UNIVERSITY OF NAIROBI

AN INVESTIGATION INTO THE PROVISION OF PERSONAL PROTECTIVE EQUIPMENT (PPE) TO CONSTRUCTION WORKERS AND ITS ENFORCEMENT MECHANISMS. A CASE STUDY OF CONSTRUCTION PROJECTS IN NAIROBI AREA.

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REG. NO. B50/7943/2005.

A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARD OF MASTERS OF ARTS IN CONSTRUCTION MANAGEMENT, DEPARTMENT OF REAL ESTATES AND CONSTRUCTION MANAGEMENT.

JULY 2008.

DECLARATION

I, the undersigned, declare that this project is my original work and has not been presented for any examination in any other university.

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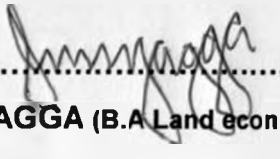
SUPERVISOR.

I declare that this project has been submitted for examination with my approval as a university supervisor in the Department of Real Estate and Construction Management.

Supervisor:(sign)  **.....Date...17../..09..../2008.**

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DEDICATION

To my wife Ireen and our unborn baby, who wiled many hours away waiting for me on numerous occasions as I researched and for your encouragement every step on the way. I have no hope of finding equivalent phrases to express my appreciation; nonetheless, my debt to you is overwhelming.

ACKNOWLEDGEMENTS

I am indebted to the many persons, who provided invaluable information, advice, criticism and encouragement, to mention but just a few: -

First and foremost, Almighty God, your provisions and divine power has led me this far.

My greatest debt is to my dearest mum, Susan, your support and love this far has been invaluable, I cannot afford to repay you.

No words can express my appreciation of my supervisor Prof. Paul M. Syagga, whose critical comments and sound advice guided my revisions and helped me clarify my vision of the final shape the study took, your availability and timely responses were invaluable. The Department of Real Estate and Construction Management staffs' positive criticisms offered during the seminars were nonetheless invaluable; the regret that I have is not being able to name all of you individually, I thank you anonymously. I am grateful to my fellow students for your wise and pertinent contribution.

I owe much to the numerous construction workers whom I was able to meet and administer with questionnaires, you made me have a first hand, valuable and informed understanding of the safety problems and non-problems you come across. Relatedly, the various gang leaders, clerk of works, site agents and management staff of different construction companies cannot be personally cited. I thank you anonymously for your help. I express my heartfelt gratitude to the Directorate of occupation health and safety services and different practicing professionals in construction industry; you were an immensely reliable source of useful information.

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ABSTRACT

Adverse work factors and hazards on construction sites seriously threaten safety of construction workers. Provision and enforcement on use of personal protective equipments (PPE) as part of the safety management actions has an important role in controlling and reducing construction workers workplace accidents and injuries.

This research was carried out to study provision, use, maintenance and enforcement mechanisms of PPE as a safety tool in construction sites. In this cross-sectional study, questionnaires, interviews and observation were employed for data collection. The questionnaires were in three categories; for construction workers, site supervisory staff and managerial staff. 100 construction workers, 25 site supervisory staff and 5 managerial staff were selected randomly from sampled construction sites and their respective management. The data obtained was presented and analyzed by descriptive statistics.

The findings showed an undesirable level of 32% (average) for PPE provision to construction workers and 36% of the workers were trained on PPE usage. 91 cases of injuries were attributable to lack of use of PPE or that could probably have been eliminated were reported. Effective enforcement on use of PPE by directorate of occupation health and safety services was noted to be lacking mainly due to inadequate funding, recruitment of staff, professional training for Occupation Health Safety practitioners and provision of tools and equipment.

The researcher suggests, though Directorate of occupation health and safety services is the enforcing agent, the responsibility for use of PPE on construction site should lie principally with the contractors, employers and workers. This responsibility must be embedded in the management culture and practices of all organizations involved in the planning and execution of construction operations for successful safety programs specially workers training in relation to the use of PPE.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem.

Construction industry comprises the erection, repair and demolition of building and civil engineering structures *(Ivor H.S, 1984)*. The Kenyan construction industry contributes 4.21% of the total Gross Domestic Product (GDP) and about 37.85% of the Gross Fixed Capital Formation in the country, and it employs 78,700 persons *(Economic Survey, 2000)*.

Hazards exist in every construction site in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations. The primary safety and health hazards for the construction worker are: falls, being struck by/against (falling object, machinery), caught in/between (trench cave-ins, between vehicle and object), electrocution, musculoskeletal disorders (lifting, awkward postures, repetitive motion, hand-tool vibration, flying/falling objects) and exposure to a variety of chronic health hazards (noise, silica, asbestos, manmade fibers, lead and other metals, solvents, hazardous wastes, heat, and extreme cold), *(OSHA, Occupational Standards and Health Administration)*. At every work place the responsibility for the health and safety of workers rests with the employer. The responsibility is both a legal and moral obligation, which can be recognized with the advent of organized industrial activity *(Armstrong, 1980)*.

Factories Work Act Chapter 514 of Laws of Kenya among others as well as Occupational Safety and Health Administration (OSHA) require that employers protect their employees from workplace hazards that can cause injury. Construction trades rank amongst the top according to the USA Gale Group website listing of the top 15 "most dangerous occupations" based on statistical data on fatality at work.

Personal protective equipment commonly known as "PPE" (includes, personal protective clothing PPC) means all equipment worn or held by the worker to protect him against one or more threats related to the emergence of hazardous or harmful agents in the work environment, also including all accessories and additions designated for this purpose *(Central Institute for Labour – National Research Institute, Poland).* Personal protective equipment is also defined as equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as, foot and eye protection, protective hearing devices and full body suits.

1.2 Problem Statement.

The construction industry is facing a crisis with respect to health and safety of Construction workers World over, *(OSHA, 1999)*, see table 1.2a and b below

Table 1.2a Construction fatalities by event, 2003–04

Event	2003	2004
Falls	364	445
Transportation incidents	290	287
Highway incidents	145	148
Nonhighway incidents	48	45
Worker struck by vehicle, mobile equipment	84	78
Contact with objects & equipment	231	267
Struck by object	111	150
Caught in or crushed in collapsing materials	78	71
Exposure to harmful substances and environments	179	170
Contact with electric current	132	122

Source: Meyer W. and Pegula M. 2004

Table 1.2b. Construction fatalities by occupation, 2003–04

Occupation	2003	2004
Construction laborers	270	283
Carpenters	90	107
Construction managers	63	95
Roofers	53	94
First-line supervisors	96	93
Electricians	64	70
Painters and paperhangers	55	57
Truck drivers	42	56

Source: Meyer W. & Pegula M. 2004

Concerns are growing following series of collapse of buildings under construction in the recent past. In Nairobi alone, some of major accidents (as reported in various print media) that have elicited hue and cry from the public, to mention but just a few, are; Sunbeam building *(East Africa Standard, 24th January 2006)*, Nyamakima *(East Africa Standard, 22nd January 2006)*. Safety problems in construction create barriers to workers entering and remaining in this field. In turn, the workers on construction worksites foster an environment in which these safety and health problems arise or continue. Use of Personal Protective Equipment is a risk reduction measure when such accidents arise.

In Kenya, thousands of construction workers incur injuries at their places of work every year *(Daily Nation, 3rd December 2005)*. According to the Ministry of Labour's Directorate of Occupational Health and Safety Services (DOHSS), which is the regulator of health and safety at work under the Factories Act, two hundred and thirty six cases of injuries were reported in a one-year period covering 2005/2006 in Nairobi's Industrial Area and Construction sites. The directorate agrees that the statistics may not be representative of the events on the ground since more than half of the employers have not registered with the

directorate. The directorate classified forty per cent of the incidents as serious, with 10 fatalities. It indicates that top on the list of employees in danger of being injured were labourers working in the mining, transport and construction industries, with 114 cases reported.

Stake holders in the construction industry such as developers, contractors, labor unions, training programs, manufacturers, and employees working in the construction industry have to cope with making decisions based on intuition and limited knowledge or awareness of the various types of personal protective equipment and clothing to undertake different construction trades.

Any accident that results in loss of labour productivity is not only of concern to the contractors for whom it means a decline in profits but also a concern to the client because injury will lead to an increase in time necessary to complete the project and the cost, this affects the construction comfort levels in comparison to other physically demanding industries. As a result, output and general performance suffer leading to low labour productivity that increases building and construction cost indices *(Turin, 1975)*. Accidents on site not only result to monetary compensation, medical expenses but also include incidental expenses caused by disruption of work, damage to property and other costly factors that accompany nearly every accident *(Whyte, 1960)*.

In tendering for construction projects and subsequent tender evaluation; costs such as for preliminaries, specifications of materials have specific provisions. In contrast, critical items of Personal Protective Equipment are not considered. Safety and specifically PPE for work sites are neither factored in any of the tender evaluation procedures nor in supervision of the construction projects. Though provisions for insurance for injury to third parties *(JBC 1999, Agreement and Conditions of contract for building works)* and workmen (Workmen compensation policy) are provided in most of tender documents they have not adequately induced the Contractor to provide PPE and proper use of the same.

The positive correlation of PPE in construction industry and safety are not adequately considered in the statutory laws, national development planning and even as part of construction costs. The general trend the world over is towards greater concern for issues relating to occupational safety, comfortable work environment and employee oriented work practices *(Woolf et al, 2000).*

PPE issues in the construction industry in Kenya receive inadequate attention and provision as evident in the safety laws, needless to mention inadequate efforts to ensure strict compliance to any of the laws. Nonetheless, the advantages of use of PPE on construction sites need to be properly communicated to the contractors, the building client and the construction team alike. Construction industry unlike other industries has not given PPE greater priority. This prevails for many reasons, mainly owing to cost, lack of enforcement and ignorance of the stakeholders concerning the process of construction on the site and the important relationship between PPE and safety.

As the construction labor force becomes more diversified, the construction industry as a whole cannot afford to overlook the genuine need of PPE as a safety measure for construction workers, apprentices and applicants. This study is intended to call attention to the real contemporary safety issues of construction workers. These issues merit attention to, and action by, all those who share responsibility in the arena of construction safety.

1.3 Objectives of the Study.

The objectives of the study are to: -

1. Find the adequacy of provision, use and maintenance of personal protective equipment to the construction workers.

2. Evaluate the adequacy of training on use and need of PPE among the construction workers.

3. Find out whether there are hazards and accidents that could be minimized by use of PPE as a safety tool in the construction sites.

4. Assess the adequacy of enforcement mechanism for provision and use of personal protective equipment in the construction industry.

5. Make recommendations on use and enforcement of PPE.

1.4 Research Questions.

In this study, the researcher seeks to answer the following questions: -

1. *Level of Provision and adequacy:* To what level are construction workers provided with PPE? Are the PPE provided, if any, maintained?

2. *Extent of Awareness:* To what level are the construction workers inducted on the correct and necessity of PPE use?

3. *Adequacy of Enforcement Machinery:* To what level is enforcement mechanism adequate?

1.5 Research Hypotheses.

Absence of elaborate and vigilant enforcement mechanism is the main cause of inadequate provision and non-use of personal protective equipment by construction workers.

1.6 Justification and significance of the Study.

This study is intended to: First, assess provision of personal protective equipment in construction sites. The exposition of adequacy of provision of PPE

is worthwhile contribution to the existing spectrum of knowledge in the field of construction workers PPE.

This study provides a guideline in future efforts for parties interested in improving on this present situation as well as informative and organized literature on PPE for those who wish to further research on this topic.

This study evaluates the level of awareness among construction workers on the various types of protective gear; this will serve as a launch of awareness campaign among parties engaged in construction sites.

The literature reviewed in this study serves as an organized body of knowledge that the parties engaged in construction sites can utilize in providing personal protective clothing as well as theoretical framework to incorporate into the construction sites.

The study discusses enforcement machinery of construction workers personal protective equipment and points shortcomings and relevance. In future endeavors to review such enforcement machinery this research can serve a vital role.

This study outlines benefits of provision of PPE to all construction industry stakeholders, this not only motivates construction operatives but it is directly proportion to levels of productivity.

The results and recommendations derived from this study avails useful information for use by the various industry stakeholders on various PPE on different types of construction trades.

1.7 Scope of the Study.

1.7.1 Physical scope.

The choice of Nairobi was considered based on the fact that it is the capital city of Kenya with a developed infrastructure and therefore a center of construction activity varying from stages, types, size and complexity on different construction sites, like in other developing countries where such activities are concentrated in the capital cities *(Rukwaro, 1990 and Nyagah, 1989)*.

An observation revealed that there were many construction projects within close geographical proximity. This is of much significance as construction workers in different sites were observed to evaluate the variables of interest to the study.

Limitations of time and resources could not allow carrying out a study through out Kenya and therefore Nairobi was convenient area that represents the entire construction sites on variables considered in this study.

1.7.2 Conceptual scope.

The aim of the study is use of personal protective equipment at construction sites during the construction process. This in essence includes construction projects under construction only. The research includes PPE for various construction trades, as well as handling of building materials, components, mechanical plant and equipment.

This research concerns the risks avoidable by use of PPE at the construction site environment as it affects the workers. It does not deal with third parties, authorized visitors to the construction site nor members of the public.

The study does not deal with technical clinical health effects to workers for lack of PPE such as earmuffs, welding goggles etc.

The research considers contractors registered with Ministry of Public works handling construction projects located in Nairobi and running for over three months. The registered contractors are considered as the most suitable because they are capable of handling projects of high scope and the period is long enough to develop an established practice.

In a nutshell the interest of the researcher revolves around the provision of protective gear to operatives, their level of awareness and enforcement machinery. This definition of scope aids in keeping the study within manageable limits.

1.8 Research methodology

Research methodology stipulates the various activities and procedures that were undertaken to come up with the findings of this study, it describes details of methods used in data collection, data measurement and data analysis needed to accomplish the research objectives. In addition, it formulates and explains the statistical parameters used to analyze the data. An insight into the sample of projects studied, their safety features and attributes that necessitated the study in the particular projects are discussed below.

1.8.1 Research design.

This research is a descriptive research, which seeks to identify and record provision, usage, maintenance, training and enforcement mechanism of PPE on construction sites. It undertakes a case study approach, to enable categorization of the subject matter *(Fellows, 2003).* Case studies encourage in-depth investigation of particular instances within the subject. In addition, the nature of the in-depth data to be collected may limit the number of case studies, when the research is subject to resource constraints. As in any other case study research, this study combines a variety of data collection methods, structured questionnaires, participant observation, semi-structured interviews and field measurements.

The research strategy used to accomplish the study objectives conforms to ethical standards and legal requirements for research participants. These include amongst others issues such as seeking of management permission before visiting of any of the sites. Labour matters are sensitive and therefore it was necessary to assure the respondents and all subjects that the information given was treated with confidentiality and only be used for purposes of the research. Confidentiality of the information was expressly emphasized in the cover letter seeking permission to obtain information on projects sites.

1.8.2 Description of study area and population.

Nairobi is the capital and largest city of Kenya and 4th Largest city in Africa, it is also the capital of the Nairobi Province and of the Nairobi District. The city is located at 1°16′S, 36°48′E and occupies 684 square kilometres (260 sq miles). It is situated 1661 metres (5450 ft) above sea level *(http://en.wikipedia.org/wiki/Nairobi)*.

Kenya's construction industry activities like in other developing countries are concentrated in the capital cities. Most firms involved in construction activities are located in Nairobi as identified from Ministry of Roads and Public Works register of approved building Contractors, 3rd edition, June 2007. The population of active project sites considered in this study is within the geographical boundaries of the city of Nairobi. The choice of Nairobi was because it is the capital city of Kenya, and in comparison to other parts of Kenya, it has the highest number of active construction sites. Active sites enabled the most reliable observation of use of PPE on construction sites. For holding certain work related hazards parameters, such as climate, constant it was necessary to confine site observations to one geographical area.

The study was confined to construction activities that are largely manual as well as mechanized operations. Different construction activities require different PPE depending on the danger they pose to the construction worker.

In establishment of a sample frame for this study an elaborate selection criteria was applied in qualification of project sites and firms for study. Two options underwent critical examination before determination of a method that provided the most viable sample frame.

First option, The Nairobi City Council (NCC), has a jurisdiction over all development projects within the city boundaries, hence a natural starting point for identifying active construction sites for the study. All project plans and building works developers are supposed to seek approval from the Nairobi City Council, City Planning department to ensure that they conformed to their by-laws. The NCC personnel also carry out inspection of on going works; this procedure ensures that only approved drawings are implemented on construction sites. This option was aborted because the researcher established there were some construction projects that went on even for a year pending formal approval. Secondly not all approved construction projects were implemented forthwith, some were abandoned. The aforementioned factors distorted the originally assumed population and the resultant sample frame.

Second option. A population comprising of one hundred and eight (108) contractors registered with the Ministry of Roads and Public Works under category A was the basis for determination of the sample, *(Ministry of Roads and Public Works register of approved building Contractors, 3rd edition, June 2007).*

1.8.3 Sample size.

Out of the population of 108 listed contractors in class A. The criteria for sampling the construction site was,

- Nature of on-going construction project. The project had to be general construction works, this facilitated observation of many construction trades.
- Size of the construction project. The contract sum was a minimum of Kshs 100.0million.
- Number of projects per Company. Only one project per Company was picked. The project had to be the biggest in scope.
- Location of on-going project. The project had to be located in Nairobi.
- Location of registered office. The registered office of the construction firm had to be in Nairobi.

A representative sample of 5 construction firms and one of their ongoing projects that met the above criteria were picked. Moreover, a population of 108, that incidentally was too big given the minimal resources at the disposal of the researcher in terms of constraints of time and limited financial ability. The need to exhaustively analyze minute aspects of the study did not warrant unmanageably large population.

Nevertheless, researchers on construction projects in many cases have worked with relatively small sample sizes for various reasons. Li and Lee *(1999)* investigated postural analysis of four jobs on two building construction sites. The sample size determines the type of applicable statistical tools. Therefore, by using a suitable statistical tool, some of the problems that could be associated with the sample size can be minimized *(Lapin, 1982)*.

The five identified firms selected were requested to avail the most active project site. Construction projects availed were purposively scrutinized to ensure that the projects picked for analysis were suited and were the ones that the firm accorded the highest priority in terms of resources (manpower, equipment, time resources) and other administrative functions. The study confined itself to ongoing projects

because of the observational requirements necessitated by the nature of research.

1.8.4 Data collection instruments and procedures.

The following research instruments were used in collection of primary data.

1.8.4.1 Interviews

Structured interview sheet design was in such a way that the stratification of the data for analysis was possible. The questions are directed at safety policy on construction sites, provisions of PPE to construction workers, training of construction workers on use of PPE, adherence to legal provisions on use of PPE. Structured interviews were carried out with Directorate of occupational health and safety services.

Unstructured interviews were also employed with site personnel, including site agents, clerk of works to assist in explaining and clarifying any information required.

1.8.4.2 Observation.

This aided by use of a checklist to assess prevalence of risks on the construction risks and different types of PPE provided for:

- Eye and face protection
- Hearing protection
- Respiratory protection
- Hand and arm protection
- Foot and leg protection
- Head protection
- Body protection

This involved visiting each construction site identified; seek authority and entry permission from the contractors' whose sites were under study. The researcher was guided by observation of the selected items listed above. This approach's adoption is because of the need to collect certain data without ambiguity. Harper *(1994)* recommends observation as the most fruitful method of data collection because it reduces the chances of recording incorrect data by respondents.

Use of checklist was employed as a data collection instrument because it enabled a uniform method of comparison of various construction sites.

1.8.4.3 Questionnaires.

Administration of questionnaires with both close-ended and open-ended questions was carried out among the construction workers. The open-ended questions were specifically for the purposes of harnessing in cases where there was need for further clarification. The questionnaires sought to find out; -

- Types of PPE on site,
- Who provides the identified PPE's above,
- The level of awareness and training,
- Care and maintenance of PPE,
- What discourages use of PPE,
- Incentives for use of PPE.

The questionnaires were pre-tested to receive comments and suggestions. In additional questions from prospective respondents were to give an indication of expected responses. The responses were scrutinized with the view of detecting ambiguities either in the asked questions or in the given answers.

Use of questionnaires was employed as a data collection instrument because it helped to clarify some of inadequately captured phenomena and activities that were otherwise subject to ambiguity if only observed.

1.8.4.4 Photographs.

A camera was used in capturing various constructions workers in their normal operations at different construction activities with or without their PPE's. The different construction site working conditions were also photographed for recording.

1.8.5 Data presentation and analysis.

The raw data obtained is presented in form of graphic representation i.e. charts and tables.

More data relating to the use of PPE by construction workers and construction site working conditions is presented in form of plates.

Analysis of the data is mainly by use of descriptive statistics such as the mode, Frequency distribution tables and percentages.

1.9 Structure of the Study.

This study is organized in four chapters.

Chapter I; discusses the background of the problem of personal protective equipment in the construction sites and related legislative provisions in the construction industry. It also discusses the problem statement, objectives of the study, research questions, research hypotheses, significance, scope, limitations and structure of the study. In addition this chapter discusses the relevance of the research methodology employed in conducting the study. The research design, target population, sample, data requirements and collection procedures, collection tools, measurement criteria for the variables and data analysis procedures and methods to be employed.

Chapter II; reviews in detail the relevant literature on personal protective equipment in construction sites. Various types of PPE available for construction

workers, PPE programme on construction site are discussed extensively. Legislation relating to provisions of PPE and their implementation on the construction sites are discussed.

Chapter III; presents the analysis of the data in the form of descriptive and inferential statistics. The various data collected is subjected to various forms of analyses. This aids in identifying characteristics and phenomena of the variables that are among the objectives of this research.

Chapter IV; covers profound and extensive discussion, conclusions and recommendations based on the study findings. It also outlines areas for further research within the field of personal protective equipments and clothing.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature covering various aspects on Personal Protective Equipment (PPE). The main issues concerned with achieving the research objectives and testing the research hypothesis are explained here in detail. In discussing PPE various categories and types are identified and their requirements discussed. Implementation of PPE program on construction sites, legislation and enforcement of PPE program are discussed profoundly. Finally, the chapter dwells on the conceptual relationship in selection, roles of employer and employee and relationship of provision of PPE and safety in construction sites.

2.2 PPE definition.

Personal protective equipment, PPE, is designed to protect employees from serious workplace injuries or illnesses resulting from contact of chemical, radiological, physical, electrical, mechanical or other workplace injuries, *(OSHA 2002)*. In addition, PPE refers to all equipment worn or held by the worker to protect him against one or more threats related to the emergence of hazardous or harmful agents in the work environment, also including all accessories and additions designated for this purpose *(Central Institute for Labour – National Research Institute, Poland)*.

PPE is used as part of an integrated organizational approach to health and safety management. It should complement other control methods such as engineering controls and work practice controls e.g. initial design specifications, enclose process, change process, isolate process, job rotation, personal hygiene, house keeping and maintenance. It is not reasonably practicable to eliminate all risks to the health and safety to anyone at the construction site. PPE are therefore worn as a method of controlling risk.

A hazard cannot be eliminated by PPE, but the risk of injury can be eliminated or greatly reduced. For example, wearing hearing protection reduces the likelihood of hearing damage when the earplugs or muffs are appropriate for the kind of noise exposure and they are used properly. However, hearing protection does not eliminate the noise *(http://www.ccohs.ca)*.

Other reasons for use of PPE stem from need of establishing good occupational safety and health standars such as-; *(http://en.wikipedia.org)*

- Moral - An employee should not have to risk injury at work nor should others associated with the work environment.
- Economic - many stakeholders realize that poor occupational safety and health performance results are costly (e.g. through insuarance compensation to the incapacitated, costs for medical treatment, and the loss of the "employability" of the worker). Employing organisations also sustain costs in the event of an incident at work (such as legal fees, fines, compensatory damages, investigation time, lost production, lost goodwill from the workforce, from customers and from the wider community).
- Legal - Occupational safety and health requirements may be reinforced in civil law and/or criminal law; it is accepted that without the extra "encouragement" of potential regulatory action or litigation, many organizations would not act upon their implied moral obligations.

2.3 Standards of personal protective equipment.

It should not be assumed that all protective safety wear is appropriate for all circumstances. One has to make an assessment of the risks at the work place and parts of the body in danger. The choice of equipment must then take into account the following, *(Davies et al, 1996)*; -

- The physical effort required to do the job,
- The methods of work
- How long the PPE requires to be worn
- The requirements of visibility and communication.

PPE must meet the following considerations *(Royal Decree 773/1997, of 30th May);* -

- The purpose of PPE is not to carry out a task or activity but to protect the worker from the risks involved in that task or activity.
- PPE must be worn or carried by the worker and used in the manner provided for by the manufacturer.
- PPE must be a protective element for the person who uses it, not for the protection of other persons or products.

The additions or accessories whose use is essential for the correct working of the PPE equipment and which contribute to ensuring the assembly's protective effectiveness are also deemed to be PPE. Working clothes that, although specific to the activity, serves to identify a work group or used merely to protect their outdoor clothes or to keep them clean and not to protect the health or physical integrity of the persons who wear them they are not classified as PPE. Example: uniforms or aprons for construction workers, etc.

2.4 PPE for use on construction sites.

The range of PPE is wide. Construction site PPE are discussed under the following categories:

- Eye protection and face protection,
- Hearing protection,
- Respiratory protection,
- Hand and arm protection,
- Foot and leg protection,
- Head protection,
- Body and fall protection mechanisms.

The categories are discussed below:-

2.4.1 Eye and face protection.

Some of the most common types of eye and face protection include the following:

- **Safety spectacles.** These protective eyeglasses have safety frames constructed of metal or plastic and impact-resistant lenses. Side shields are available on some models.
- **Impact-resistant spectacles.** This eyewear can be used for moderate impact from particles produced by such jobs as carpentry, woodworking, grinding, and scaling.
- **Side shields.** These protect against particles that might enter the eyes from the side. Side shields are made of wire mesh or plastic. Eye-cup type side shields provide the best protection
- **Goggles.** These are tight-fitting eye protection that completely cover the eyes, eye sockets and the facial area immediately surrounding the eyes and provide protection from impact, dust and splashes. Some goggles will fit over corrective lenses.
- **Welding shields.** Constructed of vulcanized fiber or fiberglass and fitted with a filtered lens, welding shields protect eyes from burns caused by infrared or intense radiant light; they also protect both the eyes and face from flying sparks, metal spatter and slag chips produced during welding, brazing, soldering and cutting operations. OSHA requires filter lenses to have a shade number appropriate to protect against the specific hazards of the work being performed in order to protect against harmful light radiation.
- **Laser safety goggles.** These specialty goggles protect against intense concentrations of light produced by lasers. The type of laser safety goggles an employer chooses will depend upon the equipment and operating conditions in the workplace.

- **Face shields.** These transparent sheets of plastic extend from the eyebrows to below the chin and across the entire width of the employee's head. Some are polarized for glare protection. Face shields protect against nuisance dusts and potential splashes or sprays of hazardous liquids but will not provide adequate protection against impact hazards. Face shields used in combination with goggles or safety spectacles will provide additional protection against impact hazards.

Some of most common and dangerous construction activity in regard to face and eye protection is welding operations. Welding operations poses great danger since the intense light associated with it can cause serious and sometimes, permanent eye damage if operators do not wear proper eye protection. The intensity of light or radiant energy produced by welding, cutting or brazing operations varies according to a number of factors including the task producing the light, the electrode size and the arc current. Table 2.4a below shows general guidelines for selection of eye and face protection equipments in the construction industry; -

Table 2.4a: Selection guide for eye and face PPE.

Source	Type of hazard	Protection
Impact – Chipping, grinding, machining, masonry work, wood working, sawing, drilling, chiseling, powered fastening, riveting, and sanding,	Flying fragments, objects, large chips, particles, sand, dirt	Spectacles, with side protection, goggle and face shields. For severe exposure use face shield over primary eye protection
Heat - Casting, hot dipping, welding, cutting and brazing.	Hot sparks	Face shields, goggles, and spectacles, with side protection. For severe exposure use face shield.

	Splash from molten metals	Face shields worn over goggles.
	High temperature exposure	Screen face shields, reflective face shields.
Chemicals – Acid and chemical handling, degreasing, plating	Splash	Goggle, eyecup and cover types. For severe exposure use face shields.
Dust – Woodworking, general dusty conditions	Irritating mists	Special purpose goggles
	Nuisance dust	Goggle, eyecup and cover types.
Light and/or Radiation – welding, electric arc	Optical radiation	Welding helmets or welding shields. Typical shades (appendix 04)
Welding – gas cutting, torch brazing, torch soldering	Optical radiation	Welding goggles or welding face shield. Typical shades (appendix 04)
Glare	Poor vision	Spectacles or welding face shield, typical shields (appendix04), Spectacles with shaded or special-purpose lenses, as suitable.

Source: OSHA 2002

2.4.2 Hearing protection.

Repeated exposures to loud noise can lead to permanent, incurable hearing loss. The best hearing personal protective equipment (PPE) is the one that is comfortable and convenient, and that you can wear every time you are exposed to hazardous noise. Some of construction activities that require hearing protection are; - work with metal presses, work with pneumatic drills and compressors, pile-driving work and woodworking.

Determining the need to provide hearing protection for employees can be challenging. Employee exposure to excessive noise depends upon a number of factors, *(http://www-old.itcilo.org);*

- The loudness of the noise as measured in decibels (dB).
- The duration of each employee's exposure to the noise.
- Whether employees move between work areas with different noise levels.
- Whether noise is generated from one or multiple sources.

Generally, the louder the noise, the shorter the exposure time before hearing protection is required. For instance, a construction worker may be exposed to a noise level of 90 dB for 8 hours per day (unless they experience a Standard Threshold Shift) before hearing protection is required. On the other hand, if the noise level reaches 115 dB hearing protection is required if the anticipated exposure exceeds 15 minutes.

Table 2.4b, below, shows the permissible noise exposures that require hearing protection for employees exposed to occupational noise at specific decibel levels for specific time periods. Noises are considered continuous if the interval between occurrences of the maximum noise level is one second or less. Noises not meeting this definition are considered impact or impulse noises (loud momentary explosions of sound) and exposures to this type of noise must not exceed 140 dB. Examples of situations or tools that may result in impact or impulse noises are powder-actuated nail guns, a punch press or drop hammers.

Table 2.4b: Permissible Noise exposures 1/4 or less 115

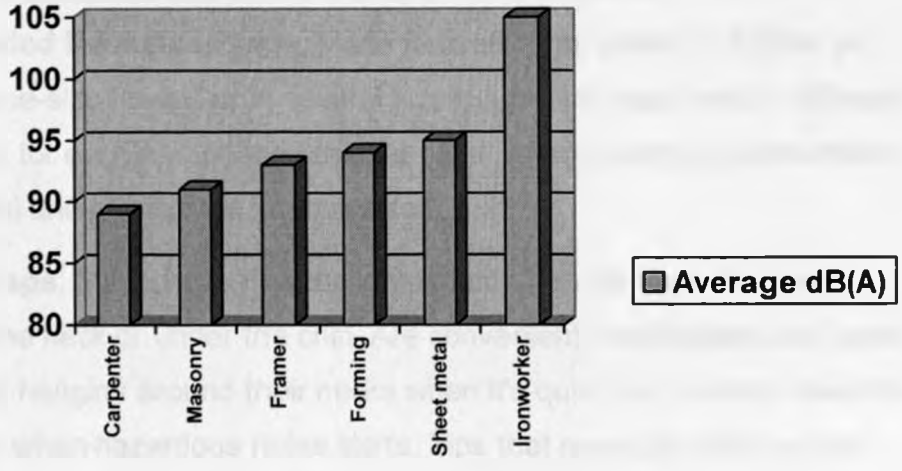
Duration per day, in hours	Sound level in dB*
8	90
6	92
4	95
3	97
2	100
11/2 5	102
1	105
1/2	110
1/4 or less	115

**When measured on the A scale of a standard sound level meter at slow response.*

Source: OSHA, 29CFR.

Chart 2.4c below shows average dB for some of construction activities/trades.

Chart 2.4c: Average dB(A) for some of construction activities/trades.



Construction activity.
Source: OSHA, 29CFR

Most construction noise comes from construction equipment and plant as shown in table 2.4d below:

Table 2.4d:Average DB of some of construction equipments.

Equipment	Decibels	Equipment (Cont'd)	Decibels (Cont'd)
Pneumatic chip hammer	103-113	Earth Tamper	90-96
Jackhammer	102-111	Crane	90-96
Concrete joint cutter	99-102	Hammer	87-95
Stud welder	101	Front-end loader	86-94
Bulldozer	93-96	Backhoe	84-93
Skilsaw	88-102	Gradeall	87-94

Source: OSHA 2002

The noise levels change. The noise from a gradeall earthmover is 94 decibels from 10 feet away. The noise is only 82 decibels if you are 70 feet away. A crane lifting a load can make 96 decibels of noise; at rest, it may make less than 80 decibels.

Hearing PPE include *(www.ehs.ucr.edu):* -

- **Expandable Foam Plugs**. These are made of a formable material designed to expand and fit to the shape of the ear canal.
- **Pre-Molded Reusable Plugs**. Made from silicone, plastic or rubber as either "one-size-fits-all" or in several sizes. A person may need a different size plug for each ear (sealing the ear canal without being uncomfortable takes trial and error of the various sizes).
- **Canal Caps.** Some have headbands that can be worn over the head, behind the neck or under the chin. Are convenient - employees can leave the band hanging around their necks when it's quiet, and quickly insert the plug tips when hazardous noise starts. Tips that resemble stand-alone earplugs seem to block the most noise (not all canal caps have tips that adequately block all types of noise).

- **Earmuffs**. They block out noise by completely covering the outer ear (can be "low profile" with small ear cups or large to hold extra materials for use in extreme noise). Some include electronic components to help users communicate or block impulsive noises. Not recommended for workers who have heavy beards or sideburns or who wear glasses (the hair and the temples of the glasses break the seal that the earmuff cushions make around the ear - earplugs are best). Can be hot and heavy in some environments.
- **Single-use earplugs** are made of waxed cotton, foam, silicone rubber or fiberglass wool. They are self-forming and, when properly inserted, they work as well as most molded earplugs.

Chart 2.4e; below shows some of hearing protectors.

Chart 2.4e: Hearing protectors.

Source: OSHA 2002

2.4.3 Respiratory protection.

Respiratory protective equipment falls into the category of respiratory tract personal protective equipment in which the protection against air-borne contaminants is obtained by reducing their concentration in the breathing zone to below the recommended exposure levels. Respiratory protection is used to protect employees from respiratory hazards such as toxic chemicals, dusts, infectious agents, etc. There are many different types of respirators. Some respirators protect against particulates, while others protect against vapors

Some of construction activities that require use or respiratory PPE include; Rock crushing and handling, sandblasting, dismantling buildings containing asbestos, insulation, welding or cutting materials with coatings containing zinc, lead, nickel, or cadminium, spray painting, blasting, Work in shafts, sewers and other underground areas connected with sewage.

The type of respirator worn by workers depends on the level of exposure. A medical evaluation will be necessary to determine if an individual can wear a particular respirator. Medical conditions, such as heart disease, emphysema, asthma, or other lung disorders, may make it difficult for an individual to wear a particular type of respirator. There are two major categories of respirators: air purifying respirators and supplied air respirators *(http://www.tfhrc.gov)*.

Air purifying respirators purify the air a worker breathes by removing or filtering the contaminant from the air before it enters the wearer's lungs. The filter removes the contaminant from the air before the air enters the inside of the respirator through the inhalation valve and supplies clean or purified air to the wearer. When the wearer exhales, air from the lungs is released through a separate valve called the exhalation valve.

Facial features can prevent a good respirator seal from occurring with the wearer's face. Facial hair, such as beards, stubble, and sideburns that lie

between the sealing surface of the respirator and the face will result in leaks of contaminated air into the mask. Likewise, deformities on the face, such as scars, acne, and lack of teeth, can cause leaks. Because of the potential for leaks through an improper seal, beards and other facial hair that lies along the sealing surface are not permitted for workers who wear respirators, and special care must be given to proper fitting of respirators for workers with facial deformities. Air purifying respirators can only be used in atmospheres with sufficient oxygen and where air contaminants do not exceed the concentration range specified for the respirator. Below are four sub-categories of air purifying respirators described by the type of face-piece:

- Single use disposable (not recommended for lead work)
- Reusable half-face
- Reusable full-face
- PAPR (powered air purifying respirators), half- or full-face

All air purifying respirators, whether half-face, full-face, or powered have the following limitations: Cartridge life problem, the cartridge has only so much capacity, and when that capacity is reached, the cartridge is no longer any good. If the cartridge is used for organic vapors or gases and the capacity is reached, the contaminants will pass through the filtering material directly into the worker's lung.

Oxygen limitations. Air purifying respirators can only be used when there is sufficient oxygen in the air. The minimum concentration must be no less than 19.5 percent.

Lastly, IDLH concentrations (immediately dangerous to life or health). Under these concentrations it is much too dangerous to trust this type of respirator. It doesn't provide enough margin of safety, (http://www.mtas.es/insht/en/practice).

Supplied Air Respirators is another type of respirator. These respirators do not depend on filters. Instead, they provide an independent supply of uncontaminated air. This type supplies air to the face-piece through a length of hose called an air line. Air line respirators are called "Type C" respirators. When they are used for abrasive blasting operations, they are called "Type CE" respirators. Type CE respirators are commonly used on lead jobs involving bridges and steel structures. The air line is connected to either a compressed-air cylinder or else to a compressor that is equipped with equipment to purify the air. The air supply can be used to pressurize the mask to achieve a high protection factor.

Limitations of Supplied Air Respirators include; The air line impairs worker movement. The air line cannot exceed 300 feet (91.4M) in length according to regulations. Workers also must retrace their steps coming off of the job.

The air line is vulnerable to damage. Rough or sharp surfaces can puncture the line. The rubber hose may deteriorate from exposure to chemicals or to sunlight. Falling objects, vehicles, and heavy equipment also can damage the air line. The system air compressor must be located away from potential chemical or contamination hazards.

All filters and alarms must be working properly and the system must be maintained according to the manufacturers' recommendations. The maximum inlet pressure cannot exceed 125 psi (862kPa) or fall below 80 psi (522kPa).

There are supplied airline masks which include an escape SCBA (self-contained breathing apparatus) tank. A small tank contains a 5 to 10 minute air supply. When this back-up tank is provided, workers can be assigned to enter almost any area no matter what the concentration of contaminant in the air.

Table 2.4f below highlights various respirators and their ability to protect against different hazards.

Table 2.4f: Respiratory PPE selection guide.

RESPIRATOR TYPE	PROTECTION	NO PROTECTION
Filter Respirator (HEPA cartridge)	_Dust _Fumes _Smoke _Mist _Microorganisms _Asbestos	_Chemical vapors or gases _Oxygen deficiency
Chemical Cartridge/Canister Respirators	_Certain gases and vapors up to a particular concentration	_Oxygen deficiency _Particulate matter
Air Supply Respirator	Depending on type: _Particulates _Chemical vapors and gases _Oxygen deficiency	

Source http://ehsd.tamu.edu.

2.4.4. Hand and arm protection.

In construction site the workers face potential injury to hands and arms that cannot be eliminated through engineering and work practice controls, employers must ensure that employees wear appropriate protection. Potential hazards include; skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, abrasions, cuts, punctures, fractures and amputations.

Hand and arm protective equipment includes; -

- Gloves,
- Finger guards and
- Arm coverings or elbow-length gloves.

There are many types of gloves available today to protect against a wide variety of hazards. The nature of the hazard and the operation involved will affect the

selection of gloves. Some factors that may influence the selection of protective gloves in a construction site include; type of chemicals handled, nature of contact (total immersion, splash, etc.), duration of contact, area requiring protection (hand only, forearm, arm), grip requirements (dry, wet, oily), thermal protection, size and comfort, abrasion/resistance requirements.

Gloves made from a wide variety of materials are designed for many types of workplace hazards. In general, gloves fall into four groups:

- Gloves made of leather, canvas or metal mesh;
- Fabric and coated fabric gloves;
- Chemical- and liquid-resistant gloves;
- Insulating rubber gloves.

Table 2.4g: Glove selection guide.

Glove Type		**Protection**
Leather, Canvas or Metal Mesh Gloves	Leather gloves	Protect against sparks, moderate heat, blows, chips and rough objects.
	Aluminized gloves	Provide reflective and insulating protection against heat and require an insert made of synthetic materials to protect against heat and cold.
	Aramid fiber gloves	Protect against heat and cold, are cut - and abrasive - resistant and wear well.
	Synthetic gloves	Protection against heat and cold, are cut - and abrasive - resistant and may withstand some diluted acids. These materials do not stand up against alkalis and solvents.
Fabric and Coated Fabric Gloves	Fabric gloves	Protect against dirt, slivers, chafing and abrasions. They do not provide sufficient protection for use with rough, sharp or heavy materials.

	Coated fabric gloves	Used for tasks ranging from handling bricks and wire
Chemical - and Liquid - Resistant Gloves	Butyl gloves	Protect against highly corrosive acids and also resist oxidation, ozone corrosion and abrasion,
	Natural (latex) rubber gloves	Protect workers' hands from most water solutions of acids, alkalis, salts and ketones
	Neoprene gloves	They protect against hydraulic fluids, gasoline, alcohols, organic acids and alkalis.
	Nitrile gloves	Protection when working with oils, greases, acids, caustics and alcohols

Source: OSHA 2002.

2.4.5 Foot and leg protection.

Workers on construction sites need to be protected from a wide range of potential foot and leg injuries that include the following: - Carcass work, foundation work and road works, scaffolding work, demolition of carcass work, work with concrete and prefabricated parts involving formwork erection and stripping, roof work, work on steel building construction, masts, towers, lifts, steel hydraulic structures, cranes, metal assembly work, glass products etc.

The type of foot and leg protection to provide to construction workers will depend upon the specific workplace hazards one identifies and the specific parts of the feet or legs exposed to potential injury. Foot and leg protection choices include;

- **Leggings**. Used to protect the lower legs and feet from heat hazards, like molten metal or welding sparks. Safety snaps allow leggings to be removed quickly.
- **Metatarsal guards**. Made of aluminum, steel, fiber, or plastic, these guards maybe strapped to the outside of shoes to protect the instep area from impact and compression.

- **Toe guards.** Toe guards may be made of steel, aluminum, or plastic. They fit over the toes of regular shoes. These guards protect only the toes from impact and compression hazards.
- **Combination foot and shin guards**. These guards may be used in combination with toe guards when greater protection is needed.
- **Safety shoes.** These sturdy shoes have impact-resistant toes and heat-resistant soles that protect against hot work surfaces common in roofing, paving and hot metal trades. The metal insoles of some safety shoes protect against puncture wounds.
- **Steel-toe shoes/boots** – provide impact/compression protection for toes.
- **Puncture resistant** – protect the feet when working in areas that often have nails, screws, and other sharps on the floor.
- **Rubber-soled** – provide slip-resistance, often used in areas with wet/slippery walking surfaces.
- **Static dissipative footwear** – insulates the wearer from electrical hazards that may exist in areas where static dissipative footwear is required.

Other special shoes include; -

- **Electrically conductive shoes** provide protection against the buildup of static electricity. Conductive shoes must be removed when the task requiring their use is completed. Workers exposed to electrical hazards must never wear conductive shoes.
- **Electrical hazard, safety-toe shoes** are nonconductive and will prevent the wearers' feet from completing an electrical circuit to the ground. These shoes can protect against open circuits of up to 600 volts in dry conditions and should be used in conjunction with other insulating equipment and additional precautions to reduce the risk of a worker becoming a path for hazardous electrical energy. The insulating protection of electrical hazard, safety-toe shoes may be compromised if the shoes become wet, the soles are worn through, metal particles become embedded in the sole or heel,

or workers touch conductive, grounded items. Nonconductive footwear must not be used in explosive or hazardous locations.

- **Foundry Shoes:** In addition to insulating the workers' feet from the extreme heat of molten metal, foundry shoes prohibit hot metal from lodging in shoe eyelets, tongues, or other parts. These snug-fitting leather or leather-substitute shoes have leather or rubber soles and rubber heels. In addition, all foundry shoes must have built-in safety toes.

Table 2.4h provides general guidance for selection of foot and leg protection for the hazards associated with the listed hazard 'source' operations.

Table 2.4h: Selection guide for foot and leg protection.

Source	Typical Activity Requiring Protection	Protection
Impact-Heavy tools equipment, or objects that might roll or fall onto the feet of an employee.	Demolitions, Renovations, plumbing maintenance, trenching, materials handling	Safety shoes or boats. Toe guards may be used over regular footwear only if an employee is infrequently exposed to this type of foot hazard.
Puncture- Work where wire, tacks, staples, metal or nails could be stepped on causing foot injury	Demolition, Construction, Renovations, Building maintenance.	Safety shoes or boots with puncture protection
Compression- Handling of unusually heavy tools, objects or equipment that	Heavy materials handling, work using jackhammer, pavement breaking.	Metatarsal footwear. Metatarsal guards may be used over regular footwear only if a worker is

present a compression hazard to the top of the foot.		infrequently exposed to this type of foot hazard. Shin guards may be required for some operations where the lower leg is exposed to a rolling impact hazard.
Heat – welding, casting, hot liquids	Casting, welding, cutting and brazing.	Foundry or heat resistant shoes or boots as appropriate. Legging should be used as appropriate to protect the lower legs form welding sparks
Chemicals –Splash hazard or direct contact/work with chemicals.	Degreasing, chemical handling, chemical spill response.	Footwear may need to incorporate safety toe if an impact hazard is also present. Consult manufacturer's literature.
Electrical – Work near or with energized electrical wiring or components.	Building maintenance, construction, wiring, arc or resistance wiring.	Electric hazard safety-toe footwear.
Conductive- Work near or in explosive or hazardous atmospheres.	Spray painting or similar work with highly flammable materials	Conductive foot wear

Source; OSHA 2002

present a compression hazard to the top of the foot.		infrequently exposed to this type of foot hazard. Shin guards may be required for some operations where the lower leg is exposed to a rolling impact hazard.
Heat – welding, casting, hot liquids	Casting, welding, cutting and brazing.	Foundry or heat resistant shoes or boots as appropriate. Legging should be used as appropriate to protect the lower legs form welding sparks
Chemicals –Splash hazard or direct contact/work with chemicals.	Degreasing, chemical handling, chemical spill response.	Footwear may need to incorporate safety toe if an impact hazard is also present. Consult manufacturer's literature.
Electrical – Work near or with energized electrical wiring or components.	Building maintenance, construction, wiring, arc or resistance wiring.	Electric hazard safety-toe footwear.
Conductive- Work near or in explosive or hazardous atmospheres.	Spray painting or similar work with highly flammable materials	Conductive foot wear

Source; OSHA 2002

2.4.6 Head protection.

Elimination or control of a hazard that lead to or might lead to an accident should, of course, be given first consideration, but many accidents causing head injuries are of a type difficult to anticipate and control. Protecting construction workers from potential head injuries is a key element of any safety program. A head injury can impair a worker for life or it can be fatal. Wearing a safety helmet or hardhat is one of the easiest ways to protect an employee's head from injury. Hard hats can protect employees from impact and penetration hazards as well as from electrical shock and burn hazards, *(http://home.nycap.rr.com).*

Employers must ensure that their employees wear head protection if any of the following apply; objects might fall from above and strike them on the head, they might bump their heads against fixed objects, such as exposed pipes or beams; or there is a possibility of accidental head contact with electrical hazards, working underneath or in the vicinity of scaffolding and elevated workplaces, erection and stripping of formwork, assembly and installation work, work on scaffolding and demolition work, work on steel bridges, steel building construction, masts, towers, work in pits, trenches, shafts and tunnels, earth and rock works, work in underground workings, quarries, open diggings etc

Head hats protect the wearer by providing the following features, *(http://home.nycap.rr.com)*; -

- A rigid shell that resists and deflects blows to the head.
- A suspension system inside the hat that acts as a shock absorber.
- Some hats serve as an insulator against electrical shocks.
- Shields your scalp, face, neck, and shoulders against splashes, spills, and drips.
- Some hard hats can be modified so you can add face shields, goggles, hoods, or hearing protection to them.

In general, protective helmets or hard hats should do the following:

- Resist penetration by objects.
- Absorb the shock of a blow.
- Be water-resistant and slow burning.
- Have clear instructions explaining proper adjustment and replacement of the suspension and headband.

Hard hats must have a hard outer shell and a shock absorbing lining that incorporates a headband and straps that suspend the shell from 1 to 1 1/4 inches (2.54 cm to 3.18 cm) away from the head. This type of design provides shock absorption during an impact and ventilation during normal wear.

Protective hats are made in the following types and classes *(http://home.nycap.rr.com);* -

- **Type 1** - helmets with full brim, not less than 1 and 1/4 inches wide;
- **Type 2** - brimless helmets with a peak extending forward from the crown.

For industrial purposes, three classes are recognized:

- **Class A** - general service, limited voltage protection; are intended for protection against impact hazards. They are used in mining, construction, tunneling, etc
- **Class B** - utility service, high-voltage protection and from impact and penetration by falling or flying objects
- **Class C** - special service, no voltage protection, designed specifically for lightweight comfort and impact protection.

2.5 Implementation of PPE program on construction sites.

A PPE program must be comprehensive. It requires commitment and active participation at the planning, development, and implementation stages from all levels: senior management, supervisors, and workers. A good PPE program consists of these essential elements (http://www.ccohs.ca); -

- Workplace survey
- Selection of appropriate controls
- Selection of appropriate PPE
- Fitting
- Training
- Management support
- Maintenance
- Auditing of the program

The first critical step is to identify physical and health hazards in the construction site. This process is known as a "hazard assessment." Potential hazards may be physical or health-related and a comprehensive hazard assessment should identify hazards in both categories. Examples of physical hazards on construction sites include moving objects, fluctuating temperatures, high intensity lighting, rolling or pinching objects, electrical connections and sharp edges. Examples of health hazards include overexposure to harmful dusts, chemicals or radiation (OSHA, 2002).

The hazard assessment should develop a list of potential hazards in the following basic hazard categories; impact, penetration, compression (roll-over), chemical, heat/cold, harmful dust, light (optical) radiation, and biologic.

Once the need for PPE has been established through hazard assessment, the next task is to select the proper type. Two criteria need to be determined (http://www.ccohs.ca), these are:

- The degree of protection required, and

- The appropriateness of the equipment to the situation (including the practicality of its being used and kept in good repair).

The degree of protection and the design of PPE must be integrated because both affect its overall efficiency, wear-ability, and acceptance.

The following guide lines should be followed; - match PPE to the hazard, obtain advice, involve workers in evaluations, consider physical comfort of PPE (ergonomics), evaluate cost considerations, review standards, check the fit, perform regular maintenance and inspections, conduct training, audit the program.

PPE that fits well and is comfortable to wear will encourage employee use of PPE. Most protective devices are available in multiple sizes and care should be taken to select the proper size for each employee. If several different types of PPE are worn together, make sure they are compatible. If PPE does not fit properly, it can make the difference between being safely covered or dangerously exposed. It may not provide the level of protection desired and may discourage employee use.

Construction workers must be trained to know at least the following (OSHA, 2002): When PPE is necessary, What PPE is necessary, How to properly put on, take off, adjust and wear the PPE, the limitations of the PPE, proper care, maintenance, useful life and disposal of PPE.

The workplace should be periodically reassessed for any changes in conditions, equipment or operating procedures that could affect occupational hazards. This periodic reassessment should also include a review of injury and illness records to spot any trends or areas of concern and taking appropriate corrective action. The suitability of existing PPE, including an evaluation of its condition and age, should be included in the reassessment.

2.6 Legislation and Enforcement of PPE on construction sites.

PPE program is part of a cross-disciplinary area concerned with protecting the safety, health and welfare of people engaged in work or employment and entrants otherwise called Occupation, safety and health (OSH).

In kenya, The Factories Act, Chapter 514 of Laws of Kenya is an Act of Parliament that makes provision for the health, safety and welfare of persons employed in factories and other places, and for matters incidental thereto and connected therewith. The Act came into operation on 1st September 1951. The Factories Act has been replaced by the *occupational safety and health Act 2007.*

Part I of the Act specifies the application of the Act and the power to exempt it in case of emergency. Part II defines a 'factory' as well as general interpretation of the Act. Part III pertains to the registration of factories. Part IV describes general health provisions applicable to working conditions in factories specifically those relating to cleanliness, overcrowding, ventilation, lighting and sanitary conveniences. Part V describes relevant safety provisions for mobile devices, transmission machinery, unfenced machinery, vessels containing dangerous liquids, self-acting machines and the training and supervision of inexperienced workers. This part also regulates various lifting machinery and steam boilers, and specifies provisions for fire prevention. Part VI covers drinking water supplies and washing facilities. Part VII covers protective clothing and protection. Parts VIII and IX specify miscellaneous provisions, and Parts X and XI cover administration, offences, penalties and legal proceedings.

The Act has been amended several times. In 1981, Legal notice 75 of 22nd April, Factories (Extension of application) order, under section 60, included the building operations and works of engineering construction as factories

The relevant sections on provision of PPE are as outlined below; -

Section 29; 'No person shall be employed at any machine or in any process, being a machine or process liable to cause bodily injury, unless he has been fully instructed as to the dangers likely to arise in connexion therewith and the precautions to be observed, and -
(a) has received a sufficient training in work at the machine or in the process; or
(b) is under adequate supervision by a person who has a thorough knowledge and experience of the machine or process'

Section 53, 'Where in any factory workers are employed in any process involving exposure to wet or to any injurious or offensive substance, suitable protective clothing and appliances, including, where necessary, suitable gloves, footwear, goggles and head coverings, shall be provided and maintained for the use of such workers'

Section 54, '(1) In the case of any of the processes specified in the Fourth Schedule to this Act, suitable goggles or effective screens shall be provided to protect the eyes of the persons employed in the process.
(2) Where in any factory electric arc welding is carried on, effective provision shall be made, by screening or otherwise, to prevent persons employed (other than persons employed in the welding process) being exposed to the electric arc flash.

Section 55, '(1) Where the Minister is satisfied that any manufacture, machinery, plant, equipment, appliance, process or description of manual labour used in factories is of such a nature as to cause risk of bodily injury, or be offensive, to the persons employed, or any class of those persons, he may, subject to the provisions of this Act, make such rules as appear to him to be reasonably practicable and to meet the necessity of the case'

Section 69, '(1) An inspector shall, for the purpose of the execution of this Act, have power to do all or any of the following things, that is to say –

(*a*) to enter, inspect and examine, by day or by night, a factory, and every part thereof, when he has reasonable cause to believe that any person is employed therein, and to enter, inspect and examine, by day, any place which he has reasonable cause to believe to be a factory and any part of any building of which a factory forms part and in which he has reasonable cause to believe that explosive or highly inflammable materials are stored or used;

Provided that -

(i) An inspector shall, whenever it is practicable so to do and will not in his opinion defeat the object of his inspection, notify the occupier or some other person in authority at a factory of his arrival at the factory for the purpose of inspecting it;

(ii) When an inspector has inspected a factory without having first given the notification referred to in paragraph (i) of this proviso, he shall, within a reasonable time after such inspection, inform in writing the occupier and the Chief Inspector of the reason why no notification as aforesaid was given;

(*b*) To take with him a police officer if he has reasonable cause to apprehend any serious obstruction in the execution of his duty;

(*c*) To require the production of the registers, certificates, notices and documents kept in pursuance of this Act and to inspect, examine and copy any of them;

(*d*) To make such examination and inquiry as may be necessary to ascertain whether the provisions of this Act, and of the enactments for the time being in force relating to public health, are complied with, so far as respects a factory and any persons employed in a factory;

(*e*) To require any person whom he finds in a factory to give such information as it is in his power to give as to who is the occupier of the factory;

(*f*) to examine, either alone or in the presence of any other person, as he thinks fit, with respect to matters under this Act, every person whom he finds in a factory, or whom he has reasonable cause to believe to be or to have been within the preceding six months employed in a factory, and to require every such

person to be so examined and to sign a declaration of the truth of the matters respecting which he is so examined; so, however, that no one shall be required under this provision to answer any question or to give any evidence tending to incriminate himself;

(*g*) In the case of an inspector who is a medical practitioner, to carry out such medical examinations as may be necessary for the purposes of his duties under this Act;

(*h*) To exercise such other powers as may be necessary for carrying this Act into effect including the taking of such measurements and photographs and making such recordings as he may consider necessary for the purposes of any examinations or investigation under this Act.

(2) The occupier of every factory, and his agents and servants, shall furnish the means required by an inspector as necessary for an entry, inspection, examination or inquiry, or the taking of samples, or otherwise for the exercise of his powers, under this Act in relation to that factory.

(3) If any person willfully delays an inspector in the exercise of any power under this section, or fails to comply with the requisition of an inspector in pursuance of this section to produce any register, certificate, notice or document which he is required by or in pursuance of this Act to produce, or willfully withholds any information as to who is the occupier of any factory, or conceals or prevents, or attempts to conceal or prevent, a person from appearing before or being examined by an inspector, that person shall be deemed to obstruct an inspector in the execution of his duties under this Act.

(4) Where an inspector is obstructed in the execution of his powers or duties under this Act, the person obstructing him shall be guilty of an offence and liable to a fine not exceeding six hundred shillings or, in default of payment, to imprisonment for a term not exceeding three months; and where an inspector is so obstructed in a factory the occupier of that factory shall be guilty of an offence.

Fourth schedule of the Act stipulates processes/activities requiring provision of suitable goggles or effective screens such as dry grinding of metals, or articles of metal, applied by hand to a revolving wheel or disc driven by mechanical power, welding or cutting of metals by means of an electrical, oxy-acetylene or similar process etc.

Order under section 61 (1) – provides that a person employed must not willfully interfere with or misuse any means, appliance, convenience or other thing provided in pursuance of the Act for securing health, safety or welfare, and he must use any means or appliance for securing health or safety provided for his use under the Act. He must not willfully and without reasonable cause do anything likely to endanger himself or others'.

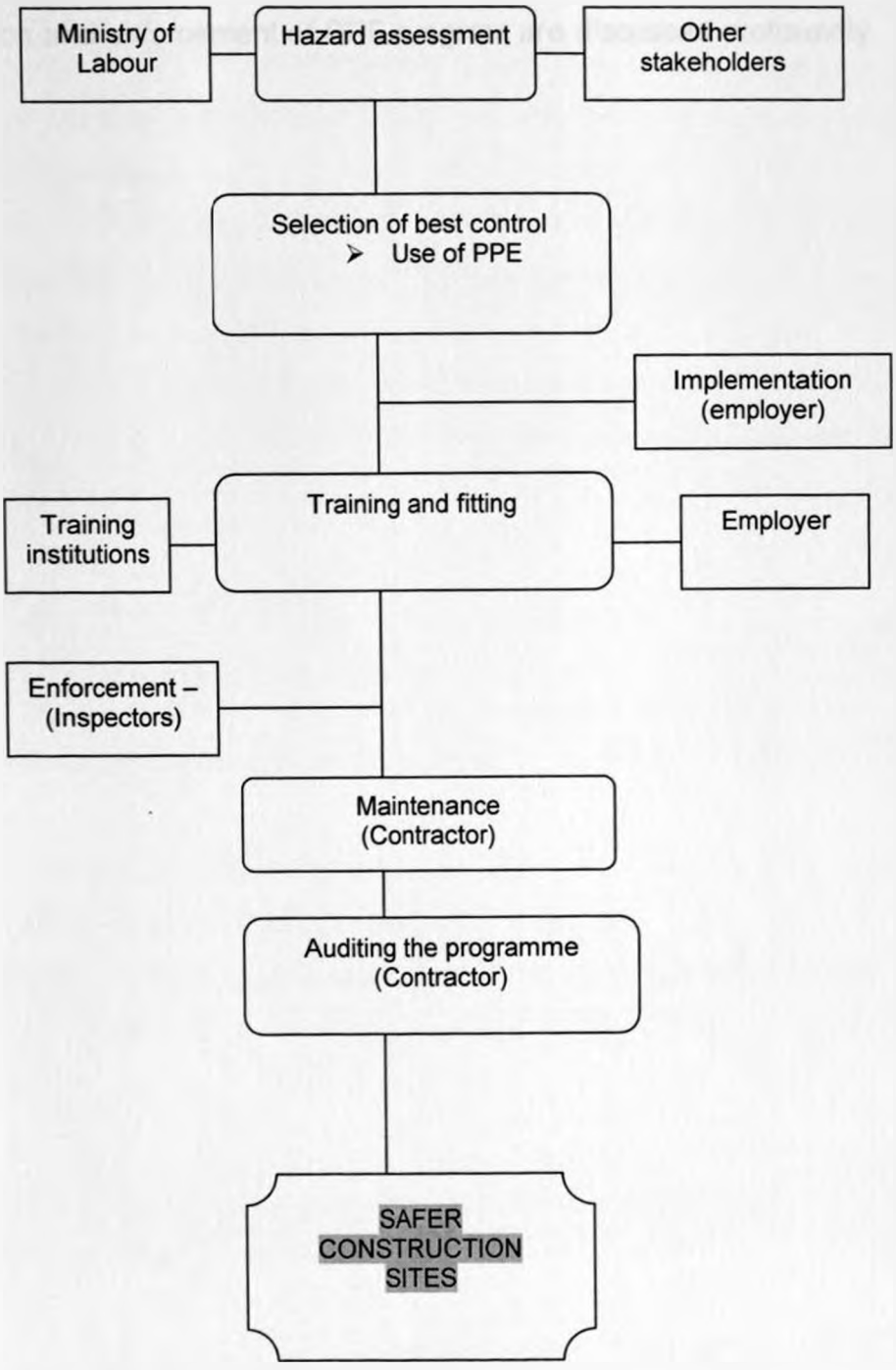
2.7 Conceptual framework and conclusion.

The potential hazards in a construction site are numerous and complex. Often times, wearing Personal Protective Equipment, PPE, is a necessary defense against certain types of hazards and/or in the event of an emergency. To avoid potentially hazardous situations, each construction site must conduct a hazard assessment to identify the hazards and select the most appropriate type of PPE for protection.

There is a legal requirement for industry to be responsible for managing - workplace health and safety. This requirement, expressed as the "Duty of Care" principle, is the basis of the Factories Act, CAP 514 of 1981. Employers have a "Duty of Care" to ensure the health, safety and welfare at work of employees and others by taking all practicable measures to control risks against injuries in the workplace. Implementing the Duty of Care principle means planning for prevention of workplace accidents, injuries and illness. Failing to comply with the "Duty of Care" provisions of the Act is an offence.

Chart 2.4j below illustrates conceptual framework for effective PPE programme on construction sites; -

Chart 2.4j: Conceptual PPE programme on construction sites.



Source, field study 2008.

In conclusion, construction site are fright with hazards that have been identified for workers based on a review of commonly performed construction trades. This chapter sought to identify various PPE categories, types and their requirements on different construction trades. Implementation of PPE program on construction sites, legislation and enforcement of PPE program are discussed profoundly.

CHAPTER THREE

DATA PRESENTATION, ANALYSIS AND RESULTS

3.1 Introduction.

This chapter presents both the qualitative and quantitative analyses of the various findings on personal protective equipment aspects on construction sites. Data collection as aforementioned in the previous chapter involved direct observation of the selected construction sites using an observation checklist to establish availability, use, maintenance of PPE and accident prevalence. Three sets of questionnaires were administered to sampled construction firms managerial staff, site supervisory team and to the construction workers. A semi-structured interview was carried out with the directorate of occupational health and safety services.

3.2 Questionnaire response rates.

Questionnaires (see appendixes; 01, 02 and 03) were administered to workers (skilled and unskilled) and supervisory staff in five construction sites and the management of the respective construction firms.

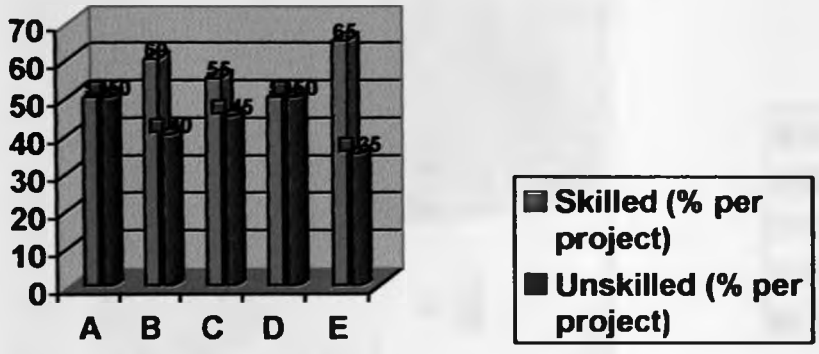
Administered questionnaires to construction workers on different construction sites were as shown in table 4.2a and chart 4.2b below.

Table 3.2a: Administered questionnaires to construction workers.

Project	Skilled	Unskilled	Total
A	10	10	20
B	12	8	20
C	11	9	20
D	10	10	20
E	13	7	20
Total	54	46	100

Source: Field study, 2008.

Chart 3.2b: Administered questionnaires to construction workers.



Source:Field Study, 2008.

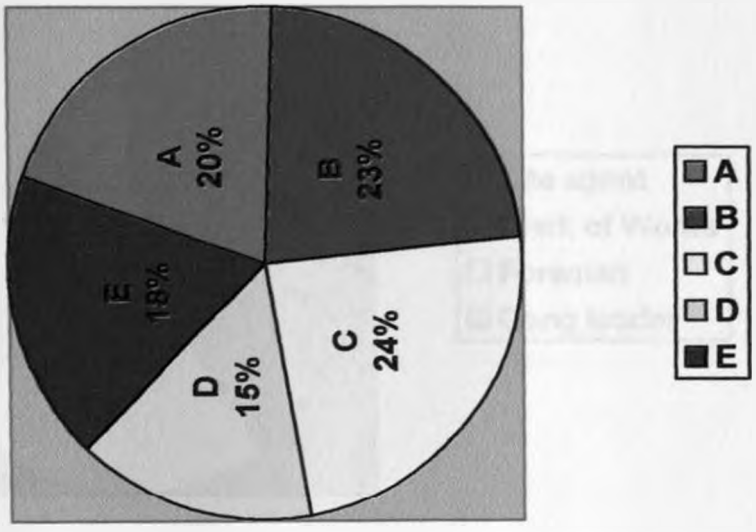
Table 3.2c and chart 3.2d below shows the response rates out of the 100No. questionnaires administered to construction workers.

Table 4.2c: Response rate from construction workers.

Project	Number Issued	Number returned (A)	Response percentage (of the total returned) [(A/71)*100]
A	20	14	20%
B	20	16	23%
C	20	17	24%
D	20	11	15%
E	20	13	18%
TOTAL	100	71	100%

Source: Field study, 2008.

Chart 3.2d:Questionnaire response rate.



Source: Field study, 2008.

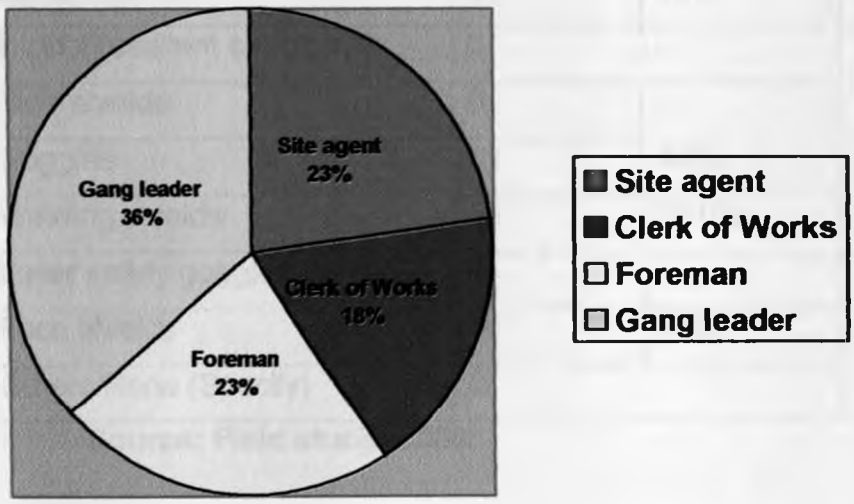
The response rate from site supervisory staff in the different construction sites are as shown below in table 4.2e and chart 4.2f.

Table 3.2e: Site supervisory staff interviewed.

Title	No. Issued	No. Returned. (A)	Percentage of the total returned. [(A/71)*100]
Site agent	5	5	23%
Clerk of works	4	4	18%
Foreman	6	5	23%
Gangs leader	10	8	36%
Total	25	22	100%

Source: Field study, 2008.

Chart 3.2f: Site supervisory staff interviewed.



Source: Field study, 2008.

At least one senior level management staff in the respective construction companies was administered with a questionnaire. All the firm questionnaires were returned, that is 100% response.

3.3 PPE; - provision, use and maintenance.

Provision and use of different types of PPE namely; face and eye, hearing, respiratory, hand and arm, foot and leg, head as well as body protective clothing were covered in the questionnaires as well as observation checklist. The findings were as follows.

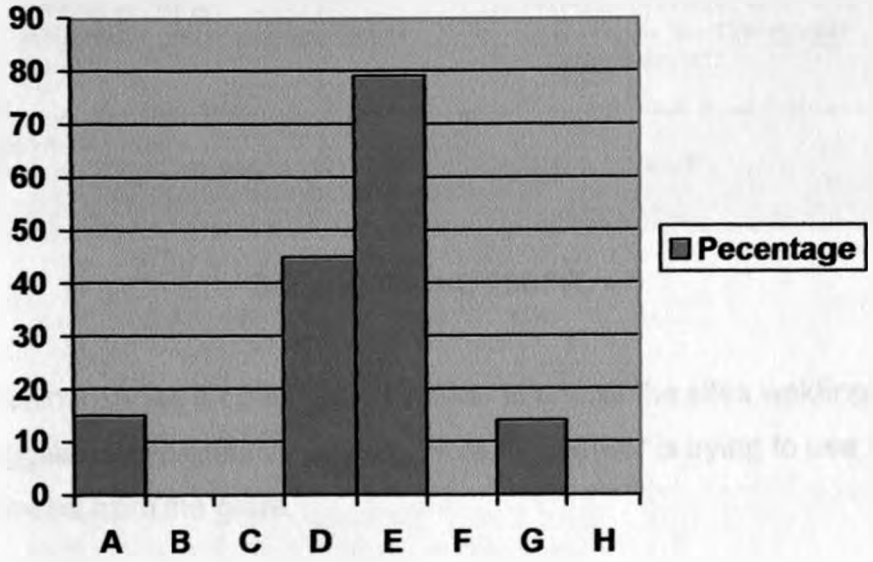
Face and eye protective devices when handling construction trades such as grinding, chiseling, welding, woodworking, drilling, riveting, when working with chemicals or faced by other conditions such as glare and dust. The various responses (out of 71repondents) on provision and use of face and eye PPE were as out lined in table 4.3a and chart 4.3b below.

Table 3.3a: Level of provision with face and eye protective device.

No.	Protective device	Frequency	Percentage
A	Safety spectacles	11	15%
B	Impact resistant spectacles	0	-
C	Side shields	0	-
D	Goggles	32	45%
E	Welding shields	56	79.0%
F	Laser safety goggles	0	-
G	Face shields	10	14%
H	Others/None (Specify)	0	

Source: Field study, 2008.

Chart 3.3b: Face and eye protective devices provision percentages.

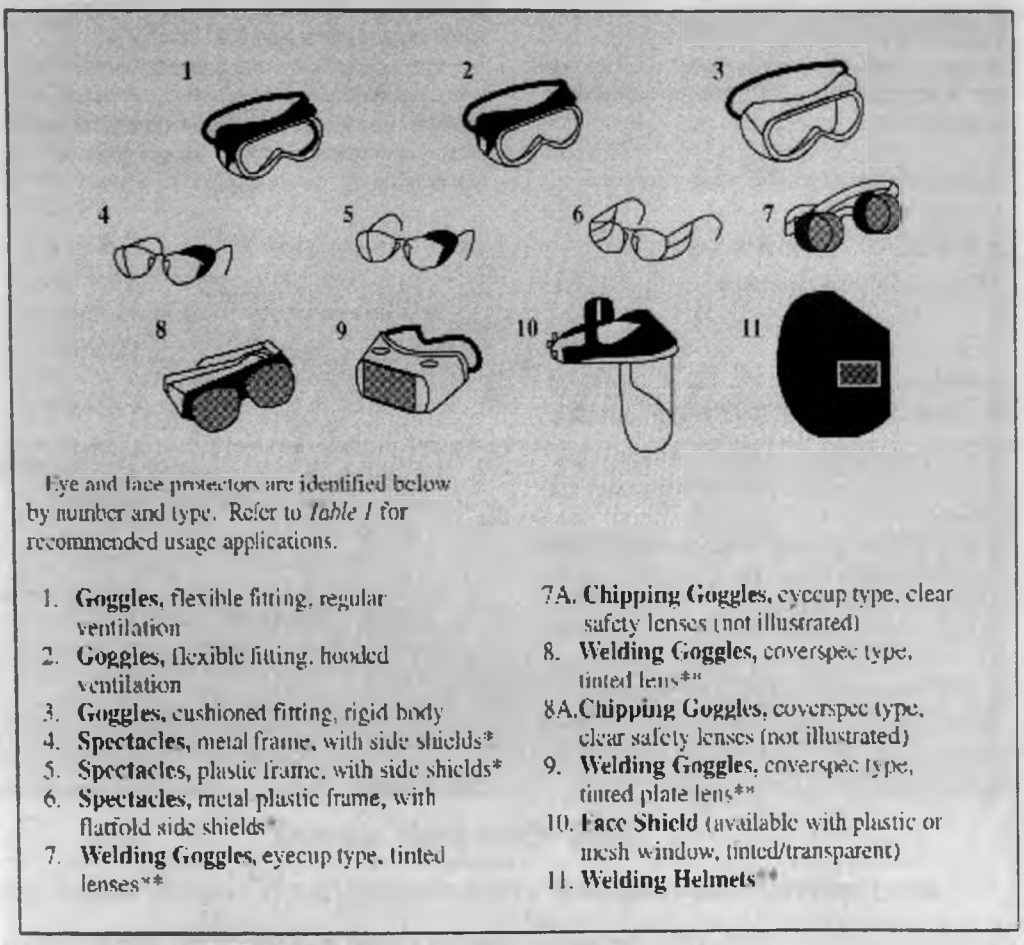


Protective device (see table 4.3a)
Source: fieldstudy 2008.

Chart 4.3c below shows types of face and eye protective devices.

Chart 3.3c: Eye and face protectors

Figure . Recommended Eye and Face Protectors



Source: OSHA, 29CFR.

Plate 3.3d below shows a construction worker in one of the sites welding without welding goggles (eye protective device). Note the worker is trying to use his hand to shield himself from the glare.

PLATE 3.3d: Welding activity going on.

Source: field study 2008.

Table 4.3e below shows Construction Industry Requirements for filter Lens shade numbers for protection against radiant energy.

Table 3.3e: Construction Industry Requirements for Filter Lens

Welding Operation	Shade Number
Shielded metal-arc welding 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	10
Gas-shielded arc welding (nonferrous) 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	11
Gas-shielded arc welding (ferrous) 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	12
Shielded metal-arc welding 3/16-, 7/32-, 1/4-inch diameter electrodes	12
5/16-, 3/8-inch diameter electrodes	14
Atomic hydrogen welding	10 - 14

Carbon-arc welding	14
Soldering	2
Torch brazing	3 or 4
Light cutting, up to 1 inch	3 or 4
Medium cutting, 1 to 6 inches	4 or 5
Heavy cutting, more than 6 inches	5 or 6
Gas welding (light), up to 1/8-inch	4 or 5
Gas welding (medium), 1/8- to 1/2-inch	5 or 6
Gas welding (heavy), more than 1/2-inch	6 or 8

Source: OSHA, 29 CFR.

Hearing protective devices are necessary in construction sites since most of the activities such as drilling, rock crushing, concreting, woodworking, metal fabrication, pile driving etc have high noise levels. Out of the 39 construction workers who responded to this question none indicated that there was such provisions of any protective devices such as; expandable foam plugs, Pre-molded reusable plugs, canal caps, earmuffs, single-use earplugs or any other form of protective device.

Plate 3.3f below shows construction workers in one of the sites excavating in rock with a compressor without any hearing protective devices.

Plate 3.3f: Excavating in rock.

Source: field study 2008

Respiratory protective devices are important to protect construction workers from respiratory hazards such dust, fumes, smoke, chemical vapors, oxygen deficiency when doing tasks like painting, foul drainage, cutting metals with coating such as lead, excavations, concreting demolitions etc was noted to be minimal. Out of the 71 questionnaires received only 17 respondents indicated they are provided with respiratory protective devices, this represents 23.9%.

Note in plate 3.3f above despite the dusty rock crushing activity none of the workers has respiratory protective equipment. Plate 3.3g and h below captures

concreting and plasterwork activities respectively going on. Concreting requires workers to have respiratory PPE because of dust when batching and mixing especially from cement.

Plate 3.3g: Concreting going on.

Source: field study 2008

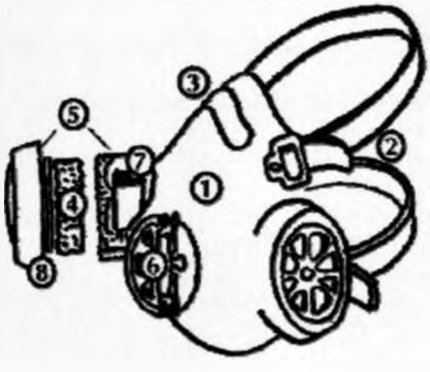
Plate 3.3h: Plasterwork

Source: field study 2008

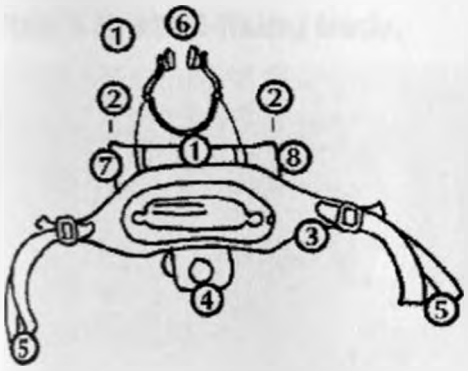
Chart 3.3i below show types of respiratory protective equipments.

Chart 4.3i: Types of respiratory protective equipment

i. Mask



ii. Half-mask



iii. Respirator

iv. Respiratory protective helmet

Source, ILO 1995.

Hand and arm protective devices are essential on construction sites for protection against hazards such as skin absorption of harmful substances, chemical or thermal burns, bruises, abrasions, cuts, punctures etc. Provisional of gloves was noted to be available to 15 out of the 71 respondents; this represents 21%. This low percentage is confirmed by observation from plate 3.3d, f and g and f above. Note in plate 3.3j below none of the steel fixers has gloves. Note also one of the steel fixers nursing his hand that had been pierced while fixing steel.

Plate 3.3j: steel-fixing trade.

Source: field study 2008

Foot and leg protective devices are virtually important in carrying all aspects of construction activities due to hazards such as heat, compression, impact and electrical. The responses on provision (out of 71) of the various foot and leg protective devices are as indicated in table 3.3k below; -

Table 3.3k: Level of provision with foot and leg protective devices.

No.	Protective device	Frequency (A)	Percentage [(A/71)*100]
i.	Leggings	32	45.0%
ii.	Toe guards	Nil	-
iii.	Safety shoes	Nil	-
iv.	Others	11	15.0%

Source: Field study, 2008.

Plate 4.3e above shows only one of the workers has safety shoes as foot and leg protective device.

Another aspect covered on the questionnaires is provision and use of head protective devices such as head hats to protect against hazards such as falling objects, pumping head against fixed objects, head contact with electrical objects, impact. Out of the 71 respondents 68 or 95.78% indicated that they were provided with helmets.

The high percentage on use of head protective devices is confirmed in the above plates. Note in plate 3.3g and j, all the workers have head protective devices. However note in plate 3.3l a woman construction worker-carrying bucket full of aggregate with no head protective equipment.

Plate 3.3l: placing of aggregate

Source: Field study 2008

Plate 3.3m captures workers doing roofing and rendering without any head protective device incase one trips and falls.

Plate 3.3m: Roofing and rendering going on.

Source: Field study 2008

Chart 3.3n below shows head hat for head protection.

Chart 3.3n head protective device.

i

ii

Source, http://home.nycap.rr.com

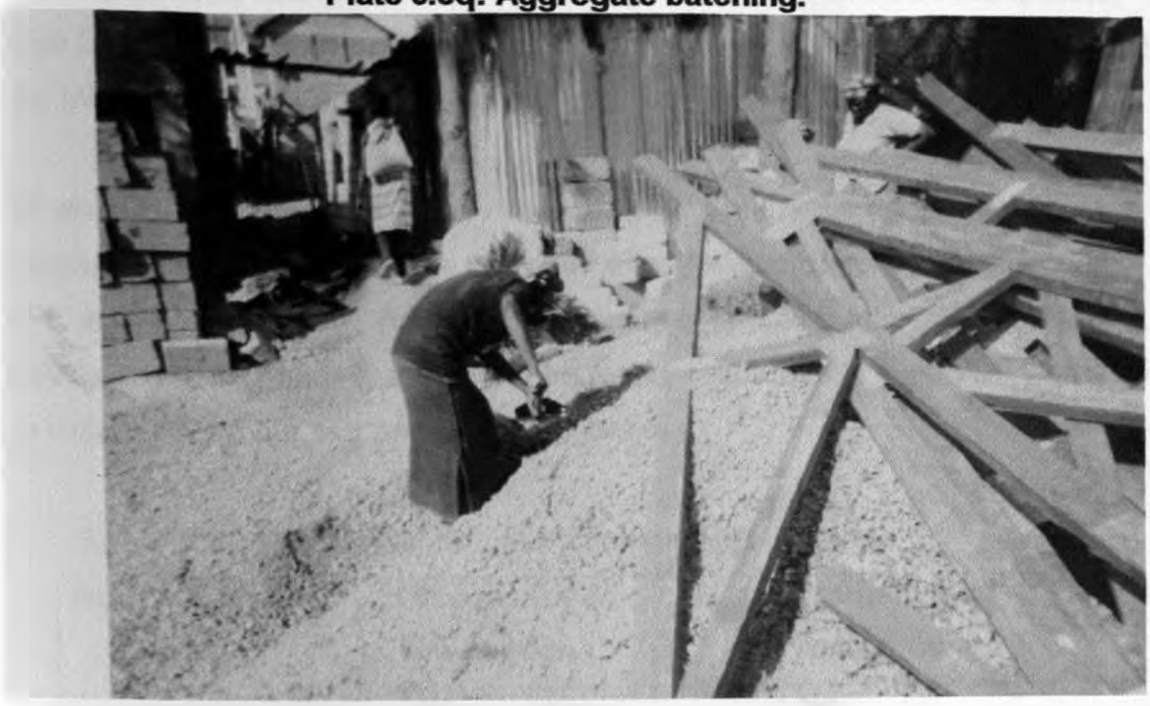
Body protective clothing is useful in construction for protection against temperature extremes, hot splashes, hazardous chemicals and potential impacts from tools, machinery and materials. 15 out 71 or 21% respondents indicated they were provided with overalls whereas the rest indicated they used their own worn-out clothes as work clothes that served to protect against dirt.

Plate 3.3p shows site supervisory staff without any work clothes. Plate 3.3q shows a woman construction worker batching aggregate with no work clothes.

Plate 3.3p: Site supervisory staff supervising cart and fill.

Source: field study 2008.

Plate 3.3q: Aggregate batching.



Source: field study 2008.

A question relating to explicit provision of PPE, as a competitive pricing item in the standard tender documents was covered in the questionnaires. None of the respondents indicated that there was such provision in the standard tender documents. This by extension means even the professional consultants were not keen to mention and enforce use of PPE as a safety tool on site.

In relation to use of PPE in construction sites, 14 out of 22 or 64% of the site supervisory respondents indicated that they advised their workers to always use PPE. However this was hampered by reluctance of use by some workers.

In regard to ways by which the supervisory team encourages the construction workers to use PPE, all the site supervisory respondents indicated that they had no incentive scheme save for training.

Another aspect covered in the questionnaire was on legal requirement for use of PPE to establish level of awareness among construction workers. 45 out of the 71 or 63% of construction workers respondents thought it was Ministry of local

Government that was mandated in enforcing use of PPE on construction sites, while 22 out of 71 or 31% and 3 out of 71 or 4% thought it was Ministry of Labour and Ministry of public works respectively.

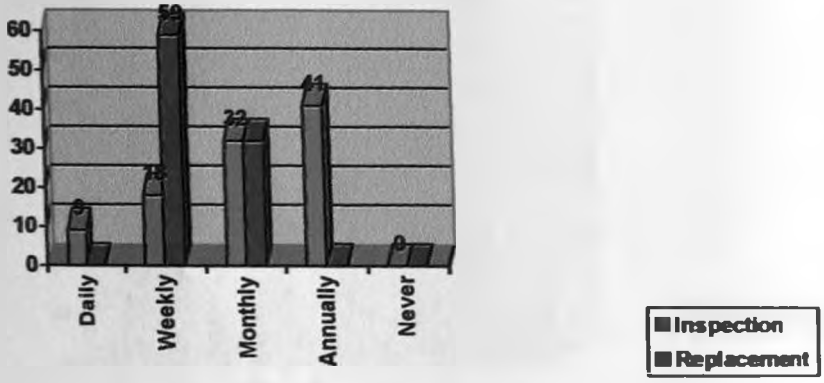
On whether or not the supervisory team had a maintenance program-; two measures were included on the questionnaire; that is, frequency of inspection of PPE and replacement of the defective ones over specified intervals, that is daily, weekly, monthly, annually or never. The responses from site supervisory staff are as indicated in table 3.3r and chart 3.3s below.

Table 3.3r: PPE inspection and replacement intervals.

No.	Intervals	Frequency of inspection		Frequency of replacement	
		No. (A)	% [(A/22)*100]	No. (B)	% [(B/22)*100]
i.	Daily	2	9.0	0	0
ii.	Weekly	4	18.0	0	0
iii.	Monthly	7	32.0	7	32.0
iv.	Annually	9	41.0	13	59.0
Vi.	Never	0	0	0	0

Source: Field study, 2008.

Chart 3.3s: PPE replacement intervals



Period

Source:Field study, 2008.

3.4 Training on use and need of PPE.

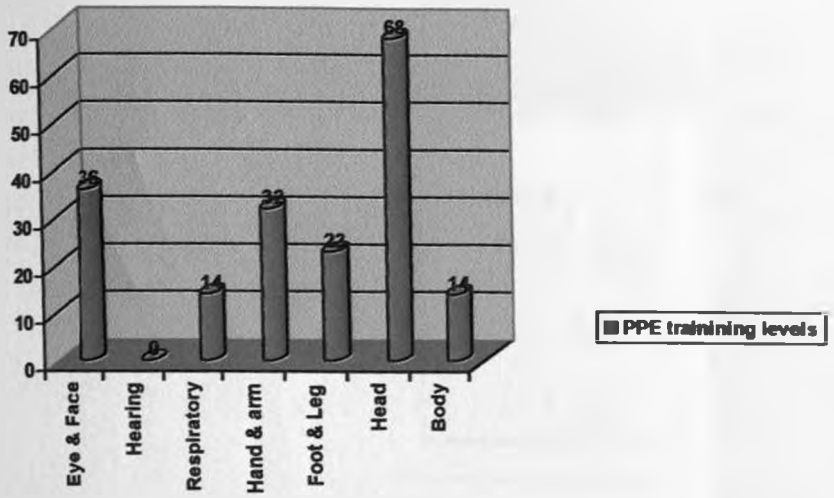
Training is important for any PPE program so as to at least cover aspects such as; - when is PPE necessary, what PPE is necessary, how to properly put on, take off, adjust and wear the PPE, proper care, maintenance, useful life and disposal of PPE. Table 3.4a and chart 3.4b below shows responses on training levels on use of different PPE by the site supervisory staff.

Table 3.4a: PPE training levels.

No.	Protective device	Frequency (A)	Percentage [(A/22)*100]
i.	Eye and face PPE.	8	36.0%
ii.	Hearing PPE	Nil	0
iii.	Respiratory PPE	3	14.0%
iv.	Hand and arm PPE	7	32.0%
V.	Foot and leg PPE	5	23.0%
vi.	Head PPE	15	68.0%
vii.	Body PPE	3	14.0%

Source: Field study, 2008.

Chart 3.4b: PPE training levels



Type of PPE device
Source: Fieldstudy 2008

Another question related to frequency of holding PPE drills by the site supervisory staff. The responses were as indicated in table 3.4c below.

Table 3.4c: frequency of PPE drills.

No.	Period	Frequency
i.	Daily	0
ii.	Weekly	0
iii.	Monthly	13
iv.	At random	4
Vi.	Never	0

Source: Field study, 2008.

On whether the firm's management offered training to supervisory staff, 3 out of 5 managerial staff respondents or 60% indicated that they did whereas 2 of the 5 respondents indicated that they held training for every new employee.

Another aspect covered on the questionnaires was related to testing at what point do the supervisory team train or retrain the workers on use of PPE. This is necessary since different tasks require different types of PPE to use. The responses are as indicated in table 3.4d below.

Table 3.4d: PPE Training times.

No.	Training times	Frequency (out or 22 respondents)
i.	New workers	6
ii.	Start of the project	0
iii.	Changes in task	7
iv.	Changes in PPE required	4
Vi.	Never	0

Source: Field study, 2008.

3.5 Hazards, accidents and safety on construction sites.

In order to establish whether hazards and accidents that necessitate use of PPE are prevalent on the construction site, two aspects were addressed, that is; prevalence of different types of hazards and frequency of accidents reported. The hazards identified were-;

a) Mechanical hazards e.g. impact, penetration, tripping, cave-in
b) Electrical hazards e.g. electrocution, short-circuiting
c) Heat/cold hazards e.g. heat stroke, welding, exposure to hot substances
d) Chemical hazards e.g. splashes, contact with chemicals, harmful dust, foul smell
e) Radiation hazards e.g. light (optical) radiation

All the respondents indicated hazards are prevalent and therefore need to use PPE.

Numbers of injuries/accidents occurrences reported arising from the above hazards since inception of the different projects is indicated in table 3.5a below: -

Table 3.5a: Number of accidents reported.

Hazard		Accidents reported		Applicable preventive PPE.
		No. (A)	% [(A/91)*100]	
Mechanical	Impact	17	18.7	-Head PPE -Foot and leg PPE -Hand and arm PPE
	Penetration	24	26.4	-Face and eye PPE -Head PPE -Hand and arm PPE -Foot and leg PPE -Body PPE
	Tripping/falling	8	8.8	-Face and eye PPE -Head PPE -Foot and leg PPE -Body PPE
	Noise	3	3.3	-Hearing PPE
	Collapse	1	1.1	-Respiratory PPE -Body PPE
	Suffocation/oxygen deficiency	0	0	-Respiratory PPE
	Vibration	12	13.2	-Hand and arm
Electrical actions	Short-circuiting	3	3.3	-Hand and arm PPE -Head PPE -Foot and leg -Body PPE
	Electrocution	0	0	

Heat/cold actions	Exposure to hot conditions	2	2.2	-Body PPE -Foot and Le PPE -Hand and arm PPE
	Exposure to cold conditions	0	0	-Body PPE -Foot and Le PPE -Hand and arm PPE
Chemical	Contact with chemicals	11	12.1	-Face and eye PPE -Head PPE -Hand and arm PPE -Foot and leg PPE -Body PPE
	Chemical splashes	1	1.1	
	Harmful dust	0	0	
	Foul smell	9	9.8	-Respiratory PPE
Radiation	Light radiation	0	0	-Face and eye PPE -Body PPE
	Ionizing radiation	0	0	
	Total	91	100	

Source: Field study, 2008.

The management was asked if they employed a safety officer on site to check among other things PPE as a safety device. Only one of the five firms or 20%, reported to have a safety officer or safety committee to plan and execute safety issues on site while the rest indicated that the site agent doubles up as the site officer.

On written site safety policy more so addressing on provision of PPE, their maintenance and safety warning signs. Only one of the respondents indicated that they had a written site safety policy and accident/injury reporting procedure.

The question of monitoring and evaluation was included on the questionnaire to test if such site safety policies are effective on site. 3 of the 5 managerial staff respondents or 60% indicated that senior level managers do visit the site and also use record of accidents/injury on site as a monitoring and evaluation tool.

To test whether safety matters are of concern in the project meetings the respondents were asked if safety is part of agenda of such meetings. 2 of the 5 managerial staff respondents or 40% indicated that safety matters are always discussed in the project review meetings whereas 3 of the 5 the respondents indicated that safety matters are discussed when need arises.

A question on effects of accidents/injuries related to lack of use of PPE was also included in the questionnaires. 3 of the 5 managerial staff respondents or 60% indicated that they had had cost and time overruns resulting from such incidents.

3.6 Enforcement mechanisms.

In regard to establishing on enforcement on use of PPE the site supervisory staff were asked the number of times the factory inspectors had visited the site since inception of the project. All the respondents indicated none of the factory inspectors had ever visited their sites.

To test on vigilance and enforcement of use of PPE on site by the directorate of occupation health and safety services the respondents were asked if they had ever been prosecuted or penalized for lack of the same. None of the respondents indicated that they had ever been sued or penalized for lack of PPE among construction workers on site.

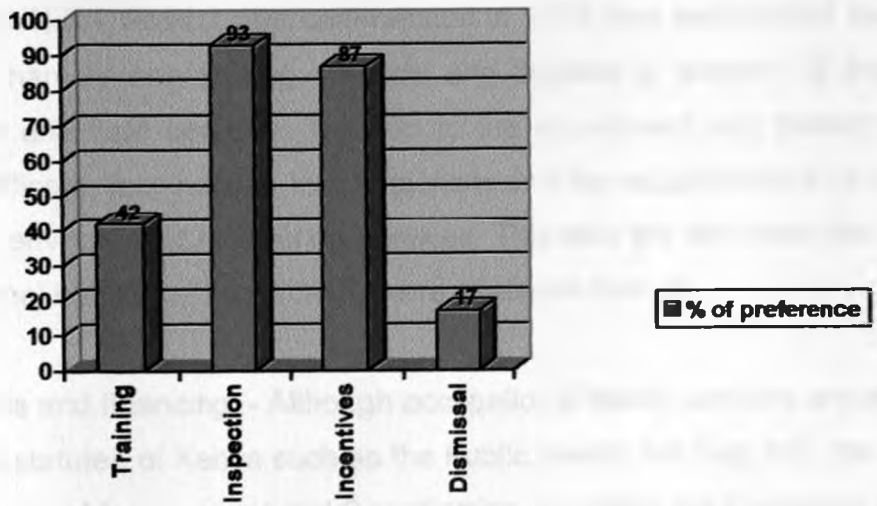
In regard to possible enforcing mechanism for use of PPE on construction sites. The responses from site supervisory staff are as shown in the table 3.6a and chart 3.6b below.

Table 3.6a: Enforcement mechanism for use of PPE.

No.	Mechanism	Frequency	Percentage
i.	Training on use of PPE	7	30.0%
ii.	Step-up on site Inspection	15	66.0%
iii.	Use of incentives	14	62.0%
iv.	Dismissal from site for misuse	3	12.0%

Source: Field study, 2008.

Chart 3.6b: Enforcement mechanism for use of PPE



Mechanisms (see table 3.6a)
Source: Fieldstudy, 2008.

Occupation health and safety Act 2007 came into effect on December to replace the Factories and other places of work act chapter 514 of laws of Kenya. The respondents were asked if they new of the Act. Four of the respondents indicated that they knew of the new Act.

In regard to compliance with Occupation health and safety Act, a notification of intent before commencement of construction is required to be given to Directorate of Occupation health and safety services. None of the respondents indicated that they complied with this requirement.

An interview with the directorate of occupation health and safety services staff was as follows; history of the Directorate is traced back to the enactment of the Factories Act Cap 514 in 1951 now replaced by Occupation Safety and Health Act 2007 that saw the emergence of occupational safety and health in Kenya. The crafting of this legislation was prompted by the enactment of the Workers' Compensation Act Cap 236 in 1948. However, it was not until 1974 that the then Minister for Labour requested the International Labour Organization during the 62nd International Labour Conference for assistance to strengthen factory inspection and in the establishment of specialized inspections. This culminated in the ILO/FINNIDA Project that commenced in 1978 that established specialized divisions, namely engineering, medical and hygiene in support of the general inspection and field services. This led to the recruitment and training of three medical officers, four nurses, four hygienists and the establishment of laboratory and work environment monitoring services. This was the first time that coherent occupational health services (OHS) were offered in Kenya.

Legal basis and financing; - Although occupational health services are referred to in several statutes of Kenya such as the Public Health Act Cap 242, the Environmental Management and Coordination Act 1999, the Petroleum Act Cap 116, the Food, Drugs and Chemical Substances Act – Cap 354, the Factories Act Cap 514 now the Occupation Safety and Health Act 2007 is the primary Occupational Safety and Health. Over the years only minimal occupational health services have been offered to small enterprises and the informal sector due to limited resources and facilities that are made available through government funds. This is despite that the Act provides for the establishment of a Fund to support occupational safety and health services through contributions from employers, but to date the Fund has not yet been established.

Providers, functions and staffing; - The Directorate of Occupational Health and Safety Services under the Ministry of Labour and Human Resource Development

currently has an authorized establishment of 239 occupational health and safety officers. In addition to routine and specialized inspections, the Department provides medical surveillance and runs a workers' clinic that is supported with medical supplies by the Ministry of Health Medical, Supplies Department. The Department is also staffed with occupational hygienists who provide workplace environmental monitoring and teaming up with the engineers and other personnel provide advice on the prevention and control of workplace hazards. Only about 25% of the posts are filled and this poses a big challenge in the provision of occupational health services. Other challenges include; -

- Poor coverage especially of the informal sector that employ the majority of the workforce
- Recognition of occupational hazards, diseases,
- Recognition of OHS as a primary business concern by stakeholders.
- Furthermore, workers have not done enough to supplement and promote activities for enhancing OHS.

In addition to the Ministry of Labour and Human Resource Development, the Ministry of Health has established an Occupational Health Division currently manned by one officer at the headquarters. The Unit, however, oversees the work of several nurses and public health officers who have graduated with a diploma in occupational health and safety from the Kenya Medical Training Center who are deployed countrywide within the Public Health Care system.

Over the last decade, more and more larger enterprises have established in-house health services that cover OHS and some non-governmental Organizations such as African Medical Air Rescue Foundation (AMREF) also carry out activities in OHS especially in support of short-term training in occupational health. Many enterprises are outsourcing medical services to private healthcare providers and insurers.

In summary the directorate reported that their primary hindrances that not only hamper coverage but also the impact of the OHS are; -.

- Proper funding,
- Recruitment of staff as per establishment,
- Professional training for OHS practitioners and
- Provision of adequate tools and equipment.

3.7 Hypothesis testing.

This was achieved by scenario analysis. This research evaluated construction workers, site supervisory staff and manager's perceptions about awareness and use of PPE, including their viewpoints on barriers that prevent workers from using it, effectiveness and importance of various PPE used on construction sites.

The key finding concerning lack of enforcement came in response to questions that asked respondents to consider the number of times factory inspector's visited their sites, number of cases penalized, prosecuted or taken deterrent measures to enforce use of PPE, all these were found to be lacking. The Directorate of Occupation Health and Safety Services conceded that they are handicapped by lack of adequate funding, understaffing, inadequate training and limited training. Considering on suggested ways by respondents in enforcing use of PPE stepping up on site inspection got the highest rating followed by use of incentives. Similar studies confirm this scenario as discussed below.

The International Safety Equipment Association (ISEA) commissioned a research as part of its "Partnership for Worker Protection" program to raise safety equipment awareness in the road construction industry. Strategic Marketing Associates (SMA), an Ohio-based research firm that specializes in the construction industry, conducted the survey that concluded, 'the main reason road construction workers do not wear personal protective equipment (PPE) when needed is because their employers do not enforce its use, (Arlington, 2001).

A task force of Laborer's safety and health fund for North America in the

testimony questions on OSHA enforcement failure concluded during 9/11, emergency published: August, 2007; Vol. 4, Num. 3 states that, "PPE compliance remain spotty, and unnecessary exposure is facilitated. OSHA standards need to be enforced and followed. If OSHA enforced its own rules, companies would have complied, and today's health crisis among workers would be much diminished."

3.8 Problems encountered.

A number of problems were encountered during the field study, the main ones were:

a) Uncooperative respondents especially at the management level of construction firms and some of the supervisory team,
b) Limited education levels of some of the construction workers hindered exhaustive discussions and input on questionnaires,
c) Suspicion and lack of trust on intended use of information hindered open discussions with some respondents,
d) A lot of time was spent before being allowed an appointment and interview with directorate of occupation health and safety services,
e) Limited financial resources and time hampered survey of many construction sites.

CHAPTER FOUR

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.1 Introduction.

This chapter outlines conclusions drawn from the data presented in the previous chapter and information obtained from observations and interviews with the various construction workers, site supervisory staff, construction firms' managerial staff, directorate of occupation health and safety services and the recommendations of the entire study.

The conclusions drawn from the findings determined the extent of achievement of the study objectives. Before the conclusions can be made, the implications of PPE provision, use, training and enforcement mechanisms in construction sites are discussed. Applicable recommendations are stipulated in the light of conclusions made. The recommendations made are for use by all stakeholders and participants in the construction industry with the aim of providing, training and enforcement of PPE use in improving safety on sites.

4.2 Discussion on the study findings.

It is evident from the analysis that safety helmets as head personal protective equipment were relatively common in construction sites than other personal protective equipment. A head injury can impair one for life or it can be fatal. Wearing a safety helmet or hardhat is one of the easiest ways to protect a worker's head from injury. Hard hats can protect workers from impact and penetration hazards as well as from electrical shock and burn hazards.
On the other extreme, hand and arm personal protective equipment such as gloves were virtually non-existent in all the sites.

Body protective clothing was also noted to be inadequate, most of the workers use their old clothes as work clothes that do not qualify to be classified as protective clothing that offer necessary protection. Foot and leg personal protective equipments were equally noted to be lacking among the construction workers.

It was noted Hazards exists in every construction site in many different forms and therefore need to use PPE. PPE is used to reduce or minimize the exposure or contact to injurious physical, chemical or biological agents. A hazard cannot be eliminated by PPE, but the risk of injury can be eliminated or greatly reduced. For example, wearing hearing protection reduces the likelihood of hearing damage when the earplugs or muffs are appropriate for the kind of noise exposure and they are used properly.

Minimal training on use and need of PPE in construction sites was noted. The culture and attitudes of construction workers, supervisors, and companies about PPE often condone risk taking and unsafe work practices, passing "bad" habits from one generation of workers to the next. Attitudes of some of site supervisory staff and management towards construction workers affected (mostly negatively) the amount and kind of on-the-job training that was provided. Construction workers are not always provided with information and training on how to work correctly and safely with use of PPE, and opportunities to learn through practice may be withheld. Due to hostility among some supervisors workers in particular, new workers, do not benefit from the informal training among their peers on site.

The Directorate of Occupational Health and Safety Services Coverage; - No actual studies have been carried out to show the extent of coverage in industries and other sectors. Inspection records, though available, may be misleading, as the exact number of construction sites requiring the services is not exactly known especially with the sprawling informal sector.

There is a mismatch in services to the needs and extension of coverage without a functional national policy and programme on occupational safety and health services that is fully supported by all stakeholders with adequate resources and facilities.

The Directorate of Occupational Health and Safety Services capacity building and quality assurance; - A major challenge exists to build the necessary capacity, not only for regulators, supervisory and advisory institutions but also for employers or workers. The Factories and Other Places of Work (Safety and Health Committee Rules) 2004.LN No. 31 is serving to improve the capacity of both workers and managers as it requires that those in safety committees must be trained by practitioners duly authorized by the Directorate of Occupational Health and Safety Services thereby ensuring quality and ethics in the profession.

4.3 Conclusions.

PPE is the final protective measure after all planning; training and procedural efforts to reduce hazards and accidents on construction sites have been taken. Deciding appropriate PPE should be a subject of an iterative hazards assessment on site. Any PPE programme must recognize the limits of acceptability by addressing; provision, training, human factors, construction site environmental conditions and ergonomics. Lack of use of PPE as a safety tool aggravates safety and may result to accidents and fatalities on sites. An accident causes substantial cost implication and delay (time overrun), in addition to the obvious injuries to the victim, and to the socio-economic impact on his family, employer and community.

The frequency with which construction workers fail to wear PPE indicates that enforcement mechanisms are lacking and therefore need for more vigilance by the Directorate of occupation health and safety services. The very fact that lack of use of PPE is much wanting is enough basis for condemnation of the existing legislation. The existing legislation does not lay any basis upon which the

workers and others parties in construction such as the client, trade union or consultants can be involved in safety matters in construction. Suffice to say the existing legislation fails to foster an integrated approach to the provision of PPE with all the parties involved in the construction process. Though Directorate of occupation health and safety services is the enforcing agent the responsibility for use of PPE on construction site should lie principally with the contractors, employers and workers. This responsibility must be embedded in the management culture and practices of all organizations involved in the planning and execution of construction operations. Employers should have the following responsibilities; -

- Providing appropriate PPE and making it available to employees.
- Ensuring employees are trained on the proper use, care, and cleaning of PPE.
- Maintaining records on PPE assignments and training.
- Supervising workers to ensure proper use and care of PPE.
- Evaluating hazards.

Construction workers should have the following responsibilities in use of PPE; -

- Wearing PPE as required.
- Attending required training sessions.
- Caring for, cleaning, and maintaining PPE as required.

Informing the Employer of the need to repair or replace PPE.

4.4 Recommendations.

It should be statutory duty for employers or Contractors to provide their employees with personal protective equipments when it is required and maintain and replace it whenever necessary.

Employers should make sure that each employee demonstrates an understanding of the PPE training as well as the ability to properly wear and use PPE before they are allowed to perform work requiring the use of the PPE. If an employer believes that a previously trained employee is not demonstrating the proper understanding and skill level in the use of PPE, that employee should receive retraining. Other situations that require additional or retraining of employees include the following circumstances: changes in the workplace or in the type of required PPE that make prior training obsolete.

Training can be done on an individual basis or in-group meetings. Training programs should reemphasize the major goals of the program and reinforce the fact that engineering controls have been considered as the primary prevention strategy. It is not good enough to tell someone to wear a respirator just because management and/or legislation require it. If the respirator is intended to prevent lung disorders, the workers should be informed of the hazards.

Workers and their supervisors will require training in when, where, why, and how to use the equipment to achieve the necessary level of protection. The workers to be trained include those who are exposed on a regular basis and others who might be exposed on an occasional basis, for example, in emergencies or when temporary work is performed in dangerous areas. The training needs and methods for all these workers are essentially the same.

The organization's occupational health and safety policy should be a statement of principles and general rules which serve as guides to action. Senior management must be committed to ensuring that the policy and procedures are carried out. PPE programs must be, and must be seen to have equal importance with all other organizational policies, procedures, and programs. The appointment of a program coordinator will go a long way to ensuring the success of a program. The coordinator has the responsibility to ensure that each of the elements of a program is in place and operational.

In the introductory phase, a PPE program must be planned carefully, developed fully and implemented methodically. It should be introduced gradually and in phases. The intention should be stated and time allowed for workers to become accustomed to wearing the PPE. The beneficial effects of the program should be publicized widely, and the target date set well ahead for compliance. Time should be allowed for workers to comply with the program, with no enforcement action taken until the target date. After the program is introduced, but only after adequate consultations with the workers and their representatives, the use of PPE may become a required condition of employment. It would not be acceptable to gradually phase in a PPE program when there is a need to enter hazardous atmospheres, or where failure to use the equipment poses a significant risk of major injury.

The greater the workers' involvement in all stages of the program, the smoother the program will be to implement and operate. Users must be told why the PPE is to be worn and trained how to properly use it. The method of implementation affects the acceptance and effectiveness of the whole program. In addition, worker compliance with the PPE program is likely to be poor if a PPE device is unattractive, uncomfortable, or is imposed on the worker with little choice in the selection.

Site supervisory staff should incorporate safety officers to make rules, warning signs etc governing when and where personal protective equipment should be worn. The rules made should apply to everyone on site and that includes visitors such as consultants, delivery drivers etc. These rules should be in writing and be brought to the attention of all those who may be affected by them so that everyone knows when and where PPE should be worn.

Employees must wear their personal protective equipment properly and as directed by their employer or comply with rules made by the person in control of

the site. They should take care of their PPE, not misuse them and report any defects or problems.

PPE should be periodically checked for damage, such as cracks, serious scratches and dents, and replaced whenever necessary, in any event they should be replaced at intervals recommended by the manufacturer. Defective or damaged PPE will not be used and will be immediately discarded and replaced. Defective equipment can be worse than no PPE at all. Employees would avoid a hazardous situation if they knew they were not protected; but they would get closer to the hazard if they erroneously believed they were protected, and therefore would be at greater risk. PPE should not be used for any other purpose and should be kept clean and a safe place.

PPE provision should be part of preliminary items in tender documents and construction project consultants should observe it in their routine inspections and reporting. In addition there should be established a professional body on safety to work in liaison with the government, legislators, contractors, trade unions to set guidelines on safety matters in construction industry.

The enforcement machinery should adopt a more liberal approach with less emphasis on litigation and more efforts being channeled towards educating the contractors on need of PPE as a safety tool.

Training; - In order to increase the number of Occupational Health Safety practitioners, intermediate courses in colleges and post-graduate courses at the University level such as are planned at Moi University will ultimately promote the profession though a lot needs to be done for industry and other sectors to absorb the graduates. A challenge exists to introduce training right from primary schools and to multi-skill healthcare workers within the entire PHC (Public health Care) in order for them to provide effective first level services.

The inspectorate department should incorporate an information and education wing in which a data bank of educative materials on PPE can be kept and practical methods of disseminating them to relevant parties devised

In summary, all parties in construction project must contribute their rightful parts towards making construction workers safe.

4.5 Areas of further study.

Further research can be done on;

- Health and Safety of Women in construction sites
- Engineering controls as safety mechanisms in construction site.

REFERENCES

Adan Enshassi (2007), '*an overview of construction injuries and fatalities in the Gaza strip*, Palestine.

Armstrong P.T. (1980), *'Fundamentals of construction safety'*, Published by Hutchison and Company Ltd.

Austen A.D. et al (1984), *'managing construction projects: A guide to processes and procedures'* International Labour Office.

Baker J.M et al, 1991, *'Durability of building Materials'* published by E&F.N Spon.

Baker J.M et al, 1991, *'Durability of building Materials'* published by E&F.N Spon.

Bongers, P.M., et al (1990). '*Ergonomics* ':

Bovenzi, M. (1996). '*Low back pain disorders and exposure to whole-body vibration in the workplace Semin Perinatol* 20 (1).

Bovenzi, M. (1996). *Low back pain disorders and exposure to whole-body vibration in the workplace Semin Perinatol* 20 (1).

Briscoe, G. (1992): '*The Economics of the Construction Industry'*, London, B.T. Batsford Ltd.

Buzzel, R.D. & Gale, B.T. (1987), *'The PIMS: Linking Strategy to Performance'*, The Free Press, New York.

Cacaiabue, P. C. (2000). *'Human factors impact on risk analysis of complex systems'*. Journal of Hazardous Materials.

Charles D. Reese & James Vernon Eidson (2006), *'Handbook of OSHA on construction safety and health'*. Published *by OSHA.*

Daily Nation, 3rd December 2005.

Davis J.S, (1972), Hazards in construction' published by William clowes and sons Ltd.

Davis, Jeffery H, '*Managing and Achieving Organization Goals'*. American Management Association, New York.

Dennis R. Harper, (1978), *'Building, the process and the product'* Lancster, Construction press.

East Africa standard, 22nd January 2006.

East Africa Standard, 24th January 2006.

Edmeads, D.H., (1972). '*The Construction Site*' London, Estates Gazette.

Fellows R. et al (1983), Construction management in practice' published by John wiley and sons Inc.

Fellows, R and Liu, A, 2nd edition, (2003), *'Research Methods for Construction'.* Blackwell Science Ltd, Oxford UK.

Fernadez, J.E. Vol.13, (1995), '*Ergonomics in the Workplace, Facilities',* Published by MCB University Press.

FOF Communications. (2000). *'A safety & Health Practitioner's Guide to Skin Protection'* Washington, D. C.

Grandjean, E. (1988), *'Fitting the Task to the Man, A textbook of Occupational Ergonomics'* published by Taylor and Francis: London.

Handley W. (1977), '*Industrial safety handbook'* published by McGraw-Hill Ltd

Heinrich H.W 1959,Industrial accident prevention, Scientific approach' Mcgraw Ltd.

Henry W. parker et al, (1972), *'Methods improvement for construction manager',* McGraw ltd.

Gichunge Hezekiah, (2000), *'Risk management in the building industry in Kenya: An analyst of time and cost risks'*, Unpublished P.H.D thesis, University of Nairobi.

http://en.wikipedia.org/wiki/Occupational_Safety)

http://home.nycap.rr.com

http://www.ccohs.ca/oshanswers/prevention/ppe/designi.

http://www.ehs.ucr.edu

http://www.kenyalaw.org.

http://www.labsafety.com/refinfo/ezfacts/ezf130.htm):

http://www.mtas.es

http://www.osha.gov

http://www.tfhrc.gov

http://www-old.itcilo.org

Illinois Ready-Mixed Concrete Association, (1997), '*Safety and Health Management Systems for the Ready Mixed Concrete Industry*' Fairbury.
ILO (1995), *'International Labour Office Safety, Health and Welfare on Construction Site'*, Geneva.

ILO (1995). International Labour Office Safety, Health and Welfare on Construction Site. Geneva.

Ivor H. Seeley, 1984, *'Quantity Surveying Practice'* published by Macmillan.
Kisner, S.M. & Fosbroke, D.E. (1994), *'Injury Hazards in the Construction Industry'* Journal of Occupational Medicine.

Joint building Council, April 1999 edition, *'Agreement and conditions of contract for building works'* published by the Joint Building Council (JBC), Kenya

Kithinji N. B. (1988), *'systems approach to building project management: Experience from Kenya'*, M.A thesis, University of Nairobi

La Dou, J. 2nd edition, (1994). '*Occupational Health & Safety'*, National Safety Council (NSC).

Laney J.C, (1982), 'site safety' construction press Ltd.

Lapin, L. (1982), '*Statistics for Modern Business Decisions'*, London: Harcort Brace Jovanovich Inc.

Laws of Kenya (1962), '*The Factories Act Chapter 51'*, Government Printer, Nairobi

Laws of Kenya (2007), '*The occupational safety and health Act'*, Government Printer, Nairobi

Laws of Kenya, *'Environmental Management and Coordination Act 1999'* Government printer, Nairobi.

Laws of Kenya, '*Petroleum Act Cap 116'*, Government printer, Nairobi.

Laws of Kenya, '*Public health Act, CAP 242*'. Government printer, Nairobi.

Laws of Kenya, '*the Food, Drugs and Chemical Substances Act – Cap 354*', Government printer, Nairobi.

Lee, C.L. (1998). '*The investigation of workers' occupational musculoskeletal problems in building constructions (in Chinese), IOSH86-H328*' Institute for Occupational Safety & Health, R.O.C.

Lusk, S. L. et al (1998), '*Use of Hearing Protection and Perceptions of Noise Exposure and Hearing Loss Among Construction Workers'*, American Industrial Hygiene Association Journal

Mccabe, S. (2001) *Bench marking in Construction*. Blackwell Science, Oxford

Mcklon, A. (1980), '*Accident Prevention Manual for Industrial Operation Engineering.*

Meyer W. Samuel & Pegula M. Stephen, (2004), '*Injuries, Illnesses, and Fatalities in Construction'* Bureau of Labour statistics.

Ministry of Roads and Public Works, 3rd edition 2007, '*Register of approved building contractors'*. Unpublished.

Morton, R. & Jagger, D. (1995),' *Design and the Economics of Building'*. E&FN Spon. London, UK.

Mugenda, O.M., and Mugenda, A. L, (1999), '*Research Methods'*, Acts Press. Nairobi.

Mwangi C.M, (1989). '*A study of construction safety administration on building sites in Nairobi area'*. Unpublished MA Thesis, University of Nairobi.

National Institute for Occupational Safety and Health –NIOSH, (1981), *Department of Health and Human Resources Publication No, 81-122*.

Neitzel, et al (1999), '*An assessment of occupational noise exposure in four construction trades,* American Industrial Hygiene Association Journal

NIOSH (1992a), '*Environmental Surveillance Report. International Association of Machinists Building'*, Division of Respiratory Disease Studies.

NIOSH (1996), '*Personal Protective Clothing/Equipment Sizing and Fit Practices'*, Unpublished Report Submitted by International Personnel Protection.

Nyagah, M. A. (1989), *'An Investigation into the Causes of Variation in Labour Productivity on Construction Sites' Unpublished* MA Thesis, University of Nairobi.

Oakland, J.S. (1999), *'Total Organizational Excellence, Achieving World-Class Performance'*, Butter worth-Heinemann, Oxford.

Oldfield, A. & Ocock, M. (1997), *'Managing project risks: the relevance of human factors'*, International Journal of Project Management.
Paul D. Leedy, 1985, *'Practical Research; Planning & Design'*, published by Collie Macmillan.

Petal Ngau et al, 2004 "Research Design, Data Collection & Analysis; A training manual" published by UNON print shop.

Prasanna Chandra 5th Edition 2003, *'Project; planning, analysis, financing, implementation and review'* published by MC graw Hill.

Public Procurement Oversight Authority (PPOA), (Rev.2006), 'Standard tender document for procurement of works (building and associated civil engineering works).

Ramus Jack & Birchill Simon, 3rd edition, 1996, *'Contract practice for surveyors'* published by Laxton's.

Republic of Kenya (2000). '*Economics Survey 2000*', Nairobi, Central Bureau of Statistics.

Royal Decree (773/1997), *'Minimum safety and health provisions relating to the use by workers of personal protective equipment'*

Rukwaro, R. W. (1990). *"The Influence of Architectural Design Parameters on the Maintenance Costs of Building Services of Office Buildings in the City of Nairobi"*. Unpublished MA Thesis, University of Nairobi..

Schneider, S. et al (1995), *'Noise, Vibration, and Heat and Cold, Occupational Medicine,* State of the Art

Seely I.H, 1986, *'Building Maintenance'*, published by Macmillan Education Limited

Seshagiri, B. (1998), *'Occupational noise exposure of operators of heavy trucks'*, American Industrial Hygiene Association Journal.

Smallwood, J. (2001), '*Construction Ergonomics in South Africa*' Department of Construction Management. University of Port Elizabeth.

Stellman & Jeanne Mager 4th edition (1998), *'Encyclopedia of Occupational Health and Safety'* International Labour Office, Geneva.

The Center to Protect Workers Right, (2001). '*Work-Related Hazards and Recommendations for Controls'.*

Thomas J.A, (1979), *'Occupation safety and health management'* McGraw-Hill.

Tubbs, R. L. (1999), *'Health Hazard Evaluation Report'* US Department of Health and Human Services, Centers for Disease Control and Prevention.

Turin, D. (1975), *'Aspects of Economics of Construction'* Godwin, London.
V.J Davies & K.Tomasin (1996), *'Construction site handbook'*, published by Thomas Telford.

Whyte B.A (1960), *'Safety on site: a manual on accident prevention'* Trade and pross.

Woolf, A.D. and Pfleger, B (2000), '*Burden of Major Musculoskeletal Conditions'*, World Health Organization International Bulletin

APPENDIX 01

QUESTIONNAIRE TO THE CONSTRUCTION WORKERS

1. What type of eye and face protective equipment are you provided with among the following?

No.	Protective device	Yes (√)	No (X)
i.	Safety spectacles		
ii.	Impact resistant spectacles		
iii.	Side shields		
iv.	Goggles		
v.	Welding shields		
vi.	Laser safety goggles		
vii.	Face shields		
viii	Others/None (Specify)		

2. What type of hearing protective equipment are you provided with among the following?

No.	Protective device	Yes (√)	No (X)
i.	Expandable foam plugs		
ii.	Pre-molded reusable plugs		
iii.	Canal caps		
iv.	Earmuffs		
v.	Single-use earplugs		
vi.	Others/None (specify)		

3. Are you provided with any respiratory protective device?

a. Yes b. No

4. Are you provided with any hand and arm protective device such as gloves?

a. Yes b. No

5. What type of foot and leg protective equipment are you provided with among the following?

No.	Protective device	Yes (✓)	No (X)
i.	Leggings		
ii.	Toe guards		
iii.	Safety shoes		
vi.	Others/None (specify)		

6. Are you provided with any head protective device such as head hat?

a. Yes b. No

7. Are you provided with any body protective equipment such as protective clothing?

a. Yes b. No

8. Are you aware of any legal requirement on use of the various types of personal protective equipment as indicated below?

No.	Type	Yes (✓)	No (X)
i.	Eye and face PPE.		
ii.	Hearing PPE		
iii.	Respiratory PPE		
iv.	Hand and arm PPE		
v.	Foot and leg PPE		
vi.	Head PPE		
vii.	Body PPE		
viii	Others/None (Specify)		

9. Which institution is legally mandated to enforce use of PPE on construction sites?

a. Ministry of Local Government b. Ministry of labour c. Ministry of Public works d. None

10. What enforcing mechanism would you suggest to encourage of PPE.

a. Training on use of PPE b. step up inspection by Government

c. Incentives for use of PPE d. dismissal from work for lack of use of PPE

APPENDIX 02

QUESTIONNAIRE TO SITE SUPEVISORY STAFF

1. Do you have a PPE program/policy on site?
   a. Yes b. No

2. Do you train your workers on use of the following Personal Protective equipment (PPE).

No.	Type	Yes (✓)	No (X)
i.	Eye and face PPE.		
ii.	Hearing PPE		
iii.	Respiratory PPE		
iv.	Hand and arm PPE		
v.	Foot and leg PPE		
vi.	Head PPE		
vii.	Body PPE		
viii	Others/None (Specify)		

3. How often do you hold drills on use of PPE among the construction workers?

   b. Daily b. Weekly c. Monthly d. At random
   e. Never

4. When do you train or retrain your workers on use of PPE?

   a. New workers b. Start of the project c. Changes in tasks
   d. Changes in PPE required e. Never

5. How often do you inspect PPE in use among the construction workers?

   b. Daily b. Weekly c. Monthly d. Annually
   e. Never

6. How often do you replace defective PPE?

   c. Daily b. Weekly c. Monthly d. Annually
   d. Never

7. In what ways do you encourage workers to wear on PPE?

   a. Reward scheme b. training c. Report to management
   d. firing non cooperative workers

8. Which of the following hazards is prevalent on site?

a. Mechanical hazards e.g. impact, penetration, tripping, noise, suffocation, noise, falling
b. Electrical hazards e.g. electrocution, short-circuiting
c. Heat/cold hazards e.g. heat stress, exposure to hot substances, cold stress
d. Chemical hazards e.g. splashes, contact with chemicals, harmful dust, foul smell,
e. Radiation hazards e.g. light (optical) radiation, ionizing radiation from hazardous waste

9. Indicate the number of accidents/injuries reported however minor, against each of the hazards below since inception of the project.

Hazard		Weekly	Monthly	Annually	Never
Mechanical	Impact				
	Penetration				
	Tripping/falling				
	Noise				
	Collapse				
	Noise				
	Suffocation/oxygen deficiency				
	Vibration				
Electrical	Short-circuiting				
	Electrocution				
Heat/cold	Exposure to hot conditions				
	Exposure to hot conditions				
Chemical	Contact with chemicals				
	Chemical splashes				
	Foul smell				
	Harmful dust				
Radiation	Light radiation				
	Ionizing radiation				

10. How often do factory inspectors visit the site?

a. Weekly b. Monthly c. Periodically d. Never

APPENDIX 03

QUESTIONNAIRE TO CONSTRUCTION COMPANY MANAGERIAL STAFF.

1. Have you employed a safety officer(s) or established a safety committee to check among other things provision and use of PPE on site?

a. Yes b. Outsourced c. site agent doubles as safety officer

d. none

2. Do you have a written site safety policy or manual addressing among other things PPE provision, maintenance and warning signs for use of PPE?

a. Yes b. No

3. Monitoring and evaluation are requirements for an effective PPE program. In what ways do you monitor and evaluate your PPE program (if there).

a. Site visits b. Reports on accidents/injuries on site c. Camera surveillance workers d. none

4. Periodic site meetings are normally held to review project progress. Do you include site safety matters as part of agenda of such meetings?

a. Always b. Sometimes c. When need arises

d. Never

5. Are safety issues such as provision of PPE to construction workers explicitly mentioned in the tender documents?

a. Yes b. No c. rule of trade

6a. Training and retraining of staff on PPE requirements is part of any effective site safety scheme. Do you a staff training or sensitization scheme for site supervisory staff on PPE done?

a. Yes b. No.

6b. How often do you hold a staff training or sensitization scheme for site supervisory staff on PPE done?

a. Monthly b. Annually c. New employees d. No training program.

7. Accidents/injuries on site are not only costly but also may result to completion period overruns. Have encountered cost or time overrun as a result of injuries/ accidents as a result of lack of use of PPE on site?

a. Yes b. No

8. Has ever been prosecuted or penalized for lack of use of PPE on site.

a. Yes b. No

9. Are you aware of the new 'Occupation safety and Health Act 2007'?

a. Yes b. No

10. One of the requirements of the Act is writing to the director expressing interest to commence works. Do you communicate such intentions?

a. Yes b. No c. ignorant