

**UNIVERSITY OF NAIROBI  
FACULTY OF ARTS  
DEPARTMENT OF SOCIOLOGY**

**A VULNERABILITY AND CAPACITY ASSESSMENT: A STUDY OF SELECTED  
PLANTS IN NAIROBI'S INDUSTRIAL AREA ^**

**BY**

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## DECLARATION

I Elizabeth Wangui Mukora do hereby declare that this MA research project is my original work and has not been submitted to any other university for academic credit.

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## **DEDICATION**

I dedicate this work to my father Lawrence Mukora for financing my education this far. I also dedicate it to all the industrial area workers who get up every morning and work tirelessly in the industries even in the most deplorable conditions.

I wish to thank and acknowledge the efforts made by my father Lawrence Mukora to see me come this far.

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**Thank you all and may God bless you**

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## ABSTRACT

This is an exploratory study in which the vulnerability and capacity of selected plants based in Nairobi's industrial area is assessed. The objectives of the study were to identify the awareness level of industrial plant employees, to establish if there were any structural changes that had occurred in the industrial plants in regards to industrial safety and to identify the vulnerability levels of elements at risk in the industrial plants.

The study employed both primary and secondary techniques and tools of data collection. Nairobi's industrial area was purposively selected for its proximity, its likelihood of housing each of the 6 categories of industrial plants and being the largest single industrial area and the oldest in Kenya, with firms dating back to World War 1. This was also so since Nairobi's industrial area also houses the offices of the Directorate of Occupational health and safety which played a major role in this study. The study interviewed a total of 75 industrial plant workers based in the plant's production area ( 64 male and 11 females). Secondary data was sourced from the published and unpublished information from libraries which included books, magazines, newspapers, scholarly journals and copies of the Kenyan Law. The data was analysed through the use of MS Excel and Statistical Package for Social Scientists (SPSS) packages.

Findings indicated that industrial plant workers employ a larger male work force in the production area as compared to females. Further, the findings revealed that these workers are poorly informed on their safety in the workplace. This was evident from respondents who had encountered an accident but could not relate to how it had been responded to. Though the majority of these respondents worked in an environment where at least one safety equipment was available, less than half of the respondents were trained or oriented on the safe use of the equipments which with the wrong application can lead to injuries or multiplicity of the accident. This is besides the existence of safety committees mandatory in each plant and whose mandate is to enforce safety in the work place. These plants however did have future plan/s to improve on safety. Some of these plans included;

and fire alarms, display of exit maps, introduction of a drainage for spilled products among others. Various factors were identified as contributing to the vulnerability of industrial plants to hazards. They included; the lack of safety awareness among workers, low knowledge on equipment use, poor drill participation, locking in of workers as they work, the lack of collaboration, ignorance among workers, selective training of workers and the high cost of installing safety equipments among others.

The study recommends that future researches of the same nature be conducted in other major towns and special attention be paid to those not registered under the Directorate of Occupational Health and Safety Services whose registration may mean that there is some level of compliance.

It is also recommended that a comparative study of the same nature be conducted with the quest to identify if any differences exist between casual and permanent workers as pertains to occupational safety. Further research should also be conducted in the area of proper working gear and protective equipments required for workers in different production areas.

The outcome of this research also gave an indication that there was a higher level of compliance in plants that had international affiliation, (meaning that they had their mother companies in other countries) as compared to those that were purely local. Research should be conducted to establish if there is any relationship in these findings and factors that contribute to them.

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## **ACRONYMS AND ABBREVIATIONS**

<b>API</b>	<b>American Petroleum Institute</b>
<b>DMTP</b>	<b>Disaster Management Training Program</b>
<b>DOHSS</b>	<b>Directorate of Occupational Health and Safety Services</b>
<b>EWS</b>	<b>Early Warning Systems</b>
<b>GOK</b>	<b>Government of Kenya</b>
<b>ILO</b>	<b>International Labour Organization</b>
<b>IR</b>	<b>Infrared</b>
<b>KNCP</b>	<b>Kenya National Cleaner Production Centre</b>
<b>NFPA</b>	<b>National Fire Protection Agency-US</b>
<b>NUW</b>	<b>National union of workers -Australia</b>
<b>OSHA</b>	<b>Occupational Safety and Health Administration-US</b>
<b>RF</b>	<b>Radio frequency</b>
<b>SEWS</b>	<b>Standard Early Warning Signals</b>
<b>UNEP</b>	<b>United Nations Environmental Program</b>
<b>VCA</b>	<b>Vulnerability and Capacity Assessment</b>

## CHAPTER ONE: INTRODUCTION

### 1.1: Background

Industrial accidents have been experienced world wide. In 1984, a 45 minutes release of methylisocyanate from the Carbide corporation pesticide plant into the atmosphere killed 3,598 Indian people; by 1989, a further 50,000 had been seriously affected, while 150,000 others suffered from the after effects. In Ukraine, the effects of the Chernobyl Nuclear power plant (in April of 1986) were not only just a big blow to the economy, but the effects are still being felt even today. Over 40,000 people were displaced, while thyroid cancers increased 285 times after the accident. It is also estimated that at least a million children and young adults residing in the area are at an elevated risk of thyroid cancer (Reeds, 1996:173).

Kenya has also had its share of industrial accidents. The most recent of these is the fire outbreak in Libra house and a section of Sadolin paints company. Between the year 2002 and 2005, 15 major accidents had been reported to Directorate of Occupational Health and Safety Services (DOHSS), with 256 deaths occurring in different industries. Of the 15 accidents, 3 were reported in 2002, 4 in 2003, 4 in 2004, and 4 in 2005. Of the 256 deaths, 53 occurred in 2002, 20 in 2003, 95 in 2004, and 86 in 2005. Some of these accidents included a gas leakage at a horticultural processing factory leading to 35 hospitalized, an explosion of a cylinder containing anhydrous ammonia gas as it was being loaded in Kisumu; fire in Standard motors Ltd, Kisii, and a section of a textile factory in Nakuru, 4 employees in a geothermal production well exposed to hydrogen sulphide gas at Olkaria and a blast at a steel factory injuring 8 in Kilifi (DOHSS-Annual Reports, 2002-2005).

Over the years, industrial hazards have contributed to the rise of vulnerability with the continued growth in technology. There is therefore an urgent need to identify industrial hazards with the aim of building capacities to manage industrial accidents before they can become disasters. Hence, a vulnerability and capacity assessment (VCA) is imperative.

VCA is a tool used to identify the coping strategies as well as the responses linked to resources, which in the face of a hazard determine how vulnerable individuals or households become (Bonvin, 1996:23). Such efforts help to ensure that a strong emergency response is in place since we cannot completely prevent industrial accidents from occurring without shutting down the plants. These accidents occur mainly in the form of fires, explosions, chemical leaks and poisonous releases. Because of the processes involved in industrial plants, if not controlled, they can lead to damage of property, environment and pose danger to lives. This is because industrial disasters can occur at any stage in the production process, thus endangering personnel of a factory, the people living close by, or even the environment itself. It is therefore essential for those involved to measure these risks in order to anticipate or mitigate them better and reduce their impacts. (Stephens, 1996: p41- 42).

Besides the great losses in property, the effects of fires on people generally take the form of skin burns caused by exposure to thermal radiation; as well as toxic fumes inhaled. Fires may take the form jet fires, pool fires or flash fires. Explosions on the other hand are categorised by a shock wave, which can be heard as a bang; and which depending on their magnitude may damage buildings by way of causing collapse, flying glass and debris, as well as injure people. Explosions take the form of gas or vapour cloud explosions while toxic releases will mainly take the form of vapours. Sudden releases have the potential to cause death and severe injuries several kilometres from the point of release depending on the weather conditions. These materials can be carried for considerable distances through water, air or even gear. Nuclear radiation falls in this category (Stevens, 1996:46).

It is imperative to note that most hazard events are difficult, if not impossible to control. We cannot for instance completely prevent industrial plant accidents from occurring without shutting down the plants. However, a safe way of using them responsibly is by reducing disaster risk by decreasing the level of vulnerability (DMPT, 1996:10). This can be done through capacity building by way of training and creating awareness. To do this, information collected through a Vulnerability and Capacity Assessment (VCA) may act

as a guide on the areas needing attention. IFRC has specifically advanced three justifications for doing a VCA. Firstly, development plans require it since VCA is linked more to "development" than "relief" and vulnerabilities or "shocks" in the development plans set back peoples' lives by affecting the development of a community or nation. Worries about such "shocks" also make people less innovative and willing to take risks. Secondly, VCA is needed for disaster preparedness and mitigation. It tells us something about the means people employ to cope and this is the surest basis on which to build appropriate and cost-effective actions for preparedness and mitigation. Finally and very importantly, the process of a VCA, if properly done, confers advantages to vulnerable people in terms of raising public awareness, sensitization and empowerment, thereby giving the community knowledge of risks and capacities (Bonvin, 1996:8).

Industrial accidents are preventable if only response and preparedness safety issues were taken seriously in every industrial facility and attention given to the root causes of safety accidents in Kenya, which include; the safety policy not defined and communicated; responsibility, authority and accountability not assigned; emphasis on production rather than safety; lack of direct communication with management; inadequate safety inspection procedures; insufficient safety training for normal and emergency situations; inadequate employee selection; and insufficient supervision and rewards ( Khisa.2004:38 ). With the root causes already identified therefore, VCA as a tool will act as a base identification tool for identifying how safety mitigation and response is on the ground in order to pave way for recommendations that will be used to create disaster preparedness and mitigation capacities thereby facilitating development of emergency coping strategies.

## 1.2: Problem Statement

Statistics show that the number of emergencies involving hazardous substances are rising with increasing use, transportation and disposal of chemicals worldwide (Bonvin, 1996:17). While Kenya has not experienced an industrial accident in the magnitude of Carbide or Chernobyl, it is not immune from the possibility given that many different production processes and chemicals are employed everyday involving a wide range of materials that could cause a fire, an explosion, or toxic release. According to Reeds (1997:167), past histories of chemical and industrial accidents are not necessarily good predictors of future incidents, since many incidents are not reported whereas near-accidents/misses are generally not reported at all.

Industrial accidents in Kenya are on the rise. A recent report by Kenyatta National hospital indicated that a hands unit was required due to the risen cases of patients (i.e. between 5-20 every week), with hands or arms completely chopped off; attributed to either assault or industrial accidents resulting from the lack of proper protective gear; or absence of protective measures in many industries ( All Africa:2006 ).

According to DOHSS, of the 5,395 industrial accidents reported in Kenya between the year 2002-2005, 257 cases were fatal (DOHSS Annual Report: 2002-2005). Of these cases, several have been major industrial accidents, the more recent being the fire outbreak in Libra house and a section of Sadolin paints company, with the former leading to the loss of 13 lives and 1 person escaping with minor injuries in the Sadolin case. Property and damages worth thousands of shillings were also incurred in both cases. Preliminary investigations to the Libra house accident revealed the lack of a fire exit and non operational fire extinguishers (Daily Nation, 2006:5). This is besides the existence of Cap 514 Sec 41(1) and 42 part 4 of the factories Act, which requires that every factory provides and maintains adequate and suitable means of extinguishing fire.

Section 42 part 4 of the industrial Act is perhaps the least adhered to. For the sake of emergencies, it states that any person within the factory for employment or meals should not be locked in, such that they cannot easily open the exit from inside. According to a



survey by the Daily Nation (7<sup>th</sup> August: 2006), many factories in Nairobi, Nakuru, Kisumu Thika and Eldoret routinely lock in night shift workers supposedly to curb theft. The death of 13 people in the Libra house fire probably occurred for this same reason.

The lack of safety committees or the existence of dormant ones is another safety problem in Kenyan industries. According to the factories Act (Cap 514 Sec 65 subsect.A) factories which regularly employ at least 20 employees should have a safety committee. According to DOHSS however, only a selected number of employers adhere to this, with the majority of new industries avoiding registration with DOHSS to avoid the responsibilities that come with it; such as meeting the training expenses for the employees. In 2003 for instance, of the estimated 100,000 work places liable for inspection, only 10,826 were recorded under DOHSS. Without safety committees, then most likely the industrial safety issues which follow their formation are being compromised. \*

This study therefore aims at doing a VCA to establish the extent to which safety rules and regulations are being adhered to, in relation to the emergency preparedness and response resources available in the plant. The study therefore aimed at getting information on safety issues such as the level of awareness on safety among workers and the structural changes that have taken place to improve the capacity of industrial plants.

The study was informed through the following research question;

#### **Research Question**

What are some of the structural changes that have taken place in industrial plants to improve the level of awareness of workers and improve the vulnerability of elements at risk?

#### **1.3: Objectives of the Study**

The study's broad objective was to assess the disaster capacity levels of industrial plants in Nairobi's industrial area.

The specific objectives are:

1. To identify the awareness level of industrial plant employees;
2. To establish if there are any structural changes that have occurred in industrial plants concerning industrial safety;
3. To identify the vulnerability levels of elements at risk in the industrial plants.

#### **1.4: Scope and Limitations of the Study**

This research was aimed at assessing the vulnerability and capacity of industrial plants to disasters in selected plants at the Nairobi's industrial area. The study achieved this by mainly assessing issues on employee safety awareness, behaviour change and the vulnerability levels of elements at risk. The study was mainly inbound and did not include assessment of outbound processes that may include packing and transportation. It did not also touch on resources that included engineering processes since it required an expert in the field.

Though industrial safety issues are broad, the study limited itself to vulnerability and capacity assessment of elements at risk related to the three principal hazards. These were fire, explosions and toxic releases. The study also limited itself to the capacity assessment of resources related to emergency mitigation, preparedness and response.

Though industrial areas can be found in other major towns, the study was only based in Nairobi due to time and financial limitations. The results of which were generalized to reflect a picture of the state of safety preparedness and response in Kenya's industrial plants.

## **CHAPTER TWO: LITERATURE REVIEW**

### **2.1 Development of Industrial Safety**

Historically, the effects of industrial disasters were typically confined to workplaces or to the transportation systems that shipped raw materials and finished goods. Accordingly, most public policies for disaster reduction emphasized on safer industrial technologies and upgraded working conditions - at the mine face, on the foundry floor, in the machine shop, the power station, or on the ships and railroads that transported a majority of industrial products (Rosner and Markowitz, 1987). At the time occasional extraordinary disasters affected larger populations that were not directly associated with the industrial production system. For instance, in 1917, the explosion of a munitions ship in the harbour of Halifax, Nova Scotia, destroyed much of the surrounding city. This was the period of industrial revolution (Prince 1920, in Mitchell 2003).

Before the coming of the steam engine, nearly all industrial accidents were regarded as the employees own fault. The advent of the steam engine, followed by the electric motor and the tremendous increase in the use of power driven machinery made possible, soon brought an increasing stream of serious and fatal injuries; workmen whirled to death by projecting screws caught in their clothes, crushed flat between belt and pulley, others chewed up inch by inch when caught up in massive gears, or flesh eaten away upon falling on unprotected acid. These accidents were accelerated even further by the great depression of the 1970's. The shocking nature of these accidents brought a change in workers attitude <sup>1</sup>.

With the help of the newspapers and through organized labour, they fought for guarding of hazardous machinery and compensation for injuries as they continued to display pictures of mutilated bodies and fingers of young girls. What followed was the enactment of the first law on hazardous machinery in Massachusetts in 1877. The newspapers continued to display sympathy arousing injuries, and by 1900, most industrialised states

<sup>1</sup> **Industrial Safety, (Blake, 1963: 12)**

had some form of safeguarding legislation with factory inspection to enforce it. After much struggle, employee compensation followed by the workmen's compensation legislation was developed in 1885 in Germany under Bismarck. By 1915, organizations like the National Safety Council which expounded different safety issues further had come up and is still operational even today ("Blake, 1963:13).

The year 1919 saw the entry of International Labour Organization at the end of World War 1, whose initial aim was humanitarian, to calm industrial unrest, and fight for the working conditions of workers (ILO, 2000).

Britain at the time, being one of the super powers and highly industrializing countries also adopted industrial safety issues that were being adopted by other countries. Britain like other colonialists had set up industries in their colonies, Kenya being one of them. With the growth of pressure from the human rights campaigns, Britain was forced to adopt its industrial law in Kenya, just the way it was, with just but minor changes to suit the environment. The Factories Act and other places of work Act, chapter 514, came into operation on the 1st of September 1951 and has been amended once in 1990. The Directorate of Occupational Health and Safety Services in Kenya, under the Ministry of labour and Human Resource Development is the national body charged with its enforcement. ILO has also played a major role in setting the industrial safety standards of not only Kenya, but many other countries around the world.

## **2.2 THE GROWTH OF NAIROBI'S INDUSTRIAL AREA**

The Nairobi's Industrial area is the largest single industrial area in Kenya, employing thousands, and is the oldest established industrial area in Kenya with firms dating back from World War 1, such as Lord Delamare's Unga limited, sold to the Kenyan farmers in 1928.

The arrival of the Kenya Uganda railway in Nairobi in 1899 saw Nairobi become the new head quarters of the Kenyan colony (Mwangi, 1975:28). In August 1899, the government administration of Ukambani province (in which Nairobi lay) was transferred from

Machakos to Nairobi, and it is from this point onwards that Nairobi began to assume the functions of the future capital city (Nrxson, 1973:52). With the colonial administrative activities and the now ready infrastructure and market for mass produced goods, industries began to crop up around the railways terminus. Because of the rising demand for space, plots for industrial activities were set aside for allocation. (Mwangi, 1975:28) Official concern on the development of the Nairobi Industrial area was then given expression by the colonial Government in 1947. It became obvious that the Nairobi Urban Area had achieved dominance as the administrative, commercial and industrial centre of the East African towns. A commission was then set up to draw a master plan for the development of a colonial capital which envisaged Nairobi as the industrial centre of East Africa. The planning group in their 1948 report recommended that a well defined area for exclusive industrial activities be demarcated to the south east of the Nairobi Railway station (Mwangi, 1975:35).

Today, Nairobi's industrial area falls into seven distinct sections. These include:

- a. Haile Selassie avenue race course road area.
- b. The railways installations.
- c. The area South East of factory road, North West and North East of Machakos road.
- d. The area East of enterprise road and Uhuru highway.
- e. The area between Kilmarnock and Liverpool roads, and
- f. The Manchester - Oldham -Newcastle -Leeds road area (Ogendo, 1977:15).

Because of this growth in the industrial area, settlement areas developed around the industrial area. The higher skilled operatives, the administrative and managerial staff who are normally in the higher income brackets settled in the better parts of the southern residential areas although most of them live in the western, North western and the better part of the Northern residential areas (Ogendo, 1977:16). Slums have also cropped up around these industries and now form a good source for cheap labour for them.

## 2.3 PRINCIPAL INDUSTRIAL HAZARDS

According to Stevens et. al (1996) in the UNEP training manual - Industrial Accident Prevention and Preparedness - there are 3 principal types of hazards experienced in industries. These are fires, explosions, and toxic releases.

### 2.3.1 Fires

Fires occur in industry more frequently than explosions and toxic releases. A study carried out by the Kenya National Cleaner Production Centre (KNCP) in 2003 on Occupational Health and Safety Management in Kenya identified fire as the greatest challenge to the safety of industrial plants ( Khisa, 2004:38).

According to Stevens et.al (1996), the consequences in terms of loss of life are generally less, though they leave lifetime scars and disabilities. The effects of fire on people usually take the form of skin burns caused by exposure to thermal radiation. The severity of burns depends on the length of time exposed, the intensity of the heat, and the distance from the source. This is because heat radiation is inversely proportional to the square of the distance from the source, which means that at twice the distance from the source, the intensity will be reduced to a quarter.

Stevens continues to state that fires also give off fumes which may include toxic gases. For example, combustion of polyurethane foam gives off cyanides. Fire can cause severe damage to physical structures either by combustion, or by the effects of heat. It may also have an effect on essential services with damage to power and instrumentation supplies, possibly causing an escalation of the incident.

According to ILO (1996:4), fire can take several forms which include:

*Jet fires:* a long, narrow flame produced, for example, from an ignited gas pipeline leak.

*Pool fires:* produced, for example, by the ignition of crude oil released from a storage tank into a bund.

*Flash fires:* rapid, virtually instantaneous, ignition which could occur if an escape of gas reached a source of ignition and rapidly burnt back to the source of the release.

*BLEVEs*: Boiling Liquid Expanding Vapour Explosions, sometimes called a 'fireball', which is a combination of fire and explosion with an intense emission of radiant heat following failure of a pressure vessel due to overheating of the tank wall surrounding the vapour space.

### **2.3.2 Explosions**

According to Baker et al (1983), "an explosion is said to have occurred in the atmosphere if energy is released over a sufficiently small time, and in sufficiently small volume so as to generate a pressure wave of finite amplitude travelling away from the source. However, the release is not considered to be an explosion unless it is rapid enough or concentrated enough to produce a pressure wave that one can hear". According to Stevens (1996:41), such explosions can be either confined such as those which occur within some form of containment (e.g. vessels, pipe work), or in less obvious situations (e.g. between buildings), or unconfined occurring within the open air.

Explosions are sometimes called a 'fireball' - i.e. a combination of fire and explosion with an intense emission of radiant heat following failure of a pressure vessel due to overheating of the tank wall surrounding the vapour space. Baker continues that these explosions are characterized by a shock-wave which can be heard as a bang. The consequence of such a bang or Shockwave can cause damage to buildings and people can be blown over. Not only can the effects of such overpressure be fatal, the indirect effects of collapsing buildings, flying glass and debris cause far more loss of life and severe injuries (Baker, 1983)

According to ILO (1988:2), explosions can be classified in either 3 ways as either deflagration or detonation, gas or dust form, or in vapour form. Explosions can be said to occur either in the form of a deflagration or a detonation, depending on the burning velocity during the explosion while deflagration occurs when the burning velocity or the flame speed is generally slow, of the order of 1m/sec. On the other hand, a detonation occurs when the flame speed is extremely high and travels as a shock wave, with a

typical velocity of 2000-3000 m/sec. Of the 3, a detonation generates greater pressures, and is far more destructive than a deflagration.

Gas explosions can occur when considerable quantities of flammable gases are mixed with air to form an explosive vapour cloud before ignition takes place, whereas dust explosions occur when flammable solids in the form of very fine powder are intensively mixed with air and subsequently ignited (Stevens, 1996).

An explosion therefore occurs following an initiating event such as a fire or a small explosion that causes powder that has settled on surfaces to become air borne, the effects of which are depended on a number of factors including wind speed and the degree of dilution of the cloud with air. These explosions are said could lead to large numbers of casualties and wholesale damage both on site and beyond; and since grain, milk powder, and flour are flammable, dust explosions have been more common in the agricultural industry. Such subsequent series of explosions have been known to have led to catastrophes and the destruction of complete factories (ILO (1988:2).

### **2.3.3 Toxic releases**

Toxic releases involve the escape of poisonous vapours from their confinement. Sudden releases of toxic vapours have the potential to cause death and severe injuries at a great distance.

According to Stevens (1996:41), toxic releases have the capacity to produce lethal concentrations several kilometres from the point of release, with the number of casualties depending upon the weather conditions, the population density in the path of the cloud, and the effectiveness of the emergency arrangements.

Toxic releases are possible in the work places where they are used at any time and caution needs to be taken. In 2005 for instance, a chemical gas leakage occurred at a horticultural processing factory in Nairobi's airport area leading to the hospitalization of 35 employees. In a different incident the same year, 4 employees were reported to have fainted after they were exposed to hydrogen sulphide as they worked in a geothermal production well at Olkaria (DOHSS Annual Reports-2005).



Toxic materials are not just confined to the atmosphere only, they can also be carried considerable distances by water. Their release into the public sewage system, or rivers, canals and other water courses, either directly or through contaminated water used in fire fighting can result in serious threats to public health (Stevens: 1996:41).

#### **2.4 MAJOR CAUSES OF INDUSTRIAL ACCIDENTS**

According to Blake (1963), and ILO (1991) and other scholars, the major causes of industrial accidents include:

- Component failure.
- Deviations from normal operating conditions.
- Human and organizational errors.
- Outside accidental interferences.
- Natural forces such as floods or lightning.
- Acts of mischief or sabotage.

According to Takala (2002), the fundamental precondition for safe operation is that components can withstand the operational loads and thus enclose any potentially hazardous substances. He continues to say that, this is not always the case, and accidents do occur. This he says is mainly due to inappropriate design, against internal pressure and external forces, failure of vessels due to pipe work corrosion, and the failure of components such as pumps as well as temperature sensors.

According to ILO (1991), while component failures can be avoided by careful design or maintenance, deviations from normal operating conditions require in-depth examination of operational procedures. The consequences of these failures can be understood only after examination of the behaviour of the entire system, in the event of such a failure. Counter measures on the other hand can be provided by reliable process control, good operating procedures, as well as a proper inspection and testing program.

In Kenya, the Directorate of Occupational Health and Safety Services is charged with inspecting and enforcing compliance under the Factories Act of 1951. Of importance in preventing component failure is the human ability to run a major hazard installation, not only for plants which require a lot of manual operation but also for highly automated

plants requiring human intervention only in the case of an emergency or in setting operation procedures.

Common errors such as wrong button error, mix up of hazardous substances, communication errors, incorrect repair, unauthorised welding, or even over expectation from the operating personnel can be reduced through careful selection of personnel, as well as regular training (Takala, 2002:335).

According to ILO (1963) in their Safety Manual, accidents arising out of outside interferences cannot always be avoided due to their nature and untimeliness. These are such as derailment of an outside consignment ferrying dangerous substances near the vicinity. However, consideration in siting the plant of designing it can come along way in preventing some of these accidents.

Natural forces have also been noted as a cause of industrial accidents. These are such as lightning, wind, extreme sun, or even earthquakes which can be difficult to mitigate against especially if they are occurring for the first time. However, some measures such as the installation of lightning arrestors as well as environmental study in advance before location of a plant can act as a preventive measure.

Worth noting is that every major hazard installation can be the target of acts of mischief or sabotage. Because these are not anticipatable acts, the design of the installation should be considered to lock out and prevent in every way possible the access of such persons to the facility (ILO, 1963:16).

According to Blake (1963:140), house keeping can be a major cause for industrial accidents in some industries. In the industrial sense, house keeping signifies not only cleanliness, but having a place for everything and everything in its place. He continues to state that a condition of this kind cannot be maintained by an occasional grand clean up and setting things in order; it must be continuous and given proper attention and thought. A place is clean when it is clean from unnecessary things. He continues to state that a large proportion of fires in plants are due to poor house keeping. Besides poor disposal of

combustible as well as improper cleaning that ends up feeding the fire, these very materials can be cause for inadequate exit in the case of emergencies, or act as destruction.

In Kenya, the root causes of occupational safety accidents include the safety policy not well defined and communicated; the lack of responsibility, authority, and accountability not assigned; emphasis on production rather than safety; the lack of direct communication with management; inadequate safety inspection procedures; insufficient safety training for normal and emergency situations; inadequate employee selection, supervision and rewards. This is according to a study carried out by the Kenya National Cleaner Production Centre (KNCP) in 2003 to establish the state of occupational health and safety management in Kenya (Khisa, 2004:38)

## **2.5 PLANNING FOR EMERGENCIES**

When planning for emergencies, it is important to consider a mode of assessment that will help to identify the real position that the industrial facility is in resource-wise and their capacity to respond should an emergency occur at any given time. One such important disaster preparedness tool used is the Vulnerability and Capacity Assessment tool. Stevens (1996:23) defines Vulnerability and Capacity Assessment as a tool used to identify the coping strategies as well as the responses linked to resources, which in the face of a hazard determine how vulnerable an individual or households become (Stevens, 1996:23).

### **2.5.1 Aspects on Vulnerability and Capacity Assessment**

According to Reeds et. al (1997:11), vulnerability is the degree of loss to an inventory of those people or things which are exposed to the hazard should a hazard of a given severity occur. Chambers (1989) defines vulnerability as not meaning the lack of wants, but rather defencelessness, insecurity and exposure to risks, shocks and stress. Capacity on the other hand is the exact opposite of this. According to Bonvin (1996), while vulnerability is about not having, capacity is about having. He continues to state that people's capacities are highlighted by coping strategies and that the weaknesses and gaps

brought about by vulnerability can be identified by doing a vulnerability and capacity assessment. Cannon et. al (1994) affirms the importance of doing a VCA by stating three advantages of doing it. The first is that development plans require it as VCA is linked more to "development" than "relief", since vulnerabilities or "shocks" set back peoples' lives and the development of a community or nation. The presence of such shocks cause worries that make people less innovative and willing to take risks.

Secondly, VCA is needed for disaster preparedness and mitigation. VCA tells us something about the means people employ to cope, and this is the firmest basis on which to build appropriate and cost-effective actions for preparedness and mitigation.

Finally, and very importantly, the process of a VCA if properly done, confers advantages to vulnerable people in terms of raising public awareness, sensitising a community, and empowering them through providing knowledge of risks and capacities.

Imperative to note however is the importance of timing on the appropriate time to carry out a VCA. According to Bonvin (1996), the 'worst' time to do a VCA is during an emergency of some kind. Bonvin goes on to say that vulnerability assessment is an on going process to be started ideally during the "quiet times" between disasters. It should address risk and those long term factors which make people more vulnerable to a hazard. He goes on to show the connection between VCA and the disaster development cycle.

### VCA and the Development Cycle

#### **1. The pre-disaster stage**

For VCA to be most useful, it needs to be carried out in the "quiet" periods. It is a tool of disaster preparedness and national plans as well as individual organization plans should include an inventory -always kept up to date- and who is vulnerable, when and why. Ideally there should be an up-to-date VCA "on the shelf" with predictions for each type of possible hazard. This is because the impact of a threat - or the risk - can be reduced in advance of it happening by VCA. In some cases, the threat can even be removed, moved away from, or the impact of the disaster reduced.

## **2. In emergency response**

VCA does have a role in emergency response but it would be the wrong time to do it. The only time when it would be right to do a VCA during the response stage is only when faced by a slow onset disaster like drought. This way, it can serve as a good needs assessment tool and can be an effective starting point for vulnerability analysis for the next disaster.

However, with the nature of industrial accidents, which are sometimes difficult to detect, it is of priority to do a VCA and come up with response mechanisms and strategies even in the absence of signs of one on the way. Most industrial accidents can cause immense damage in very short periods and can therefore give no room for doing a VCA to come up with response measures. For instance, a 45 minutes chemical release in Bhopal India left 3,598 in India dead. However, where natural disasters have a history of occurring, assessment can be done after the first detection by the use of early warnings.

## **3. Post disaster rehabilitation**

The post disaster phase is a good opportunity to evaluate the impact of the threat and review what is needed to avoid future problems. The disaster may have brought new opportunities for doing things that were not possible before. These can include the occurrence of completely unexpected accidents like the sudden chemical blast. Doing a VCA at this point gives an opportunity for learning from mistakes and errors that may have occurred. The results obtained from such a VCA are important for developing response and mitigation strategies to avoid a repeat of the same.

For instance, in the early industrialization of Great Britain and the United States, boiler explosions were the most common industrial disasters. They often led to catastrophic fires on board ships and trains, factories, apartment buildings, and many other places where they could be found. Now the problem of boiler explosions in these regions is much reduced as a consequence of repeated

research and improvements in industrial design and construction standards (Hamilton, 1973:296).

Finally, VCA is essential in long term development.

#### **4. Long term development**

Although its role has not been given the importance it deserves, development is all about strengthening the capacities of people not only to cope with serious threats but more importantly to reduce day to day problems since vulnerability reduction is a long term process and hence of concern mostly for development (Bonvin, 1997:14). Near accident misses for instance should be given the same attention given to a real accident. According to Reeds (1997:167), near misses are rarely reported yet the fact that an accident did not occur is not a measure of the possibility. As long as man keeps producing, then industrial accidents remain a high possibility and should attract the possibility of revising the already existing vulnerability and capacity assessment.

##### **2.5.1.1 Emergency Plan**

When preparing for emergencies, it is always of great importance to have an emergency plan in place. This is because industrial hazards can occur at any stage in the production process. Because these products and processes can exacerbate the consequences of an accident such as the personnel of a factory, the people living close by, or even the environment itself, it is essential for those involved to measure these risks in order to anticipate them better and reduce their impact (Stevens, 1996:41).

Every industrial facility should therefore have an emergency plan and it should address all potential emergencies that can be expected in the workplace. The first step is to perform a hazard assessment to determine hazardous materials in the workplace and potentially dangerous conditions.

According to Stevens (1996) in the UNEP training manual, an emergency plan must include, as a minimum, the following elements:

1. Emergency escape procedures and emergency escape route assignment,

2. Procedure to be followed by employees who remain to perform (or shut down) critical plant operations before the plant is evacuated,
3. Procedures to account for all employees after emergency evacuation has been completed,
4. Rescue and medical duties for those employees who are to perform them,
5. The preferred means for reporting fires and other emergencies, and
6. Names or regular job titles of persons or departments to be contacted for further information or explanation of duties under the plan.

Takala (2002) though not in disagreement has expanded further the key elements that an onsite emergency plan for a large establishment would require:

1. Assessment of the size and nature of the events foreseen and their probability.
2. Formulation of the plan and liaison with outside agencies including emergency services.
3. Procedures: raising the alarm and communications.
4. Appointment of key personnel and definition of their duties and responsibilities.
5. Setting up of an emergency control centre.
6. Action on site: fire-fighting procedures, rescue systems, evacuation arrangements, and first aid arrangements.
7. Plant shut-down procedures.
8. Drills and continuous repeated exercise of emergency procedures (Takala, 2002:339)

While the two consider slightly different items to constitute the emergency plan, it is clear that all the elements considered are of value to the emergency plan. UNEP tends to simplify the requirements and is probably looking at smaller organizations while Takala is putting into consideration the possibility of large industrial installations.

While these procedures could be well documented in any organization, it would be wrong if strict application of all these safety measures, followed by the set procedures which are to be applied in the case of an accident, were not put in place to ensure that the impact of an accident was brought under control as rapidly as possible. These procedures include

fire safety installations such as lances and extinguishers, equipment to limit the impact of an explosion such as protective banks and water curtains as well as evacuation plans for the populations and employees involved (OSHA, 2002:36)

OSHA continues to state that it is the duty of every employer to ensure that all employees know details of the emergency action plan including evacuation plans, alarm systems, reporting procedures for personnel, shutdown procedures, and types of potential emergencies. In addition, OSHA states that this plan must be reviewed with employees initially when it is developed, whenever the employees' responsibilities under the plan change, and whenever the plan is changed. A written copy should also be provided to every new employee or kept where employees can refer to at convenient times. Drills also need to be held at random intervals, at least annually, and include if possible, outside police and fire authorities.

#### **2.5.1.2 Escape Routes**

This is one area that has been much abused by Kenyan industries, judging from previous accidents. People have lost lives locked up in buildings such as the Libra house accident, while others have been near misses with the staff managing to put out fire within the entrapment.

**E.g. According to the Daily Nation (Aug-2006:4) reporting on a fire accident, ..."[the] blankets company only experienced its 4<sup>th</sup> fire outbreak on Tuesday [Aug 1<sup>st</sup> 2006]. In the factory were 26 employees. ...they struggled to put out the flames, but they could not escape because the exit door was locked. When the alarm bell sounded, technical director xy<sup>J</sup> drove to the scene...but he had left the keys in his office 800 metres away. He had to drive back to bring them".**

Such is the situation in a number of industries in Kenya. Continuing on the same, a survey carried out by the Daily Nation (August 2006) in Nairobi's industrial area revealed that many factories lock in late night workers until morning when the managers report to open the doors from outside. A manager interviewed by the Daily Nation at one factory admitted they locked in workers to minimise theft, and did not think there was

<sup>2</sup> Name of director left out to protect identity



any risk since they had never suffered a fire accident. This is however contrary to section 42 of the factories Act, all the way to part 6; part 4 of which states that any person within the factory for employment or meals should not be locked in such that they cannot easily open the exit from inside.

The Act continues to state that it is mandatory for every industrial facility to have at least 2 escape routes with the specifications of a slide door or a push out door open 24 hours, and which must be clearly labelled in red, well enough to be visible even in the dark. It should also be free from obstruction. This is captured in Cap 514, Section 42 of the Laws of Kenya under fire prevention. However, though the law has always required that emergency exit doors be labelled in red, DOHSS has since changed this to green-colour<sup>3</sup> due to misconception of the colour red to indicate danger, therefore rendering the escape routes a 'no go zone'.

According to Takala (2002:350) affirming the same, escape routes need to provide a safe method of evacuation from the plant in case of fires or other emergencies. There must be 2 independent escape routes from any single workplace, located in such a way that they have a low probability of being locked or destroyed by the fire or explosion. It is also important to evaluate the locking mechanisms and the need for windows to be able to check the situation outside before opening the doors. They should also be marked in accordance with the accepted standards and have the signs readable in the dark.

#### **2.5.1.3 Raising the alarm and Communication**

Raising the alarm and communication are two very crucial aspects during emergencies since a good emergency plan can fail due to poor communication resulting from the failure of the alarm to pass the appropriate message. For this reason, they will be important to discuss in this study.

According to OSHA (2002), emergency communication equipments such as amateur radio systems, public address systems, or portable radio units should be present for

<sup>3</sup> The Safety Bill capturing the Green colour labeling for exit doors has since been passed to law by parliament on the 17<sup>th</sup> of October 2007.

notifying employees of an emergency or for contacting local authorities such as law enforcement officials and the fire department.

Public address systems are important especially in industrial plants where many employees are found in valid departments, and when immediate information needs to be conveyed without delay.

Having all this in place may however not serve the intended purpose if the manual or even the automatic alarms triggered through sensing a hazard are not understood. Sharing of this information is very vital. Alarms must be audible or seen by all people in the plant and have as required in the plan, an auxiliary power supply in the event electricity is affected. These alarms must be distinctive and recognizable as a signal to evacuate the work area or perform actions designated under the emergency action plan.

In the Kenyan industries for instance, the alarm is a signal that is likely to be misinterpreted with majority of employers using the alarm to signal different aspects such as lunch break or closing of the gate for late employees.

To avoid such misinterpretations, the employer must explain to each employee the meaning of different signals such as alarms as well as the means for reporting emergencies such as manual pull box alarms, public address systems or telephones. In addition, emergency phone numbers should be posted on or near telephones, on employees' notice boards, or in other conspicuous locations. The emergency plan should also be in writing and management must be sure that each employee knows what it means and what action is to be taken. OSHA advises that for firms with less than 10 employees, the plan can be communicated orally while beyond that should stick to written (OSHA, **2002:9**).

Different literacy levels also need to be considered in the written communication. According to a safety trainer at the DOHSS one of the main challenges that they face during training is in communication due to the different education levels of employees represented. An alternative language should therefore be considered in providing such written information so as to ensure that it is not only legible but also easily understood.

## **2.6 EMERGENCY RESPONSE**

According to Warfield (2007), emergency response refers to efforts put to minimize the hazards created by a disaster; such as search, rescue and emergency relief and involves actions taken immediately before, during and just after a disaster or major emergency, with the goal of saving lives, minimizing property damage, and enhancing the beginning of recovery from the incident.

Hazard protection measures are part of emergency response and aim at minimizing or completely preventing losses that are likely to occur should a hazard accident arise.

This section will therefore deal with the measures that can be put in place either to prevent or respond to disasters likely to occur resulting from the three principal hazards: Fire, Explosions, and Toxic/Chemical releases.

### **2.6.1 Fire Protection**

According to Khisa (2004:38), based on a study carried out by the Kenya National Cleaner Production Centre (KNCP) in 2003 on Occupational Health and Safety Management in Kenya, fire is the greatest challenge to the safety of industrial plants. Judging from the recent industrial accident cases reported in the country, fire is indeed the leading hazard to industrial plants. Worth noting is that the two other principal hazards; toxic release and explosions are all likely to end up in a fire. It is therefore of need to put into place fire protection measures to prevent the evolvment of fire as a secondary hazard. The first step is understanding the type of safety equipments or systems that are relevant and in which plant.

According to Takala (2002), methods and systems of fire protection can be active or passive depending upon how they are set to work. They may also be intensity reducing or consequence reducing depending upon how they work.

Takala explains that intensity reducing methods reduce the heat load and the eventual exposure time to a fire, and that these methods can be cooling, removal of oxygen, inhibiting mixing of gas and air, or inhibiting the chemical reaction by adding special

neutralisation substances. On the contrary, consequence reducing methods isolate the flame; cool or even prevent further propagation by use of flame arrestors.

Takala lists the fire protection systems that can be installed to include:

1. Water and foam systems,
2. Room extinguishing systems,
3. Powder systems,
4. Twin agent systems, and
5. Hand apparatus (Takala, 2002:348)

#### **2.6.1.1 Water systems**

Every large industrial plant needs to have water and foam systems when operating. Water is very useful as an extinguisher due to its cooling effect and normally high availability. Water can be used together with foam in conjunction with oil and other liquid hydrocarbons in extinguishing fire. The water equipments such as fire hydrants and fire hoses must be provided at strategic locations throughout the facility. In areas where liquid hydrocarbon fires can occur, the hydrant must be able to supply foam. These Hydrants must be positioned so that any water protected part of the plant or platform can be reached by at least two jets of water from separate hydrants. Hose reels too must be provided inside production areas in addition to the required hydrants (NFPA<sup>4</sup> code no. 15).

Sprinklers can be provided as a wet or dry system, and can be fitted with preaction controls so that should these preaction controls detect a fire or the possibility, then they automatically go on. Wet pipe sprinkler systems are designed to work when there is constant water pressure in the water distribution network and at each sprinkler nozzle. It is recommended that each sprinkler be automatic, separate, and independent in its operation, so that water only sprays from nozzles when a predetermined temperature is exceeded. A dry pipe sprinkler system is similar to a wet pipe sprinkler system except that the distribution network of each nozzle has a constant air pressure. This means that these preaction sprinkler vfill only be pressurised with water upon detection of a fire.

<sup>4</sup> NFPA-National Fire Protection Agency-US

Lastly, there are deluge systems. These systems are fitted with open nozzles so that when water valves are opened, all nozzles will spray simultaneously and automatically from a fire detection system, or manually from push buttons (NFPA, Code no. 13)

#### **2.6.1.2 Foam systems**

Foam systems are especially suitable against fires in liquids. The quality of the foam is its ability to separate the liquid surface from the oxygen in the air. Foam systems work by creating a gas tight blanket that prevents re-ignition. Depending upon the type of foam, there could also be a cooling effect. All foam systems, independent of size and complexity, consist of fire water, foam liquid mixer, and foam generator and injector. (Takala, 2002:352)

Foam is best suited for extinguishing oil or flammable liquid fires. However, it is not effective for alcohol, esters, or lacquer thinners because they react chemically with it. Substances with low boiling points such as ether and carbon disulfide vapours also need consideration when extinguishing since they are likely to penetrate the foam blanket once it has been formed and burn on top of it. Special foam powders are available for such fires. These include foams such as protein foam, fluorprotein foam, synthetic foam, aqueous film forming foam and alcohol resistance foam. The foam systems need to be protected against temperatures below 27 degrees F because they freeze, and adding anti freezing solutions is likely to damage the chemical reaction (Blake, 1963:364).

In order to appropriately respond in emergency situations then, the following factors need to be considered with these systems, without which the response can be useless or even more harmful. These include:

- Maximum/minimum storage temperature;
- Corrosion hazards;
- Availability in emergency situations;
- How it mixes with other types of foam;
- Solubility in the burning liquid;
- Destruction of foam by other extinguishers;

- Ageing, pollution and sedimentation;
- And lastly the foam and the expansion factor (Takala, 2002:353).

### 2.6.1.3 Room extinguishing systems

According to NFPA (2002), room extinguishing systems imply that a permanent and dedicated reservoir is in place where the extinguishing medium is connected by permanent pipes to nozzles in the room. NFPA continues to list the available systems here as carbon dioxide total flooding system; wet sprinkler system; water fog systems; and light foam systems. These room extinguishing systems and recommended areas of use are illustrated in the following table.

**Table 1: Summary of room extinguishing systems and their recommended areas**

<b>Room Extinguishing system</b>	<b>Recommended Areas</b>
<b>Carbon dioxide total Flooding system</b>	<b>Locked areas to eliminate the risk of exposing personnel or responders.</b>
<b>Wet sprinkler system</b>	<b>Often used indoors due to its importability, for situations where reactive chemicals and substances are not used.</b>
<b>Water fog system</b>	<b>Used indoors to extinguish oil and gas fires offshore as they use less water than conventional wet sprinkler systems.</b>
<b>Light foam system</b>	<b>Preferred in small closed systems where water is not suitable like where it can cause lighter hydrocarbons to float.</b>
<b>Halon systems*</b>	<b>Are commonly used in electrical and instrumental rooms where cable fires could occur.</b>

•The extinguishing effect of halogen systems work by way of inhibiting the chain reaction in a fire. This is through pressure cylinders which have been pressurised with nitrogen accompanied by nozzles with valves that are automatically or manually opened in case of a fire. Though they have been effective, and are still in use, halogen systems are toxic in addition to their negative effect on the ozone layer, and are therefore on their way out of use. Other types of systems like special water fog systems are being considered as replacement for halons (NFPA, 2002).

#### 2.6.1.4 Powder Systems

Powder is mostly used in fixed systems and is found in capacities of 100, 250, and 500kgs and more. It is also portable when used in hand extinguishers. Powder is a good extinguisher for liquid fires, gas fires and fires in electrical equipment. Sodium bicarbonate is the most commonly used powder. However, claims are that bicarbonate and sulphate are better than sodium bicarbonate, especially because they do not destroy foam when used simultaneously (API<sup>5</sup>. 2001).

Because fire extinguishers are the most commonly used response equipments to fire, it is worth indicating a summary of the different colours of extinguishers and what they represent.

**Table 2 Extinguisher colour and implications**

<b>Container colour</b>	<b>Agent</b>	<b>Class of fire</b>	<b>Recommended expulsion</b>
<b>Blue</b>	<b>Dry Powder</b>	<b>A,B,C/D</b>	<b>On site</b>
<b>Black</b>	<b>Carbon dioxide</b>	<b>C</b>	<b>By arrangement</b>
<b>Cream</b>	<b>Foam</b>	<b>A/B</b>	<b>On Site</b>
<b>Red</b>	<b>Water</b>	<b>A</b>	<b>On Site</b>

Source: Fire Cone Kenya (2000)

**A** Represents fires involving solid materials, usually organic in nature e.g. wood, paper/ cardboard

**B** Represents fires involving flammable liquids e.g. oil, gases, rubber and plastic material

**C** Represents fires involving electrical equipment

**D** Represents fires involving materials e.g. Magnesium, Sodium or Titanium

#### 2.6.2 Fire Warning Systems

According to Takala (2002:355), fire and gas detection systems are very important in enhancing safety in any industrial facility, and act as early warning systems. They must be present in the plants and buildings to be protected in order to automatically detect fires

<sup>5</sup>API stands for American Petroleum Institute

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and gas leakages and in turn raise the alarm. These detection systems can also be part of the active fire protection system that automatically starts some protection fire responding systems such as sprinklers. Takala continues that these detectors must function during any fire or explosion, and for a sufficient period of time in order to give adequate signals for these automatic actions like starting the sprinkler or the alarms. Different types of detectors fall under the categories of gas, flame, heat and smoke detectors.

#### **A. Gas detectors**

Gas detectors are important for industries that specifically deal in hazardous or flammable gases. Installation of such a detector can go along way in preventing a toxic release accident such as the case of the Methylcyanate release accident that occurred in Bhopal India in 1984. To be of the greatest help to an industrial facility, gas detectors need to detect gas before it reaches danger zones in order to be controlled before it becomes a disaster.

According to Nicholson (2007), apart from the different technologies applied for the construction of sensors, the greatest difference between sensors for flammable gases and toxic gases are the sensitivity. However, this is not the only aspect that should be considered when installing a gas sensor; the project should consider an adequate easy to use signal acquisition system, able to promptly inform the personnel about the type of the event and the degree of danger. A control card should also be considered to indicate when something is wrong, or like when the sensor has low power, or even when there is the lack of continuity in one or more wires.

In addition, when considering the installation of a gas detector, it is important to consider a fast responding one especially where time factor is critical. The most commonly used is the ex-detector that reacts on a flammable gas by reacting with a catalyst, causing a temperature rise. Infrared (IR) gas detectors are the ones widely used. Because the sensitivity of different gases varies considerably, care is needed with IR detectors in areas where different types of gases occur. Gas detectors are also fitted with alarms to alert on the possibility of dangerous gases detected or dangerous levels. While detectors can

signal poisonous or toxic gases, care is needed to ensure that only the relevant gas it is designed for is detected and not otherwise (Takala, 2002:355).

#### **B. Fire detectors**

Fire detectors are just as important as gas detectors. In principle, three types of fire detectors exist; flame detectors, heat detectors, and smoke detectors.

Flame detectors use the principles of ultra red and infra red radiation. To be most effective, they should be tuned to differentiate between a steady fire and e.g. steaming pipes, or UV rays from the sun. Heat detectors can be of a fixed temperature type; meaning that they can detect either when temperatures rise above normal, or when they rise at an abnormal rate. It is safest to combine both of these principles. Smoke detectors on the other hand are based upon detection of solid and liquid combustion particles released into the atmosphere. Usually, a mixture of smoke and temperature detectors in an area increases the probability of detecting a fire independent of the type of fire (API, 2002:355).

#### **2.6.3 PREVENTION AND RESPONSE TO EXPLOSIONS**

According to Parlay international, there's a risk of explosion when working with explosives, reactive or unstable chemicals, and pressure vessels. Parlay continues to state that many explosions occur when gases are exposed to sources of heat or an increase in pressure. Some chemicals can even explode if exposed to water or air. Understanding the materials and the factors that trigger an explosion is one way of preventing this dangerous workplace emergency. The first way of doing this is by identifying the category in which the explosives belong. Parlay goes further to identify the 3 categories that explosives can belong according to the level of the hazard. These are:

**Class A explosives** - These are the most powerful and include dynamite and nitroglycerin.

**Class B explosives** - Include such substances as propellants and flash powders.

**Class C explosives** -These are usually manufactured materials that contain small amounts of Class A or B explosives, such as fireworks.

However, Parlay continues to note that this classification may be limiting since it does not take into account the majority of explosive hazards found at the worksite. Though these chemicals are not classified as explosives, they can be explosive under certain circumstances. These materials and situations can be dangerous and cause explosions as described below:

- Explosive vapours which can be ignited by a spark, friction or heat;
- Flammable vapours in confined areas;
- Reactive chemicals such as oxidizers which can ignite when mixed with or stored near certain other chemicals or explode when exposed to air or water;
- Pressure vessels such as compressed-gas cylinders or steam boilers when there's a rupture or valve failure;
- And old chemicals that may undergo changes, making them increasingly unstable.

Parlay goes further to state the safety precautions associated with explosives and gives an emergency toolkit for the same.

#### **2.6.3.1 Employee Safety Precautions**

Employees are the most directly involved with explosives or explodable equipment. It is for this reason that they are the most helpful when it comes to detecting dangers or measures that need immediate attention to prevent explosions. According to Parlay, the following precautions can help employees achieve this.

- Learn what substances are incompatible with each chemical and whether the chemical may be safely exposed to air, water or combustible materials;
- Be especially cautious when working in confined spaces;
- Treat any build-up of heat in the container or surrounding air as a danger signal;
- Report any defects or damage to containers;
- Ventilate properly;
- Clean up spills, dust and oily rags;

- Stay alert for leaks and other dangers.
- Lastly, employees should strictly observe safe storage of materials according to the manufacturer's specifications.

#### **2.6.3.2 Explosion Emergency Toolkit**

As is possible with all other industrial hazards, some explosions will still occur as surprises even with all these measures in place. An emergency toolkit is therefore necessary. Parlay gives the explosion toolkit as follows:

1. Follow your company emergency plan.
2. Evacuate quickly.
3. Close windows and doors behind you.
4. Report the explosion and its circumstances to your emergency response coordinator.
5. Finally, stay upwind.

#### **2.6.4 TOXIC RELEASE PREVENTION AND RESPONSE**

According to David et al, (1988) the probability that an accidental release will occur depends on the extent to which deviations (in magnitude and duration) in the process can be tolerated before a loss of chemical containment occurs. To prevent or deal with these chemical releases, he states 3 factors that must be considered. These are process design, procedures and practices, and protection technologies.

##### **A. Process Design**

Process design as David states involves the activities or principles adopted in the production process in order to reduce or completely avoid a certain hazard. Under this, four principles of addition, substitution, deletion, and duplication (or redundancy) exist in dealing with the production process. Addition principle considers the introduction of chemicals or products that render the hazard harmless. However, while this is possible, it is not practical in all cases as it may render the production process useless, while deletion involves doing away with the hazard completely.

While it is important to put these processes into consideration, it is important to remember that accidents cannot be completely avoided and control factors need to be considered hand in hand.

These factors include the installation of:

- (1) Sensing and measurement equipments such as gas detectors,
- (2) Controllers,
- (3) Final control elements,
- (4) Switches and alarms,
- (5) Emergency shutdown and interlock systems, and
- (6) Having a computer control.

Other processes that include the location of the plant in terms of weather, the availability of a safe control room and distant storage facilities from population as well as minimal hazardous material storage also need consideration in the process design (Quass,1988).

#### **B. Procedures and Practices**

In the procedures and practices, David (1988) considers quality machinery, contained mechanical equipment and protective devices as important in increasing plant safety. However, they must be supported by the safety policies of management designed to match the level of risk. This is because the effectiveness of any safety program is determined by a company's commitment to it. David continues to note that since human error is a common cause of accidental chemical releases, personnel selection and training as well as the maintenance of a qualified and experienced work force is a significant part of release prevention. The potential for an accidental chemical release may also be reduced by repairing or replacing equipment that seems headed for failure.

#### **C. Protection Technologies**

Protection technologies is the third factor in preventing and controlling toxic releases. According to De Wolf (1988), this technology of protection involves equipment and systems used to capture or destroy a toxic chemical that has escaped from primary containment. De Wolf lists such technologies to include:

- Flares,

- Scrubbers,
- Enclosures and
- Incinerators.

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Flares- Flares which are routinely used in the chemical process industries are used to dispose off intermittent or emergency emissions of flammable waste gases because they can handle larger flow variations than can process combustion devices such as boilers. Though flares can be a useful protection against accidental releases of toxic chemicals, their use requires a thorough analysis of each specific application because of their potential to cause secondary hazards such as fires.

Scrubbers- Scrubbers are a traditional method of absorbing toxic gases from process streams, and can be used for controlling toxic gas releases from vents and pressure relief discharges from process equipment, or from secondary containment enclosures.

Absorbers- Absorbers are useful for protecting against accidental releases of toxic chemicals. Absorbers are often dedicated to specific units because of the diverse nature of gas contaminants and the poor turndown ratio of absorbers. Important to note is that there may be circumstances where their use is difficult such as with flare systems as it may exacerbate the original problem.

The types of absorbers most applicable to accidental chemical releases are spray towers, packed towers, and **Venturis**.

Enclosures- Lastly, De Wolf states that enclosures are containment structures that can capture toxic chemicals spilled or vented from storage or process equipment, thereby preventing their immediate discharge to the environment, and can contain the spilled liquid or gas until it can be transferred to another containment, discharged at a controlled rate, or transferred at a controlled rate to scrubbers for neutralization.

## 2.7 ORGANIZATION'S ROLE IN SAFETY PROMOTION

There is a vital need for people to be aware of the hazards to which they are exposed and how to protect themselves against them. They should know where these hazards are and what their effects might be. Every member of the organization is expected to have this

vital information before handling any processes or activities in the plant. If possible, such information is best if included in part or wholly in the orientation of new workers.

### **2.7.1 Employee Role**

According to ILO (1988), workers should co-operate with and participate in the implementation of the organizational safety plans and other measures related to the major hazard control system in operation. It is expected of workers to play an active role in constantly watching over the safety of their work places and equipment that they use and in applying all safety and health instructions pertaining to work. In addition, employees should ensure that safeguards and safety devices that have been installed are not abused by other employees and that they are used for the right purpose. These devices should also not be altered or displaced from their rightful places. Such equipments that should not be altered include controls, machines, valves, piping, electrical conductors and appliances that no authorization to operate, maintain or use has been given.

ILO also continues to advise that any worker who would suspect that operating or carrying out a certain process would be risky should immediately report to the supervisor for an investigation to be done. Finally, every worker needs to be fully informed in an adequate manner of the major accident hazards involved in his or her work. With workers' co-operation therefore, imminent industrial hazards are one step towards prevention.

### **2.7.2 Role of Management in Safety Promotion**

The management of an industrial plant which can cause a major accident has the prime duty to control this major hazard. To do this, it must be aware of the nature of the hazard, the events that can cause accidents, and the potential consequences of such accidents. With this knowledge then, the information can be passed down to other employees on the prevention and response measures to take in the case of a hazard occurrence.

According to OSHA (1990), the effectiveness of response during emergencies depends on the amount of planning and training performed. Management must therefore show its support for plant safety programs and the importance of emergency planning. OSHA advises that if management is not interested in employee protection and in minimizing

property loss, then little can be done to promote a safe workplace. It is therefore management's responsibility to see that a program is instituted and that it is frequently reviewed and updated.

ILO (1988:11) gives 5 main responsibilities of management in maintaining safety as follows:

1. To provide the information required to identify major hazard installations;
2. To carry out hazard assessment;
3. To report to the authorities on the results of the hazard assessment;
4. To set up an emergency plan; and finally
5. To take measures to improve plant safety.

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## **2.8 BUILDING CAPACITIES**

Building capacities is the main goal of this paper. It is therefore of importance to expound on the same, being the greatest tool that can empower a vulnerable community. According to Blake (1963:2), practically all accidental injuries and deaths are preventable by the unflinching use of methods and practices well within the abilities of every person.

It is therefore of vital need for people to be aware of the hazards to which they are exposed, and how to protect themselves against them. They should know where these hazards are and what their effects might be. This is a first requisite of accident prevention and building capacities since one who does not know what a hazard is, is not likely to recognize its existence.

Building capacities means learning, adopting and devising methods to prevent or respond to hazards by eliminating vulnerability. According to Dembo et. al (1988), there is a growing awareness that the impacts of industrial hazards often fall disproportionately on disadvantaged and relatively powerless groups.

In Kenya for instance, the industrial area employs a large number of casual employees. These employees mainly come from the surrounding slums and form a large force in providing for the manual labour involved in these industries. Most of these casual jobs require little education background, and are mostly dependent on physical fitness. With the poor social background of these casuals, safety is likely to come second. Employers



of such labourers should therefore ensure that they do not take advantage of their vulnerable situation and instead provide safe working conditions for them just as with the permanent employees.

Anderson (1989:10) affirms that it is not only the exposure to hazards that puts people at risk but also socio-economic and political processes in society that generate vulnerability. They create the conditions that adversely affect the ability of communities or countries to respond, cope with, or recover from the damaging effects of disaster events. Anderson continues to state that these conditions precede the disaster event, contribute to its severity and may continue to exist even afterwards. This can however be reversed through passing down information to vulnerable people and involving them in their risk capacity building program. Safety training is one way of building this capacity.

According to Dembo et. al (1988), once such vulnerable groups are empowered to defend their interests, hazards will be less likely to develop or continue.

Dealing with vulnerability is therefore the main action in preventing the development of hazards to major accidents or disasters, and eliminating them is usually the main focus in building capacities.

Blaikie et. al (1994) defines vulnerability as insecurity, the reverse of security. He goes further to state that it reflects the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard; and involves a combination of factors that determine the degree to which someone's life and livelihood is put at risk by a discrete and identifiable event in nature or in society.

As illustrated by Blaikie in the equation 'Disaster = Vulnerability + Hazard', all that is needed for a hazard to progress to a disaster is the presence of vulnerability. To avoid an industrial disaster therefore, vulnerability has to be eliminated.

### **2.8.1 Safety Training**

Educating or training the vulnerable group is the way forward in eliminating vulnerability since the victim can have all that is needed to fight the threat or hazardous occurrence, but without understanding and knowledge on how to do that, all efforts may be rendered useless.

For instance in 2002, a blankets factory in Nakuru suffered an explosion from one of its machines. The night shift employee then Mr.Lazaro Omondi claimed that he did not know what to do except switch off the main electricity switch, and then with his colleagues run for their lives from the fiercely spreading fire. Large losses were incurred in machinery as well as materials and production was affected. Asked why he did not use the provided fire extinguishing materials to fight the fire, they claimed they did not know how to use them. Later, he and six other colleagues were laid off on negligence for using just buckets of water to try and put out the fire, and never touching the fire extinguishers (Daily Nation, 2006:4).

This is an example of the lack of safety training among employees. The presence of safety equipment can turn out to be useless if the people affected do not know how to make use of the same.

To anticipate the existence of hazards, or to correct them when already existing therefore obviously requires knowledge. This is a first requisite of accident prevention since one who does not know what a hazard is, is not likely to recognize its existence. (Blake, 1963:72). Education should therefore attempt to familiarize and de-sensationalize hazards. Everyone who lives in a hazard prone area or is vulnerable to a hazard attack including employees should understand the potential for the hazards. The objective is to develop an everyday acknowledgement of hazard safety in which people take conscious precautions because they are aware of the possibility of a hazard occurrence. Such understanding should include an awareness of what to do in the event of a hazard. This awareness can be developed through regular practice drills, practice emergencies and assigning important safety remembrance days in order to develop automatic behavioural responses (DHA, 1997:23).

In Kenya, safety training is standardized as required by the Factory rules, Legal Notice No.31 of 2004. Under this, a curriculum of a safety course set to take a minimum of 30hours has been developed for the purpose of ensuring uniformity, consistency and standardization. This is in order to ensure that no important aspects of safety are overlooked. Besides training by DOHSS, the duty of training has also been delegated to other institutions of safety which must be registered and approved by DOHSS. Every

committee member in the factories and other places of work must undergo these training and possess a certificate as evidence and in turn pass the knowledge to other staff. This is captured in Sec 65A (1) of the factories Act. First aid training is also a must. All trainers approved by DOHSS are also expected to strictly adhere to a standard curriculum<sup>0</sup> as recognized under the First Aid rules, LN no.160/1977. The law also goes ahead to clearly specify on the requirement of first aid equipments such as the contents of the first aid box required at any one time for plants with different numbers of employees. Of importance as well is the requirement for a specific number of first aiders per a number of employees present, with the requirement that a first aider/s be present for every shift. The first aid course is designed to cover not less than 30 contact hours '.

## **2.9 THEORETICAL FRAMEWORK**

Kerlinger (1986) defines a theory as a set of interrelated constructs or concepts, definitions and prepositions that present a systematic view of phenomena by specifying relationships among variables with the purpose of explaining and predicting natural phenomena.

Jary and Jary (1995) also define theory as any set of hypotheses or principles linked by logical or mathematical arguments which is advanced to explain an area of empirical reality or type of phenomenon.

Theories are closely related to models in that they try to explain empirical reality just as theories do.

According to the wikipedia dictionary, an abstract model (or conceptual model) is a theoretical construct that represents something, with a set of variables and a set of logical and quantitative relationships between them.

The study will be guided by the hazard management model, the crunch and release model and Albert Bandura's social cognitive theory.

<sup>6</sup> The course content for the First Aid training curriculum will be availed in the appendix.

<sup>7</sup> Republic of Kenya, Factories Act. CAP 514.

### **2.9.1 DISASTER CRUNCH AND RELEASE MODEL**

The crunch model provides the framework for understanding the causes of a disaster. According to different scholars; Bankoff (2001), Heijmans (2001), Cannon (2004), and Marcus (2005), in this model, the progression of vulnerability of a community is revealed, and the underlying causes that fail to satisfy the demands of the people identified. The crunch model then goes further to estimate the dynamic pressures and unsafe conditions which are the factors that contribute towards the vulnerability of a people.

The progression of a disaster from a hazard is therefore dependent upon the presence of these dynamic pressures and the unsafe conditions, meaning that a disaster happens only if a hazard meets a vulnerable situation.

The release model is the reverse of this. It indicates how risk and vulnerability can be overcome. According to Blaikie et al., (1994); ADPC, (2000); Heijmans (2001); and Marcus (2005), the release model indicates how the risk of disasters can be reduced by applying preventive and mitigation actions. It begins by addressing the underlying causes and analyzing the nature of hazards. This leads to safer conditions which help to prepare the community to deal with disasters. It shows that to reduce the risk of disaster, the very factors that cause risk should be addressed. This means working against all the components of the crunch model.

A hazard occurrence is an event that could lead to danger, loss or injury to elements at risk. An accident at an industrial plant can pose a threat to elements which include the employees, machinery and equipment, buildings, stocks, environment, and the neighbouring industries and communities. Industrial plants become vulnerable when employees are unable to adequately anticipate, withstand, and recover from hazards. Without safety awareness, mitigative and response measures in place, then hazards will build up with the presence of this vulnerability to graduate to disasters. Eliminating this vulnerability by way of ensuring mitigative and responsive measures in place will reduce hazards to just hazards.

### 2.9.2 HAZARD MANAGEMENT MODEL

Different scholars have made contributions in the development of the hazard management model. They include scholars like Perry (1982), Quarantelli (1981), Kasperson (1985) and Pijawka (1985).

The hazard management model is useful in providing a standardized means for structuring hazards and for identifying systematic opportunities for hazard control.

The hazard management model considers four managerial activities as ways of dealing with technological hazards, flowing in a sequence of hazard assessment, control analysis, control strategy, and implementation and evaluation.

Each stage in the hazard evolution is connected by links, each of which represents an opportunity for blocking the hazard.

Hazard assessment stage considers four major steps; hazard identification, assignment of priorities, risk estimation, and social evaluation. Control analysis then judges the tolerability of the risk and rationalizes the effort that is made in preventing, reducing, and mitigating a hazard. Implementation measures that follow include putting the mitigative resources in place. Kasperson and Pijawka (1985) view this stage as a crucial and problem prone stage of hazard management. Challenges lie between implementing health and safety measures, availing resources, and complying with the control actions.

The theory notes the importance of feedback between the stages. Implementation of control measures being the last stage in the hazard management model therefore requires evaluation of the accomplishments of hazard management. Since the depicted sequence is an idealization and simplification of a process that is often not linear or which jumps over stages, the outcome of the evaluation may mean checking to the next relevant stage where shortcomings will be addressed.

In summary, hazard management is the purposeful activity by which society informs itself about hazards, decides what to do about them, and implements measures to control them or to mitigate their consequences with the two essential functions of intelligence

and control. In comparing natural disasters and technological emergencies, Perry (1982) argues that technological emergencies such as industrial accidents are compressed in time; that is\* the time between hazard awareness, problem identification, risk assessment, and the decision to evacuate may be extremely short. As such, they require proactive assessment and control since unlike most natural hazards they are undetectable.

The lack of familiarity with technological hazards, generally low levels of community awareness and preparedness, the rapid onset of the hazard event, and the potential for larger secondary consequences present critical problems for industrial plants. Compliance is therefore heavily dependent upon the voluntary cooperation of the regulated plants to pass intelligence to those at risk, devise mitigation means, provide resources and be armed with response measures; since no matter how competent the management process, hazardous events will still occur with the likelihood of harming people, disrupting communities, and endangering institutions.

### **2.9.3 ALBERT BANDURA'S SOCIAL COGNITIVE THEORY**

Social cognitive theory is rooted in a view of human agency in which individuals are agents proactively engaged in their own development and can make things happen by their actions. The theory unlike other theories of human functioning does not overemphasize the role that environmental factors play in the development of human behavior and learning. Key to this sense of agency is the fact that among other personal factors, individuals possess self-beliefs that enable them to exercise a measure of control over their thoughts, feelings, and actions (Bandura, 1986:25).

Bandura provided a view of human behaviour in which the beliefs that people have about themselves are critical elements in the exercise of control and personal agency.

Because human lives are not lived in isolation, Bandura expanded the conception of human agency to include collective agency where people work together on shared beliefs about their capabilities and common aspirations to better their lives.

The theory views people as learning not only from their own experience but by observing the behaviours of others. These collective systems develop a sense of collective efficacy and a group's shared belief in its capability to attain goals and accomplish desired tasks.

Rooted within Bandura's social cognitive perspective is the understanding that individuals are imbued with certain capabilities that define what it is to be human, as follows:

#### *Symbolize*

Humans possess an extraordinary capacity to symbolize. By drawing on their symbolic capabilities, they can extract meaning from their environment, construct guides for action, solve problems cognitively, support forethoughtful courses of action, and gain new knowledge by reflective thought, which they communicate with others at any distance in time and space. This in industrial accidents reflects the capacity for plant owners to develop technologies, and their capacity to analyze the processes and come up with safety precautionary measures.

#### *Vicarious learning*

People learn not only from their own experience but by observing the behaviours of others. This vicarious learning permits individuals to learn a novel behaviour without undergoing the trial and error process of performing it. In many situations, it keeps them from risking costly and potentially fatal mistakes. The observation is symbolically coded and used as a guide for future actions. Different industrial safety measures have been developed world wide to curb the occurrence of accidents and most of these have been developed out of a hazardous occurrence to an industrial facility; at one time.

#### *Forethought*

People plan courses of action, anticipate the likely consequences of these actions, and set goals and challenges for themselves to motivate, guide and regulate their activities. It is because of the capability to plan alternative strategies that one can anticipate the consequences of an action without actually engaging in it such as in the development of

disaster response measures, even without having to experience the disaster to be prepared.

*Self-regulation mechanisms*

Individuals have self-regulatory mechanisms that provide the potential for self-directed changes in their behaviour. It is therefore the choice of people to decide to do or adopt one thing and not another; such as the decision to train employees on safety and adopt structural changes such as the installation of fire extinguishers.

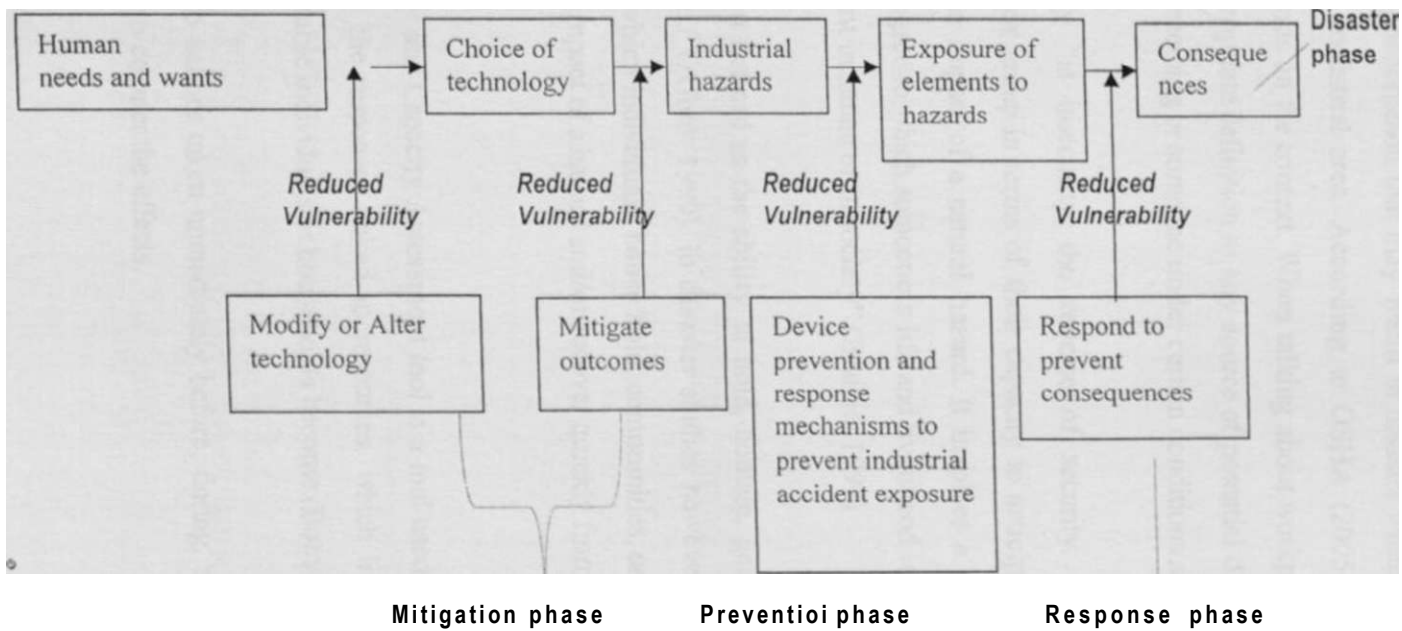
Lastly, social cognitive theory asserts that providing information alone is not sufficient to change behaviour; rather, sustained behaviour change requires the skills to engage in the behaviour and the ability to use them consistently and under difficult circumstances. This would be ideal in responding during emergencies or disasters.



## CONCEPTUAL FRAMEWORK

Figure 1

Understanding the evolution of hazards : The Model of Hazard Evolution



Modified from Kasperson and Piiawka: 1985

### **Definition of Key Terms**

Hazard- The oxford advanced learners dictionary (1990) defines a hazard as a naturally occurring or human-made phenomenon that may result in disaster when occurring in a populated, commercial or industrial area. According to OSHA (2005) however, the definition of a hazard depends on the context. When talking about workplace health and safety OSHA gives the appropriate definition as any source of potential damage, harm or adverse health effects on something or someone under certain conditions at work.

Vulnerability- Vulnerability "is insecurity, the reverse of security. It reflects the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood is put at risk by a discrete and identifiable event in nature or in society" (Blaikie: 1994)

Capacity- Capacity has been defined as the ability to hold, contain, get hold of, learn things, qualities or ideas etc.( Oxford: 1990). In disaster studies however, capacity has been defined as the state in which individuals, house hold, communities, and nations have resources that can resist the impact of a hazard and/or recover quickly from them (Bonvin: 1996)

VCA tool- The Vulnerability and Capacity Assessment tool is a tool used to identify the coping strategies as well as the responses linked to resources, which in the face of a hazard determine how vulnerable individuals or households become (Bonvin, 1996:23).

Response- Response refers to actions taken immediately before, during, and just after a disaster or major emergency to counter the effects.

## **CHAPTER THREE: METHODOLOGY**

### **3.1 Introduction**

This study covered selected industrial plants in Nairobi's industrial area. This industrial area is the oldest and the largest industrial zone with over five thousand industries in operation.

### **3.2 Research Design**

The study was an exploratory one. According to Babbie (1995), an exploratory study is typical when a researcher is examining a new interest, or the subject of study is itself new or unstudied, as is relevant to this study, where no similar study has been carried out academically. Vulnerability and capacity assessment as relates to safety and disasters is one area that has not been studied. Exploratory study design therefore provided the opportunity to get an even clearer insight on the subject.

This exploratory study combined both qualitative and quantitative methods. Quantitative methodology was considered as it aided in providing standard information on demographic characteristics of respondents as well as in providing a resource and hazard analysis profile that is important to this study.

Qualitative methods were important as they helped to better understand any phenomenon more broadly, to expound issues, and back up information that may have been difficult to convey quantitatively. In this study, the key informants were interviewed. The key informant was the safety manager who was responsible for employee safety. They provided more information on plant safety and on any structural changes that had occurred or were in the implementation process that enhanced industrial plant safety.

### **3.3 Sampling Design**

Sampling design is the part of a research plan which indicates how cases for the study are to be selected. This study selected cases through the use of both probability and non probability sampling methods.

The study universe that was sampled included all the industrial plants at Nairobi's industrial area registered with DOHSS. Only a sample was used for the study as opposed to each and every case due to limitations in time and resources.

### **3.3.1 Site Selection and Description**

Nairobi was purposely selected due to its geographic location and the existence of varieties of industrial plants. This means that at any one time, either of the three principal hazards: fire, explosions, or toxic releases important to this study had a possibility of occurring. According to the DOHSS statistics, at least 1,200 different industries are registered in Nairobi under 50 different categories of industrial classifications. This sampling frame constructed from DOHSS as at September 2007 was adopted for the study.

Nairobi's industrial area was ideal for this study being one of the oldest industrial zones in Nairobi as designated in the recommendations of the 1948 master plan.

Location-wise, the industrial area is bordered to the West by the city centre and the residential areas of Mbotela, Makadara and Ofafa to the North. It is also bordered by the airport corridor to the east and the national park to the south; the area which is also referred to as Athi Kapiti plains extensions due to an expansive flat terrain. The Nairobi industrial area covers 12% of the entire Nairobi, on 960 hectares of land set aside for the industrial zone.

The site was unique as it houses the headquarters of the Directorate of Occupational Health and Safety Services, which was useful and relevant in contribution to this study. The industrial area falls under seven distinct sections. These are the Haile Selassie avenue race course road area, the railways installations, the area south east of factory road, north west and north east of Machakos road, the area east of enterprise road and Uhuru highway, and the Manchester Oldham Newcastle Leeds road area.

Though other industrial areas exist in Kenya, the Nairobi's industrial area was particularly singled out for reasons of limitation in time, finances, and ease in accessibility.

### 3.3.2 Selection of Industrial Plants and Respondents

Though different categories of industries exist, only industrial plants were selected as opposed to other industries as most of their processes began from raw materials as opposed to dealing with or modifying finished products. For this reason, several chemicals and or vigorous processes were involved in production and therefore tended to have a higher likelihood of generating an industrial accident or disaster. Besides this, statistics have shown that these plants have in the past tended to cause more disasters. This is according to Reeds (1997:165) where of the 15 major industrial accidents that occurred between the year 1984 to 1995, 10 resulted from industrial plants. This translates to 67% of the major accidents reported then.

The selection of industrial plants at Nairobi's industrial area was informed by records of the DOHSS. Fifty classifications of industries found in Kenya exist, under DOHSS, the national Occupational Health and Safety body. For purposes of this study, 6 classes qualified; they included the manufacture of chemicals and chemical products, the manufacture of steel products, plastics manufacture, the manufacture of paints and solvents, the extraction of crude petroleum and natural gas.

This was based on the plant processes and activities that have a higher likelihood of causing one or all the three principal hazards: fire, explosions, and toxic release. Owing to limited time and financial resources, one industry was sampled randomly from each category to make 6. Since the employee population in each plant was uneven, proportionate random sampling was used as illustrated below.

Total No. of units or stratum X Target units

Total No. of units in universe

Total No. of employees per plant X Target units (110)

Total No. of employees in all the plants under study

The study targeted 110 respondents from the industrial plants. These were selected by use of proportionate random sampling.

**Table 3** showing the sampled plants and number of respondents

<b>Existing Industrial Plants</b>	<b>Classes of industrial plants</b>	<b>Type of plant to be randomly selected</b>	<b>No. of employees in selected plants</b>	<b>No of selected Employees</b>
<b>82</b>	<b>Manufacture of chemical and chemical products</b>	<b>Agro Chemicals Plant</b>	<b>55</b>	<b>14</b>
	<b>Manufacture of steel products</b>	<b>Steel manufacturing company</b>	<b>75</b>	<b>19</b>
	<b>Plastics manufacture</b>	<b>Polythene plant</b>	<b>63</b>	<b>16</b>
	<b>Manufacture of paints and solvents</b>	<b>Paint and paints related production plant</b>	<b>21</b>	<b>5</b>
	<b>Crude petroleum depot</b>	<b>Joint oil depot</b>	<b>52</b>	<b>13</b>
	<b>Natural gas depot</b>	<b>Gas reception and repackaging depot</b>	<b>36</b>	<b>9</b>
<b>Total number 82</b>		<b>6</b>	<b>427</b>	<b>110</b>

### 3.3.3 Selection of Key Informants

Key informants were selected purposively. They included the safety manager in each plant. The reason for their selection was because they were involved in decision making in the plant, and the decisions they made were likely to influence the state of safety in the plant. Some of the responsibilities that the safety manager is charged with include the provision and maintenance of a healthy and safe environment to work in. They were 6 in number one for each of the six organizations.

Purposive selection of key informants was based on the limitation on the number of persons likely to have held the health and safety manager position. In the occurrence that

several persons were responsible for safety, another determinant for selection of the key informant included the determination of whether the respondent sat in the health and safety committees.

### **3.4 Unit of Analysis and Unit of Observation**

According to Mugenda (1999), the unit of analysis refers to those units that we initially describe for the purpose of aggregating their characteristics in order to describe some larger group or abstract phenomenon. In this study, the unit of analysis was the capacity of industrial plants.

The unit of observation has been described as the subject, item, or entity, from which we measure the characteristics to obtain the data required in the research study (Mugenda, 1999). Accordingly, the study derived information from the production employees, the health and safety manager and the plant supervisors from whom data was collected.

By way of observation, the plant installation also served as a unit of observation.

### **3.5 Techniques and tools of data collection**

The study was designed to assess the vulnerability and capacity of industrial plants in Nairobi.

The research was informed by both primary and secondary sources of data. The techniques and tools selected for both primary and secondary data collection were dependent on the type of study and the limited time and resources available.

#### **3.5.1 Primary data**

Primary data involved first hand information that was obtained from the respondents who included the plant's production employees, the health and safety manager, and the production supervisors.

### Techniques and tools of primary data collection

The techniques that were used to collect primary data included interviews and observation techniques. The tools that were used for interviews were the questionnaire and interview guide while the tool for observation included an observation checklist.

The questionnaire tool was used as the main instrument of collecting data in order to facilitate in the collection of quantitative data. The questionnaire was applicable when seeking answers that did not need elaboration. It was important to this study in acquiring information providing for rating, ranking, and information on attitudes and opinions. For this study, both open ended and closed questions were included in the questionnaire tool that was administered to the production employees. The VCA questionnaire tool which was both open ended and closed was administered to their supervisors due to their expected thorough knowledge on safety, being charged with supervision of the production staff.

The interview guide was administered to the key informants who included the health and safety managers.

The personal interview is important when seeking to elicit the most valid and reliable responses including feelings and expressions on issues raised. It is also important as it builds rapport and may reduce the power imbalance between the interviewer and the respondent (Hammer and Saunders, 1994 in Oyiekanmi, 1997).

This tool therefore enabled the researcher acquire information on the knowledge and perceptions on capacity assessment and industrial safety of the safety managers. It was also used to help gain more insight and provide more information to supplement the questionnaire tool.

In order to supplement the above methods, observation technique by the use of an observation checklist was employed to provide evidence on the information provided by the respondents.



### **3.5.2 Secondary Data**

To obtain information on already existing information on industrial safety, secondary data was used. Secondary data included both published and unpublished information from libraries, mainly the DOHSS resource centre. These sources were books, magazines, newspapers and scholarly journals on occupational safety as well as copies of the law and rules on occupational health and safety in Kenya.

### **3.6 Data Analysis**

Data analysis is the process of interpretation of the collected raw data into useful information. Since both qualitative and quantitative data were obtained from the field, the data analysis involved analyzing both the qualitative and quantitative data separately. These were first coded to allow for further analysis.

#### Quantitative Data

The raw data generated through the use of questionnaires was analysed quantitatively. This was generated from the closed questions administered to the respondents. This data was then coded and analyzed using the statistical package for social sciences (SPSS). De Vause (1986) defines descriptive statistics as a way of generating variables by summarizing patterns in the response of people in the sample. As such, this study used descriptive statistics to reduce the data masses to forms that can be clearly understood and appreciated. Descriptive statistics were also used to analyse and present the quantitative data which contained numerical information. This was through the use of percentages which were used to show variations on the outcomes from the findings.

Nominal and ordinal measurement scales were used to make inferences to the outcome of the data. Nominal measurement is used for variables in which each participant or observation in the study must be placed into one mutually exclusive and exhaustive category. According to Mugenda (1999:65), this type of measurement merely groups subjects or cases from the sample into categories. Ordinal measurement on the other

hand, besides grouping, it also assigns ranks to the variables but stops at that; and does not tell us anything about the absolute magnitude.

In this study therefore, nominal measurement was used for classification of variables such as age, and employment status while ordinal measurement was used to quantify variables like employee education statuses and skill levels on safety training, and rank by order of differing degrees. The data was also presented by way of tabulation, showing a summary of the findings under different variables.

### Qualitative Data

Data collected through the key informant guide and the open ended questions from the questionnaire tool was analysed qualitatively. According to Bogdan and Biklen (1982), qualitative data analysis refers to working with data, analyzing it, breaking it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others. As such, the data collected was analyzed qualitatively in order to reduce the data to more manageable and understandable observations that can be appreciated. This was achieved through first categorizing and coding the data appropriately. This was followed by an analysis of the emerging patterns and themes in order to induce information and meaning in a proper and organized manner and reducing the bulk quantitative data and retaining the relevant data. This was then presented through percentages, cross tables, and charts.

### **3.7 Problems experienced in the field**

The study involved covering long distances to the industrial plants and making several trips to get conclusive information. This was fatiguing and a lot of finances were spent. Initially, it was impossible to access any plant with the university's introduction letter and the researcher recalls being turned away by the plant security even before accessing the plant's reception area on suspicion of being from the media. Sometimes a lot of bureaucracy was involved to access the plants. Eventually, the researcher sought help from DOHSS staff for assistance to access the plants since they have the right of way. There was also the problem of slow co-operation from the safety managers to interview

the respondents and the researcher was sometimes forced to part with lunch money for some safety managers or supervisors to get faster access to the respondents.

Some of the respondents were also afraid of attempting some questions for fear that the safety manager would read their responses. However, confidentiality was assured to them. Some safety committee members were also dishonest in their responses in the bid to cover up for their weakness. This was however noted from the responses of other respondents.

Lastly, the researcher was denied the opportunity to take photographs citing strict orders from above and other times citing the risk of sparks from the camera. The researcher was therefore left with no choice but to have representation diagrams.

## CHAPTER FOUR: DATA PRESENTATION AND ANALYSIS

### 4.1 Introduction

In chapter four, the findings from the field based on the specific objectives of the research are presented and analyzed. The study's specific objectives sought to identify the safety awareness level of industrial plant employees, to establish if there were any safety related structural changes that had occurred in the plants presently or in the future plans, and to identify the vulnerability levels of elements at risk in the industrial plants.

The findings have been presented through the use of percentages, frequencies, tables, pie charts and bar graphs.

### 4.2 Background characteristics of the respondents

A total of 75 respondents were interviewed. The key variables observed here included age, gender, education level, and the employment status of the respondents.

#### 4.2.1 Age and Gender Distribution

The respondents interviewed were aged between 18 to 49 years and above. Majority of these were male at 86% while only 14% were female. The bulk of the respondents were young adults (26-33) making up 49% of the total respondents, followed by middle aged adults (34-41) at 23%. Only 15% were between 18-25 years, while those between ages 42-49 were 10%, and over 49 years only making up for 3% as indicated in table 4 following.

Table 4 Age \* Gender Cross tabulation

		Gender and Age percentages				
AGE GROUP		Male	% of males	Female	% of females	Total percentage
Age	18-25	10	13%	2	3%	16%
	26-33	27	36%	9	11%	48%
	34-41	17	23%	0		22%
	42-49	8	11%	0		11%
	49+	2	3%	0		3%
Total		64	86%	11	14%	100.0

The study therefore reveals that employers have a higher preference for employing young and middle aged adults between the ages of 18-41. Alternatively, it may be assumed that these jobs attracted these age groups, perhaps for the reason of the heavy manual and physically taxing labour involved, and the increased vulnerability of muscle strain for older ages. This may also be the reason why most workers over 40 years as well as females either held positions such as mechanics, in office workers, administrative work or supervisory roles that did not require much interaction with heavy machines.

#### 4.2.2 Respondent's Level of Education and Employment term

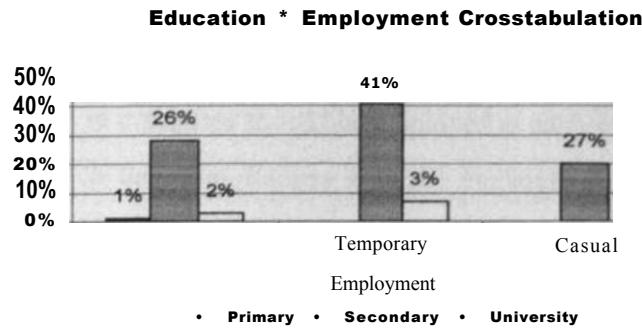
On the level of education, 71% of the respondents had gone up to secondary school, with 7% having been to the university and only 1% having reached primary school as indicated in table 5 following.

**Table 5 Education background of respondents**

<b>Education level</b>	<b>Frequency</b>	<b>Percent</b>
<b>Primary</b>	<b>1</b>	<b>1</b>
<b>Secondary</b>	<b>71</b>	<b>90</b>
<b>University</b>	<b>7</b>	<b>9</b>
<b>None</b>	<b>0</b>	<b>0</b>
<b>Total</b>	<b>79</b>	<b>100.0</b>

Narrowing these findings further revealed that only 29% of the respondents were employed on permanent basis while the remaining 71% was made up of 44% temporary workers and 27% casuals. This is as represented in the following bar graph following.

**Figure 2 Representing respondent's education level versus their employment terms**



These findings from figure 2 reveal that only 29% of the respondents were permanently employed, with the remaining 71% being either temporary or casual employees. Such statistics are common in most plants and industries that employ temporary or casual labourers. In Australia for instance, casual employees make up over one quarter of the total workforce in both factories and industrial facilities, a proportion which is said to have doubled with time (NUW<sup>8</sup>:2004).

With those casually or temporarily employed accounting for a larger percentage of the respondents. Dr. Juma (2000:51) the director of African Virtues universities, a branch of Kenyatta University, explains the high figures in non permanent staff to be the related to the nature of Kenya's reward structure which favours those with formal education qualification, thus leading to the rise in public demand for higher and higher levels of education as primary and secondary levels can no longer guarantee modern sector wage employment.

This can also explain why all the casuals had secondary education and none had university education. While there were 3% university graduates working as temporary employees, they all held professional positions such as chemical liquid formulators, lab assistants, and clerks.

The large number of casuals and temporary workers in the plants could also be the result of the low employment levels in Kenya. As such many people find that the only entry point into the workforce is through casual employment, with the hope that this will lead to permanent employment at a later date. This kind of desperate state has made casual

\* NUW Represents National Union of Workers in Australia.

labourers and temporary workers remain working in the same capacity for over 5 years, even if the Kenyan labour laws through the industrial court in 1967 ruled that casual labourers in industries should be employed as casuals for a maximum period of six weeks after which they can discuss with the employer for consideration on permanent basis (GOK.,1951). This desperate situation may also force casual and temporary workers to work for low wages and limited benefits, a situation that in turn make casuals an attractive proposition for companies trying to cut down costs.

With such desperation, workers will therefore be willing to work under any circumstances even if it means working under unsafe conditions. From the research, it is evident too that a large percentage of casuals were not trained in safety as it is thought that they may leave employment at any time, having no firm attachment in the workplace. As such, these workers will be vulnerable to many dangers and hazards in the workplace and may not complain even if they detest these difficult conditions since they also face the disadvantage of ease of dismissal.

#### **4.2.3 Gender and designation**

Based on the findings ( see table 4), 86% of the respondents were male while only 14% were female. There was also variation in what each gender did. The male respondents worked as clerks, supervisors, assistant supervisors, machine operators, chemical formulators, cylinder decanters, cylinder vettors, laboratory technicians, chemical fillers, yard men, tank men, crane operators, mechanics, off loaders, melters, twistors, equipment printers, loaders, maintenance, and security staff. On the other hand, female respondents worked as quality controllers, storekeepers, and packers.

This gender disparity can be explained from the vigorous activities involved in the factories that more often than not require masculine power. This is not a unique case for Kenya only but a world wide issue. According to the world bank (1995:44) one reason why employers tend to shy away from employing more women in the factories is that women workers are often seen as the victims of regulations; regulations such as those whirfi prevent women in "dangerous" occupations or working in the night, thereby tending to reduce the demand for women workers.

According to Hensman (1988) and Bullock (1994) reproductive factors also play a role. One of these is maternity leave which comes with benefits. According to Hensman and Bullock, it has been recognized for some time that legislation that grants generous maternity benefits to women can and does work against the interests of the very women it seeks to protect, especially when such benefits are financed mainly by the employer.

Another factor associated with this is traditional gender roles and gender stereotypes, which in the short term, tend to be reproduced rather than transformed by factory work, therefore explaining the reason why there are more women to be found in tailoring and garment factories. Besides this, in a country such as Bangladesh, employers have been seen to often have the attitude that women are not committed to the labour force, and younger women preferred for employment as they are seen to have low aspiration wages, are docile, and are easy to dismiss (Jessica and Shahra .1997).

#### **4.3 Safety Awareness Level of Employees**

##### **4.3.1 Hazard awareness**

It is vital for employees in any work place to be aware of the hazards to which they are exposed and how to protect themselves against them. They should know where these hazards are located and what their effects might be in case they impact on vulnerability. This is a first requisite of accident prevention and building capacities, since one who does not know what a hazard is, is not likely to recognize its existence (Blake, 1963:2). It is also the duty of the employer in any industrial plant to come up with measures to deal with it in a productive manner. To do this, the nature of the hazard must be known and its level of threat to life and property. With this knowledge then, the information can be passed down to other employees on the prevention and response measures to be taken in the case of the hazard impacting on vulnerability.

Workers have a duty too. They should co-operate with and participate in the implementation of the organizational safety plans and other measures related to the major hazard control system in operation. It is expected of workers to play an active role in constantly watching over the safety of their work places and equipments that they use, and in applying all safety and health instructions pertaining to work (ILO,1988). In



Kenya, the Factory Act clearly outlines the different provisions, laws and implications of default as well as expectations of both the employer and the employee in the work place with the aim of ensuring that the safety and health of workers is not compromised at all times. To achieve a safe working environment therefore is a duty of both the employer and the employee. It is of high priority therefore for workers to first understand what they are exposed to if they are to implement the safety prevention and response measures in case of an accident.

However, the lack of knowledge of specific hazards present in the workplace is seemingly the situation in the industrial plants. This is judging from the outcome of the findings, where workers did not seem clear on the hazards they were exposed to. The table below shows in percentages the hazard awareness levels of different respondents from each plant.

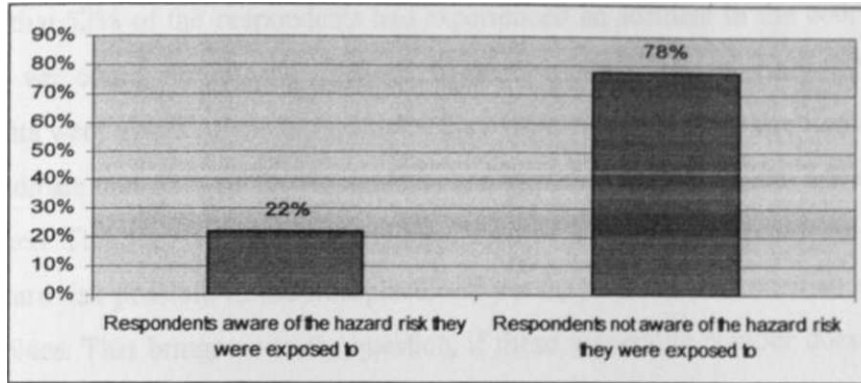
**Table 6 Representing hazard awareness of respondents**

<b>Company</b>	<b>Hazard risk possible in the plant</b>	<b>% of respondents who were aware of the hazard they were exposed to</b>	<b>% of respondents who were not aware of the hazard they were exposed to</b>
<b>Paints plant</b>	<b>Fire</b>	<b>50%</b>	<b>50%</b>
<b>Chemicals plant</b>	<b>Explosion and toxic Gas</b>	<b>7%</b>	<b>93%</b>
<b>Joint oil depot</b>	<b>Fire and Explosion</b>	<b>14%</b>	<b>86%</b>
<b>Plastics plant</b>	<b>Fire and toxic Gas</b>	<b>0%</b>	<b>100%</b>
<b>Steel plant</b>	<b>Fire and Explosion</b>	<b>28%</b>	<b>72%</b>
<b>LPG plant</b>	<b>Fire, Explosion and toxic Gas</b>	<b>35%</b>	<b>65%</b>
<b>All companies</b>		<b>22%</b>	<b>78%</b>

Those respondents who were classified as not being aware of the hazard risk they were exposed to included those who did not identify any hazard among the choices given and those who identified a hazard they were not exposed to.

A total graphical representation of hazard awareness for the total respondents of all the six industrial plants is represented in the following bar chart.

**Figure 3** A chart representation showing respondent hazard awareness

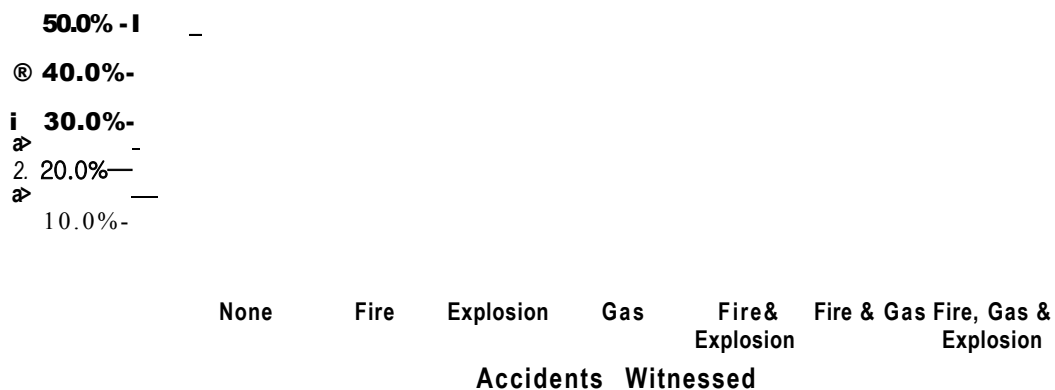


Knowledge of the hazards workers are exposed to is an important requisite to knowing how to counter its occurrence. With only 22% of the respondents correctly identifying the hazard risk they were exposed to, the findings suggest the high levels of vulnerability workers are exposed to and the high likelihood of an accident graduating to a disaster.

#### 4.3.2 Response to hazards

To further establish employee safety awareness level, respondents were asked to identify if they had witnessed an accident or disaster in the course of their work. Those who had encountered one went further to describe how it had been dealt with. Of those who had witnessed one, 19% had witnessed a fire, 9% an explosion, 1% poisonous gas exposure, 9% both a fire and an explosion, 3% a fire and gas accident, while 11% had witnessed a fire, a gas and an explosion accident in their workplace as illustrated in the bar chart following.

**Figure 4** Representing accidents witnessed



These figures from the findings on different accidents witnessed translates to 52%, meaning that 52% of the respondents had experienced an accident in the course of their work. If we could revisit the findings in section 4.2.1, above, only 22% of the respondents were aware of the hazard risk/s they were exposed to, yet the findings in this section indicate that 52% of the respondents had experienced an accident at least once as they worked. This leaves us with a possible deficit of 30% of the respondents not aware of the hazard risk possible in the workplace, and yet they have experienced an accident in the workplace. This brings us to the question, if these vulnerable number does not know what they are exposed to, then are they likely to have had an idea on how to respond to these accidents?

To answer this question, it is of essence to mention how each category of accident (fire, explosion, and toxic release) should be responded to in relation to the data collected for each hazard risk.

According to Parlay (2000), procedures of responding to any hazard risk should start by following the company's emergency plan. As was noted, it is only in 2 plants out of the 6 where emergency plans were clearly understood. The LPG plant had their emergency plans written and displayed for the workers on the walls. While it is not mandatory that emergency plans be displayed by way of hanging, they should be kept in a place where all workers can read and revisit at whatever time. The other plant that had these plans was the joint oil depot which had them on the shelves of the office, citing the reason for not displaying by hanging to the volume of the booklet. The plans here included fire, oil spills, and injury procedures.

While both the chemical and the plastics companies claimed they had emergency plans, the findings indicated doubt. The safety managers for both plants both thought that the emergency plans were the commonly displayed fire response stickers that show how to react in the case of a fire. These they kept referring to and it was clear that they had no emergency plans. The outcome from the steel plant was not any different. However, the response was different. While the safety manager indicated that they had emergency plans, he was unable to state what was in the plan. This was evident from the conflicting information given indicating that the installation of alarms on cranes was part of the emergency plans.

According to Parlay (2000), besides following the companies emergency plan, common explosion response should include evacuating quickly from the scene, shutting windows and doors, and reporting the explosion and its circumstances to the emergency response coordinator. Apparently as was noted, responding to explosions is not clear to most workers, and all plants visited under this study as well as the law seems to magnify fire as a possible hazard risk, and very little effort is put in a risk such as an explosion. Perhaps this was the reason why all that the respondents who had encountered an explosion in the workplace only had to say that the injured were administered first aid, and then taken to hospital. There was also misconception on procedures. One respondent said that to prevent further explosions, they assembled, while in the real sense assemblies are mainly held to account for the workers as well as be briefed regarding the accident.

Another possible hazard risk in some plants was a toxic release. A toxic release can be best countered through prevention as well containment because of its uncontrollable ease of spread once it has been introduced into the atmosphere. Some mechanisms however exist to ensure that the release is "locked in" before it reaches the environment. According to De Wolf (1988), these protection technologies involve equipment and systems used to capture or destroy a toxic chemical that has escaped from primary containment. Such technologies include flares, scrubbers, enclosures, and incinerators (Findings on this can be seen in table 14). However, should the toxins be released where there is no containment, then the company's emergency plan should be followed. Crucial steps however that must be in the plan include evacuation and evacuation procedures, reaction to the accident such as lying low, and prevention of further release of the toxins. From the findings, those who had encountered a toxic release said it had been countered by shutting down the cylinder to stop the gas leak, had the gas valve closed, sent the leaking container for inspection, as well as evacuation from the gas leak area. Though these responses were adequate on how to respond to a toxic release they were given in bits by different respondents.

Fire was the third hazard risk considered. One of the procedures for responding to a fire once it has started includes raising the alarm to signal other workers so that they can

evacuate immediately. According to the Kenya Red Cross Society (2002), other procedures include:

- ^Shouting for help/raising the alarm
- Calling 999 and reporting while continuing to raise the alarm
- Warning others from going towards the fire direction.
- If the fire is manageable, attempting to fight it using a fire extinguisher or other available equipments, or otherwise staying away from the fire.

Due to the high magnitude of effort put to counter the fire hazard risk by both the law and different plants, this was the most familiar hazard risk with the respondents. Responses included breaking the alarm glass, the use of the extinguisher to put out fire, wearing of personal protective equipments, putting off the main power supply, use of water, the use of sand and finally assembly. The greatest responses included the use of fire extinguishers and water. Though all the procedures were mentioned, none of the respondents gave the responses in full.

While a good effort can be seen from the responses given for each hazard, it is worth remembering that these was made up of 54% of the respondents while 46% did not know anything at all on how the accident incurred had been countered. This is an unfortunate case since accident briefing is recommended after every accident, if future accidents of the same nature are to be dealt with appropriately and prevented from graduating to major disasters.

Since close to half of the respondents did not know how the hazard risk they had encountered had been dealt with, and not all the remaining were thorough on the response, especially explosions and toxic releases means that should they face a similar accident in future, then there is the likelihood they may not be in a position to respond appropriately as it may graduate to become a disaster if the lack of accident briefing remains the same.

#### **4.3.3 Safety Equipment knowledge and location**

An assessment of respondents' knowledge of safety equipments and their location was carried out. When asked, all the respondents admitted knowing the safety equipments in the factory area. However, this was not the case when the respondents were asked to identify the equipments. None of the respondents exhaustively identified all the equipments in the production area. However, 73% correctly identified one or more of the equipments present, while 27% identified equipments that were not present in the plant. The fire extinguisher was the most highly recognized equipment in the plant with almost every respondent mentioning it.

The respondents were prompted further to assess their knowledge on equipment use.

When asked, 85% of the respondents admitted knowing how to use the safety equipments. However, when asked where they had acquired the knowledge from, 54% said they had acquired it through training, while 26% said they had acquired it through personal interest and 15% through observing as the equipments were being used.

Training on correct and safe use of safety equipments is not an option for employers. It is not only a way of reducing vulnerability but is also a requirement by law. Training on safety is recommended by the laws of Kenya under Section 65A (1) and further provisions have been made under Legal Notice No.31 of 2004 and the 2007 fire risk reduction rules Section 21(1), where every employer is supposed to ensure that workers are instructed on the safe use of safety and fire fighting appliances.

Training therefore cannot be compared to observing an equipment being used or learning through personal interest since some information requires expertise. Fire extinguishers that a majority of respondents were highly familiar with have different variations. Such details include the type of extinguisher for different fire types, operation of different models, correct use to protect the operator, or even the direction to face the extinguisher while operating, and how to fight different types of fires.

Knowledge of safety equipments and their location as such may be of little value if those directly exposed to a disaster do not know how to operate the equipment by way of training. The fact that 41% of respondents had not been trained on safe use of response equipments suggests increased vulnerability not only to the workers but also to the other

elements at risk. One such increased vulnerability would be an instance where a worker decided to put out an electric fire using a water extinguisher. Clearly, instead of reducing the hazard risk they are exposed to, the likelihood of it generating to a disaster would be multiplied.

#### **4.3.4 Knowledge of Emergency Exits**

Section 42 of the factories Act makes it mandatory for every industrial area to have at least 2 escape routes. However, only 2 of the 6 industrial plants visited had formal emergency exits. Formal in this case means an exit that is not used for any other purpose but emergencies and is well labeled as an emergency exit. However, evidence available is that some employees are not aware of what an emergency exit is.

When asked if they were aware of any emergency exits in the plant production area, an overwhelming 79% agreed they knew, even though none existed in the plant. Only 21% correctly indicated not knowing the existence of any.

It was clear from the key informants that what they used as emergency exits were the normal entry and exit doors that were used ordinarily during work hours. From the researcher's observation, this means that at one time or another, there was the likelihood of obstruction at the doors having witnessed temporary blockage of the doors while bringing in or loading outgoing product.

This clearly indicates the likelihood of a disaster should an accident occur and workers are unable to evacuate. With only 2 plants having emergency exits, leaving 4 with none suggests the elevation risk and heightened vulnerability for the workers. This means that should an accident source be from the main door, then workers will be clearly trapped in.

#### **4.4 Safety Structural Changes that have taken place in the Industrial Plants**

The second objective sought to establish if there were any structural changes that had occurred, or were in plan in the plants, that were likely to affect the face of safety in future.

Before 2002, many industrial strikes and demonstrations were witnessed mainly in the industrial production factories and plants in Kenya. However, come 2002, DOHSS under the ministry of labour was made an independent unit and given more powers to enforce more compliance in workplaces such as the founding of safety committees, therefore seeing a reduction to the strikes.

##### **4.4.1 Safety measures**

To engage in the discussion on the safety institutions in place in each plant therefore, it is important to note the state of the health and safety committees in the plants since they play an important role in the institution of safety in the plants.

##### **Health and safety committees**

Health and safety committees are recommended by law in every workplace, acting as the backbone of safety in the workplace, and charged with the responsibility of handling health and safety issues affecting workers in addition to being a representative body for all employees. Though their mandatory existence in every workplace was spelt out by the factories Act in 1951, the findings from the field indicate that companies have been slow to implement this.

As established, though all the 6 plants included in the research had operated for over 8 years, only two companies had had a health and safety committee for over 7 years. The two included the LPG plant and the Joint fuel depot, whose compliance can be attributed to international pressure from mother countries, being subject to international safety standards as well. These two plants both had about 10 year old committees. As for the other companies, it was established that the paints plant had a 3 year old committee and yet it has been in operation for about 9 years, the steel plant had operated for over 10 years and had a 3 year old committee, the 7 year old chemical manufacturing plant had



a 2 year old committee, while the plastics manufacturing plant had a 1 1/2 year old committee though having operated for 8 years. This summary is as shown in table 7 following.

**Table 7 Showing patterns of founding health and safety committees in the plants**

PLANT NAME	PLANT AGE	COMMITTEE AGE
LPG plant	Approx. 30 yrs	10 yrs
Joint Oil Depot	30 yrs	10 yrs
Paints plant	9 yrs	3 yrs
Steel plant	10 yrs	3 yrs
Chemicals plant	7 yrs	2 yrs
Plastics plant	8 yrs	1 1/2 yrs

Having presented a picture of the health and safety committees in the workplace, the following findings reflect the structural changes that have taken place in the different plants as reflected from the institution of these safety committees.

Major changes in the plastics plant can be seen to coincide with the formation of safety committees. In the almost 2 years the committee has existed, the plant has set aside an area to be used as an assembly point during accidents. One emergency exit has also been installed during the same period. Some emergency points have also been labeled and boundaries drawn in the working area to prevent cross over of workers or equipments to the gang ways.

In the last 3 years when the paints plant has had a safety committee, the plant has increased the number of portable fire extinguishers from 4 to 6 and has also had fire points and locations of response equipments marked. The plant has also since installed an alarm system. From the key informant, the plant has wanted to do more such as the installation of air suckers but has been restrained by finances.

Unfortunately, not much besides the institution of more fire extinguishers was identified from the steel plant. Though the plant has installed smoke detectors, they are located in the offices and as argued by the key informant, would not be appropriate in the working

area as smoke is expected with the metal smelting processes. However, most of what can be referred to as institutional changes such as the reinstallation of their broken down alarm, fire exits, fire points and danger warning signs as well as the assembly area unfortunately lies in their future plans.

In the two years that the chemicals plant has had a safety committee, the plant has introduced 13kg portable fire extinguishers to counter large fires. The plant has also rearranged the work area to create enough space for the gangways. They have also marked and set aside an assembly point in case of an accident. Though not adequate, there has also been the installation of air suckers for the dusty working area.

The joint oil depot being among the two plants that have had the longest existing committees has had a series of institutional changes. During this period, there has been the introduction of foam tanks and manual water jets and sprinklers (these and other equipments can be seen in table 16). Most recent, about two years ago, there was the introduction of an underground water tank with approximately 1000cc water storage capacity. An automatic water engine was also added to the existing manual one. While a portable water jet existed, it had since been replaced with two rotating ones.

The LPG plant which had a health and safety committee for about 10 years moved to a new facility about two years ago. Perhaps this is one of the reasons why the plants stood out from the rest of the plants examined as far as safety is concerned. The overall safety manager for the company also happened to be a member of the national industrial safety committee. Perhaps this could be another of the reasons why everything beginning from the plant design was set to meet the safety standards. From what the researcher was made to understand, the earlier plant was a complete contrast to the current one, and operated in limited space as compared to the current spacious grounds. However, the changes the LPG plant had made are commendable. Some of the changes included the installation of barriers for incoming vehicles to regulate the category and number of vehicles driving in, the display of the accident safety statistics, general health and safety rules and the fire site plan at the plant entrance, drawing of boundaries for drivers driving in, the installation of

four emergency exits and the installation of an automatic fire engine. Other equipments can be seen in table 16.

#### **4.4.2 Training**

Through interviews, key informants admitted that they strictly following the safety programmes recommended by DOHSS. They also admitted going further to include other safety training areas they found of need. The interviews further revealed that committee members had undergone the required training in safety and been issued with certificates.

Usually, according to the law, training of new committee members is carried out once after which the trainees are required to go through refresher courses that should not be later than two years. Despite having had all the safety committee members trained, it was nonetheless clear that a problem existed when it came to training and passing down the knowledge to those not in the committee. The findings on the training patterns are illustrated in table 8 following.

**Table 8 Table showing patterns of training among the respondents**

<b>Designation</b>	<b>Number Interviewed</b>	<b>Number trained</b>	<b>Number untrained</b>
Supervisor/Assistant	6	5	1
Storekeeper	2	2	0
Maintenance	2	1	1
General worker	11	3	8
Mechanic	1	1	0
Laboratory technician	1	1	0
Liquid and solid formulator	5	2	3
Machine operators	8	6	2
Yard and tank men operator	4	3	1
Operations	3	1	2
Clerk	2	2	0
Hand filler	1	1	0
Office assistance	2	2	0
Validations and vetting	3	3	0
Product handler	1	1	0
Helper	3	0	3
Crane operator	1	0	1
Twisting	2	0	2
Melter	2	0	2
Quality controller	1	0	1
Product printer	2	0	2
<b>TOTAL</b>	<b>63=100%</b>	<b>34=54%</b>	<b>29=46%</b>

Of the respondents interviewed, only 54% had received some training in safety while 46% had not had any form of safety training. As compared to the committee members who had all received training on safety, it clearly raises the question on whether these plants undertake the safety courses just to fulfill the requirements by law or they do it because they are conscious of the importance of safety.

From the findings, a pattern can be observed in the way training has been conducted in these plants. As it appears, training is done favouring different groups of people. Those

respondents in professional positions such as supervisors had large numbers trained as compared to the less professional. While 6 supervisors and assistants were interviewed, only 1 was untrained, 8 machine operators, only 2 were untrained and all the clerks, office assistants, validators and vettors were all trained. These are positions that require professional knowledge. However, the less involving that can be seen as mostly manual had most of the respondents untrained. Of the 11 general workers/labourers, 8 were untrained, whereas the 2 respondents doing metal twisting, and the 3 helpers were all untrained.

This is an unfortunate case where though training can be seen to be adopted by different plants, it is not conducted fairly and leaves some groups more vulnerable as compared to others.

#### **4.4.3 Safety equipments**

Installation of safety equipments in every workplace is recommended by law. It was encouraging to note there were a variety of equipments installed in different plants. These equipments included fire extinguishers, personal protective equipments, fire water, foam, fire engine, fire hydrants, fire blanket, sand, water curtain, alarm systems, accident data sheets, and sprinklers among others. Other high level technologies included neutralization flash downs for chemical spills and air suckers to remove toxic gases.

Worth noting however is that while all the safety managers clearly identified all the equipments that are available to counter the possible hazards, not all the necessary equipments were present in all the plants and there were variations with one plant having more than another. This can be mainly blamed on the law. One such case is in Section 42(1) of the safety provisions incase of fire, where it states that "in every factory there shall be provided and maintained so as to be readily accessible, a means for extinguishing fire, which shall be '*adequate and suitable*' having regard to the circumstances of each case..." (gok ,1951)

While this law is clear on recommending the installation of safety equipments in every workplace, it leaves the safety inspectors partially handicapped. This is because it does not give clear guidelines on what should be installed in different work areas and the numbers for each equipment. The closest the law gets is by stating the installation of

adequate safety equipments, but no clear laid down guidelines to be followed in doing this.

#### **4.4.4 Future plans**

It was established that despite the slow pace in embracing safety in different plants, they all had future plans in place to improve safety conditions in the plant.

For the chemical producing plant, future plans included setting up a better budget and allocating more funds to safety, introduction of more fans in the chemical storage area, (which apparently was quite dusty with chemical and the researcher recalls coughing from chemical exposure) and the introduction of more visual aid for display in the plant's working area. This according to the safety manager were going to come as a plea to the government, citing high costs in acquiring them. They also had plans to introduce more extensive training for workers on safety; but this would happen only if the government through DOHSS was willing to lower the cost of employee training.

So as the workers wait for extensive training and the introduction of more fans in the working area, workers will have to put up with the risks involved with the dangerous dusty chemical which is choking even with the presence of a mask. It can only be hoped that before then, an accident leading to more toxic exposure will not occur and intoxicate them; which apparently is the position at which they stand at the moment.

The paints plant had no drainage incase there was a spillage of products. This was cited as one of the principle plans for the future. There were also plans to install an instant shower to be used by workers incase they had chemical spills on their body or on clothing. The paints plant, being involved with a lot of toxic chemicals also expressed the need to fristall fans and air suckers, which did not exist in the plant. As was noted by the researcher, this plant was in dire need of a drainage. With the greasy product witnessed dripping on the ground close to the gangway, it posed the danger of slipping and perhaps causing sparks that are likely to cause ignition of the highly flammable product. Perhaps even more principle that should have been considered in the future plants was seeking to expand the space in the working area which was too small and with the little space as it were, there was increased risk of getting trapped incase there was an accident.

In the process of smelting, twisting and shaping metals to final products, the steel company workers encountered a lot of dry burns. As a result, the key informant relayed plans to purchase an ambulance in future instead of relying on personal vehicles to rush workers to the hospital. In addition, due to the intensity of the burns suffered, other plans included hiring a full time nurse for the production area. The alarm that the company has had was faulty and was not functional after it was destroyed following heavy rains in 2005. As such the plant was now planning to have it repaired or purchase another one all together. Finally, the gangways were covered with metallic raw materials and finished products. This would be removed in future to facilitate easy movement especially during emergencies. There were also plans to build emergency doors which were non existent. It is only hoped that while the plant awaits the installation or repair of the alarm, that there will be a means of communication in the case of an accident, the absence of which would leave workers open to risk. Also, while the company saw the need for introduction of a full time nurse due to the intensity of burns incurred by workers, the researcher saw the priority need as being the provision of safe personal protective equipments as opposed to the sacks that the workers struggled to tie on their legs as they shaped the red hot metal, considering that the sisal sacks are highly flammable. The clearance of gangways was a good consideration for the future. However, this should have been a matter of priority and not a future plan; but before then, the workers will have to put up with the open risk of tripping and getting injured as they evacuate during an accident.

The plastics company which smelts plastics and produces them as finished products saw the need to install safety signs around the plant as of dire need. The safety manager expressed the plan to install machine operation hazard charts and danger warning signs, having none in the working area. Display of exit maps, the installation of emergency exit signs, marking and setting aside a fire assembly point, and lastly marking of fire points for equipments such as fire extinguishers and the fire alarm were also in the plans.

The lack of guiding signs such at the emergency exit or assembly point may likely leave the workers confused during emergencies and leave them open to danger. The constant display of signs and warnings keep workers daily reminded and alert of where to locate

response equipments or even which direction to take during emergencies. It is also such display that guides visitors to the plant on the course of action to take without wasting too much time. Though the plant did have it in their future plans, the introduction of masks for the workers should have been considered. With the plant making use of highly intoxicating chemicals in the production of plastics, the plant ought to have considered introducing masks for the workers as well as provide additional fans in the working area. Such intoxication is likely to increase vulnerability of workers and increased chances of causing accidents owing to the reduced concentration caused by intoxication.

The fuel depot plant operated by 3 fuel companies, and which is guided by both local and international safety standards was in the course of taking up safety training for lorry drivers. It was revealed further by the key informant that they were also planning to introduce training in disaster emergency response as an internal training area for their workers. Included would be teaching on industrial hygiene as it relates to safety, and setting up of a system for reporting near misses to investigate small fires and prevent them from growing to become large fires. Also in the future, employees would be taught on the use of different safety equipments around the plant. This perhaps is one thing that should have been implemented way before with the installation of the different equipments in the plant. As seen in table 14, these plant has installed a good number of safety equipments, however, if workers are not taught on how to operate them, then they are as good as not being installed since even the wrong use of the right response equipments is likely to multiply an accident instead of reduce it.

The liquidified gas offload plant was planning to train workers more on safety so as to ensure that safety standards continued being upheld. Though being the only plant with fire fighting gear (four pairs), there were future plans to purchase even more. A new pair of sprinklers for offloading tankers was also in the plan. This was the only plant that showed full committed to safety issues. Reducing their commitment to safety is perhaps the one reason that would increase their vulnerability during accidents.



While it can be seen from the plans how promising the changes for the future of safety in the different plants is, it can only be hoped that these plans would not just remain on pen and paper, or on someone's mind, but would be implemented with the same enthusiasm. Some plans nevertheless are a matter of priority and should not have been designated for the future.

#### **4.5 Vulnerability of Elements at Risk**

Objective three sought to establish the vulnerability levels of elements at risk. The elements at risk included all the workers at the plants, the buildings, machinery and assets at the plants.

Vulnerability is the degree of loss to an inventory of those people or things which are exposed to the hazard should a hazard of a given severity occur. (Reeds, 1997:11) This however does not mean the lack of wants, but rather defencelessness, insecurity and exposure to risks, shocks and stress (Chambers 1989). As such the study sought to identify the levels of defencelessness in the plant that would affect the elements at risk should an accident occur in the plant's production area. This section discusses the various levels at which elements at risk are vulnerable.

In this section a hazard profile of each plant has been carried out independently since the vulnerability and capacity of each plant is different.

#### **THE PLASTICS PLANT**

##### **a) Hazard Identification**

The plastics plant which melts plastics, reshapes and prints them to come up with different polythene wrappers is open to disaster at the printing and melting stages of the production process. Because of the heat employed during the melting process that mainly relies on electric power, they face the possibility of an explosion accident. The chemicals employed during printing of the polythene bags also present the possibility of a toxic release accident owing to their high likelihood of causing intoxication.

##### **b). History of hazards incurred and damages**

Perhaps for reasons of not wanting to portray the plant in bad light, or for other reasons not known, the key informant gave minimal and sometimes conflicting information on the history of hazards they have incurred in the plant. While the key informant only mentioned a minor boiler explosion that caused a fire, the other respondents recalled a time when a gas cylinder in the plant exploded and had to be sent for decanting. The key

informant on the other hand when contacted for more information denied the claims Damages incurred included the destruction of a smelting container.

**c). Current Capacity Assessment**

**Safety training**

Findings indicated that 54% of the respondents were trained on safety, while 46% were not. It was established further that all the committee members had also received training. Such selective training shows a poor reflection of commitment to safety.

It is the duty of committee members to educate those not in the committee on safety. From the Findings 46% of the respondents had not benefited from the knowledge of the committee members. While 100% of the committee members had been trained, all of them had last received training over 2 years ago which is contrary to the factories Act.

These findings are summarised in 9 following.

**Table 9 Table showing safety training patterns in the plastics plant**

<b>%of untrained respondents</b>	<b>% of trained respondents</b>	<b>% of trained committee members</b>	<b>When last trained (Committee members)</b>	<b>Law requirement</b>	<b>% of compliant committee members</b>
<b>46%</b>	<b>54%</b>	<b>100%</b>	<b>2-3 years: 100%</b>	<b>Refresher courses be undertaken after 2 years for committee members</b>	<b>0%</b>

**Drills**

Only **27%** of those interviewed indicated having participated in a drill, leaving 73% never having participated. However, these findings were disputable and the researcher discovered that there was a level of untruthfulness. Those who claimed to have participated in a drill said it had taken place in 2007 the same time the research was done. Since none of the respondents were less than 2 years old in the plant, it was not possible to have had one section of the respondents being involved in the drill and not others.

Seeking clarification further it was established that all those who admitted participating were committee members and may have been trying to cover up a weakness.

Though carrying out of drills is mandatory by law, it is a sad thing that none of the respondents in this plant had participated in one.

According to Chandler ( 2003) drills are important since it is during such exercises that important information such as identification of the emergency team leader from whom to take directions during emergencies as well as the identification of alarm systems and emergency warnings and communication systems to be used, evacuation routes, assembly or designated alternative areas which provide a safe refuge internally or externally, communication of worker responsibilities, and what is required after the exercise is passed. Another essence of emergency drills is that with subsequent exercise, more experience is gained that ensures that a real accident is reacted to with efficiency and with reduced time.

The lack of drills therefore increases the likelihood of leaving workers confused and relying on guess work in the case of an emergency, increasing their level of vulnerability.

### **Emergency Exits**

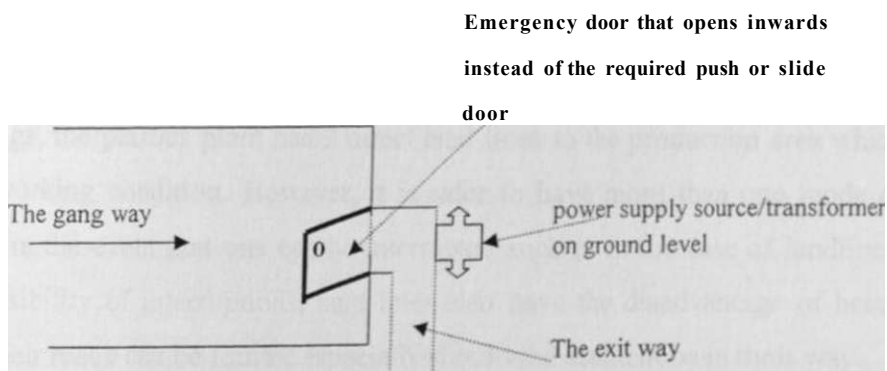
This plant had one emergency door and another under construction. This was well marked as an emergency exit, but unlike the requirements by law, it was not open as is required at all times. However, there was a key in a box and instructions to open the door in the case of an emergency. From the key informant, this was locked for security reasons. Despite this however, something else was wrong. The door was a "pull-door" instead of a "push", or slide door as is required for easy exit. Another complaint that came from the respondents and which was also observed was the small size of the door, comfortably allowing only one person at a time. About two steps from the emergency door was the electricity power generator/transformer source, meaning that if for instance the electricity source became a secondary hazard as workers evacuated, then they would be at risk. Section 17(1) of the Factories act has talked on this where it states that the emergency exit should be located in a manner that the exit will not lead any person to a

trap in the work place in the event of a fire breaking out. The same law goes further to give directions on the emergency exit to be at least 90 cm wide and situated as far away as possible from the ordinary exit.

Apparently, it is sad to note that such efforts to install an emergency exit can turn out to be useless if it exposes the unsuspecting workers it is supposed to protect, to a trap with even greater vulnerability in times of emergency.

Below is an aerial view illustration of the emergency exit in the plant showing the power supply transformer on ground level just outside the emergency exit door.

**Diagram 1** An aerial representation of the plant's emergency exit location



### **Locking in Employees**

It came out clear that locking of employees in the production area as they work is very much prevalent in our industries. The key informant when questioned on the same however did not deny, as he remarked; "this is Kenya *bwana*, you know the state of security". Though a good number of the respondents claimed they did not know why they were locked in from outside, the majority of the respondents when asked admitted that this practice went on to prevent possible theft from both outsiders and insiders.

Despite this, they admitted that they were not comfortable with being locked in since they understood the danger it exposed them to. One of the respondents related how an employee was injured at night and they had to wait for long before the doors were opened to ferry the injured to hospital. A typical scenario experienced by the researcher during research is in a case where after touring of the plant's production area, when it was time

to leave, all the doors had been locked and the supervisor had to send someone to ask for the doors to be opened.

### **Communication Systems**

According to OSHA (2002), and whose safety standards have been incorporated in Kenya's safety system since 2007, emergency communication equipments such as amateur radio systems, public address systems, or portable radio units should be present for notifying employees of an emergency or for contacting local authorities such as law enforcement officials and the fire department. Of even great importance are public address systems especially in industrial plants where many employees are found in various departments and when immediate and similar information needs to be conveyed without delay.

From the findings, the plastics plant had 2 direct land lines to the production area which were in good working condition. However, it is safer to have more than one mode of communication in the event that one can be interrupted such as in the case of landlines. Besides the possibility of interruptions, land lines also have the disadvantage of being stationary and their reach can be limited especially should the accident be in their way.

According to Wood (1996), the disadvantage of using landlines during disasters is that there might not be someone near to answer the call when it is made, the cables may be destroyed, there may be too much traffic from outsiders, landline reception may be very poor or suddenly non existent or there may be no power mains to the power exchange.

Portable communication systems are therefore highly encouraged as backup for land lines. These portable systems which are also referred to as terrestrial or ground systems include Amateur radios, gateway services, marine and private HF radio networks.

While portable systems like VHF ( very high frequency) radios would work as a good substitute for landlines, they are only recommended for distances of between 5-50kms. The big problem with HF radios in particular is the antenna system which must be resonant at the frequency being used. This issue gives two problems. First, as compared to other systems, their antennas tend to be bigger than other antennas, secondly they need

to keep being changed the frequency through the day so antenna size needs to keep being changed to give good reception. While the problem of HF bands and radios as well as antenna problems can be solved with the introduction of gadgets known as wide banders owing to their simplicity in tuning, they have the disadvantage of size where some models are rather long, about 30m-50m and therefore needing enough space to spring them up. They are also so wide that they tend to collect more noise for the receiver to handle.

Amateur radios are another system of communication that can be used in disasters due to their efficiency. However, the rules allow such radios to be used for research education and personal use by private persons. Such radios are similar to those used by the police and are also sometimes referred to as walkie talkies. Rules for their use include the frequency they can or cannot operate on. According to Wood (1996) most governments expect their amateur radios to provide emergency communications in the case of an emergency or disaster. Wood continues that in countries such as Yugoslavia, the Caribbean hurricane and many more cases show that amateur radios will work when nothing else will. They also have the advantage of being cheap to purchase the equipment. Though these radios have the advantage of staying on air even when other systems have gone down, they have the disadvantage of non confidentiality since many other operators will be listening with great interest at the conversation. The rule of their use also requires the use of no more than plain language. Another problem with these systems is delay. It takes quite some minutes before the message arrives to the addressee due to their procedures. For instance if it requires four repetitions of the message, then it can take 20-30 minutes to ask a question and get a reply. Despite this delay and other disadvantages, they are effective in communicating to a wide range of audiences and will be effective when all other systems have gone down.

### **Safety equipments**

Every plant and workplace is expected by law to ensure that safety equipments to fight a possible hazard be provided and be maintained in good order at all times. However, the

same law does not specify what equipments and what numbers should be installed. The law simply leaves it as 'adequate' equipments should be installed.

This lack of specificity has left the individual plants at the liberty of deciding what to install and the number of equipments.

Since the law does not specify the number of equipments required and type per plant, no further analysis of safety equipments could be done. Nevertheless every plant is required by law to have fire fighting measures in place though it may not be the most likely hazard in the plant, reason being that a fire can start from unexpected activities such as an electricity shot, or simply from machine friction. This plant had 11 portable extinguishers, 3 hose reels, 5 scrubbers and 2 absorbers. The researcher however felt that this plant needed to install sprinklers particularly in the raw product storage area that would perhaps be un-penetratable supposing fire began to spread fast.

#### **Fire detectors**

According to the Factories Act Section 28(1), every occupier should provide and maintain fire detection appliances. Part 3 of the same section goes further to recommend that fire detection appliances be connected to audible and visual flashing devices to provide a warning to the workers for emergency response. This connection can automatically raise the alarm without necessarily requiring the workers to visually identify the fire. This also ensures that the fire is put out in good time before it grows to become unmanageable.

The plastics plant did not have a fire detector in place. This means that since they had not installed one, they would have to rely on visual identification of the fire before it can be responded to. This clearly leaves the workers as well as the company assets at the danger of destruction in the event that a fierce spreading fire should break out and no one is present to identify it.

#### **Fire Alarms**

The need for safety alert equipments is captured in section 26(1) of the fire risk reduction rules. Though the law is not very specific on the fire alarm as the required safety alert equipment, the mention of it in passing in Section 22(a) of the factories act makes it a



safety requirement. This section states that the fire fighting team shall ensure that all fire fighting appliances, fire detectors, fire alarm and any other facility for fire safety are in place and regularly serviced. Nothing beyond this however is mentioned on the fire alarm. This means that no specifications on it are given.

It was impressive to note however that the plastics plant had 2 fire alarms both electric powered and with a battery backup. This means that should power be interrupted, then there is an auxiliary power supply in place to prevent the alarm from going off.

Besides these, being able to recognise the sound of the alarm to signify danger and clear association of different sounds or signals with their correct meanings is also an important aspect to avoid misinterpretations. To leave no room for such misinterpretations, the employer must explain to each employee the meaning of different signals such as alarms as well as the means for reporting emergencies such as manual pull box alarms, public address systems, or telephones (OSHA, 2002).

Since this plant uses an alarm or a siren as a time check, the respondents of this plant were presented with a question to determine if they could tell the difference between a danger alarm and the time check alarm sounded in the plant.

Though all the other respondents identified the alarm as signifying danger, one respondents said that it did not signify danger as the company only had one alarm; the time check alarm. Though a good number of respondents could tell the difference in the 2 alarms as being attributed to the sound, some respondents associated the sound with the direction it was coming from while one respondent said the emergency danger alarm was identifiable by the time it was sounded. This means that should this alarm have coincided with the time check alarm, then it would not have indicated danger. Another respondent could not tell the difference at all. This clearly demonstrates the partial sharing of information.

According to the American National Fire Protection Association-NFPA (2007), the purpose of the employee alarm systems is to reduce the severity of workplace accidents

and injuries by ensuring that alarm systems operate properly and procedures are in place to alert employees to workplace emergencies.

If an employee cannot tell the meaning of an emergency alarm, then it follows that they may not react to it appropriately.

### **Emergency exit maps**

Emergency exit maps are of essence in any workplace as they guide those faced by a risk on the direction to take while evacuating. They have also been enforced in section 17 (5) of the Factories Act which states that every occupier shall ensure that every emergency exit route is clearly marked in writing or by signs indicating the direction of exit and that a drawing or map showing evacuation routes shall be posted in prominent positions in the workplace (GOK, 1951).

Through the display of such maps, employees are always kept alert on actions to take in case of an emergency and on the location of hazards and response equipments.

### **B f f i f f i & S**

According to the Seattle Fire Department (2007) every business should have an emergency plan that outlines employees' fire response and evacuation routes, prevention tips and other related training. The employer, being the expert in the building and having knowledge on the layout of the workplace as well as knowing the concerns of the employees holds the responsibility of writing the emergency plan. It is from this plan that the map is represented. With this knowledge of the workplace, the employer can now create the emergency exit map. In this map is information such as the location of all fire exits, emergency response equipments such as personal protective equipments and extinguishing equipment. Such information should then be posted in different work stations within the reach of employees and where they can easily see it.

Though the law requires it and is also of essence for the safety of workers during emergencies, the plastics plant did not have an exit map displayed either by hanging or on a shelf where workers could reach it at their own convenience. The absence of this exit map can create confusion for workers while reacting to an emergency and also cause delay.

### **Collaborations**

Acquiring personal safety and response equipments in place for use in case of an emergency, is important in any workplace. However, even with the most sophisticated equipments, one can be overwhelmed depending on the nature and the size of the accident. As such, it is important to have back-up resources and equipments through collaborations with those who have them.

Findings showed that the plastics plant did not engage in any collaborations with their neighbours and relied solely on their equipments and the fire brigade. Relying on the fire brigade however may not necessarily lead to efficient response to the accident. According to studies conducted by Kamau (2007) on the challenges in preventing and fighting structural fires in Nairobi's informal settlements, the number of fire stations cannot efficiently cover the population in Nairobi. This is based on the international standards on establishing a fire brigade which dictate that one fire station should cover a population of 200,000 people, whereas Nairobi has a population of over 3 million people and only three fire stations. The three existing fire stations do not also have sufficient equipment that is necessary to respond to fires. This means that the current fire brigade cannot efficiently respond to fire outbreaks and many are the cases that go unattended to. More to this, though the fire brigade may be called upon to respond and is available, delay may be unavoidable given that the call may be made during peak hours characterized by serious traffic jams.

Entering into collaborations with the immediate companies therefore may be the most reasonable thing to do if they hope to react to the emergency in the shortest time possible.

### **Feel Safe or Not**

When the respondents of this plant were asked if they felt safe or not, 54% said they did while 46% said they did not. Reasons for feeling safe included that they had been taken through a safety program, had been trained on safety, and the presence of emergency doors and safety equipments. Those who did not feel safe said they felt vulnerable due to the absence of drills and testing of safety equipments, the far location of the emergency exit door, the small size of the emergency door and its location next to the transformer

power supply source, because they were locked in as they worked, and lastly because of the chemicals they handled and always had to be alert to any eventualities.

## THE PAINTS PLANT

### a). Hazard Identification

The paints plant which manufactures paints and paint associated products is open to the risk of fire and explosion accidents. This is because of the high flammability of materials employed in the production process. The confinement of these highly flammable materials in containers makes them open to explosion under conditions such as with exposure to very high temperatures.

### b). History of hazards incurred and damages

Findings from the key informants indicated that no accidents had been encountered in the plant ever since it was established.

### c). Current Capacity Assessment

#### Safety training

**Table 10** Table showing a summary of the safety training patterns of the paints plant

<b>1 %of untrained respondents</b>	<b>% of trained respondents</b>	<b>% of trained Committee Members</b>	<b>When last trained (Committee members)</b>	<b>Law requirement</b>	<b>% of compliant committee members</b>
<b>67%</b>	<b>33%</b>	<b>100%</b>	<b>Within a year from the time the research was conducted: 100%</b>	<b>Refresher courses be undertaken after 2 years for committee members</b>	<b>100%</b>

As represented in table 10 above, only 33% of the respondents were trained in safety. The remaining 67% had not received safety training. All these 33% had last received training within a year from the time the research was conducted. All the 33% were also committee members, meaning that all the respondents who were none committee members lacked training. This shows that knowledge on safety has remained with the committee members and has not been passed down. This is an unfortunate situation and one is left to wonder whether the plant is really committed to safety, or had committee members only trained

to fulfil the law, and supposedly owing to the evidence of a certificate required by safety inspectors during inspection.

The lack of sharing information on safety with none committee members opens a leeway for vulnerability either caused by these untrained employees or due to the lack of safety response information.

### **Drills**

Conflicting information was given by the two sets of respondents. While all the workers of the plant said they had never participated in a drill, their supervisor claimed they had. On assessing the responses, it was apparent that the supervisor was trying to cover up for their failures. This means that there had never been any drills conducted in this plant.

Apparently it is during drills that practice on responding to accidents is made perfect. It is also during such drills that short comings in the plant's emergency plans are noted and corrected. The absence of drills therefore leaves the plant poorly prepared in the face of an emergency.

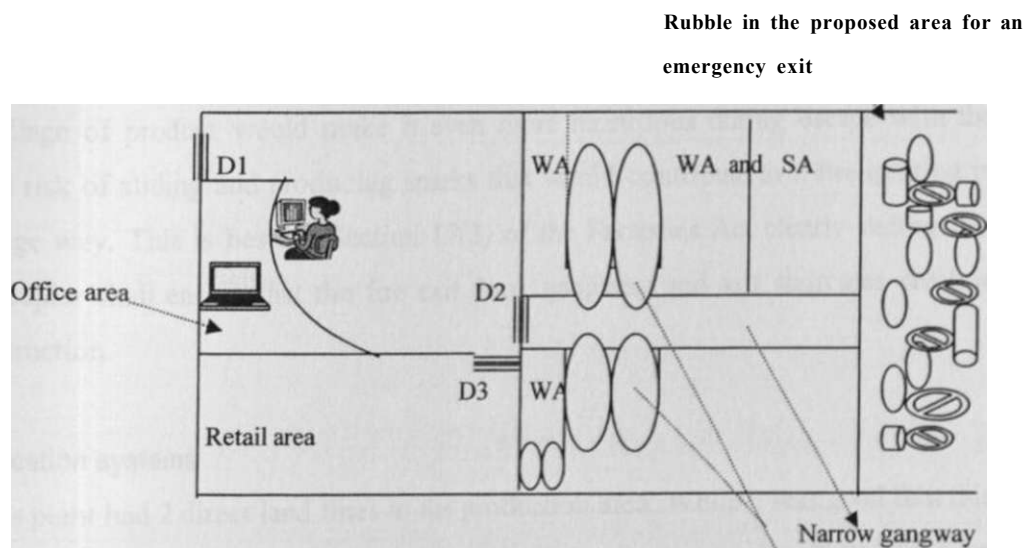
According to the Pasadena fire department (2006) fires and other accidents can happen anytime in the workplace. This can create an enormous risk to everyone working in such a vicinity. When this happens, evacuating the buildings for reasons such as fires, gas leaks, earthquakes, hazardous material spills or even storms will in most cases be the most ultimate thing to do. As such, knowing what to do is the key to surviving in times of such emergencies. Conducting regular drills therefore provides the knowledge and confidence to escape the accident safely. For any plant to be successful during such evacuations, taking chances that it will succeed should be last thing. Whereas a good evacuation program is essential, planning must be backed by practice. Such practice is achieved when drills are conducted.

The absence of drills in plants such as these one therefore leaves the workers at the risk of operating on assumptions during evacuations.

## Emergency Exits

From the key informant, the location of an emergency exit door at the back of the production area was in their future plans. However at the time, the area was full of product rubble and the only escape route in the case of an emergency was through a small door which led to the main office door, and whose door was a "pull door" as illustrated in diagram 2 below. This would mean trouble for instance in a case where workers jammed at the door making it difficult to open.

Diagram 2 showing an aerial view of the paints plant and the problem of emergency exits



### KEY-

D1 = entrance door through to the office work area.

WA = working area.

D2 = entrance to the production area.

SA = storage area.

D3 = entrance to the retail area through the office area.

From diagram 2 above, the amount of activity around the only possible exit from the production area can be seen as represented by D2. The entry door D3 which leads to the retail area could also be a source of obstruction for the evacuating workers through D2 as workers from D3 also try to find their way out. As noted earlier, the door D1 which is the only way that would act as an emergency exit as well as the normal entry door is a "pull

in" door creating the opportunity for workers getting trapped at the door supposing they leaned on it as they tried to find their way out.

The situation in this plant prevails despite, stipulation by the factories Act in Section 42 part 3 which states that the contents of any room in which persons are employed shall be so arranged that there is a free passage-way for all persons employed in the room, to a means of escape in case of a fire or any other hazard.

Further, as illustrated in diagram 2, the plant production area was also literary squeezed, where arms apart meant touching the machines. A few workers could also be seen working in limited space. This plant was therefore in dire need of space with some equipments being partly on the gang ways. There was also poor house keeping with some oily product finding its way from the machine cylinders to the ground through leaks. Such spillage of product would make it even more hazardous during escape with the increased risk of sliding and producing sparks that would contribute to a fire igniting in the passage way. This is besides Section 17(3) of the Factories Act clearly stating that every occupier shall ensure that the fire exit door, gangway and exit staircases are free from obstruction.

#### **Communication systems**

The paints plant had 2 direct land lines to the production area. While it was good that this plant had direct lines that could be used in the case of emergencies, they could be rendered useless during emergencies.

As earlier noted, according to Woods (1996), land lines also have the disadvantage of being stationary and their reach can be limited especially should the accident be in their way, meaning that should a call be made, then there's a likelihood of having no one to answer to it. It has also been noted that during disasters, in more cases than not, as other equipments are destroyed, so are telephone cables. The use of landlines alone is therefore discouraged as they may also tend to have poor reception, be none existent at the time or be jammed with outsiders' calling.

It was therefore advisable for this plant to adopt more than one communication system to complement the land lines should they fail. ®

To complement the landlines, the plant would have considered adopting portable



communication systems such as Amateur radios, gateway services or private HF radio networks.

### **Safety equipments**

The paints plant had 6 portable fire extinguishers and 2 smoke detectors installed.

While the law does not specify on the number of equipments required and the type per plant, it is clear that with the nature of business for this plant, more safety equipments were of essence. Due to the high flammability possible in the products manufactured that would even lead to explosions owing to their confinement in containers, more fire fighting equipments would have been necessary for this plant. Such safety equipments would include hose reels, water jets and large volumes of stored foam systems should have been present in this plant since the plant was at the risk of class B fires (flammable liquid products such as oil). Since the plant was dealing in liquid products, some of which would turn to vapour under certain conditions such as excessive heat, the plant would also have required the installation of sprinklers to reduce the possibility or stop a further explosion. According to Wildergen (2000) this mechanism works by break up of the large droplets from the sprinkler once they come near a flame and the resulting water vapour in turn dilutes the gas mixture resulting in the burning rate reduction or even flame quenching.

### **Fire detectors**

Early warning systems act as an important disaster prevention tool wherever they are installed. They help to reduce losses by communicating that something is wrong way before it happens or gets out of hand. Fire detectors being early warning systems-EWS are therefore not only important for this but are stipulated by the Kenya's Factory Act. This is found in Section 28(1) (see the previous section on the plastics plant under fire detectors) of the same Act.

From the findings, this plant had installed 2 fire detectors in the work area which were in good working condition. While it is a good thing for this plant to have installed the fire detectors for the above reasons and since they reduce the response time, it would have been of preference if the plant had first invested in fire fighting equipments if they hoped

to be in the position to put out the fire fast enough considering the high and fast flammability of products handled by the plant. According to Carlos (2006) a good EWS is composed of four phases but it is the fourth that can make the difference in all. The first three include a system that monitors precursors, then forecasts a probable event, notifies a warning or an alert and the fourth being the onset of emergency response activities.

In plants such as this one that onJy had 6 fire extinguishers as the only response equipments in the working area may not quite fulfil the successful EWS cycle supposing a fire originated from the paint manufacturing cylinder, considering the high flammability and likelihood of an explosion. The fire detectors will have fulfilled all the three phases of an EWS but the failure to have appropriate and sufficient equipments will have rendered the EWS unsuccessful.

#### **Fire alarm**

Standard Early warning signals (SEWS) are intended for use as an alert signal to be played with the aim of drawing attention to a following emergency warning or to indicate a course of action to be taken such as to evacuate. Fire alarms fall in this category. According to NFPA (2007), fire alarm signals can be of two types. They can be audible or visual. Though not recognised by NFPA any longer due to their increased use to carry other meanings or due to their ineffectiveness, these audible alarms include bells, horns, and sirens which can sometimes be used in exceptional cases. However those recommended include the standard fire alarm signal and voice announcement systems. In order to accommodate for those with hearing impairment and who are perhaps secluded in a working area, or due to the noise in the production area, the alarm should include flashing or probe lights.

From the findings, the plant had one fire alarm that was electric powered. It did not have an auxiliary power backup such as a battery. A backup is recommended to ensure that the alarm does not go off or be rendered non functional in the event that power is put off to prevent multiplicity of the accident. In this plant, should such a case have occurred or there be an electricity power interruption, then the plant would have been incapacitated in

the use of the fire alarm. This would in turn have slowed down response and increase the levels of risk as alternative methods of communication are sought, especially considering that this plant did not have other communication modes such as speakers.

Having the fire alarm installed is not enough. It should communicate the intended message and should be distinct from all other alarms.

Based on this, all the respondents identified the fire alarm sound to signify danger to them. The question on differentiating the different alarm sounds could not apply for this plant as the respondents claimed that this was the only alarm sounded in the plant and did not use one for time check or any other alarm.

### **Emergency exit maps**

While the Factories Act Section 17(5) requires that emergency exit maps be displayed by way of hanging or be placed in a prominent place where all workers can revisit at their own pleasure, this plant like the other 4 did not have emergency exit maps displayed. Without maps, a situation where there is confusion as the workers try to locate the exits and the response equipments is inevitable. Usually, while drills serve as a reminder on procedures to follow during an emergency, the law recommends drills to be carried out at the least once a year. One day in the year may not serve as sufficient reminder for all procedures and routes contained in emergency exit maps. Besides this, new employees may have joined the plant after the drill was conducted and may therefore need sufficient time to familiarize themselves with the emergency procedures in the new workplace. Providing an emergency exit map which was lacking in this plant aids the process.

### **Collaborations**

The paints plant had not entered into any agreement with any firm or institution to collaborate during emergencies. Besides the steel plant, this plant too had the least response equipments (6 fire extinguishers). Though the plant was not as large as most considered for this research, the highly flammable product the plant handled ( whose products are closely related to the then burnt down Barot agencies and Sadolin paints that both suffered after a fire spread very fast) requires more response measures in place.

If plant cannot acquire sufficient response resources, collaboration would be the next best thing to do to ensure immediate response without having to wait for the already overburdened fire brigade. While the plant may request the neighbouring institutions for assistance during the accident, such an immediate arrangement may not always be guaranteed to materialise. This is owing to the fact that situations have been observed where neighbouring institutions have chosen to withhold their equipments and not assist the troubled company in the fear that the hazard may spread to their vicinity.

Without sufficient equipments and no collaborations therefore, this plant finds itself in the vulnerable position of total destruction should they be faced by a disaster.

#### **Feel safe or not**

Half of the respondents in this plant reported feeling safe while they worked. The remaining 50% did not respond to this question. Reasons for feeling safe included the presence of safety equipments and the presence of a health and safety committee. Comparing with the responses they gave for recommendations in the plant, their lack of response could be interpreted as fear of expressing honest opinion. The recommendations they gave for the plant included encouraging the labelling of items in the production area, making the gangways clear and encouraging every worker to be responsible for their workplaces or ensuring good house keeping.

## THE JOINT OIL DEPOT

### a). Hazard Identification

The joint oil depot which deals with the reception, storage and dispatch of fuel products is open to the risk of fire and explosions in the course of loading and dispatching the product. The plant stores and handles highly flammable materials which can explode when temperatures high enough to support burning ( 100°C ) are reached such as in the case of a fire accident.

### b). History of hazards incurred and damages

The plant has operated for over 30 years and reported having never experienced any accidents or damages within the plant. The plant has however incurred accidents in the process of transportation of the product by the petrol tankers. More details regarding the accidents were considered classified.

### c). Current Capacity Assessment

#### Safety training

**Table 11** Table showing a summary of the safety training patterns in the joint oil depot plant

<b>%of untrained respondents</b>	<b>% of trained respondents</b>	<b>% of trained Committee Members</b>	<b>When last trained (Committee members)</b>	<b>Law requirement</b>	<b>% of compliant committee members</b>
<b>14%</b>	<b>86%</b>	<b>100%</b>	<b>Within a year = 40%</b> <b>2-3 years= 60%</b>	<b>Refresher courses be undertaken after 2 years for committee members</b>	<b>40%</b>

From table 11 above, only 14% of the respondents lacked training in safety, all of whom included non committee members. This means that 100% of the committee members had at one time been trained in safety. The pattern of their training included 40% having been trained within a year and 60% between 2-3 years. This means that these 60% of the

committee members were not compliant with the law which requires that committee members get refresher courses at least at the expiry of 2 years from the last training.

Failing or getting late to offer refresher courses to committee members implicates all the other workers since they rely on these committee members for safety knowledge. Other than acting as a reminder for the committee members on earlier learnt safety issues, any new issues arising in safety are also communicated during refresher trainings. In addition to the committee members, the plant also needed to extend training to the 14% who were untrained as they can be the cause of accidents and major losses.

#### Drills

From the findings, 85% of the respondents had participated in an emergency drill while the remaining 15% had not participated at all. All the respondents who had participated in a drill had done so the same year that the research was carried out. The findings indicated that the drills in the joint oil depot were conducted quarter yearly. This is good consciousness to safety considering that some plants recorded 0% participation. Despite this however, the plant had left out 15% of the respondents from the drills. Though it may be assumed that some of the staff are well aware in advance that it is a drill and therefore need not leave their work, it is wrong to assume that anyone is well conversant with the procedures during an evacuation.

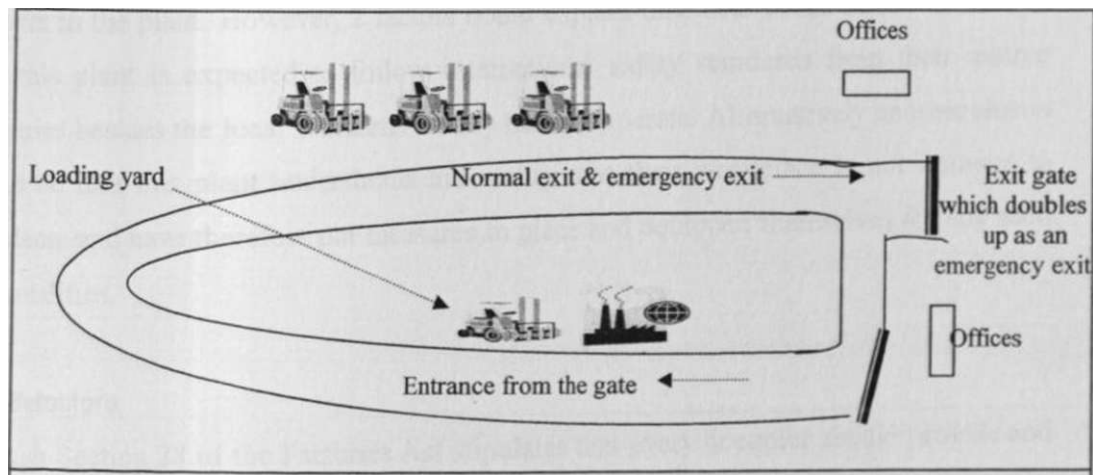
According to NFPA (2003) the primary reason for conducting drills is to educate building occupants about the procedures to follow in the event of an emergency that requires evacuation. NFPA continues that though the evacuation routes may be hard to miss by any employee, it is easy for the same employees to overlook such features of a building as they go about their day-to-day routine. Sometimes the escape routes are not obvious and since people will enter and leave buildings through the same entrance, in the event of an emergency, these same people might travel past the emergency exits to get to the building entrance they are familiar with. Drills therefore provide an opportunity for occupants to locate and use the correct exit routes and alternative routes under non threatening conditions. This familiarity according to NFPA is what increases the probability of a successful evacuation during an actual emergency.

## Emergency exits

As illustrated in diagram 3 below, this plant operated in an open yard with only one exit gate which doubled up as an emergency exist for vehicles which had to load products parked head first. However, this was not sufficient considering that there could be atleast 3 vehicles in the yard at the same time, meaning that should an accident originate from a tanker at the exit gate, then the other tankers would be trapped in.

This exit gate was also not labelled as an emergency exit for vehicles. Besides the vehicles there was also no emergency exit for the workers present. This presented an extremely risky situation considering that the plant deals in motor vehicles fuels which are highly flammable.

Diagram 3 An aerial view illustrating the state of emergency exits in the joint oil depot



## Communication systems

The joint oil depot stood out as the only plant that had 2 modes of direct communication to the production area. One was portable while the other was immobile. These were 6 VHF radios and 5 direct landlines. All of them were in good working condition. This shows good effort in disaster preparedness since should one mode fail during emergencies, then the other can be used as a substitute.

While VHF radios are a good substitute for landlines, they work for distances of between 5-50kms. Landlines on the other hand have been known to have cable break down during disasters or have simply been rendered unusable due to congestion from external callers.

Besides these advantages VHF, radios stand a better chance of operating during disasters more than landlines considering that they will be less open to congestion, are portable and will in more times have people listening when a call is made due to the multi information sharing capability they possess.

### **Safety equipments**

The LPG plant had 12 portable fire extinguishers, 3 hose reels, 2 foam systems, 2 water jets, 2 sets of water sprinklers, 4 water curtains, 2 tanks of fire water, 1 fire detector, 25 smoke detectors, and 1 enclosure. Though the law does not stipulate on the number of safety equipments that a plant should have, this plant had satisfactory safety equipments and it could be seen that consideration had been taken on the possible magnitude of a disaster in the plant. However, 2 factors could explain this. One could be due to the fact that this plant is expected to follow international safety standards from their mother countries besides the local standards if they have to operate. Alternatively another reason could be that this plant understands the reality that their workplace is not immune to accidents and have therefore put measures in place and equipped themselves for any such eventualities.

### **Fire detectors**

Though Section 28 of the Factories Act stipulates that every occupier should provide and maintain fire detection appliances, this was the only plant that had complied with this law and had a fire detector in the production area. This was a good step to take considering the high flammability of products handled in this plant. A fire detector can prevent great losses by creating a fire warning signal when a fire is still small and manageable thereby preventing it from growing to become a disaster. However, much as the fire detectors exist, what they signify or represent must be understood by the workers, failure to which their presence may not make a difference unless their warning provokes the execution of the proper measures.



### **Fire alarm**

The plant had 2 fire alarms both of which were electric powered. The alarms did not have any auxiliary power supply. Without battery backup or even having a manual alarm as a substitute puts the plant at the risk of failed communication with the fire alarm in the event that the power supply has to be shut down.

To assess further what meaning these alarms carried to the respondents, they were asked to identify what the alarm sound signified to them. The findings indicated that all the respondents viewed the sound of a fire alarm in the premises to signified danger. Respondents were also asked to differentiate between this alarm and any other alarm sounded in the plant. This question received different responses. While quite a good number said they could differentiate it with the difference of sound, some respondents thought it was differentiated by its physical location and the actions that followed such as shouting or commotion. This means that should the sound of the alarm not be followed by shouting, of supposing the respondents were alone in a location where they could not gauge the behaviour of others, then they most likely would not respond to it. One other respondent also thought that all the alarms sounded were similar while 4 respondents could not tell the difference.

Having safety equipments such as the fire alarm in place may not serve the intended purpose if they are not understood. If an employer does not eliminate such misinterpretations, then no matter how sophisticated equipments a plant may have, they will be rendered useless at their most significant time.

### **Emergency exit maps**

The joint oil depot had their exit maps displayed on the office shelves for the convenience of any worker who wanted to visit them. They could not be displayed by way of hanging because of their volume.

Emergency exit maps are important as they ensure that workers are not stranded during evacuation, and that they are not tempted to use the exits they are more familiar with. Having an emergency exit map was a good thing for this plant, but it needed to come up

with formal emergency exits for both the vehicles and workers at the plant instead of reusing the normal entrance and exit ways.

### **Collaborations**

The joint oil depot had formal collaborations meaning that the agreement had been put down in writing. The items for collaboration included foam, personnel and **VHF** radios. The companies for collaboration included Oil Libya, Kenya Shell, Oil Com, NOCK, and Kenya Pipeline, all of whom were surrounding neighbours at Wundanyi road off Nanyuki road (see table 15).

It however came out during the interview with the key informant for the Joint oil depot that since the agreement was entered into, no meetings had been held to establish good associations and to ensure that it was not merely an agreement on pen and paper only, more so considering that these neighbours were all competitors with one another and competition rivalry may be a factor that could lead to reluctance to assist with resources when needed. Change in management could be another factor. This was actually given as one of the recommendations by the key informant as an area needing future improvement in their plant.

### **Feel safe or not**

Only 25% of the respondents reported not feeling safe as they worked in this plant. Apparently, they gave similar reasons for not feeling safe which included being situated in the middle of oil companies that they considered to be highly open to risk. To feel safer, they gave recommendations which included having awareness created to all, having increased staff training in safety and the need to conduct drills with the neighbours as well.

## THE STEEL PLANT

### a). Hazard Identification

The steel plant was in the business of smelting metals, casting and twisting them to finished products. A fire outbreak was possible because of the high fire temperatures employed in the different production processes. Explosions are also possible in the smelting process if the metals are not well inspected before introduction to the furnace.

### b). History of hazards incurred and damages

The steel plant incurred a fire and an explosion accident about 2 years ago. The accident was as a result of a furnace that exploded due to wear and tear. Two people were rushed to hospital with some burns. The furnace was also completely destroyed and a new one had to replace it.

Burns have been another hazard that occurs frequently in the plant as the workers twist and shape the hot metals. Burns and scalds were relayed by the key informant as an almost normal occurrence in the plant.

### c). Current Capacity Assessment

#### Safety training

**Table 12** Table showing safety training patterns in the steel plant

<b>% of untrained respondents</b>	<b>% of trained respondents</b>	<b>% of trained Committee Members</b>	<b>When last trained (Committee members)</b>	<b>Law requirement</b>	<b>% of compliant committee members</b>
<b>67%</b>	<b>33%</b>	<b>100%</b>	<b>Within a year from the time the research was conducted</b>	<b>Refresher courses be undertaken after 2 years for committee members</b>	<b>100%</b>

From table 12 above, only 33% of the respondents in this plant were at one time trained in safety while 67% had never been trained. It was also established that half of those who were trained were committee members who had received training within a year from the

time the research was conducted. The remaining half however was last trained over 4 years ago. One respondent even reported having been last trained 19 years ago the same year this respondent joined the plant. As is expected in any plant that is conscious of the safety of its workers, once the committee members have received training, they should be ready to pass it down to the rest of the workers. This was not the case in this plant. It was clear that this plant took keen interest in training committee members whose training requirements were clearly spelt out by the law and backed by a certificate as compared to the other workers who have nothing to show.

Without training, the plant can be putting itself at the elevated risk of taking the wrong actions during emergencies for reasons such as panic.

According to Graham (1983), several persons will react in different manners when faced with the same threatening situation. When faced with a potentially dangerous and unfamiliar situation, it is a natural reaction to be afraid. If ways of mastering such fear is not learnt, it leads to panic. This is potentially so in an individual with no background or training on how to react to catastrophic situations. One attitude of such people is to refuse to accept danger as a part of a protective mechanism that creates a feeling of wellbeing. Another attitude that can result from dominating anxiety is a refusal to accept the problems by contending that regardless of whatever steps are taken, nothing will do any good. This however according to Graham will depend on how well prepared and trained these people are both from a psychological and practical point of view. Letting a person know in advance what to expect and how to react to it can help to reverse such reactions. In order to familiarize workers with such knowledge therefore, there is need for them to know their duties in an emergency situation from the developed contingency plans and this and more is achievable through safety training.

### **Drills**

An overwhelming 94% of the respondents of the steel plant had never participated in a drill. The 6% who reported having participated in one did so in 1990, which translates to 17 years ago as per the time the research was carried out. While the law is very clear on drills, one is left to wonder how this plant has gone without performing them for such a

long time yet they are registered under DOHSS whose inspectors must in the course of their inspection view the drill register. It can only be concluded that either this inspection is never carried out or the plant's safety manager simply doctors the records.

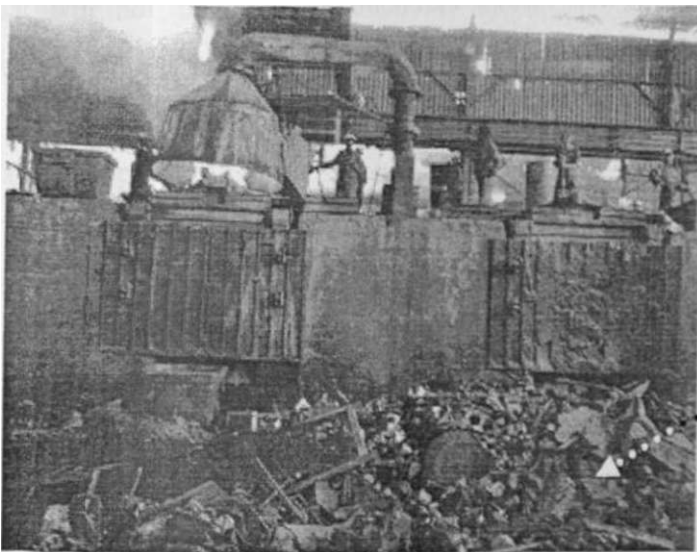
Having suffered an explosion about 2 years ago, the explosion would have been expected to be a wake up call for the plant to realise the essence of safety issues such as drills. Sadly, not even this accident was enough to teach them a lesson.

### **Emergency exits**

The steel smelting plant had no emergency exits. The gang ways were also full of finished products or metals waiting smelting. The only clear way that the workers would have used in case they were evacuating during an accident as it emerged was for use by vehicles delivering or loading materials. The doubling up of this gang way for use by both workers and vehicles is a clear illustration of the possible danger of tripping and being trapped open to workers during evacuation.

Below is a photo of workers working in the steel plant.

**Picture 1            Picture showing obstructed gangways**



**Workers busy working in a smelting plant surrounded by debris. The exit is on the back side of this photograph but the photo could not be taken from that position because it was blocked by a loading track using the gang way.**

**When the gangways are blocked by delivering or loading trucks, the rubble as shown by the arrow would serve as a maneuver option for the evacuating workers.**

**Picture taken from the field by the researcher in December 2007**

### **Communication systems**

The plant had one direct mode of communication to the production area. This was one mobile cell phone. Again like some of the other plants that had one mode of communication, different modes of communication should be used along side one another to backup each other up in the event that one mode may fail. Having only one direct line is also unreliable since it means that whenever the mobile cell phone is not in operation for reasons such as the lack of network, then there is no other direct line to the production area.

Direct lines come in handy during accidents for use by responding parties such as the fire brigade as they try to find out the state of the accident or as they try to make their way there. As has been noted during disasters, family and friends jam the lines as they attempt to find out about the state of their loved ones caught in the disaster. If the special response groups as well as the public and the groups such as the media will scramble for the only direct lines available, then there is likely to be slow and in the worst case scenario no communication at all.

Such would be the case in a plant like this should the only direct communication system available fail. To be on a safe side, investment in some VHF radios or armature radios that will not be open to outsiders except for responding groups to be used for communication would be ideal as backup for the mobile cell phone.

### **Safety equipments**

The plant had 11 portable fire extinguishers in the production area, 3 of which needed repair. This plant only had the fire extinguisher as the only safety equipment in the production area. Though the law does not give guidelines on the number and type of safety equipments that must be installed in different plants, it is clear that this plant did not have sufficient equipments in the working yard. With the large open furnaces in the plant and heavy dependence on electricity, the plant should have considered the installation of carbon dioxide or foam systems as well as hose reels and sprinklers at the least. Fire extinguishers which sometimes require close proximity to the fire source would not be ideal for a large fire in the event that another explosion as the earlier one reported from the furnace happened in this plant causing a fire disaster.

### **Fire detectors**

The steel plant did not have any fire detector. The key informant argued that the plant uses an open fire as a key ingredient in the smelting of metals and therefore a fire detector would not be necessary as it would keep signalling any time the furnace was lit. This however was not a weighty argument considering that the furnace was put off during the night and the plant did not have a night shift. As such, a fire detector would have come in handy to monitor any fires during the night.

### **Fire alarm**

The steel plant had a non-functional alarm having been destroyed in 2005 by heavy rains. It was no wonder that the question on differentiating the emergency alarm and any other alarm sounded in the organization was ignored by some respondents. Those who attempted gave a clear indication that none of them had the fire alarm in mind as they gave their responses. To them, the only alarms they knew were related to the machinery. Both the crane and the furnace had monitoring alarms fitted in them. It is no wonder that the respondents said that the first alarm they heard very often in the plant was the alarm heard when the furnace was put on and the other referred to the warning signal given by the furnace to mean that the heat needed to be controlled.

Section 22(A) of the Factories Act makes the fire alarm a necessary equipment in any workplace (see section C under the plastics plant).

With the amount of noise that was made in the production process and with the lack of an alarm, unsuspecting workers face an elevated chance of being victims of an accident due to the lack of a danger communication equipment.

### **Emergency exit maps**

The steel plant did not have any exit maps displayed by hanging or in a place convenient to the reach of employees. Even worse, the key informant did not seem to understand what an emergency exit map was as he kept referring to the fire safety warning signs that provide guidance on actions to take should a fire occur.

Though the need for exit maps has been stressed in Section 17(5) of the Factories Act (see section C under the plastics plant) it was clear this had been ignored. The absence of exit maps is likely to leave workers stranded on the alternative directions to take during emergencies should the customary emergency exits be rendered unusable.

### **Collaborations**

If a plant cannot acquire all the necessary resources for response during emergencies, it can consider entering into special arrangements with those who have them for assistance in times of major accidents or when they are overwhelmed. Sadly, this plant had the least equipments in their production area. With only 11 portable extinguishers, collaboration would have been the way forward. However, they had not entered into any agreement whatsoever with any company and relied solely on their extinguishers to counter any accidents. This clearly was an overestimation of what fire extinguishers can do.

### **Feel safe or not**

The findings indicated that only 25% of the respondents reported feeling safe as they worked while 75% said they did not. Having safety procedures in place, spacious working area, the absence of toxins, clear gangways, the presence of an alarm and other safety equipments and having trained workers were the reasons given for feeling safe. These responses however were suspect. They represented a lot of dishonesty in the respondents in issues such as the presence of an alarm which last operated in 2005. Other dishonest responses included the presence of adequate safety equipments while the plant only had fire extinguishers which were not even sufficient as well as the presence of clear gangways which actually doubled up as loading and offloading ways. Apparently most of these responses came from safety committee members and it was evident that they were trying to cover up for weaknesses.

The 75% who reported not feeling safe gave reasons as including the high voltage used in the production processes and the smoke which opens workers to respiratory problems, the presence of few extinguishers, the lack of sufficient safety equipments, the high likelihood of an explosion, the presence of many dangerous points in the work area and the lack of seriousness to worker safety suggestions made during meetings.



## THE CHEMICALS PLANT

### a). Hazard Identification

The chemicals plant which formulates agro chemicals and fertilizers is open to toxic releases and explosions. A toxic release can be experienced during chemical formulation stage while an explosion is possible if products are poorly stored.

### b). History of hazards incurred and damages

The plant was faced by 2 explosions in the year 2006. The first explosion was caused by product trapped in the conveyer belts of a machine. No damages were incurred in this case. The second explosion that resulted was attributed to the delivery of product that had been badly stored by the supplier. When the off loading workers unbolted the container, an explosion occurred leading to injuries from the explosion impact. This accident was accompanied by a toxic release exposure that left 5 workers choking. The 5 were rushed to hospital. Besides injury to the workers who missed work days, nothing was destroyed.

### c). Current Capacity Assessment

#### Safety training

Table 13 Table showing a summary of safety training patterns in the chemicals plant

% of untrained respondents	% of trained respondents	% of trained Committee Members	When last trained	Law requirement (Committee members)	% of compliant committee members
42%	58%	100%	33% within a year since the last training 67% between 2-3 years from the last training	Refresher courses be undertaken after 2 years for committee members	33%

As shown in table 13, 42% of the respondents had received training while 58% had not. A fraction of 20% had last been trained 1 year ago while 80% had been trained between

2-3 years ago. All the committee members had received training but 67% of the committee members had exceeded the 2 year margin period given for them to undertake refresher courses. It is only hoped that the 67% who had last been trained over 2 years ago were in the plant's plan to be retrained the same year.

### **Drills**

The findings indicated that only 17% of the respondents reported having participated in a drill while 83% had not. All the 17% were committee members and their drill dates coincided with their training dates. This was an indication that these respondents took part in a drill during their training period only. One portion of the respondents had been trained and participated in a drill in 2005, another did so in 2006 and the remaining group in 2007. This clearly indicates that these committee members had never had an unannounced or a real drill as all these had taken place during training.

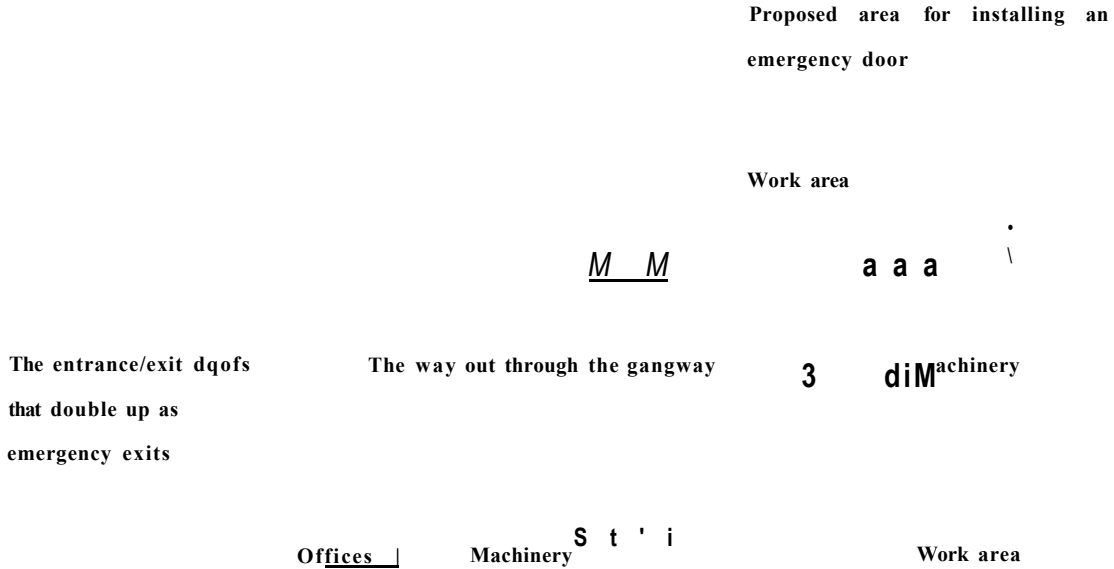
The lack of drills can leave a plant risking its staffs safety and the assets since the absence of practice can introduce panic that can cause workers to forget crucial procedures such as turning off machines.

According to the Seattle fire department ( 2007 ) fire or other safety drills can make the difference in helping employees know what to do when the hazard occurs. Drills should also be scheduled and conducted during all shifts and for all employees and can be pre-announced or unannounced. However, only the first drills should be announced. This drills are important as they not only ensure that employees duplicate as closely as possible the actions they would take if a catastrophe occurred but they are also the best indicators that during an emergency, evacuation will go smoothly and successfully. It is also from these drills that workers gain knowledge and confidence to escape safely without having to panic.

### **Emergency exits**

Though the plant had clear gang ways, it was operating with one main door which doubled up as a product reception and dispatch door. The same door was used as the emergency exit as illustrated in diagram 4 following.

**Diagram 4 An aerial view of the chemicals plant reflecting on the state of emergency exits**



From the diagram above, the distribution of the work area can be seen as concentrated more towards the back of the plant. Though the plant had clear gang ways, in the event that the source of the hazard was originating from the direction of the main door, then no doubt the occupants of the building would be trapped in.

The key informant however relayed plans to have an emergency door installed in the future as represented by symbol 'X' in the diagram. As the workers wait for its installation, they will have to put up with the possibility of getting trapped in the event that there is product being dispatched at the time when an emergency evacuation is taking place, or should the source of the disaster be from this main door.

### **Locking in workers**

From the findings, this plant did not lock in its workers as they worked. Since the plant did not have sufficient air suckers, the main door had to remain open at all times to ensure that there was sufficient air circulation to avoid dust accumulating in the working area.

### **Communication systems**

At least 2 modes of communication would be efficient in the production area to be used for communicating during emergencies. However, the chemicals plant did not have even one direct mode of communication. The absence of a direct communication means such as VHF radios exposes the plant to possibilities of experiencing difficulties and delay as they wait for connection of their calls. A variety of communication systems for communicating during disasters or emergencies exist that they can choose from.

The US Justice programs department (2006) provides guidance on this.

According to the department, communication equipments during emergencies can be seen as either wired or wireless. The major advantage of wireless equipments such as radio frequencies (RF) like VHF radios and walkie-talkies over wired such as radios and computers is their ability to provide communications over large distances, through obstacles depending on the frequency and to an almost unlimited number of users. Due to their uniqueness among users, they are also hardly subject to saturation by users. On the other hand these wireless equipments have the disadvantage of having communication interfered with from the atmospheric disturbances and high level broadcast equipments. These RF systems do not also pass through water and the transmission quality begins to deteriorate as the edge of the coverage area is approached. Wired systems are also secure as compared to wireless in this case RF systems as they are confined to wired network and maintain privacy. They are also comfortably usable underground unlike wireless systems that will need to be tuned on ground level to get reception.

To come up with a comfortable communication system, picking equipment from both categories such as a landlines and VHF radios would work best combined.

### **Safety equipments**

The plant had 10 portable fire extinguishers, 1 hose reel, 2 scrubbers, and 2 enclosures to collect any spilled products. Though the law is not open on the number of equipments that different workplaces should have, these equipments were almost sufficient considering that the plant had invested in 2 50litre extinguishers. However, since the workers of this plant were open to the possibility of toxic exposure due to the much dust in the production area, the plant should have considered the introduction air suckers as

well. At the time, the dust was causing choking (the researcher remembers coughing from dust inhalation) and a toxic exposure could be a slow onset disaster. The plant should have also considered a mass storage of water in the event that there is shortage of water supply to the hose reels.

#### **Fire detectors**

The plant had no fire detector. A fire detector is not only essential but a requirement by law. Without a fire detector a fire can start in the night when no one is in the plant's vicinity and be discovered only when it has grown and caused a lot of damages that are more costly than the cost of installing the fire detector.

#### **Fire alarms**

The chemical plant had 2 battery powered fire alarms. Battery powered alarms have lesser chances of power interruption as with electric powered ones. Nevertheless, if they are not checked regularly, they have the likelihood of failing when they are needed most. To assess if the respondents could identify the sound of the emergency alarm, they were asked to tell the difference between the fire emergency alarm sound and the time check alarm that the plant was using. Apparently, this plant had done a good job of explaining to the respondents the difference because all except one respondent could tell the difference. Having worked in the plant for 4 years, it can only be assumed that this respondent was either ignorant of safety issues or had never attended safety meetings.

#### **Emergency exit maps**

This plant did not have any emergency exit maps. Again like other plants that did not have one displayed, this plant faced the risk of getting workers confused during evacuation since exit maps do not always point at one direction for evacuation but provides alternative routes in case one route is unusable. Even worse, as earlier findings indicated, only committee members among the respondents in this plant reported having participated in a drill. This means that the workers did not have both evacuation information by way of exit maps as well as practice through drills. In such a situation, the most visible reaction cropping from the lack of prior familiarization and the knowledge

of what to do is either to act on guess work or panic. Such reactions are likely to damage the courage of even those that may be put for the response. According to NFPA (2001) individuals tend to function similarly to those they are with during the emergency. If an individual panics, then those around him or her are likely to do the same. Prior orientation to a situation or important information such as the exit maps or by way of drills is therefore of essence to eliminate or deal with such reactions.

### **Collaborations**

This plant had not entered into any form of collaboration with any plant for assistance in case their resources were overwhelmed during an emergency situation. The only form of formal collaboration the plant had entered into was with Cosmos hospital located on Lunga Lunga road a short distance from this plant. While it is a good arrangement with the hospital, having to send workers to the facility could perhaps be avoided if the plant concentrated on first entering into emergency resource collaboration among other measures such as the installation of an emergency door. With such collaborations, there possibly would be no casualties in the first place.

### **Feel safe or not**

In this plant 67% of the respondents indicated that they felt safe as they worked while 33% did not. Reasons given for feeling safe included the existence of safety equipments, spacious working environment, personal protective equipments, wide exits and safety training offered. Reasons for not feeling safe included the lack of emergency exits and the use of dangerous chemicals such as corrosives and powders.

## THE LPG PLANT

### a). Hazard Identification

The nature of business for the LPG plant included product reception, storage of LPG gas, repackaging and dispatch. The plant was faced with the possibility of a fire, explosion and toxic release. These accidents were possible in the product reception and refilling stage.

### b). History of hazards incurred and damages

Since the plant moved to a new location about 2 years ago, only 2 accidents had been reported. Apparently this was the only plant with an accident data sheet displayed. From the data sheet, the 2 accidents had occurred 644 days ago as at December 2007. They involved 2 workers who suffered a twisted arm as they off loaded containers. The 2 had first aid applied. No other damages were incurred.

### c). Current Capacity Assessment

#### Safety training

Table 14 A summary of the safety training patterns in the LPG plant

% of untrained respondents	% of trained respondents	% of trained Committee Members	When last trained	Law requirement	% of compliant committee members
6%	94%	100%	Within a year from the time the research was conducted: 80% Over 2-8 yrs ago: 20%	Refresher courses be undertaken after 2 years for committee members	20%

As shown in table 14 above, an overwhelming 94% of the respondents in the LPG plant were trained in safety. Only 6% were not trained. All committee members had also been trained. Those committee members who had last been trained 1 year ago made up 80% while the remaining 20% had received training over 2-8 years ago. While it is remarkable that 94% of the respondents had received training, it was established that one of the

respondents was last trained 8 years ago. The respondent worked as a tank man operator and perhaps due to the strategic role he played in the plant could not afford to be absent from his work area. Apparently, he had joined the plant 9 years ago and received training only at the time he had joined the plant.

Training and refresher courses play the important role of informing trainees on ways to prevent, respond and revive safety knowledge acquired from fading away. Training is therefore of essence and should never be an exception to anyone who works in the plant. As long as one is within the plant, they are open to risk just as everyone else is.

### **Drills**

All the respondents of this plant had participated in a drill. Drills in this plant were held once every month. This shows good effort to safety, but it is also hoped that the drills were not just treated as drills owing to their monotony but that every time they were held they reflected the possibility of a real emergency. According to the Pasadena fire department (2006) once the drill is over, everyone should gather together to discuss any questions and problems that occurred during the drill. If any irregularities are noted, the drill procedures should be redesigned and changes communicated to make the next drill even more effective. If this is what happens during every drill and that the response time keeps improving or is satisfactory, then the drill can be said to be successful.

### **Emergency exits**

The LPG plant production area had 4 emergency exits. They were also clearly labelled in green as per the new requirements by law ( from the traditional red label that was often misconceived to indicate danger) and indicated the direction of evacuation. Since it involved the use of stairs, they were also protected to prevent falling over.

### **Communication systems**

The plant relied on 6 VHF radios as direct lines of communication to the production area with 5 working and 1 waiting repairs. VHF radios are reliable for use during emergencies due to their low likelihood of interruption from the public and the media as they try to seek information. They can also cover distances of between 5-50kms. Their portability



also ensures that they can be used away from the risk area. They do however have some disadvantages in that they cannot function underground and have to keep being tuned to catch the right frequency. They have also been known to collect noise as the distance widens and have no privacy in that multiple persons can listen at the same time. For such reasons therefore, at least 2 modes of communication are recommended to back up one another in case one mode fails or is unsuitable for the information being relayed. One affordable direct mode that can complement these disadvantages of VHF radios are landlines. The telephone landlines for instance can work comfortably underground and distance does not affect the clarity of reception. They also have privacy as they are restricted to wired network. They in turn cannot be mobile as VHF radios are and are open to congestion by the outsiders.

The US Justice programs department (2006) has given guidelines on the factors to keep in mind when choosing a communication system to use during emergencies. They include consideration of the maximum output power of the transmitter that does not shorten the battery life, secure communications compatibility meaning that the equipment can easily transmit signals on encryption, access to programmability, user compatibility i.e. support different types of users, line of sight or freedom from obstructions, battery life and its locking ability, mobility options, digital compatibility, durability, the unit cost even after buying, operating skill requirements and lastly training required to operate the communications system.

While most workplaces will opt for landlines as the direct mode of communication due to their affordability and use for business as well, they have the disadvantage of possible congestion from outsiders. They also depend on wired network, meaning that the destruction of wires presents the possibility of breakdown in communication.

Using the above guidelines, safe options can be reached by the plant in choosing an alternate direct communication to back VHF radios in the event that they failed.

### **Safety equipments**

The plant had 10 portable fire extinguishers, 3 sets of sprinklers, 2 fire water tanks of 1030m<sup>3</sup> both combined, a manual diesel fire pump of 450m<sup>7</sup>h, 7 fire hydrant outlets and 4 sets of fire fighting gear. This plant had made good effort in installing safety equipments. It was the only plant with fire fighting gear.

### **Fire detectors**

The LPG plant had 3 fire detectors but they were installed in the office and not in the production area. Fire detectors should have been installed in the working yard as well particularly considering the high ignition level of LPG gas. The importance and necessity of fire detectors in the factories and other places of work has been noted by the Factory Act in Section 28 part 1 and 3. (see earlier section under fire detectors).

In their installation, fire detectors act as early warning systems (EWS). According to Carlos (2006) EWS are able to measure, forecast and warn on a threat so that it is quickly responded to before it gets out of hand. Without a fire detector therefore, the plant occupants are left with the option of having to physically sight the fire with the hope that there will be time enough to prevent it from spreading and become unmanageable.

### **Fire alarms**

The LPG plant had installed 2 manual alarms; one located at the working yard and the other next to the offices. While this arrangement is good since the alarms can be operated away from the danger area, manual alarms have the disadvantage of going off should the alarm controller be forced to clear from the scene in the face of danger in the event that they are not portable.

To assess the knowledge of the respondents on the fire alarm, the respondents were asked whether they associated the sound of the alarm with danger. From the findings, all except one did associate the sound with danger. This respondent did not think that the alarm signified danger but that it was just a signal for the workers to evacuate. Since this is the only alarm that was heard in the plant, the question on differentiating the different alarms sounded did not apply.

### **Emergency exit maps**

This exit map was displayed in the production area and another copy was available with the security personnel at the gate. A fire exit map was also displayed in the working yard of the plant. Besides this, the plant had gone a step forward to display a simple exit map at the back of every visitor's badge and simple steps to take in case the alarm is sounded. This showed great commitment to safety and preparedness for any disasters or accidents.

### **Collaborations**

In order to get backup help during emergencies in case the LPG plant was overwhelmed, it had entered into formal resource collaborations with Kenya Pipeline, Kenya Shell, National Oil, Nairobi Joint Depot and Oil Com. They also had an unwritten agreement with the Fire brigade. This is good effort since all these plants were in the neighbourhood and would provide quick response before the fire brigades arrival. With 5 plants on standby, it would be likely that the Fire brigade would find the emergency already arrested.

Below is a photograph of the researcher assessing the plant

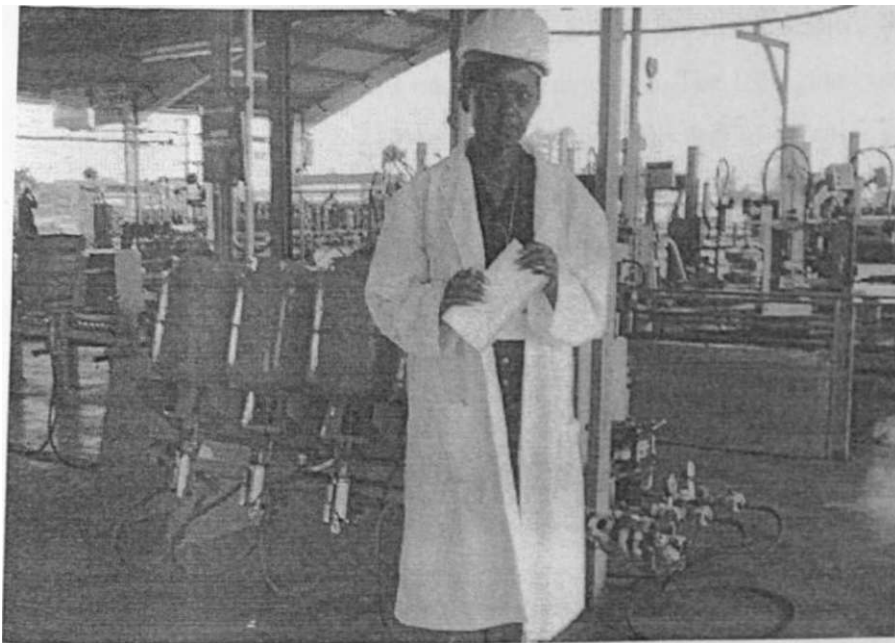


Photo taken from the field in 2007

### **Conclusion on VCA of all the plants in total**

Having looked at the capacity of each plant individually, a summary of the capacity assessment for all the plants combined shows that while safety training is recommended by the Factories Act, only 53% of all the respondents had undergone some form of safety training leaving 47% as never been trained. The law also goes ahead to recommend that safety committee members be trained formally and undergo refresher courses at the least within 2 years. A 100% compliance to this was seen only in the paints and the steel plant. The joint oil depot reported 40% compliance, 33% in the chemicals plant and 20% in the LPG plant. The plastics plant recorded 0% compliance. In total, only 49% of the respondents were compliant.

Drill assessment indicated that 49% of the respondents had at one time participated in a drill. This drill results reflected contrasting results with a 100% participation recorded in the LPG plant compared to the paints plant at 0%. This is contrary to Section 23(1) of the Factories Act which stipulates that every workplace should conduct drills at least once a year. Drills go hand in hand with emergency exits since it is during drills that workers become familiarised with not only the exit procedures but also the emergency exits to use. Section 42 of the Factories Act gives guidelines on emergency exits and recommends at least 2 emergency exits in a work area be installed. Based on this, only the LPG and the plastics plant had emergency exits. The LPG plant was fully compliant, while the plastics plant only had one exit that sadly led to a power supply transformer which in itself was a possible trap in the event that it too became a source of danger.

Locking in of workers as they work was another issue assessed. This is prohibited by the law as it leaves workers with no source of escape during emergencies. Findings however indicated that this is rampant in our industries. From the 3 plants (the chemicals plant, the plastics and the paints plant) that did not work in an open yard, 52% of the respondents reported being locked in as they worked with the main reason being attributed to theft prevention both internally and externally.

Having a means of communication during emergencies was another important factor considered. The presence of direct lines to the production area is important for fast and efficient communication during emergencies. The plastics, the paints, the steel and the LPG plant each had 1 direct mode of communication. This included landlines for the

plastics and the paints plant, mobile cell phone for the steel plant and VHF radios for the LPG plant. The joint oil depot plant had 2 direct modes of communication. These were VHF radios and landlines. Having 2 modes puts a plant in a better position in the event that 1 mode should fail. Assessed also were safety equipments. While the law is not specific on the equipments recommended for different plants, 2 plants had invested heavily in this. They included the joint oil depot and the LPG plant. Other plants had almost satisfactory equipments while others were below sufficient equipments. The fire extinguisher was the most common equipment present, perhaps owing to its mention by the law. Another equipment mentioned in the law is the fire alarm. Of the 6 plants, only the steel plant did not have a fire alarm having broken down in 2005 while the LPG plant had manual operated alarms. That of the chemicals plant was battery powered while that of the paints and the joint oil depot plant were electric powered. Only the plastics plant had an alarm with an auxiliary power supply. It was both battery and electric powered. Without an auxiliary power supply, alarms may fail when they are needed most. Manual alarms if immobile may also be abandoned for a moment if the operator is open to risk. If workers have to respond to these alarms appropriately, it is recommended that emergency exit maps be displayed either by hanging or within the reach of workers. From the findings, only the LPG and the joint oil depot plants had exit maps. The same plants also happened to be the only ones that had entered into collaborations with other companies for response resources in case they are overwhelmed during catastrophes. Other plants relied on the fire brigade as their source of help during emergencies. However, the fire brigade in itself is already overwhelmed in the first instance faced by many challenges such as operating below the international standards for a fire brigade and therefore not the most reliable point to place all hopes.

One plant however did stand out in enforcing safety. This was the LPG plant. Among the outstanding issues included the conduct of drills, the availability of emergency exits, all except one respondent was untrained in safety and was the only plant that had fire fighting gear, an accident data sheet displayed and had an exit map placed at the gate reception for use by any external emergency responders. In close range though not as good as the LPG plant was the joint oil depot. This plant had invested heavily in response

equipments though it fell short in some of the other areas. Both plants were also the only ones that had entered into collaborations and had the longest serving safety committees. These plants as the researcher later came to learn may have been so because they also faced pressure to enforce international safety standards from their mother countries if they had to operate. It can be concluded then that local safety standards are not treated with the seriousness they deserve.

#### **4.5.1 Challenges in Mitigating, Preparing and Responding to hazards that contribute to vulnerability**

As it was noted, ensuring adequate mitigation, preparedness and response measures in order to reduce vulnerability in the work place can be a challenge. In order to ensure that workers' work in a safe environment, there must be someone willing to implement the measures. A response was therefore sought from the key informants on the factors that limited them in the course of implementing measures in the workplace. The following problems were noted.

##### **Mutual Aid Association**

Mutual aid or plants collaboration in the case of a hazard occurrence was noted as a challenge. From the key informant, collaboration is not backed up by meetings to ensure good associations during disaster emergencies. This means that the agreements are mainly on pen and paper but may later turn out to be unworkable during emergencies. As noted from those plants that had emergency collaborations, most of the companies they collaborate with are mainly those in the immediate neighbourhood and which apparently could be rivals in competition. As such, regular meetings to renew the association and relationship (which was lacking) was necessary to ensure that safety was not compromised especially if the plants had been involved in rough rivalry in the course of doing business.

##### **Drill response time**

Drills are important as they ensure that procedures to apply in the case of accidents or emergencies are well understood by those at risk. However, it was been noted that the same drills can be a problem in themselves. Due to the frequency and timing of most drills, workers had become lax on responding and as relayed from the key informants, response time which is of essence and which should be improving with every drill called had tended to lag the other way. Response had become slower with workers assuming that every time the alarm was sounded it was the usual drill. The following case study represents such a case.

### Case study 1

On one of my visits to the field, a fuel depot sounded an alarm. Close to the gates were parked a long line of fuel tankers waiting to reload from the immediate neighbouring plant. As is expected, the vehicles should have been turning back from the danger area to avoid multiplying and causing a secondary hazard. However, such an expected reaction that comes with the sound of an alarm was not reflected.

Except for a few onlookers who rushed to peep the vicinity, the drivers who apparently have been trained on safety (as was relayed in one of the interviews) did not seem moved. It appeared they had grown used to the drills. When contacting one of them, he responded, "*aah, ni He maioezi wanakuwanga nayo* [well, it's the practice (drill) they normally have]". Worth noting is that the alarm went off when the researcher was at the said place and did not notice any communication made to the drivers on what was happening in the said plant for them to conclude that it was "just" a drill. It was clear they too had grown accustomed to the drills..

### **Training of permanent versus Temporary/Casual employees**

Training of permanent as compared to temporary employees on safety was noted as a challenge. As was eminent, it was more preferential to train permanent employees since they were likely to stay in the plant longer as compared to temporary employees. As it came out clear, it was financially and time straining to invest so much in training an employee only to have them leave and the same investment be repeated on another employee. This was therefore noted as a challenge and perhaps a good way of explaining the low count from the findings on trained casuals.

### **Language and Literacy levels**

Low literacy levels were identified as a challenge. Though literacy levels can be dealt with when it comes to employing at different levels such as in the office administration areas, the same may not always apply in the production area. One factor noted was with temporary employees such as those who are outsourced for defined periods or doing manual work that was more physically than mentally involving. One case was identified where drivers who came to the production areas to load product were not easy to communicate with, with some being from outside Kenya such as Somali. While it was of



dire need to communicate to them on safety due to their open potential to danger or even being a possible danger to themselves and others, language stood out as a challenge.

### **Ignorance**

This was overwhelmingly noted as one challenge in most plants. It was identified that most workers did not see the need to observe the safety measures put in place especially if they felt they could achieve the same end through a short cut. It was noted that most of the time some workers tended to have a don't-care attitude, often compromising on safety.

### **Cost of training**

Safety training conducted for workers according to the law rests solely on the employer. This training has to be conducted through trainers appointed by DOHSS. With the law making it mandatory for committee members to undergo the training, it was felt that the cost was quite expensive. From the key informants, training other workers internally was just as expensive especially if it involved hiring external trainers. This was an outcry for the government to intervene and subsidise safety training costs.

### **Cost of Installing Safety equipments**

The cost of installing safety equipments was noted as being quite high. In one plant, a vacuum sucker was greatly needed but could not be installed because it was too expensive, likely to cost the company over fifty thousand shillings. A similar complaint was aired from another plant where the fire alarm was destroyed in 2005 after heavy rains and was never reinstalled or repaired citing high costs.

### **Lack of space in case of an accident**

In order to avoid multiplying accidents during emergency alerts, it is of essence to have ample space where workers can easily evacuate without either scrambling for space, trampling or falling over objects. However, this is one of the challenges noted in the plants. In some plants, the production area was too squeezed where from the gang ways, an arm's length could mean touching adjacent machines.

The lack of adequate space or what the law refers to as crowding elevates the danger of multiplying a hazard.

#### **Proximity of the fire brigade**

Although there is a fire brigade station at the industrial area, problems of delay were cited as a challenge when called to assist during an accident. However, this should not have been a problem if plants were willing to collaborate with those close to them who have the resources for help in times of emergencies.

#### **Bribe soliciting by safety Inspectors**

It was noted that some of the health and safety inspectors were a challenge to plans on mitigation, preparedness and response measures in the plants. Safety inspectors were cited as soliciting for bribes instead of playing an advisory role to the none compliant plants such as giving them the grace period required by law to ensure their implementation of the health and safety requirements.

#### **Drug abuse**

Drug abuse was noted in one plant as a threat to safety. Some of the respondents felt that these drug addicts created a risk both to themselves and to others and that management should have investigated this as they posed risk in the production area. According to Feldman (2000) the most commonly abused drugs which include narcotics such as heroin, morphine and hallucinogens such as cannabis, marijuana, hashish and hash oil are mainly used to reduce pain and create relaxed inhibitions. However, they have also been known to cause disoriented behaviour, apathy, slowed speech, decreased physical activity, drooling, itching and nausea among others. They also cause reduced concentration.

Such persons under the influence of drugs who have impaired concentration are a risk to safety in the workplace especially considering the even adverse effects of overdose such as exhibition of bizarre and dangerous behaviour as well as paranoia and confusion.

## **CHAPTER FIVE: SUMMARY AND RECOMMENDATIONS**

### **5.1 The Summary of Findings**

This was a Vulnerability and Capacity Assessment with the aim of establishing the vulnerability levels of industrial plants at Nairobi's industrial area. Below is a summary of the findings:

#### **5.1.1 Awareness levels of the respondents**

To be well equipped with knowledge in safety, workers ought to know what they are exposed to, how to respond to it, what to respond with and where to turn for their safety. For this reasons, safety awareness levels of respondents was assessed based on their knowledge of the hazards they were exposed to, their knowledge on response to the different hazards they faced, safety equipment knowledge and use and their ability to identify emergency exits.

Findings revealed that only 21% of the respondents were well aware of the hazard risk they faced while 46% of the respondents who had encountered an accident did not know how it was countered. While all the respondents were at the least able to name a safety equipment in the production area, only 41% had been trained or oriented on their safe use. It was further established that only 2 plants had emergency exits. The other 4 plants relied on the normal entry and exit ways that doubled up as emergency exits.

#### **5.1.2 Safety Structural Changes that have taken place in the Industrial Plants**

After 2002, DOHSS was made an independent unit in the ministry of labour and given more powers to enforce more compliance in workplaces. The main organ in the workplaces set up under the factories Act is the Health and safety committees which act as the backbone of safety in the workplace, and being a representative body for all workers is charged with handling health and safety issues affecting the workers.

These safety committees are expected to strictly follow the safety programmes recommended by DOHSS in the end of which each committee member is issued with a certificate and is required to get refresher courses between 1-2years. These committees

are also charged with the responsibility of passing down safety knowledge to other workers not in these committees. Though such change has been slow coming, compliance to safety committees has been adopted. While only 2 of the plants examined were found to have operated for about 30 years, the rest had between 8-10 years in existence. These two plants despite existing for over 30 years had about 10 year old committees with the rest having between 3-1 Vi year old committees. This is despite the law recommending the existence of safety committees since 1951.

Findings revealed that all safety committee members had been formally trained at one time on safety and acquired certificates though the compliance to undertake refresher courses did not automatically follow. It was however evident that not as much effort had been put in training the rest of the workers. It was established from the findings that 53% of the respondents had received safety training while 47% had not.

It was also noted that a variety of safety equipments were installed in different plants. Despite this, not all the necessary equipments were present in all the plants and variations were noted with one plant having more than another. Due to the lack of clear guidelines by the law on the recommended safety equipments and their numbers, safety inspectors are left partially handicapped when recommending what is to be installed.

To further improve safety in the workplace and reduce the vulnerability of workers, different plants had plans for the future. They included setting up a better budget and allocating more funds to safety, introduction of more fans and air suckers in the work area and the product storage areas, plans to conduct more and extensive training for workers on safety in different areas such as disaster emergency response, the introduction of a drainage to restrict spilt products, the installation of an instant shower to be used by workers incase they had chemical spills on their body or on clothing, plans to purchase an ambulance instead of relying on personal vehicles to rush workers to the hospital, a full time nurse for the production area, purchase of missing equipments such as fire alarms, clearance of gangways to facilitate easy movement especially during emergencies, the

installation of safety signs and lastly, identification of fire points as well as the display of exit maps.

### **5.1.3 Factors Contributing to the Vulnerability of Industrial plants to Hazards**

On identification of the vulnerability levels of elements at risk, the following major reasons were established as the contributing factors to their vulnerability:

- The lack of safety awareness among workers.
- Low knowledge of equipment use.
- The lack of emergency exits and inadequate training on safety.
- Poor drill participation.
- Locking in workers as they work.
- The lack of collaboration.
- Ignorance among workers.
- The lack of adequate space in case of an emergency.
- The high cost of training committee member.
- The high cost of installing safety equipments.
- Selective training of workers.
- Drug abuse among workers.
- Distance of the fire brigade and
- Soliciting of bribes by safety inspectors.

## 5.2 Recommendations

Lives have been lost, property destroyed and people injured through the occurrence of industrial accidents. With the industrial sector being a major contributor to the growth and sustenance of our economy, it is of essence to made recommendations that will lead to its further strengthening and reduce its vulnerability to destruction. Dangerous and vigorous activities are carried out every day in the industrial plants that make the reality of an accident's likelihood even more real.

It is on this basis therefore that the findings of this study make the following recommendations that will assist in strengthening the capacity and reducing the vulnerability of industrial plants to hazards.

1. Employers need to take employee training and sensitization on safety seriously since it does not benefit the workers as a whole if their supervisors are and committee members are thoroughly trained, yet the rest of the workers do not benefit from this knowledge. The same kind of knowledge should be passed down in-discriminatively to both casual, temporary and permanent employees. Though possibilities of casual turnover are higher than permanent, employers should look at the long term gains of training them, since these very casual employees might end up being the eventual cause of a costly accident. Such knowledge that should be passed down includes equipment use, the importance of drills, and the importance maintaining safety in the workplace. This way, ignorance which was cited as a challenge to safety will have been dealt with.
2. The Directorate of occupational health and safety should enforce regulations on buildings that do not meet the status of a factory requirement. This way, it will avoid the exposure of elements at risk to the imminent danger where workers cannot easily evacuate the hazard area for reasons such as a crowded working area and the lack of emergency exits. Specifications according to the Factories Act should also be followed, such as in ensuring that emergency exits promote safety by e.g. opening outwards or being slide doors, labelled, and not a hazard in themselves.

3. Employers should also reduce the risk open to workers by locking exits from outside, leaving workers with no way out in case of emergencies or accidents. Though there is the claim of locking in employees on the basis of security, employers should be ready to explore other avenues such as the hiring of security persons or alternatively installing security monitoring equipments such as CCTV, but whatever the case, the safety of workers should not be compromised over property.
  
4. Employers should be sensitized on the need for collaboration. While the fire brigade can be consulted when there is an accident, the distance between them and the element at risk as well as other factors are likely to serve as a hindrance to their response. Currently, there are just 3 fire brigade stations in Nairobi. One at Ruaraka, another at the industrial area and the third one at the town centre. Each fire brigade is supposed to serve a maximum of 200,000 people which clearly is not the case as Nairobi alone has a population of 3 million people. With its services already overstretched, it is therefore of essence that employers collaborate with other companies that could have the equipments they lack for the sake of quick and effective response.
  
5. Drills are not a choice, and more so, they should be conducted at least within every 12 months as required by law. As such, employers need to understand that drills are the only exercise that can evaluate the existing contingency plans, as well as correct the weak points in a timely manner since the same cannot be done during real emergencies. It is also during such drills that workers get to practice the real event and learn from it without having to make costly mistakes.  
With this too should come the display of exit maps.
  
6. Employers should refrain from giving bribes to safety inspectors to cover up for unsafe practices. No employer should be willing to trade the safety of his or her employees with bribes. Any employer who is enticed to give bribes to inspectors

should seek legal redress for the same or launch a complaint with the Kenya Anti Corruption.

7. The government should work out a plan to make safety training affordable as well as reduce the cost of safety equipments to ensure that they are within the reach of workplaces as much as possible.
8. A law should be formulated to be specific on issues such as safety equipments required per working area. This could be specified depending of factors such as the number of employees per working area, or after an assessment by an appointed officer or inspector to evaluate the intensity of activity or likelihood of a hazard. With the findings, they can now come up with a checklist for the same.
  - The law should also give clear guidelines on general response procedures for explosions and toxic releases. While the law gives guidance for different hazardous materials, there are no clear guidelines as those that exist for fires. Warnings such as those displayed for fires should be recommended and enforced for toxic releases as well as explosions.
9. Employers should be keen on workers they employ as they may turn out to be a source of risk both to themselves and to others they work with in the workplace. This mainly touches on employees who work under the influence of drugs.



### **5.3 Areas for Further Research**

The study conducted a Vulnerability and Capacity Assessment of Industrial plants in Nairobi's industrial area.

In future, it is recommended that further research of the same nature be carried out in other major towns and particularly in those plants that are not registered under the Directorate of Occupational Health and Safety Services, such as those considered for this research whose registration meant that they had a level of compliance to safety.

Research may also be conducted in the area of proper working gear and protective equipments required for workers in different production areas.

As was further noted, there also seemed to be a higher level of compliance to safety in plants that were affiliated or that worked as branches of international companies as compared to those that were just locally founded. Knowledge on safety also seemed to be higher in these plants.

Further research in these areas would serve to further inform this area of study and serve as a base for understanding the state of safety in our industrial plants and therefore encourage the implementation and practice of safer industrial practices.

## SUMMARY TABLES

**Table 15 A summary of the hazard profile of each plant**

Plant	Nature of Business	Stages in Production where a disaster is possible	Hazard
Joint Oil Depot	Reception and storage of fuel products and dispatch	Loading/dispatching product	Fire
LPG Plant	Reception and storage of LPG gas, repackaging and dispatch	Receiving product and re-filling	Fire, explosive materials and toxic release
Steel plant	Smelting of metals, casting and twisting to finished products	Smelting of metal	Fire and explosive materials
Plastics Plant	Melting of plastics, reshaping printing to finished plastic wrappers	Printing and melting	Fire and toxic chemical releases
Chemicals plant	Formulating chemicals to come up with agro chemicals and fertilizers	Chemical formulation	Toxic releases
Paints plant	Preparation and production of paints and paint associated products	Product formulation	Fire and flammable materials

**Table 16 Safety equipments present in every plant and their numbers**

	PLANT TYPE	Paints plant	Chemicals plant	LPG Plant	Joint oil depot	Steel plant	Plastics plant
	POSSIBLE HAZARD	Fire and flammable materials	Toxic releases	Fire, explosive materials and toxic release	Fire	Fire and explosive materials	Fire and toxic chemical releases
<b>EQUIPMENT TYPE</b>							
Portable Fire extinguishers		6	10	10	12	9	11
Hose reel			1		3		5
Foam systems					2		
Water systems like sprinklers				3 sets	2 sets		
Water curtain					4		
Fire water				2 tanks	2 tanks		
Fire hydrant points				7			
Fire warning systems							
Fire detectors					1		
Smoke detectors		4			25		
Gas leakage detectors							
Toxic chemical release protection equipments							
Flares							
Scrubbers			2				5
Absorbers							2
Enclosures			2		1		
Fire fighting gear				4 sets			

**Table 17 Showing a summary on the nature of collaboration for each plant**

<b>Plant Name</b>	<b>Nature of collaborations</b>	<b>Items for collaborations</b>	<b>Name of companies</b>	<b>Physical location</b>	<b>Plants physical location</b>
Steel plant	None				
Joint Oil Depot	Written/formal	Foam, Personnel, VHF Radios	Oil Libya, Kenya Shell. Oil com, NOCK, Kenya pipeline	Wundanyi Road-off Nanyuki Road	Wundanyi Road-off Nanyuki Road
Paints plant	None				
LPG Plant	Written/formal	Water, fire fighters	Kenya pipeline, Kenya Shell. National oil, Nairobi joint oil depot. Oil com	Tanga Road, immediate neighbours	Tanga road
Plastics Plant	None				
Chemicals plant	None				

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## APPENDIX 1

### Questionnaire for Plant Supervisors

My name is Elizabeth W. Mukora. I am carrying out a study on the Vulnerability and capacity assessment of industrial plants at the Industrial area. The study is in partial fulfillment of a degree course in the sociology of disaster management at the University of Nairobi. Your contribution in filling the questionnaires will be highly appreciated. All information provided will be treated with confidentiality. Thank you.

### VULNERABILITY AND CAPACITY ASSESSMENT TOOL

#### INDUSTRIAL AREA

#### PHYSICAL ADDRESS

<b>HAZARD PROFILE</b>	Where or in what stage of processing are these materials used?	Have these materials ever translated to a disaster or an accident?	When did it occur?	What were the effects? (e.g. injuries, deaths, losses)
Fire and flammable materials				
Explosive materials				
Toxic materials				
<b>STAFF PROFILE</b>	Permanent Number	Temporary iNumqci	number	Designations
Skilled				

Semi skilled				
Area of Skill				
TYPE	available	Number working	Number needing repair	Date Last tested
Portable Fire extinguishers				
Hose reel				
Foam systems				
Water systems Like sprinklers				
Fire warning systems				
Fire detectors				
Smoke detectors				
Gas leakage detectors				
release				
Flares				
Scrubbers				
Absorbers				
Enclosures				
Alarms systems				
VHF radios				
Direct Lines to production area				
!				

Escape routes/exits				
Are the exit maps displayed?*				
Any Other equipments available that are related to emergency response				
<b>COLLABORATIONS</b>	Nature of collaborations	Items for collaboration	Name of companies	Physical location
Formal				
Informal				

## APPENDIX 2

### Questionnaire for Production Employees

My name is Elizabeth W. Mukora. I am carrying out a study on Vulnerability and capacity assessment of industrial plants at the Industrial area. The study is in partial fulfilment of a degree course in the sociology of disaster management at the University of Nairobi. Your contribution in filling the questionnaires will be highly appreciated. All information provided will be treated with confidentiality. Thank you.

#### Section A

1. Respondent's Name  
(Optional)

2. Gender    Male [ ]      Female [ ]

3. Age group:

18-25 Yrs [ ]

26-33 Yrs [ ]

34-41 Yrs [ ]

42-49 Yrs [ ]

Over 49Yrs [ ]

4. Education level:      Primary level [ ]      University level [ ]  
Secondary level [ ]      Not been to school [ ]

5. Employment status      Permanent      [ ]  
Temporary      [ ]  
Casual      [ ]

6. What is your job title?..

SECTION 2

7. How long have you worked for this organization?

8. Are you a member of a safety committee? YES [ ] NO [ ]

9. Do you have any form of training in safety? YES [ ] NO [ ]

If YES,

a) What are you trained in?

b) When did you receive the training?

10. Which of these disasters are possible in the plant?

a) Fire disasters.....[ ]

b) Disasters related to explosion disasters.....[ ]

c) Disasters resulting from dangerous gas exposure... [ ]

d) I don't know.....[ ]

11. In the course of your work, have you ever witnessed:

a) A fire?.....Yes [ ] No [ ]

b) An explosion?.....Yes [ ] No [ ]

c) A dangerous gas exposure?.....Yes [ ] No [ ]

(a) If YES, how was it dealt with?

12. Which safety equipments do you know of in the plant?

13. Do you know where the safety equipments are located? YES [  ] NO [  ]

If YES, where?

14. Do you know how to use the safety equipments? YES [  ] NO [  ]

If YES, how did you learn? (i) Through training .....[  ]

(ii) Personal Interest.....[  ]

(iii) I have seen them being used....[  ]

16. While you are working, is there any time when the doors are locked from outside?

YES [  ] NO [  ]

(a) If YES,

When are they locked?

Why?

17. ~~How would you differentiate~~ How would you differentiate between an emergency or danger alarm and any other alarm sounded in the organization?

18. Would the sound of an alarm in the premises signify danger to you?

YES [ ]      NO [ ]

Why

19. Have you ever participated in an emergency drill? YES [ ]      NO [ ]

If YES, when and how many times?

20. Do you feel safe while working in the plant? YES [ ]      NO [ ]

Why?

21. What suggestions would you make to improve safety in the plant?

**THANKYOU FOR YOUR COOPERATION**

## APPENDIX 2

### **Questionnaire for the Health and Safety Manager**

My name is Elizabeth W. Mukora. I am carrying out a study on the Vulnerability and capacity assessment of industrial plants at the Industrial area. The study is in partial fulfilment of a degree course in the sociology of disaster management at the University of Nairobi. Your contribution in filling the questionnaires will be highly appreciated. All information provided will be treated with confidentiality. Thank you.

### **Section A**

1. How long have you had a safety committee in operation?
2. What is the safety programme inclusive of?
3. How often is safety training of staff done?
4. What do you suppose is the highest hazard risk in the organization?
5. Which safety equipments have been installed in the plant?
6. What hazards are these safety equipments suppose to mitigate or respond to?
7. Have you ever experienced an accident involving a fire, explosion, or gas leak in the plant?
8. What are the major challenges in mitigating, preparing, or responding to such accidents?
9. What future plans do you have to improve on employee safety?

**THANKYOU FOR YOUR COOPERATION**



## **APPENDIX 4**

### **Training curriculum for work place safety and Health committees**

# REPUBLIC OF KENYA

Ministry of Labour and Human Resource Development

## TRAINING CURRICULUM FOR WORKPLACE SAFETY AND HEALTH COMMITTEES

The Factories and Other Places of Work (Safety and Health Committee) Rules LN No. 31/2004

Directorate of Occupational Health and safety Services



**DOHSS vision is a healthy worker in a safe workplace**

DOSH8

## TRAINING CURRICULUM FOR OCCUPATIONAL SAFETY AND HEALTH COMMITTEES

### Preamble

This curriculum has been developed for the purpose of ensuring uniformity, consistence and standardisation of the scope and content of the occupational health and safety training for the workplaces Safety and Health Committee members. Every trainer approved under the Factories and Other Places of Work (Safety and Health Committees) Rules, Legal Notice No.31 of 2004, shall strictly adhere to this curriculum.

### 1. Occupational Safety and Health Management

#### Safety and Health Management

2V<sub>2</sub> HRS

#### Contents:

- Elements of safety management
- Elements of safety policy and effective implementation
- Worker participation
- Motivation for safety enhancement
- Management of change
- Role of training
- Performance monitoring
- Administrative elements of the Factories and Other Places of Work Act Cap 514 including:
  - ^ Registration of workplaces
  - ^ Documents required to be kept under the Act
  - > Mention existing subsidiary legislation
  - > Powers of occupational safety and health officers
  - > Prohibition notices
  - > Improvement notices
  - > Offences relating to contraventions under the Act
- Health and safety committee rules 1 HRS
  - > Formation of Committees
  - > Organisation of the committee
  - > Functions and duties of the committee
  - > Meetings and minutes of the committee
  - > Roles in the committee
  - > Duties of the occupier
  - > Duties of registered safety and health advisers
  - > Training of the committee
  - > Health and safety audit
  - > Offence in relation to audits and other offences

- Occupational accidents 1 1/2 HRS
  - > Dangerous occurrences as defined under the seventh schedule in the Factories and Other Places of Work Act, Cap 514
  - > Evacuation and emergency response
  - > Economic importance of accident prevention
  - > Accident investigation techniques
  - > Accident analysis and classification
  - > Accident reporting
  
- Personal protective equipment (PPE) 1 HRS
  - > Type of PPE
  - > Personal hygiene in the use of PPE
  - > Maintenance of PPE
  - > Criteria for selection
  - > Training & education on correct use of PPE
  - > Demonstration on proper usage of PPE
  
- Safe work procedures 1 7/2 HRS
  - > Job hazard identification and analysis
  - > Importance of Operational Manual information
  - > Safety precautions with practical examples
  - > Permit to work
  - > Role of training
  - > Performance monitoring
  - > Work in confined spaces
  - > Ergonomics
  
- Workplace inspection techniques 2 1/2 HRS
  - > Types of inspections
  - > Preliminary preparation of the inspection
  - > Executing the inspection
  - > Data analysis and report writing
  - > Implementation of the findings
  - > Use of check lists
  - > Hazard spotting - practical
  
- 2. Occupational Safety
  - Machinery safety: 1 1/2 HRS
    - > Meaning of Machinery:
      - Prime Movers;
      - Transmission machinery
    - > Hazards associated with machinery
    - > Mechanical hazards;

- > Types of motions of machinery parts
- > Machinery safeguards
  - Guarding of dangerous parts of machinery
  - Protection against electrical hazards;
- > Training inexperienced workers;
- > Safe use of hand tools
- > Wood working machinery rules
- > Eyes protection Rules

• **Construction Safety** 1 1/2 HRS

Contents:

- > Overview of building operations and works of engineering construction rules
- > Excavations
- > Scaffolding
- > Formwork
- > Roof work
- > Ladders
- > Demolition
- > Work under & over water
- > Tunnelling
- > Explosives
- > PPE
- > Hazards and their prevention

• **Docks rules for ports and harbours L N. No.306/1962** 1 1/2 HRS

- > General provisions on board ship
- > General provisions in conducting the processes
- > Special duties

• **Plant Safety** 1 HRS

- > **Meaning of Plant:**
  - **Pressure vessels including:**
    - ^ Steam boilers
    - ^ Steam receivers
    - ^ Air receivers
    - / Cylinders for compressed, liquefied and dissolved gases;
  - **Lifting machines including:**
    - ^ Cranes and other lifting machines
    - / Hoists and lifts
    - ^ Lifting tackle
- > Hazards associated with plants
- > Examination of plant
- > Maintenance of plant and preventive measures

**Fire Safety****1 1/2 HRS**

- > Causes of fire
- > Prevention of fire
- > Fire prevention policy
- > Ways of controlling the spread of fire
- > Classes of fire
- > Fire fighting equipment
- > Emergency response preparedness and evacuation procedures

- **Electrical Safety**

**1 HRS**

- > Electrical equipment
- > Electrical hazards;
- > Static electricity
- > Electric Power Special Rules L.N. No.340/1979

**3. Occupational Hygiene**

- **Chemical safety**

**1 1/2 HRS**

- > Classification of chemical agents (dusts vapours, fumes gases, mist)
- > Mode of exposure to chemical agents;
- > Overview of effects to chemical agents exposure;
- > Control measures to chemical hazard exposure;
- > Overview of exposure limits
- > Importance of Material Safety Data Sheets (MSDS)

- **Workplace health hazards**

**2 HRS**

- > Identification of workplace health hazards prevention and control
  - Physical agents
  - Chemical agents
  - Ergonomics factors
  - « Biological agents
  - Psychosocial factors

- > **Methods of controlling workplace hazards**

**1 1/2 HRS**

- Local exhaust ventilation systems (Lev)
- General ventilation systems
- Engineering controls
- Isolation
- Substitution
- PPE

**Occupational Health**

- **Occupational diseases**

**\* 2 HRS**

- > Definition of occupational diseases

- > Prescribed occupational diseases in Kenya
  - > Factors contributing to occupational diseases, prevention and control
  - > Investigation of occupational diseases
  - > Medical examinations and work involving risks to health
  - > Role of occupational health services at the workplace
- (
- **Stress at work** **1HRS**
    - > Definition of stress
    - > Causes and prevention of stress
    - > Signs and symptoms
    - > Effects of stress
    - > Coping mechanisms
    - > Role of the employer in stress prevention
  
  - **First Aid Management** **1 H R**
    - > Definition of First Aid
    - > Role of First Aiders at workplace
    - > First Aid Rules -LN 160/1977
    - > Emergency procedures and preparedness**3 D**
  
  - **HIV/AIDS Awareness** **1<sup>1</sup>/<sub>2</sub>HRS**
    - > Definition of HIV/AIDS
    - > Mode of transmission and intervention methods
    - > Demography of HIV/AIDS
    - > Signs and symptoms
    - > Effects of HIV/aid
    - > Prevention measures of HIV/Aids
  
  - **Alcohol And Drug Abuse** **1<sup>1</sup>/<sub>2</sub>HRS**
    - > Definition of Drug abuse/Drug dependence
    - > Classification of drug of abuse
    - > Factors contributing to drug abuse
    - > Effects of drug abuse
    - > Preventive strategies and interventions

**Take note that: The Time allocated for this course shall not be less than thirty • (30hrs) contact hours.**

## FIRST AID TRAINING CURRICULUM

## Preamble

This curriculum has been developed for the purpose of ensuring uniformity, consistence and standardisation of the scope and content of the first aid training at workplaces. Every training firm or institution approved under the Factories and Other Places of Work (First Aid Rules LN 160/1977) shall strictly adhere to this curriculum.

## CONTENTS

<b>1</b>	<b>Bleeding emergencies and Treatment of minor injuries</b>	<b>2 hours</b>
	<ul style="list-style-type: none"> <li>• Nose bleeding</li> <li>• Arterial bleeding</li> <li>• Bleeding from injured veins</li> <li>• Internal bleeding</li> </ul>	
<b>2</b>	<b>Management of amputated</b>	<b>1.5 hours</b>
	<ul style="list-style-type: none"> <li>• Fingers</li> <li>• Hand</li> <li>• Arm</li> <li>• Toes</li> <li>• Foot</li> <li>• Leg</li> </ul>	
<b>3</b>	<b>Management of fractures</b>	<b>2 hours</b>
	<ul style="list-style-type: none"> <li>• Neck and skull fracture</li> <li>• Jaw fracture</li> <li>• Limbs fractures</li> <li>• Rib fractures</li> <li>• Vertebral column fractures</li> </ul>	
<b>4</b>	<b>Eye Injuries</b>	<b>2 hours</b>
	<ul style="list-style-type: none"> <li>• Foreign object in the eye</li> <li>• Perforation of the eye</li> <li>• Cut on the eye</li> <li>• Allergies from contact with chemicals</li> <li>• Contact with corrosive chemicals</li> <li>• Injuries due to radiation</li> <li>• Heat burn</li> <li>• Injury from a blow</li> </ul>	
<b>5</b>	<b>Ear Injuries</b>	<b>1 hour</b>
<b>6</b>	<b>Burns and Scalds</b>	<b>2.5 hours</b>
	<ul style="list-style-type: none"> <li>• Chemical burns from corrosive chemicals</li> </ul>	



**DIRECTORATE OF OCCUPATIONAL HEALTH AND SAFETY SERVICES**

7	Unconsciousness	2 hours
	• Causes and treatment	
8	Cardio-Pulmonary Resuscitation	2 hour
9	Gassing emergencies	1.5 hours
10	First Aid to people with special problems	2 hours
	• Asthmatic persons	
	• Epileptic persons	
	• Diabetic persons	
	• Hypertensive stroke	
	• Obstetrical emergencies	
11	Ingestion of corrosive and toxic substances	1 hour
12	Lifting and carrying casualties	1.5 hours
13	Precautions to be taken against contracting Hiv/Aid while giving First Aid	1 hour
14	Requirements under the First Aid Rules -LN 160/1977	1 hour
15	Shock	
	Causes and treatment	1 hour
16	Animal and insect bites	1 hour
17	Emergency preparedness and response	1 hour
18	Examination and testing	
	• Written	1 hour
	• Orals and practical	4 hours

**Take note that: The Time allocated for this course shall net be less than thirty (30 hrs) contact hours.**