4.3 Heat Cramps

Heat cramps are muscle pains usually caused by the loss of body salts and fluid during sweating (OSHA, 2014). Dehydration is caused by the inadequate replacement of fluids and salt and can cause heat cramps and/or heat exhaustion (NCDOL, 2011) .According to OSHA (2014), workers with heat cramps should replace fluid loss by drinking water and/or carbohydrate-electrolyte replacement liquids (e.g., sports drinks) every 15 to 20 minutes. Firm pressure or a gentle massage may provide some immediate relief for a cramping muscle. The best way to prevent heat cramps is to ensure that salts are replaced during and after periods of heavy sweating (NCDOL, 2011).

2.2.4.4 Heat Rash

Heat rash, also known as prickly heat, is often associated with hot, humid environments. It is caused when sweat cannot freely evaporate from the skin and sweat ducts become plugged (NCDOL, 2011). Heat rash looks like a red cluster of pimples or small blisters and may appear on the neck, upper chest, groin, under the breasts and elbow creases (OSHA, 2014). This is the most common problem in hot work environments. Heat rash can cause a prickling sensation during heat exposure, and if the plugged sweat ducts become infected, a case of heat rash may become so uncomfortable that it can be disabling (NCDOL, 2011). According to OSHA (2014), the best treatment for heat rash is to provide a cooler, less humid work environment. The rash area should be kept dry. Powder may be applied to increase comfort. Ointments and creams should not be used on a heat rash. Anything that makes the skin warm or moist may make the rash worse. NCDOL (2011) prescribes wearing work clothes that allow the sweat to evaporate as much as possible and also providing a cooler break area to aid in allowing the skin to dry during work breaks.

2.2.5 Occupational Heat Control

2.2.5.1 Supervision on a Heat Stress Program

Exposure to heat can cause illness and death (OSHA, 2014). Heat stress is indeed a serious hazard and needs to be seen as such. It is important to identify someone trained in the hazards, physiological responses to heat, and controls. This person can develop, implement and manage the program (OSHA, 2014).

2.2.5.2 Hazard Identification

The identification and proactive management of risk is critical for safety (Bohle & Quinlan, 2000). Hazard identification involves recognizing heat hazards and the risk of heat illness due to high temperature, humidity, sun and other thermal exposures, work demands, clothing or PPE and personal risk factors (OSHA, 2014).

2.2.5.3 Water, Rest and Shade

Frequent alternation between work and rest breaks also helps limit core heat buildup and allows the body time to dissipate excess heat. It may be necessary to use a larger number of workers for especially hot jobs so that the work-rest schedule can be maintained (NCDOL, 2011). It is important to ensure that cool drinking water is available and easily accessible. It is however important to note that certain beverages, such as caffeine and alcohol can lead to dehydration (OSHA, 2014). Workers should be encouraged to drink a liter of water over one hour, which is about one cup every fifteen minutes. It is also important to provide or ensure that fully shaded or air-conditioned areas are available for resting and cooling down (OSHA, 2014).

2.2.5.4 Acclimatization

The body adapts to a new thermal environment by a process called acclimatization. Complete heat acclimatization generally takes six to seven days, but some individuals may need longer (CCOHS, 2005). OSHA (2014) asserts however that full acclimatization may take up to 14 days or longer depending on factors relating to the individual, such as increased risk of heat illness due to certain medications or medical conditions, or the environment. Some medications interfere with acclimatization (CCOHS, 2005). For example, hypotensives (drugs causing low blood pressure), diuretics, antispasmodics, sedatives, tranquilizers, antidepressants and amphetamines decrease the body's ability to cope with heat. An acclimated worker will sweat more efficiently (causing better evaporative cooling), and thus will more easily be able to maintain normal body temperatures (Wyndham, 1968). Acclimatization is a physical change that allows the body to build tolerance to working in the heat (OSHA, 2014). It occurs by gradually increasing workloads and exposure and taking frequent breaks for water and rest in the shade.. New workers and those returning from a prolonged absence should begin with 20% of the workload on the first day, increasing incrementally by no more than 20% each subsequent day (OSHA, 2014). During a rapid change leading to excessively hot weather or conditions such as a heat wave, even experienced workers should begin on the first day of work in excessive heat with 50% of the normal workload and time spent in the hot environment, 60% on the second day, 80% on day three, and 100% on the fourth day(OSHA, 2014)..

2.2.5.5 Modified Work Schedules

Work practices can be used to reduce the chances of workers' suffering from heat stress (NCDOL 2011). Altering work schedules may reduce workers' exposure to heat. OSHA (2014) suggests the following:

Reschedule all non-essential outdoor work for days with a reduced heat index.

- Schedule the more physically demanding work during the cooler times of day;
- Schedule less physically demanding work during warmer times of the day;
- Rotate workers and split shifts, and/or add extra workers.
- Work/Rest cycles, using established industry guidelines.

- Stop work if essential control methods are inadequate or unavailable when the risk of heat illness is very high.

2.2.5.6 Training

Different people judge the same risk situation in different ways (Weyman & Clarke, 2003) and for that matter, education and training is the way to establish knowledge and effective mitigating measures on heat hazard. Training should be provided in a language and manner workers understand, including information on health effects of heat, the symptoms of heat illness, how and when to respond to symptoms, and how to prevent heat illness (OSHA,2014). This is important because how risks are perceived affects how they are managed and the subsequent effect on organizational processes (Fung *et al*., 2010).

2.2.5.7 Monitoring for Heat Illness Symptoms

It is important to establish a system to monitor and report the signs and symptoms of heat stress in order to improve early detection and action. Using a buddy system will assist supervisors when watching for signs of heat illness (OSHA, 2014).

2.2.5.8 Engineering Controls Specific to Indoor Workplaces

Engineering controls are the most effective means of reducing excessive heat exposure (CCOHS, 2005). Indoor workplaces may be cooled by using air conditioning or increased ventilation, assuming that cooler air is available from the outside. Other methods to reduce indoor temperature include: providing reflective shields to redirect radiant heat, insulating hot surfaces, and decreasing water vapor pressure, e.g., by sealing steam leaks and keeping floors dry. The use of fans to increase the air speed over the worker will improve heat exchange between the skin surface and the air, unless the air temperature is higher than the skin temperature. However, increasing air speeds above 300 ft. per min. may actually have a warming effect (OSHA, 2014).

CHAPTER THREE

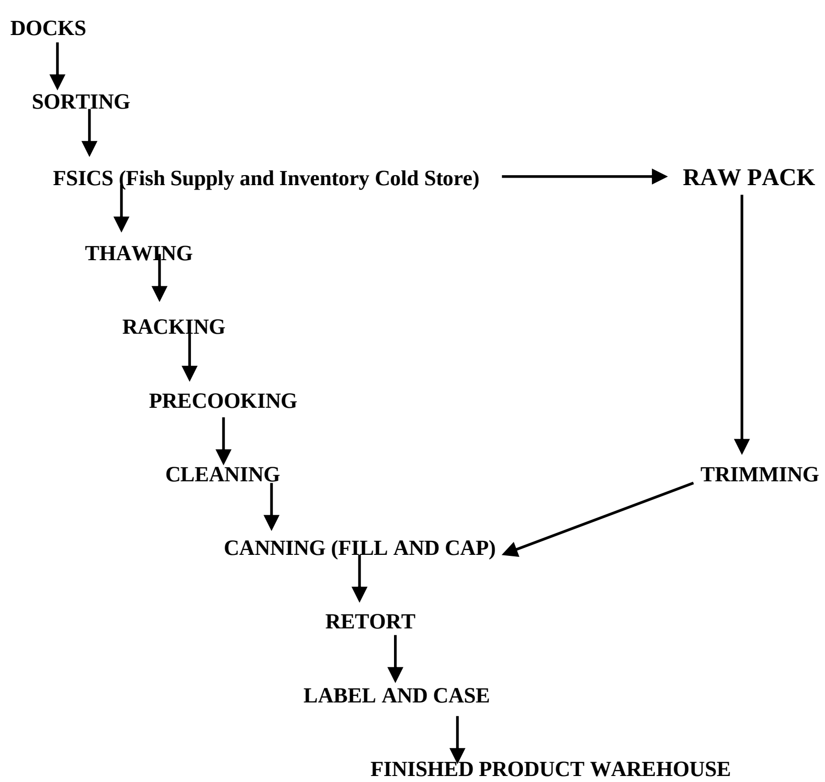
MATERIALS AND METHODS

3.1. STUDY AREA

The study was carried out on the factory floor of the Pioneer Food Cannery Limited (PFC), a free zone enterprise, which processes tuna into finished canned products. Pioneer Food Cannery Limted is currently the leading tuna processing company in Ghana. At full capacity, PFC can produce about 250 metric tons of tuna a day, mainly for export. At the time of this study, production was at about 180 metric tons daily. Current employment level is about 1500 personnel (both permanent and part time).

The figure below summarizes the flow of processes at PFC;

Figure 1: Flow of operational processes at Pioneer Food Cannery



There are six main Departments in PFC; Human Resource; Quality Health Safety Security and Environment (QHSSE), Operations, Supply Chain, Engineering and Finance / IT. The Department of concern in this study was the Operations Department. After preliminary interviews and consultations, five main sections were identified for this study. The selected departments for this survey were those affected by both heat and noise.

Table 3: Sections of PFC selected for study

	SECTION	DEPARTMENT	POPULATION
1	BOILER HOUSE	ENGINEERING	**6**
2	DEPAL	OPERATIONS	**25**
3	RETORT	OPERATIONS	**16**
4	LABEL & CASE	OPERATIONS	**56**
5	FILL & CAP	OPERATIONS	**85**
		Total Personnel=	**188**

All the sections identified for this study use several machines that are very mechanical in operation, thereby producing a lot of noise and heat. Below is a summary of the functions of the various sections identified for this study;

BOILER HOUSE: This section houses two boiler machines which are operated to produce steam used to power the 10 steam retort machines used in sterilizing canned products, also the pre-cooker machines, the bagged loins sealing machine and the seaming machines.

DE-PALLETIZER: The de-palletizer section or Depal is responsible for supplying cans unto the production floor. Cans are supplied by machines called de-palletizers, There are seven de-palletizer machines in this section which supply cans at high speeds averaging 300 cans per minute.

RETORT: This section primarily sterilizes all canned products before they are sent on for packaging. The section houses ten retort machines which deploy steam in their functioning.

LABEL & CASE: This section packages all finished products. Several machines are used in labeling cans, forming trays, applying sleeves over cans, packing cans unto pallets and shrink-wrapping and stretch-wrapping products.

FILL & CAP: This section of production receives cans that have been filled with fish. They ensure that the right media is filled into the cans and then the cans are sealed. The cans are then packed into retort baskets and forwarded to the retort section. All processes involve use of machines.

3.2. DATA COLLECTION AND ANALYSIS

3.2.1 Heat stress monitoring and Sampling

Measurement of deep body temperature is impractical for monitoring the worker's heat load, therefore, the measurement of environmental factors is also required which must nearly correlate with deep body temperature and other physiological responses to heat.

Thus work load category is established by ranking each job into light, medium or heavy on the basis of type of operations.

The Wet-Bulb Globe Temperature (WBGT) Index is the simplest and most suitable technique to measure the environment factors.

The WBGT is a Composite Temperature used for estimating the effect of Temperature, Humidity, Wind Speed (Wind Chill) and Solar Radiation on Humans. It was used for determining appropriate exposure levels to high Temperatures.

The International labour Organization (ILO) has adapted the Wet-Bulb Globe Temperature (WBGT) Index to establish an exposure limit value for work in a hot environment. This index sets the duration of work and rest periods so as to ensure that the central body temperature does not rise above 38°C based on the work load and the resultant temperature of the index is calculated using the formula:

WBGT = 0.7Tw+0.2Tg+0.1Td…………………………………………………………...(1)

Where:

Tw= Natural Wet-Bulb Temperature (Humidity Indicator);

Tg= Globe Thermometer Temperature; and

Td= Dry-Bulb Temperature (Normal Air Temperature).

WBGT = 0.7Tw+0.3Td where solar radiation is negligible………………………….. (2)

The instruments required are a dry-bulb, a natural wet-bulb and a black globe thermometer.

In this regard the HSM 100 CASELLA Heat stress monitor (*serial number: 086216*) was used in carrying out the field study. It is a modern digital instrument which records all the above stated parameters of WBGT in time weighted average (TWA).

For heat stress monitoring, 10 samples were taken from the operational areas of the factory including a sample point sited outside the factory as a control for a period of 8-hour time weighted averages.

3.2.2 Noise stress monitoring and Sampling

Noise Levels were captured in-situ in decibels on the A scale, i.e. dBA using a portable Quest Integrated Sound Level Meter type 2900 with data logging system.

Measurement of noise is often 'A-weighted' to take into account the fact that some sound wavelengths are perceived as being particularly loud and not sensitive to the human ear. Thus the A scale gives greater weight to the frequencies of sound to which the human ear is most sensitive.

Noise levels were measured by equivalent sound level recorded with the meter representing the average integrated sound level accumulated during the sampling period for 8 hours.

3.3 QUESTIONNAIRE SURVEY

Of the total population of the study area, questionnaires were administered (Appendix 1) to at least 60% of the population. At the time of this study, the total number of employees in all sections identified for the study was 188. Therefore 120 questionnaires were administered. The 120 questionnaires were distributed using a proportionate stratified random sampling technique according to the various sections. Therefore the percentage of the total questionnaires administered was proportional to the percentage each section represented out of the total population of 188 (Table 4).

Table 4: Questionnaires distribution numbers in the various sections

Total Personnel=	**188**
Total Questionnaires=	**120**

	SECTION	DEPARTMENT	POPULATION	POPULATION PERCENTAGE (%)	NUMBER OF QUESTIONNAIRES ADMINISTERED
1	BOILER HOUSE	ENGINEERING	**6**	**3**	**4**
2	DEPAL	OPERATIONS	**25**	**13**	**16**
3	RETORT	OPERATIONS	**16**	**9**	**10**
4	LABEL & CASE	OPERATIONS	**56**	**30**	**36**
5	FILL & CAP	OPERATIONS	**85**	**45**	**54**
			188	**100**	**120**

3.4. PRESENTATION AND ANALYSIS OF DATA

Data collected were analyzed using Statistical Package for Social Sciences (SPSS) 17 software. Descriptive statistics (Mean, Standard deviation, and standard error of mean) were computed for 8-hour work shift periods and t-test was conducted to determine if the differences in mean noise and heat stress levels among the various sections were statistically significant at 95% confidence level. Thus, differences amounting to p-values less than 0.05 were considered statistically significant.

CHAPTER FOUR

RESULTS

4.1 DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

4.1.1 Age Distribution

Out of the 120 employees that were interviewed from five sections of the factory on workplace physical stresses; heat and noise, majority (65.80% (n=79)) were within the age of 30 to 39 years (Table 5). Only 4.20% (n=5) of the respondents were between 50 to 59 years.

Table 5: Distribution of respondents with respect to age.

AGE GROUP	RESPONSES	PRECENTAGE (%)
20-29	24	20.0
30-39	79	65.8
40-49	12	10.0
50-59	5	4.2
TOTAL	120	100

4.1.2 Number of years worked in section

Majority of the workers, 55.0% (n=66) had spent between 11 to 15 years working in their particular section of the factory (Figure 2). Only 2.5% (n=3) had worked for between 21 to 25 years in their section.

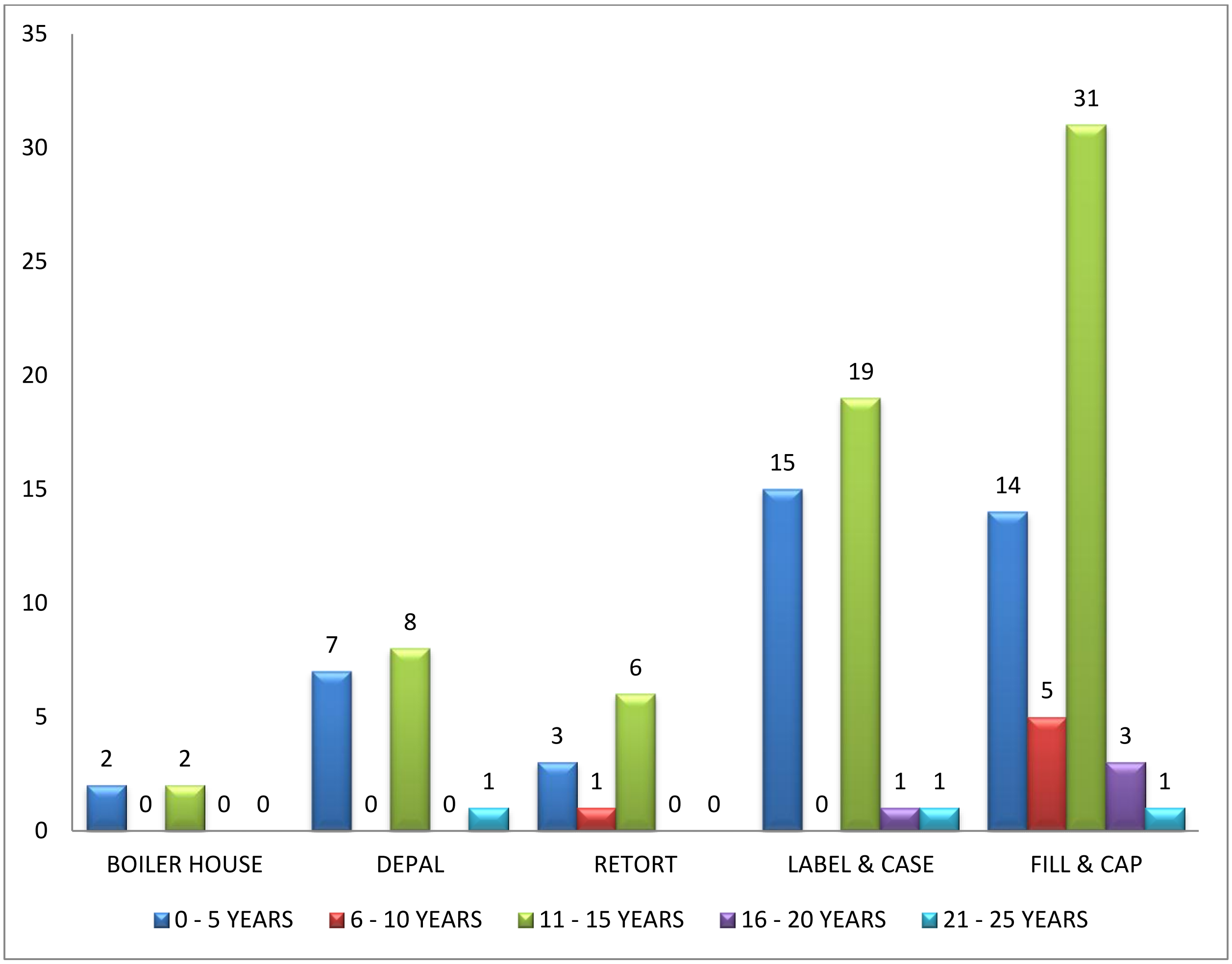


Figure 2: Average number of years spent working in each of the sections

4.1.3 Knowledge on OH&S

Majority, 98.3% (n=118) of the workers had knowledge on Occupational Health and safety (OH&S) regulations.

4.2 NOISE LEVELS IN DIFFERENT SECTIONS OF THE FACTORY FLOOR

4.2.1 Noise stresses at different sections of the factory

Table 6: Levels of noise within identified areas on the factory floor

Noise Stress Sampling Results -dB(A)							
Section	**MEASUREMENTS**			**Mean**	**Standard Deviation (SD)**	**Standard Error of Mean (SEM)**	**Range**
	N1	**N2**	**N3**				
BOILER HOUSE	71.6	94.4	82.4	**82.8**	11.41	6.58	69.0 - 95.0
DEPAL	86.2	84.1	86.2	**85.5**	1.21	0.70	84.1 - 86.2
RETORT	86.7	82.4	91.8	**87.0**	4.71	2.72	85.2 - 93.7
LABEL & CASE	84.3	85.3	85.3	**85.0**	0.58	0.33	84.3 - 85.3
FILL & CAP	91.5	85.0	90.7	**89.1**	3.54	2.05	83.1 - 100.5

The average noise levels within the factory floor irrespective of the different sections of the factory ranged between 82.8 to 89.1 dBA (Table 6) with no statistically significant differences between them (p=0.74). The Boiler house recorded the lowest noise level that was below the Ghana Environmental Protection Authority permissible level of 85 dBA.

4.2.2 Workers Perception on Noise stresses as an OH&S hazard

All the workers, 100% (n= 120) were aware that noise stress is an OH&S hazard.

4.2.3 Employees' awareness on noise levels within section

Majority of the workers, 89.17% were concerned about the levels of noise that was generated within their working area. Within the different sections of the factory, concern on noise stresses ranged from 81.25% to 100% (Table 7). The noise that was generated in the Boiler house and the Fill & Cap sections was of major concern.

Table 7: Employees' awareness on noise levels within section

SECTION	BOILER HOUSE %	DEPAL %	RETORT %	LABEL & CASE %	FILL & CAP %	TOTAL %
NOISE IS A HAZARD IN MY SECTION	100.00 **(n = 4**)	81.25 (n= **13)**	90.00% (n=**9)**	83.33% (n=**30)**	97.44% (n=**51)**	89.17% (n=**107)**

4.3 HEAT LEVELS IN DIFFERENT SECTIONS OF THE FACTORY FLOOR

4.3.1 Heat stresses at different sections of the factory

Table 8: Heat Levels within identified areas on the factory floor

Heat Stress Sampling Results - º C							
Section	**MEASUREMENTS**			**Mean**	**Standard Deviation (SD)**	**Standard Error of Mean (SEM)**	**Range**
	H1	**H2**	**H3**				
BOILER HOUSE	30.8	32.1	32.0	**31.6**	0.72	0.42	30.0 - 32.0
DEPAL	28.2	28.7	29.1	**28.7**	0.45	0.26	28.2 - 29.1
RETORT	33.0	31.7	32.2	**32.3**	0.66	0.38	31.7 - 33.0
LABEL & CASE	28.5	25.2	27.6	**27.1**	1.71	0.98	25.2 - 28.5
FILL & CAP	26.2	30.1	33.0	**29.8**	3.41	1.97	26.2 - 33.0

Apart from the Label & Case section of the factory which recorded mean heat levels below the tolerable threshold of 28 ^{o}C, heat at all the other sections were high. The highest was at the Retort Section which was 32.3 ^{o}C (Table 8). Generally, differences in heat levels among the various sections of the factory were statistically significant ($p=0.027$). The relevant differences emanated between the Boiler house and the Depal section ($p=0.00$), the Retort and Depal section ($p=0.00$), the Boiler and Label & Case section ($p=0.01$) and between the Retort and Label and case section ($p=0.01$).

4.3.2 Workers Perception on Heat levels as an OH&S hazard

Majority of the workers, 93.3% (n=112) were aware that heat stress is an OH&S hazard.

4.3.3 Employees' awareness on heat levels within section

Majority of workers, 86.67% (n =104) were concerned about the levels of heat that was generated within their working area. Within the different sections of the factory, concern on heat stresses ranged between 68.75 to 100% (Table 9). The heat that was generated in the Boiler house and the Retort section was of major concern.

Table 9: Employees' awareness on heat levels within section

SECTION	BOILER HOUSE %	DEPAL %	RETORT %	LABEL & CASE %	FILL & CAP %	TOTAL %
HEAT IS A HAZARD IN MY SECTION	100.00 **(n=4)**	68.75% **(n=11)**	100.00% **(n=10)**	86.11% **(n=31)**	88.89% **(n=48)**	86.67% **(n=104)**

CHAPTER FIVE

DISCUSSION

5.1 Noise levels in the different sections in the factory

The study has shown that noise levels around the factory were low to moderately high. Although noise level in some parts of the factory were below the standard tolerable level of 85dBA, others were higher than this set limit. They generally ranged between 82.8 to 89.1 dBA. The noise levels in this study was low compared to a similar study by Olayinka *et al*. (2009) within certain manufacturing industries in Nigeria, in which he recorded noise levels between 85.04 – 94.83 dBA. In a similar study in Saudi Arabia in two manufacturing industries, noise levels ranged between 72 and 102 dBA (Ahmed *et al.,* 2001). This goes to emphasize that high levels of occupational noise remain a problem in many regions of the world (WHO, 2004) and workers especially those on the factory floor continue to be exposed to hazardous noise levels. According to the WHO (2001) and NIOSH (1998), in places like Germany, about 4 to 5 million people, which represents 12−15% of the workforce are exposed to hazardous noise levels.

Many reasons can be assigned for the noise levels recorded for this study. Because of the considerable mechanization in the industry, most food manufacturing plants are noisy (Spellman and Bieber, 2008). All the sections were equipped with various machines for their various purposes, and the mechanical nature of the actions of these machines predictably produced high levels of noise. The Boiler house, which had two boiler machines that produced steam to feed the factory's steam needs, constantly made a loud hum with some occasional rattling sounds. In addition, there was also a steam siren at that section that was occasionally sounded for various reasons. In spite of this, the noise levels at the Boiler section were reasonably low and this could be because canning which is known to generate a lot of noise in factories due to the various operations involving the metallic cans (IPIMAR, 2004) was not handled at this section. This may further explain why apart from the Boiler house, all other sections recorded mean levels higher than the standard of 85dBA, but not exceeding 89.1 dBA.

On the other hand, the De-palletizer, Fill & Cap, Retort, Label & Case sections produced a lot of noise and this is because of the varied activities at these sections. At the De-palletizer section were seven heavy duty machines that supplied cans to the factory floor. The nature of operation of the de-palletizer machines coupled with the contact of the metallic cans against each other and also against the metal cans produced high levels of noise. Similarly, at the Fill & Cap sections where cans were filled with fish and media and then sealed with a lid, the movement of the cans and lids produced noise. The Retort and Fill & Cap had no physical separation between them and therefore the noise from the Fill & Cap was heard in the Retort section. The Label & Case section had several machines that labelled cans, sleeved cans, formed trays, shrink-wrapped and palletized products. Thus, all these sections primarily handle metallic cans which contributed to the relatively higher noise levels. High noise levels on factory floors could potentially lead to hearing impairment among workers. Butt (2012) reported higher percentage of workers with hearing problems in a factory in Pakistan with an average noise intensity of around 90 dBA. However, in this study, the average mean noise level was around 85.88 dBA.

5.2 Heat levels in the different sections in the factory

From this study, four out of the five sections of the factory had mean heat levels above the threshold of 28 ^{o}C as heat levels ranged between 27.1 and 31.6 ^{o}C. Heat levels were very high at the Boiler and Retort sections. This may be because the boiler machines combust Residual Fuel Oil (RFO) at high temperatures to produce steam. These machines were also housed in a very small enclosed area which apparently to generated relatively high heat levels, an average of 31.6 ^{o}C. Similarly, at the Retort section, all the ten Retort machines were housed in a small enclosed area and because it uses steam heat to sterilize the canned products, when the retorting process is complete and the machines are opened, steam and thus moist heat escape into the immediate small space. Although there were several heat extractors installed in this section, ventilation was quite inadequate. It was the hottest area identified in the factory. The Depal section compared to the Boiler and Retort sections generated relatively less heat (28.7 ^{o}C). The machines in the Depal section supplied cans to the factory floor by conveyor belt in a spacious and well-ventilated area with large fans and heat extractors.

Heat stress is a worrying occupational health hazard. Pourmahabadian *et al.* (2008) reported that unacceptable heat exposure levels (36 ^{o}C) amongst workers in a glass manufacturing unit in Tehran resulted in months of absence from work and other heat related diseases. Similar results have been reported by Song, (2012) in China and Ayyappan *et al*. (2011) from several locations around the world.

The Labeling & Casing section was the only section where a mean heat level of 27.1 ^{o}C was recorded that was below the threshold limit of 28.0 ^{o}C. It was this same section that also recorded high heat levels comparable to that in the Retort section. This was because a part of the Labeling & Casing section had several production lines installed in a small area, majority of the section's workers worked in this section and their body temperatures could contribute to the heat levels and also heat driven machines used to glue labels to cans were installed here.

5.3 Workers Perception on Noise & Heat stresses as an OH&S hazard

It was established that a remarkably high number of the workers were aware that noise and heat are an OH&S hazard. This was important because managers and employees need to have sufficient knowledge to identify hazards that may lead to risk in the workplace in order to inform processes to successfully control those risks (Bahn, 2012). The workers ability to successfully identify a hazard is a good step in the right direction. However, so far most research has only traditionally focused on the end process of the reporting of hazards and risk management (Biggs *et al*., 2006).

All the employees identified noise as an OH&S hazard. This could be attributed to the extensive safety campaign that had been done in the factory. It was realized that the wearing of ear protection was a major enforcement point by management. All workers were required to wear ear muffs in the various factory sections investigated in this study. Ratings were published and supervisors and departmental safety leaders were tasked and monitored closely and frequently for compliance. The factory's internal Environmental Health and Safety (EHS) unit also conducted routine inspections and assessment of all sections. Such internal assessments, evaluation and constant campaigns helped in successfully registering noise as a major hazard in the minds of the workers towards ensuring effectiveness in preventing Noise Induced Hearing Loss (NIHL) (Ahmed *et al.* 2001). Workers in all the sections had also undergone audiometric tests and briefings in the past year. Management approach towards noise stress reduction was generally good as NIHL is incurable and irreversible. It is preventable, however, and it is essential that preventive programs be implemented (WHO, 2004).

A high majority (93.3%) of the employees also identified heat to be an OH&S hazard. This is good because risk becomes amplified when it is not recognized by the workplace actors as a threat to their personal safety (Hopkins, 2005). Heat is a stress that is physically felt by the employee, characterized by discomfort, which may be why many could identify it to be a hazard. Passchier-Vermeer (1993), asserted that a feeling of resentment, displeasure, discomfort, dissatisfaction or offence occurs when heat interferes with someone's thoughts, feelings or daily activities. There were however no PPEs that were given for mitigating heat in the various sections. Discomfort allowances were however paid to employees who worked in these sections. Song (2012) reported a similar practice of occupational heat allowance policy amongst employees in a shoe factory in Fujian province in China. This may be why a few employees did not recognize heat to be a serious health hazard. Ayyappan *et al*. (2011) in a study of work-related heat stress concerns in automotive industries from Chennai, India also concluded that the case study served to re-emphasize the need for recognition of heat stress as an important occupational health risk in both the formal and informal sectors. It is particularly important to recognize that while administrative controls appear more attractive (as they do not require initial large capital investments), the loss in productivity could be substantial if one were to genuinely implement controls to ensure health and comfort of workers (Ayyappan *et al.,* 2011). When workers do not see an aggressive campaign to mitigate heat in the ways that other hazards are approached, they would perhaps come to think it is not a serious hazard if management deems compensation to be adequate. Brake and Bates (2000) supports that heat stress traditionally may have been under-diagnosed and under-reported. Heat illness is now an acknowledged occupational condition (Donoghue, 2000).

5.4 Workers Concern about Noise & Heat stresses in their sections

Generally, 89.17% of the workers were concerned about the noise levels in their section. At the Fill & Cap section where the mean noise was highest, 97% of the employees were concerned about the noise in the section. Interaction with respondents revealed that the small number of employees who were not particularly concerned about the noise at the Fill & cap section were those who worked in the Broth/Media room. This was a room located a bit further from the section where media used for the various product fill styles were prepared. The room is removed from the heavily machined area and is relatively quieter. Employees here were also required to wear ear muffs. Workers here believed that their exposure to noise was relatively lower.

At all other sections, workers who did not think that noise was a concern believed that the ear muffs they wore daily was adequate in protecting them from the noise.

Although it recorded the lowest mean noise level which was below the threshold limit, all employees at the Boiler section were concerned about the noise in their section. All workers in this section were highly specialized and skilled operators of the boiler machines and were also senior staff of the factory. They were therefore highly sensitive to OHS issues and were particularly concerned about the occasional rattling sound that the boilers made. They also expressed concern at the very high sound that the siren made. Anyone who had to trigger the siren needs to stand very close to it, and they felt the high intensity of the piercing sound was of concern.

A relatively smaller number of workers (86.67%) were concerned about heat stresses as compared to noise stress. Highest mean heat levels were recorded at the Boiler and Retort sections and this reflected in the show of concern by the workers. Heat stress is an important factor in many industrial situations and it can seriously affect productivity and health of the individual as well as diminish tolerance to other environmental hazard (Epstein and Moran, 2006).

Although the Label and Case section was where the lowest mean was recorded, it was at the Depal section rather that the lowest percentage (68.75%) of workers were concerned about the heat in their section. This can be attributed to the fact that the overall area in the De-palletizer section is relatively well ventilated whereas at the Label & Case section, majority of the population work in the hottest area which is just about 35% of the total area of the section.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

Workers were generally exposed to mean noise levels ranging between 82.8 and 89.1 dBA, which are not particularly high. Occupational noise stress seemed to be largely under control. The most critical high noise areas were the Fill & Cap and Retort areas. Management efforts toward occupational noise mitigation seemed adequate. Workers were well informed on noise; ear protection was provided for employees and strictly required for work in their sections. Compliance was also very strictly enforced.

Heat levels were high at the Boiler and Retort sections with mean heat levels ranging from 27.1 ^{o}C to 32.3 ^{o}C. Only the Label and Case section recorded a mean heat level below the threshold limit of 28 ^{o}C. Heat stress did not appear to receive much attention although some areas had cooling apparatus and heat extractors. Measures to abate heat were inadequate. Employees were basically given discomfort allowances where heat levels were high. Knowledge on heat stress was lacking. No special mitigating measures such as special PPEs, heat management and acclimatization training were provided for workers.

Workers were generally knowledgeable about OHS, attributable largely to Health and Safety talks organized by management as well as a vibrant resident Environmental Health and Safety (EHS) team. A large majority could identify that noise and heat are OH&S hazards. Workers well understood the extent and effects of noise stresses.

Unfortunately, heat stress was not as well understood and highlighted as it needed to be, considering the high heat levels recorded in the majority of sections.

6.2 RECOMMENDATIONS

6.2.1 Strengthened heat stress management

Heat stress appears to have been underestimated given the relatively inadequate attention it was given. Management need to launch a more focused approach to heat stress management because how risks are perceived affects how they are managed and the subsequent effect on organizational processes.

Education and training is the way to establish knowledge and effective mitigating measures on heat hazard. The variations in perceived exposure that are identified may help target employment groups for health promotion or education activities.

Training and health talks are a planned and regular activity in the factory presently, but it can further be strengthened to focus on groups to be target-trained to address their specific needs.

Uniforms for workers in high heat areas can be redesigned to be made of lighter materials that reduce the feel of the heat. More water fountains can be provided for workers to help them cool down periodically.

Workers can also be periodically rotated between the sections in the factory to mitigate the effect of these stresses, as indeed, continuous exposure is what causes effects. Many workers had worked in the same sections for several years.

REFERENCES

ACGIH. (2004). TLVs and BELs. Threshold limit values for chemical substances and physical agents and biological exposure indices, 168-76, ACGIH Signature Publications, Cincinnati.

Ahmed, H. O., Dennis, J. H., Badran, O., Ismail, M., Ballals, G., Ashoor, A. and Jerwood, D. (2001). Occupational Noise Exposure and Hearing Loss of Workers in Two Plants in Eastern Saudi Arabia. *Ann. Occup. Hyg*. 45(5): 371-380.

Almeida, S.M. (2012). A Study on Causes of Job Stress in The It Sector Of Bangalore. *International Journal of Research in Commerce*, *It & Management (IJRCM).* 2(4): 126-128.

Ayyappan, R., Sankar, S., Rajkumar, P. and Balakrishnan, K. (2009). Work-related heat stress concerns in automotive industries: a case study from Chennai, India. *Global Health Action* DOI: 10.3402/gha.v2i0.2060.

Bahadovi, R. S. and Bohne, B. A. (1993). Adverse effects of noise on hearing. *American Family Physician*. 47(5): 1219-1229.

Bahn, S. T. (2012). Workplace hazard identification: What do people know and how is it done?. *Proceedings of Annual Conference of the Association of Industrial Relations Academics Australia and New Zealand*. (pp. 1-9). Gold Coast, Queensland. Griffith University.

Berger, E.H., Franks, J.R., Lindgren, F. (1994). International review of field studies of hearing protector attenuation. *Proceedings of the 5th International Symposium on the Effects of Noise on Hearing*, Gothenburg, Sweden. May 12-14, 1994.

Berglund, B. and Lindvall, T. (Eds.) (1995). Community Noise. Document prepared for the World Health Organization. *Archives of the Center for Sensory Research*, 2: 1-195.

Biggs, H.C., Sheahan, V.L and Dingsdag, D.P. (2006). Improving industry safety culture; The tasks in which safety critical positions holders must be competent. In; *Proceedings CIB99 International Conference on Global Unity for Safety and Health in Construction*, Beijing, China. .181-187.

Bohle, P. and Quinlan, M. (2000). Managing Occupational Health and Safety: A Multidisciplinary Approach. South Melbourne: Macmillan. 2nd Edition. ISBN 0732940788. 3-539.

Brake, D.J.; Bates, G.P.. (2000). Occupational Heat Illness: An Interventional Study. In: Proceedings of the International Conference on Physiological and Cognitive Performance in Extreme Environments, pp. 170-172. (March 27-30, 2000) Canberra, Australia.

Bruce, R.D., Wood, E.W. (2003). The USA needs a new national policy for occupational noise. *Noise Control Eng. J.*, 51(3):162-165.

Burns W and Robinson D.W. (1970). Hearing and Noise in Industry: London; HMSO. Department of Health and Social Security. ISBN 0117600229.102-230.

Butt, M.S. (2012). Effects of physical environment factors on worker's health in micro and small sized industries of Pakistan. Lund University; Faculty of Medicine. Published Thesis for a Master's Programme in Public Health. Autumn 2012.

Canadian Centre for Occupational Health and Safety (CCOHS). (2005). Working in Hot Environments: Health and Safety Guides. First Edition. ISBN 0-660-19453-8. 2-88.

Choi, S.W., Peek-Asa, C., Sprince, N.L., Rautiainen, R.H., Donham, K.J., Flamme, G.A., Whitten, P.S., Zwerling, C. (2005). Hearing loss as a risk factor for agricultural injuries. *Am. J. Ind. Med*., 48(4): 293-301.

Cooper, C. L. and Cartwright, S. (1994). Healthy Mind; Healthy Organisation- A Proactive approach to Occupational Stress, *Journal of Human Relations*, 47(1): 455-71.

Daniell, W.E., Fulton-Kehoe, D., Cohen, M., Swan, S.S., Franklin, G.M. (2002); Increased reporting of occupational hearing loss: Workers' compensation in Washington State, 1984-1998. *Am. J. Ind. Med*., 42:502-510.

Donoghue, A.M., Sinclair, M.J., Bates, G.P. (2000). Heat exhaustion in a deep underground metalliferous mine. *Occup Environ Med* 2000; 57: 165-174.

EPA (1979). Noise labeling requirements for hearing protectors. Environmental Protection Agency, Fed. Reg., 44(190), 40CFR Part 211, 56130-56147.

Epstein, Y. and Moran, D.S. (2006). Thermal Comfort and the Heat Stress Indices; *Industrial Health* 44: 388–398.

Essandoh, P. K, Armah, F. A, Afrifa, E. K. A. and Pappoe, A. N. M. (2011). Determination of Ambient Noise Levels and Perception of Residents in Halls at the University of Cape Coast, *Ghana Journal of Environment and Natural Resource Research*, 1(1): 23-31.

Fields, J.M. (1998). Reactions to environmental noise in an ambient noise context in residential areas; *Journal of the Acoustical Society of America* 104: 2245-2260.

Fields, J.M., de Jong, R.G., Brown, A.L., Flindell, I.H., Gjestland, T., Job, R.F.S., Kurra, S., Lercher, P., Schuemer-Kors, A., Vallet, M., Yano, M. (1997). Guidelines for reporting core information from community noise reaction surveys. *Journal of Sound and Vibration* 206: 685-695.

Franks, J.H. (1998). Preventing noise-induced hearing loss: A perspective view from the next millennium. In N.L. Carter and R.F.S. Job (eds.); Noise as a Public Health Problem; *Noise Effects* 1: 11-16.

Fung, I.W.H., Tam, V.W.Y., Lo, T.Y. and Lu, L.L.H. (2010). Developing a risk assessment model for construction safety, *International Journal of Project Management*, 28: 593-600.

Givoni, B. and Goldman, R.F. (1972). Predicting rectal temperature response to work, environment, and clothing. *J Appl Physiol* 32: 812-822.

Givoni, B. and Goldman, R.F. (1973). Predicting heart rate response to work, environment, and clothing. *J Appl Physiol* 34: 201-204.

Golbabaei, F., Monazzam, M.R., Hematjo, R., Hosseini, M., Dehghan, S.F. (2013). The Assessment of Heat Stress and Heat Strain in Pardis Petrochemical Complex, Tehran, Iran; *International Journal of Occupational Hygiene IJOH*; 5(1): 6-11.

Hollmann, S., Heuer, H., and Schmidt, K.H. (2001). Control at work: A generalized resource factor for the prevention of musculoskeletal symptoms, *Work and Stress*, 15: 29-39.

Hopkins, A. (2005). Safety, culture and risk: the organisational causes of disasters. Sydney, N.S.W : CCH Australia.171p.

International Financial Corporation (IFC). (2007). World Bank Group. *Environmental, Health, and Safety (EHS) Guidelines*. General EHS Guidelines. 65-66.

International Labour Organization (ILO). (2011). *Encyclopaedia of Occupational Health & Safety*; In: Food Industry Processes; Graham, J.C., Jensen, G., Malagie, M., Smith, Donald L. International Labor Organization, Geneva. Switzerland. ISBN : 92-2-109816-8.67.

ISO 1990 Acoustics–Determination of occupational noise exposure and estimation of noise induced hearing impairment. International Standard ISO 1999, International Organization for Standardization, Geneva, Switzerland.

ISO 7243 (1982). Hot environments – estimation of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature).1-9. ISO, Geneva. Switzerland.

IPIMAR (Instituto de Investigação das Pescas e do Mar) (2004). MODULE 10; Implementation of EMAS in a fish processing industry ; Nunes, Maria Leonor; Martins, Andreia; Cardoso, Carlos; At; http://idec.gr/etiv/pdfs/Modules/mod10/MODULE_10_-_IPIMAR_vfinal.pdf .

Ivarsson, A., Bennrup, S. and Toremalm, G. (1992). Models for studying the progression of hearing loss caused by noise. *Scandinavian Audiology* 21: 79-86.

Khilman, T. (2004). 'Noise pollution in cities, Curitiba and Goteborg as examples' In: *Proceedings of the Seminar – Environmental Aspects of Urbanization – Seminar in Honor of Dr. Mostafa Kamal Tolba*, Gothenburg, Sweden.

Krake, A. M. (2006). Extremes of Temperature. In: *Occupational and Environmental Health*; Recognizing and preventing disease and injury. Oxford University Press: 240-257.

Lazarus, H. (1998). Noise and communication: The present state. In N.L. Carter and R.F.S. Job (eds.) Noise as a Public Health Problem; *Noise Effects* 1: 157-162.

Lazarus, H. (1990). New methods for describing and assessing direct speech communication under disturbing conditions. *Environment International* 16: 373-392.

Lee, S.Y., Brand, J.L. (2005). Effect of control over office workspace on perceptions of the work environment and work outcomes. *J Environ Psychol.* 25: 323-333.

Levy, B. S., Wegman, D. H., Baron, L. S and Sokas, R. K. (2005). *Occupational and environmental health, recognising and preventing disease and injury*; 6th ed. Philadelphia, USA.

Lindvall, T. and Radford, E.P. (eds.) (1973). Measurement of annoyance due to exposure to environmental factors. *Environmental Research* 6:1-36.

Lipscomb J.A. (2011). Health Care. In: Occupational and Environmental Health; Recognizing and preventing disease and injury. 6th Edition. Oxford University Press. 769-770.

McMahon, K.J. and Mallanus, P.E. (1988). Occupational Noise Exposure in the Printing Industry. *American Industrial Hygiene Association Journal* 49(1): 34-37.

Morata, T.C., Themann, C.L., Randolph, R.F., Verbsky, B.L., Byrne, D.C., Reeves, E.R. (2005). Working in noise with a hearing loss: Perceptions from workers, supervisors, and hearing conservation program managers. *Ear. Hear*. 26(6): 529-45.

Mulugate, S. (1992). Noise Levels in the Ethiopian woodworking industries. *African Newsletter on Occupational Health and Safety* 2(1): 14-17.

National Institute for Occupational Safety and Health (NIOSH) (1991). NIOSH Publications on Noise and Hearing. Perspectives in Disease Prevention and

Health Promotion, Leading Work-Related Diseases and Injuries – United States. *Noise-induced Loss of Hearing*. July 1991 edition.

National Institute for Occupational Safety and Health (NIOSH) (1996). Analysis of Audiograms for a Large Cohort of Noise-Exposed Miners; J.R. Franks, National Institute for Occupational Safety and Health, Cincinnati, OH, internal report, 7 pp.

National Institute for Occupational Safety and Health NIOSH (1996). "Preventing occupational hearing loss - a practical guide," Franks, J., Stephenson, M.R., and Merry, C.J., eds., National Institute for Occupational Safety and Health, Cincinnati, Ohio, DHHS (NIOSH) Publication No. 96-110, 91 pp.

National Institute for Occupational Safety and Health (NIOSH) (1998). Criteria for a recommended standard: Occupational noise exposure; Revised Criteria, June 1998. U.S. Department of Human and Health Services (DHHS) (NIOSH) Publication No. 98-126. 3-103.

North Carolina Department of Labor (NCDOL) (2011). A Guide to Preventing Heat Stress and Cold Stress; Occupational Safety and Health Division. 1-22.

Occupational Safety and Health Administration (OSHA). (1999a). Noise; OSHA Technical Manual. Directive No. TED 01-00-015. U.S. Department of Labor. Washington. Section III: Chapter 5. 4- 101.

Occupational Safety and Health Administration (OSHA). (1999b). Heat Stress; OSHA Technical Manual. Directive No. TED 01-00-015. U.S. Department of Labor. Washington. Section III: Chapter 4.

Occupational Safety and Health Administration (OSHA) (2005). European Agency for Safety and Health at Work. An introduction to noise at work. Fact sheet No. 56. ISSN 1681-2123. 1-2.

Occupational Safety and Health Administration (OSHA) (2014). OSHA Fact sheet; Protecting Workers from the Effects of Heat. Directorate of Technical Support and Emergency Management (DTSEM) FS-3743 08/2014. 1-3.

Olayinka, O.S. and Abdullahi, S.A. (2009). An Overview of Industrial Employees' Exposure to Noise in Sundry Processing and Manufacturing Industries in Ilorin Metropolis, Nigeria; *Industrial Health* 47: 123–133.

Ornelas, S. and Kleiner, B. H. (2003). New Development in Managing Job Related Stress, *Journal of Equal Opportunities International* 2(5): 64-70.

Parson, K.C. (2000). Environmental ergonomics: a review of principles methods and models. *Appl Ergon* 31:581-594.

Passchier-Vermeer, W. (1993). Noise and health. The Hague, Health Council of the Netherlands (Publication No. A93/02E).

Plomp, R. (1986). A signal to noise ratio model for the speech-reception threshold of the hearing impaired. *Journal of Speech and Hearing Research* 29: 146-152.

Pourmahabadian, M., Adelkhah, M. and Azam, K. (2008). Heat Exposure Assessment In The Working Environment of A Glass Manufacturing Unit; *Iran. J. Environ. Health. Sci. Eng*., 5(2): 141-147.

Ramsay, J., Denny, F., Szivotnyak, K., Thomas, J., Corneliuson, E., and Paxton, K.L. (2006). Identifying nursing hazards in the emergency department: A new approach to nursing job hazard analysis, *Journal of Safety Research*, 37(1): 63-74.

Roberts, D. (2002). Signals and Perception; the fundamentals of human sensation", ed., pub. Open University, Palgrave Macmillan.

Singh, N., and Davier, S. C. (2004). Noise pollution- Sources, effects and control; *Journal of Human Ecology*, 16(3): 181-187.

Smith, A.W. (1998). The World Health Organisation and the prevention of deafness and hearing impairment caused by noise. *Noise and Health* 1: 6-12.

Smith, A.P. (1990). Noise, performance efficiency and safety. I*nternational Archive of Occupational and Environmental Health* 62: 1-5.

Song, B. (2012). Occupational heat stress and health impact assessment at a shoe factory in China. (Unpublished Master's Thesis); Department of Public Health and Clinical Medicine, Umeå University, Umeå, Sweden.

Spellman, F.R. and Bieber, R.M. (2008). Occupational Safety and Health Simplified for the Food Manufacturing Industry; The Scarecrow Press, Inc.

Stansfeld, S.A. (1992). Noise, noise sensitivity and psychiatric disorder: Epidemiological and psychological studies. Cambridge University Press, Cambridge, UK. *Psychological Medicine, Monograph Suppl*. 22.

Suter, A.H (2012). Engineering Controls for Occupational Noise Exposure. The Best Way to Save Hearing; *Sound & Vibration*; 45th Anniversary Issue. 24-31.

Tak, S.W., Davis, R.R., Calvert, G.M. (2009). Exposure to hazardous workplace noise and use of hearing protection devices among US workers – NHANES; 1999-2004.; *Am. J. Ind. Med*., 52(5): 358-371.

Vallet, M. and Vernet, I. (1991). Night aircraft noise index and sleep research results. Noise Control Foundation, Poughkeepsie, NY, USA. In A. Lawrence (ed.). *Inter-Noise 91*. *The Cost of Noise*, 1: 207-210.

Varca, P. E. (1999). Work Stress and Customer Service Delivery, *Journal of Services Marketing*, 13(3): 229-241.

Vernon, H.M. and Warner, C.G. (1932). The influence of the humidity of air on capacity for work at high temperatures. *J Hyg.* 32: 431-62.

Weyman, A.K. and Clarke, D.D. (2003). Investigating the influence of organizational role on perceptions of risk in deep coal mines, *Journal of Applied Psychology*, 88: 404-412.

Williams, W., Dillon, H. (2005). Hearing protector performance and standard deviation. *Noise & Health*, 7(28): 51-60.

World Health Organization (2000). Guidelines for community noise. Berglund B., Lindvall T., Schwela D. H. Geneva. 21-154.

World Health Organization (WHO) (2001). Occupational and community noise. *Fact sheet Number 258*. Revised February 2001.

World Health Organization (WHO). (2004). Occupational noise; Assessing the burden of disease from work-related hearing impairment at national and local levels;

Concha-Barrientos, Marisol; Campbell-Lendrum, Diarmid and Steenland Kyle; *Environmental Burden of Disease Series*, No. 9.

World Health Organization (WHO). (2007). Raising Awareness of Stress at Work in Developing Countries; A modern hazard in a traditional working environment; Advice to employers and worker representatives *; Protecting Workers' Health Series No. 6*. Available at; www.who.int/occupational_health.

Wyndham, C.H. (1968). Change in central circulation and body fluid and blood space during acclimatization. *J Appl Physiol.* 25: 586-593.

Yaglou, C.P. and Minard, D. (1957). Control of heat casualties at military training centers. *Am Med Ass Arch Ind Hlth* 16: 302-316.

APPENDICES

Appendix 1: Questionnaire for employee survey

QUESTIONNAIRE ON NOISE AND HEAT STRESSES ASSOCIATED WITH THE PIONEER FOOD CANNERY LIMITED.

Please Tick, underline or circle your choices. Fill in with bold letters where required.

BASIC INFORMATION

i. Age: ________________

ii. Sex: ☐Male ☐Female

iii. Department/Section: ____

iv. How long have you worked in this section? __________________________

KNOWLEDGE OF OCCUPATIONAL NOISE AND HEAT STRESSES

1. Do you know about occupational health and safety? ☐YES ☐NO
2. Do you think ***heat*** is an occupation health and safety concern? ☐YES ☐NO
3. Do you think ***noise*** is an occupational health and safety concern? ☐YES ☐NO
4. Do you think there is a ***noise*** hazard present in your work section? ☐YES ☐NO

   If yes;

   4.(b). How would you rate your noise exposure level?

   ☐Low ☐moderate ☐High ☐Very high ☐Critical

4.(c) Do you think the noise levels in your section poses a health and safety risk to you?

☐YES ☐NO

5. Do you think there is a ***heat*** hazard present in your work section? ☐YES ☐NO

   If yes;

5. (b). How would you rate your heat exposure level?

☐Low ☐moderate ☐High ☐Very high ☐Critical

5.(c) Do you think the heat levels in your section poses a health and safety risk to you? ☐YES ☐NO

PERSONAL PROTECTIVE EQUIPMENT (PPEs)

6. Do you have access to noise Related Personal Protective Equipment?

☐YES ☐NO

a. If yes to question 6 above, how adequate are the PPEs in protecting you from Noise? ☐Very adequate ☐Not at all adequate ☐Somewhat adequate

7. Do you always use the available Personal Protective Equipment?

☐Sometimes ☐All the time ☐Never

8. Do you require more protection from the noise in your section? ☐YES ☐NO

9.(b). In what ways do you require more protection;____________________________________

____

9. Do you have access to heat Related Personal Protective Equipment? ☐YES ☐NO

If yes;

10. (a) How adequate are the PPEs in protecting you or mitigating heat?

☐Very adequate ☐Not at all adequate ☐Somewhat adequate

10.(b) Do you always use the available Personal Protective Equipment?

☐Sometimes ☐All the time ☐Never

10. Do you require more protection from the heat in your section? ☐YES ☐NO

11.(b). In what ways do you require more protection;____

____