PROSPECTS AND CHALLENGES OF SAFETY

EVALUATION IN AN INDUSTRY

(NIGERIAN CEMENT MANUFACTURING INDUSTRY)

BY

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DEDICATION

This project is dedicated to the Highest God. For He alone is my rock and my fortress, and for His sake alone, he lead and guided me throughout my years of study.

Also, to my lovely parents, chief and Mrs, A.R.K. Agunbiade and my brothers and sisters, Kolawole, Oluwaremilekun, Kolapo and Simisola.

CERTIFICATION

This is to certify that this project titled PROSPECTS AND CHALLENGES OF SAFETY EVALUATION IN AN INDUSTRY: NIGERIAN CEMENT MANUFACTURING INDUSTRY was carried out by AGUNBIADE KOFOWOROLA YETUNDE under the supervision of DR. J.O. ODIGURE and submitted to the chemical engineering Department, Federal university of Technology, Minna, in partial fulrfillment of the Requirements for the Award of Bachelor of engineering (B.ENG.) Degree in Chemical engineering.

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Project supervisor **Signature and date.**

DR. J. O. OGIGURE ....
HEAD OF DEPARTMENT **Signature and Date**

....
EXTERNAL EXAMINER **Signature and Date.**

DECLARATION

This project work is entirely my effort and My original work, and to the best of my knowledge has never been submitted anywhere, this I declare.

AGUNBIADE KOFOWOROLA YETUNDE

....

Signature and Date

ACKNOWLEDGEMENT.

Giving thanks is the bane of life. There are many people in this my endeavour, though too numerous to mention that have contributed towards the carrying out of this project or have rendered and appreciable support and assistance during my sojourn in this ivory tower.

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Abstract.

The safety of a cement industry is said to be of great concern to the safety experts of this industry and also its employees.

In carrying out the study, consequence analysis was used as a final decision – making tool for a safety study. Dust, which is the top-event was being investigated with other parameters which include: Number of accidents and its rate of occurrence, types of these accidents, Air – flow and Emission rates, Kiln Shell temperatures.

From the study, it has shown that considerable time and money is lost due to downtime (lost hours) and in compensation payment to employees. Investigations revealed that large emissions of cement dust and limestone are daily plunged into the atmosphere along with secondary emissions from combustible gases, an action that constitute great nuisance to the society.

The consequences of these action if not properly handled could lead to various health hazards such as the respiratory – track diseases and skin diseases. These easily result in lost hours of production and sometimes litigation expenses.

Due to the expense of these consequences, the management of safety in the industry cannot be left alone to employers, but also the employees. Also, in ensuring a high safety level using old designs and machineries is the most challenging responsibility of the company and the safety manager in particular. This can be achieved through proper planning, organizing, executing and controlling a uniquely designed program that moves the organisation towards safety and health objectives.

CHAPTER ONE

INTRODUCTION

Everyone desires safety and everyone should support it. Yet, it is sad that almost everyone takes safety for granted whether in the home, on the road, at work location or even during recreation until an accident occur. This could have been awided. However. Assuring safe and healthful working conditions is becoming an increasingly important responsibility of an organisations industrial engineering personnel.

An accident maybe defined as an unplanned, uncontrolled and unexpected event that result in nearly resulted in or had the potential to result in inviting or other damages. Considering the causer of a young secondary school leaves, who was aiming for a university education, got employed into an industing as a factory workmen for the sake of gathering make fund, only to end up having all his fingers amputated, theseby dashing his hopes for a higher degrees. If the person were you, how would one feel?

Nevertheless, the occuance of the accident explained by Heinrich (Heinrich, 1990), is batter understood using other the " sequential" or "domino" theory. This theory states that "... the natural cumulation of a serves of events or circumstances. One is dependent on another and one follows another, thus constituting a sequence that maybe compared with a row of dominos pleased on end and in such alignment in relation to one another that the fall of the first domino precipitates the fall of the entire row". This theory explains how and why accident prevention programs works i.e. that prevention stops the "accident sequence" by removing one of the factors that leads up to it live. An unsafe act or unsafe condition). The factors in the Heinrich sequential depliction originally portrayed as dominos are:

(a) Ancensity and social environment

(b) Fault of the person

(c) An unsafe act/or unsafe mechanical or physical environment.

(d) The accident

(e) The injury.

Safety can therefore be defined as a state of mind, an idea implemented by a constructive attitude that causes to recognize dangerous situations before an accident occurs. However, it has been generally accepted that the immediate causes of accidents relate to unsafe acts and physical

physical conditions. The acceptance of these beliefs led safety practitioners to focus almost entirely on training people not to commit unsafe acts, accepting the reality that the unsafe conditions exist and will remain uncorrected.

In recent years, hazards prevention by engineering design or re –design has been promoted alongside liability litigation and third –party liability actions in occupational accidents. In more and more accidents, it is being recognized that the designs of machines, equipment, processes and workplaces have all been contributory causes. The negligent party maybe the equipment manufactures, employer, job designes or safety engineer. The price paid maybe in the form of medical costs, lost production – time, higher insurance premiums or straight cash to an injured party.

No wonder, in most industries today, the slogan. "safety first and Always" are common. In the Nigerian cement manufacturing industries, various forms of pollution occur, the most visible being the dust. Many of these industries though aware of the great hazard posed to the society, Do not try to curtail dust emissions. The cleaning technologies used are still the same as from the inception of production. Unfortunately, most machineries used have been left unchanged, and their efficiency have reduced.

The high maintenance cost for the existing machineries, further complicates the prospects of ensuring high safety level. Therefore, the challenges of avoiding identifiable hazards in the cement industry requires thorough understanding of both the technological and socio – economic factors.

1.1. OBJECTIVE OF THE PROJECT:

The objective of the project include:

(a) To investigate the safety situation in the Nigerian cement industry.

(b) To determine the current state of safety management efforts

(c) To identify future challenges.

1.2. SCOPE OF THE PROJECT:

The scope of the project is based on the Nigerian cement manufacturing industries designed using the wet – processing technology at the west African Portland cement company (WAPC), plc shagamu, works, Ogun state.

1.3.LIMITATION OF THE PROJECT:

The limitation of the project include:

(a) Improper documentation of collected dates.

(b) Management of the company wanting to divulge necessary information's needed.

CHAPTER TWO

LITERATURE REVIEW

2.0 WHAT IS CEMENT:

Cement is an hydraulic bonding agent used in the building construction and civil engineering. It is a fine power obtained by grinding the clinker of a clay and limestone mixture, calaried at high temperature. When water is added to cement, it becomes slurry that gradually hardens to a stone-.like consistency. It can be mixed sand and gravel (coarse aggregates) to from motor and concrete.

There are two types of cement: the natural cement and artificial cements. The natural cements are obtained from natural materials having cement –like structure and require only calcining and grinding to yield hydraulic cement powder. Cements are available in large and increasing numbers. Each type has a different composition and specific merits and uses. Cements may be classified as Portland cement and aluminous cement.

2.1 ANALYSIS OF RAW MATERIALS:

By Jefferson (1978), the basic ingredients for Portland cement consists of limestone, sea shells, marks or chalk that provide calcareous components; clay, shale slate or sand to provide the silica and alumina contents, iron-ore, mill scale or similar material to provide the iron components. The number of raw materials required at any one plant depends on the composition of these maenads and the type of cement being produced. To affect the proportions adjusted as they are blended. A typical composition of the various raw material used are presented in table 2.1.

TABLE 2.1 TYPICAL COMPOSITIONS OF CEMENT RAW MATERIALS

CHEMICAL COMOSITION RAW MATERIALS	CaO	SiO2	Al2O3	Fe2O3	MaO	Loss
Limestone	52.0	5.7	0.1.8	0.3	0.4	40.4
High – silica limestone	33.6	36.8	1.8	0.6	0.5	26.4
Cement rock	40.0	18.0	5.0	1.5	2.0	32.0
Blest furnaces slay	35.5	33.1	9.1	0.9	164	2.1
Shale	3.2	53.8	18.9	7.7	2.2	13.1
Sand	0.8	70.0	15.0	5.0	0.2	8.6
Clay	0.5	61.0	16.9	12.4	0.4	7.8
Iron ore	-	6.7	1.4	89.7	0.4	0.2
Street – mill scale	-	2.5	1.1	89.9	-	4.0

Peray, kint. E. (1986) Pg. 116 " the Rotary kiln"

2.2 PRODUCTION OF PORTLAND CEMENT:

The Portland process which accounts for by far the largest part of worlds cement production comprises of two stages: clinker manufacture and clinker grinding. The raw materials used in clinker manufacture are calcareous materials and argillaceous materials such as clay. The raw materials are blended and ground either dry (dry process) or in water (wet process).

In the wet process, soft materials are converted to slurry with water in a wash mill. This involves rigorous agitation. The fine materials in suspension passes through a vertical screen (a perforated plate containing 6mm holes at the sides of the tank against which it is thrown.

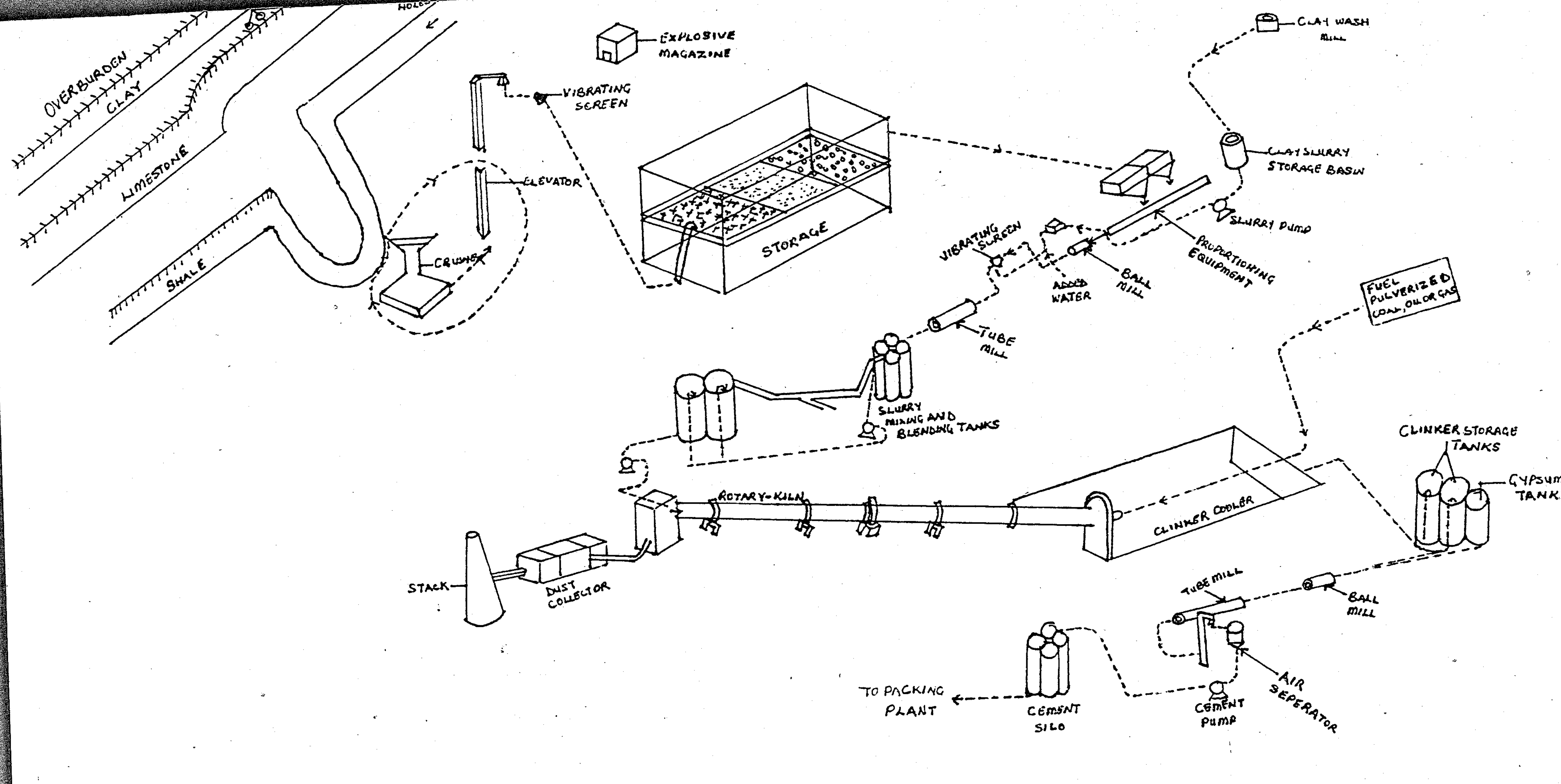
The pulverised mixture is calcined in an inclined rotary kiln at a temperature raining from 1400^0c-1450^0c. In the wet process, the kiln has to first evaporate the water in the slurry, then decomposes the clay materials ($300 - 600^0$ c) and limestone, $CaCO_3$ (80-900^o C) and finally levates the temperature of the mixture to produce the partial fusion necessary to complete linkering. On leaving the kiln, (Alite), the main ingredient of Portland cement to bicalciuim ilicate (Belite) and calcium oxide, and the polymorphism of B – bicalcium silicate to – icalcium silicate.

The lumps of cooled clinker are often mixed with gypsum, which is used to control the etting-time and other properties of the cement. Finally, the clinker is ground in the mill, creened and stored in silos, ready for packaging and despatch.

The chemical composition of the ordinary Portland cement (O.P.C) is presented below in able 2.2

TABLE 2.2 COMPOSITION ORDINARY PORTLAND CEMENT (O.P.C.)

hemical composition of O.P.C.	GRAY		WHITE
	CEMENT(%)	CLINKER(%)	CLINKER (%)
ilica (SiO_2)	18 – 24	21.7	23.8
lumina (Ai_20_3)	4 – 8	5.3	5.0
on iii Oxide (fe_20_3)	1.5 4.5	2. 6	0.2
alcium oxide (CaO)	62 – 67	67.7	70.8
agnesium oxide(MgO)	0.5 – 4.0	1.3	0.08
otassium oxide (k_2o)	0.1 – 1.5	0.5	0.03
odium oxide (Na_2o)	0.1 – 1.0	0.3	0.03
ulphates (so_3)	1.3 – 3.0	0.7	0.06



ISOMETRIC FLOWCHART FOR THE MANUFACTURE OF PORTLAND CEMENT USING WET-PROCESS TECHNOLOGY.

CHEMICAL COMPOSITION OF OPC	GRAY		WHITE
	CEMENT (%)	CLINKER (%)	CLINKER (%)
Loss on Ignition (LOI)	3.0	-	-
Insoluble Residue (I R)	1.5	-	-
Free – Lime	0.5-1.5	1.5	2.5
Lime saturation factor (L.S.F.)	88 –102	98.4	97.2
Lime combination factor (L.C.F.)	-	96.2	93.8
Silica Ratio (S/R)	1.5 –4. 0	96.2	4.6
Alumina Ratio (A/R)	1.0 – 4. 0	2.7	2.5
Tricalcium silicate, Nite (C_3S)	-	65.4	59.4
Bicalcium silicate, Belite(C_2S)	-	12.9	23.5
Tricalcium Aluminate (C_3A)	-	9.6	12.9
Calcium Alumino – ferrite (C_4AF)	-	7.9	0.6

2.3 SAFETY ANALYSIS

According to Howard (1983), safety of processes is accomplished in finial analysis, through two associated categories of process accident prevention measures. One of the categories can be classified as hardware, which relates to equipment and layouts while the other is the software which, pertains to standards, guides and procedures to be used.

However, purpose of the safety study can be carried using various methods, these methods of analysis include:

(a) failure – mode and effect Analysis

(b) cause – consequence Analysis

(c) Hazard operability study (HAZOP)

(d) Fault trees

(e) Event trees

2.3. FAILURE MODE AND EFFECT ANALYSIS (FMEA).

This is a bottom– up process where the traces indicting events forward through the system to their finial effects. Results are usually presented in table, which can become unmanageable where cause and effects are not directly related. Time sequences and interactions between different parts of the system can also difficulties. Although, it is a useful precursor to construction of fault logic diagrams, it does however not explain and produce a model for its quantification.

2.3.2. CAUSE – CONSEQUENCE ANALYSIS:

This analysis includes elements of risk analysis. With regard to the physical effects the advantage of following the cause through to its effect nut however minimising disadvantages by adopting diagrammatic presentation, with a symbolism similar to that used in fault trees. It also allows the representation of sequences and time delays. It can be used fairly directly for quantification.

2.3.3 HAZARD AND OPERABILITY STUDY (HAZOP).

According to Odigure (1998), it is a technique used mainly for safety review at the design stage and in operating plant particularly before modifications. However, as a technique, it is time consuming and requires attention of senior safety personnel while its assessment is subjective and qualitative in probability and scope.

2.3.4 FAULT TREES:

By views expressed by Daniels and Holden (1983), they are the best known and most widely used technique for developing failure logic. It main process is done has first of all selecting an undesired "top- event" and trace back to the possible causes which can be component failures, human errors or any other events that can lead to the top event.

2.3.5 EVENT TREES:

By Odigure (1998), event trees follow initial event through to possible causes of the system failure.

They are usually in a binary state system but can be used for multi- outcome states. It is however difficult to represent interactions between even state and a separate tree will be required for each initiating event.

2.4 CONSEQUENCE ANALYSIS

Consequence for the undesirable event. It is used to characterize and determine potential accidents.

The purpose of consequence analysis is therefore to act as a finial tool in discussion making of a safety study. These include by Opschoor and Schecker (1983) as:

- Description of the system to be investigated
- Identification of undesirable events
- Estimation of the possibility of the occurrence of these events.
- Determination of the magnitude of the physical effects which results
- Determination of the damage.

At the end, the results obtained can be useful for many people and institution especially in aiding then to understand the vicinity of their abode and hoe safe the technology being used is:

2.5 HAZARDS ENCOUNTERED

Nigeria has about mine cement plants capable of producing six million tones per year. The main hazard of these industries is dust. The dust level which ranges from 26 – 114mglm^3 were measured in quarries and cement works. For individual processes, the following dust levels were reported according to the international labour organisation (ILO) office:

Shale / clay extraction: 41.4 glm^3

Raw materials crushing and milling: 79.8 mg/m^3

Sieving:	384 mg/m^3
Clinker grinding:	140 mg/^{3}
Cement packing:	256. 6mg /m^3
Loading e.t.c. :	179.0mg/m^3

No wonder, these particulate emission into the atmosphere is said to have killed hundred of palm trees in Ogun state in 1986, with the Bendel cement company Ukpilla Edo state, and the Ewekoro cement works in Ogun state cited as high emitters of particulate (Environmental Dept. 1988).

In modern factories using wet – process technology, 15 –20mg particles per m^3 are occasionally the short-time dust values (ILO Encyclopaedia). Air pollution of these neighbourhood is usually about 5 –10% more compared with the initial environmental level. This pollution is caused mainly by the emission of CO, SO_X, NO_X and smaller quintiles of hydrocarbons, aldehydes, ketone from the rotary kiln, cement mill sections. These gases are emitted from the various reactions that occur in the rotary kiln while the dust level is quite high at these sections including the packing plant section. These however can be reduced through the use of electronic filters. The free silica content of dust usually varies between the raw materials and clinker or cement from which all the free silica will normally have been eliminated.

Noise, is one of the major problems faced by millions of employees currently working in factories all over the would, when exposed to the high noise level, there is bound to be hearing loss. The cement factory is not an exception. Worker at the milling section and especially kiln platforms are continuously exposed to these risk. Hearing loss can result from:

- From high-pressure wave sound: for example, an explosion. The pressure waves have a high peak value ranging from 160-180 d B_A, which causes rupture to the eardrum.
- From prolonged exposure to noise level of much lower intensity than those required to cause the permanent damage to the delicate hair cells sensors located in the cochlea. This action brings about progressive and permanent loss of hearing occurring over a period of 10 years.

Pathological condition encountered here cannot but be emphasised.

The packing/loading areas of the factory are probably the works hit of this condition. The dust particles stick to their skins there by blocking the skin pores that allow the flow of air (oxygen) in and out of the skin for a healthy skin growth. These in tune causes various skin diseases such as eczema for the employees. Also, the inhalation of these dust particles causes enormous effects on the lungs of the individuals, there by causing respiratory track diseases and digestive disorders

High ambient temperatures, especially near the furnace doors and platforms, are witnessed. This heat which later becomes radiant heat raises the temperature of its surrounding some degree Celsius higher. These make the vicinity quite hot and cases of burns can not be neglected.

2.6 ACCIDENTS:

Peray (1986) defined accidents as any unintentional or unexpected interruption of orderly progress of the work. Accidents do not happen. An accident is as a result of some unsafe acts or equipment. In quarries, accidents are due, in most cases to falls of earth or rock, or during transportation. In cement works, the main type of accident injuries are bruises, cuts and abrasions that occur during manual handling work; serious accidents are rare.

2.7 SAFETY AND HEALTH MEASURES:

A basic requirement in the prevention of dust hazard in the cement industry is a precise knowledge of the composition and especially of the free silica content of all materials used. Knowledge of the exact composition of newly developed types of cement is important.

Dust, which exist generally as one of its most problematic environmental issues however can only be reduced minimally by the use of nose-masks. In quarries, excavators should be equipped with closed cabins and ventilation to ensure pure air supply and dust suppression measure should be implemented during drilling and crushing. Also, the possibility of poisoning during blasting may occur and can be prevented by ensuring that workers and machineries are at suitable distance during short-firing and do not return to the blasting point until all fumes which are nitrogenous compounds have all cleared. Suitable protective clothing maybe necessary to protect workers against inclement weather.

All dusty processes in the cement works (grinding, sieving, transfer by conveyor baits) should be equipped with adequate ventilation systems and conveyor belts carrying cement or s raw materials should be enclosed, special precautions being taken at conveyor transfer oints. God ventilation is also required on the clinker cooling platforms, for clinker grinding and ement- packing plants.

The most difficult dust control problems is that of the clinker kiln stacks which are sually flitted with electrostatic filters, preceded by a bag or other filters. Ground clinkers hould also be conveyed in enclosed screw conveyors.

As in the case of noise inside the work boundary, most of the problems involved can be onsidered at the design stage or before new machineries is installed. According to force, R Blue circle publication, 1978), the following points should be considered, however for each nstallation.

1) Regular noise surreys of the proposed site both day and night prior to construction to accurately quantify the noise level.
2) Ensuring that areas of maximum noise levels are physically as far from the boundary as possible.
3) Considerations of natural screening of noisy areas by other areas of lower noise level.
4) Installation of noisy machinery in buildings of high mass to control noise breakout.
5) Limitations of noise breakout from buildings by the reduction in area of doors, windows e.t.c and where possible they should be cited away from sensitive areas.
6) Avoidance of noise sources at high level wherever possible.
7) Selection of quiet machineries from manufacturers and the inclusion of maximum noise limits in purchase specifications.
8) Regular noise surveys during construction and afterwards to ensure continued efficiency of adopted measures.
9) Where possible to build works away from major areas of population

(10) After construction, ensure that production staff can carry out good housekeeping duties (i.e. closure of doors and windows) with the minimum effort particularly at night.

He further stated that in implementing this, the long or short – term approach could be used in trying to protect employees. The short- term approach is solved mainly by using suitable ear defenders i.e. ear-muffs while long-term approach involves fitting of proposed designed silencers for each item of plants or purpose designed enclosures or barriers to either contain or control noise breakout.

Fan noise, which is a prevalent problem. The use of silencers in the fan offers about 10 – 15 dB_A reduction when employed in practical installations and are particularly effective when the fan to be silenced has a mid to high frequency noise problem. Another source of noise problem is the mill house. Partial endures and barriers of quite simple construction have also been employed for the control of noise. The use of simple wooden barrier between the mill is and mill control room has achieved a reduction of 11d B_A on the quiet side of the barrier.

Hot work points which is mainly on the kiln itself, should be equipped with cold air showers and adequate screening should be provided. Repairs on the rotary kiln have to be cooled adequately before being worked upon by young, health workers. These workers should be kept under medical supervision to check their cardiac, respiratory and sweat function to prevent the occurrence of thermal shock. Persons working in hot environments should be supplied with salted drinks when appropriate.

Those working at the packing plant are probably the best hit in terms of skin diseases and internal inflammatory disease. Apart from inhaling the cement (which is only minimised to a very little extent by nose – masks), the cement sticks to their skins. These however can be prevented by ensuring that the provision of shower baths and barrier creams be provided for then after showering. Desensitisation treatment maybe applied in cases of eczema.

Other measures being implored include:

(a) Training of employees for safety awareness.

(b) The federal Government putting the laid down regulations guiding then into full compliance like the factions Act 1990, in order to be certain of their safety standards

(c) Employers should provide insurance schemes for its employees.

(d) Technical research and investigative case studies to be carried out at intervals.

2.8 TECHNICAL PROSPECTS.

Whether wet or dry process, dust still remain the main problem faced by these great industry. The dust, which mainly comprises of clay dust (calcium carbonate) and the cement dust. These two modes can however be minimised. The clay dust, which is normally collected below the flap- gate of the rotary kiln, can be recycled back into the rotary kiln or be made into synthetic gypsum by reacting it with sulphuric acid. The other dust, which is obtained mainly after the grinding of the clinker and gypsum, can also be collected by the use of good and efficient electrostatic precipitators. The dust from the ESP in turn can therefore be collected with the aid of a screw conveyor back to the grinding mill. This action would definitely bring about less air pollution to the area.

2.9 CONCLUSION.

Every one desires safety. However, the general safety of the cement technology cannot be overlooked. Though, nose-masks, ear-muffs, head helmets, safety boots are all provided, the general safety awareness impact is yet to be fully established especially in the employees.

according to the International Labour Organisation (ILO) and the international standards organisation (IS0) standards.

Safety measures being implored by these industry can therefore be evaluated through the use of statistical values of accidents and injuries incurred over a period of time using the consequence analysis since it is a finial decision tool for safety study. It would aid in determining the extent of physical and human damage. It would also help to alert the employees and the people living in the neighbourhood to know how safe the technology being used is and also, enabling the industry to get information about all the known and unknown effects that are of importance when something goes wrong in the plants and getting information on how possible to deal with events.

The wet – process technology of cement production can be quantified by means of mathematical methods. Since there are however no calculation model that is available for a specific situation, the use of the regression analysis and correlation comes in handy since the extent of the safety for a span of five (5) years needs to be known, thereby creating an equation to know future consequences of each parameters measured in the nearest future.

CHAPTER THREE

METHODOLOGY.

3.1. THE COMPANY

The West African part land cement company, WAPC, PLC Shagamu works was commissioned in May 5, 1978. They produce the "Elephant brand" of Portland cement, with a present capacity close to one million tonnes per annum. The Shagamu works, which uses the wet – process technology as against the Ewekoro works, which is designed, using the dry – process technology.

3.2 TYPES OF DATA

There are several types of data that may be used to quantify rise in order to know its safety level. They include:

3.2.1 Accident Data:

The information available is often limited to historical records at the time. It is particularly based on eye – witness reports, which could be extremely subjective if the sources of information are unreliable and procedural methods, are not observed.

3.2. 2 Incident Data

These are information based on the organisations extensive investigations into the cause of incidents. They are often difficult to obtain due to official secrecy.

3.2.3 Reliability And Event Data:

Reliability data are based on the probability that the system performs as the designer intended. Event data is however, very expensive to collect and often takes a long time to elapse, before a statistically viable sample has been collected.

3.3 DATA COLLECTION

The aim of data collection is to produce a model or tool that can be used for comparison of different industrial activities. This enhances risk analysis in the best way. Developed model helps to identify trends, to increase knowledge on probabilities verifying effects and vulnerability models.

Unfortunately, for many data collections, which involve taking multiple measurements it is not uncommon that same measurements are missing on some individuals, such data often present a major problem and could seriously affect the reliability of developed model. In order for this problem to be handled, three main strategies were developed. These include:

(a) Discarding all individuals with missing values.

(b) Using all the partially observed data

(c) To full in (impute) values for any missing entries in order to produce a complete data matrix.

For this project, the type of data collected include:

(a) Total number of accidents and hours lost in the various departments of the company.

(b) The breakdown of the type and occurrence of these accidents

(c) Emission rate and Air–flow rates of the dust particles.

(d) The kiln-shell temperature.

These data were collected from the company personnel, technical and production department. They were data stored in log –sheets and computers.

3.4 DATA ANALYSIS

For the analysis of the data obtained for safety purposes, a mathematical model was developed on the accident statistic recorded over a period of five years (1995-1999).

3.4.1 ACCIDENT STATITICS

For the modelling of these values, a regression model was developed. A regression model used for the analysis of data is the one in which the expected value of the one variable, called the response variable, is related to the actual of the other variables called the explanatory variable. The model, which comes in form of linear, logarithms, exponential, power, inverse, and quadratic regressions. However the linear regression was used for this project.

CALCULATIONS:

The equation for a linear regression is:

$A = + j Y$ .... (1)

Where A = total number of accidents per year.

Y = year in question.

Let $y = Y - \tilde{Y}$

And $a = A -. \bar{A}$ .... (2)

Where $\tilde{Y}$ and $\bar{A}$ are the assumed mean from the given data of the year and total number of accidents respectively.

The normal equation for line regression where the values of j and can be evaluated is:

$\Sigma a = ni + j\,\Sigma y$ ....(3)

And $\Sigma ay = i\Sigma y + \Sigma y$ .... (4)

Where n = Number of sample spaces.

TABLE 3.1

Year : Y	1995	1996	1997	1998	1999
TOTAL NUMBER Of Accidents: A	514	502	422	398	268

Thus, from table 3.1, n = 5

=> Equ. (3) And (4) becomes:

$\Sigma a = 5i + j\,\Sigma y$ .... (5)

$\Sigma ay = I\,\Sigma y + j\,\Sigma y$ ....(6)

Since the total number of observations is odd, being equal to 5, for middle observation, $\tilde{Y} = 1997$, so we put y = Y – 1997 .... (7)

And also, $\bar{A} = 502$. So we put a = A – 502 .... (8)

Thus the calculation table assumes:

TABLE 3.2.

Y	a	Ya	Y2
-2	12	-24	4
-1	0	0	1
0	-80	0	0

1	-104	-104	1
2	-234	-468	4
Σ = 0	-406	-597	10

Thus, form equations (5) and (6), substituting in the values,

=> - 406 = 5i .... (9)

And – 596 = 10j ....(10)

Then, i = - 81. 2 and j = - 59.6 ....(11)

From Equ. (i),

a = I + j y

Substituting Equ. (ii) In (i),

=> a = - 81.2 –59.6 y ....(12)

or A – 502 = - 81.2 – 59.6 (Y – 1997)

A – 502 = - 812 – 59.6Y + 119021.2.

A = 502 + 81.2+ 119021.2 – 59.6Y

A = 119442.2 + 59.6Y .... (13).

Equation (13) fits into finding the number of accidents recorded for a given year in that company.

Also, in calculating for the various types of accident that occurred for that period of time:

Percentage occurrence = $\frac{\text{Total occurrence of the type of accident}}{\text{Total occurrence of all the type of accidents}} \times 100$

3.4.2. AIR- FLOW AND EMISSION MEASURAEMENT.

For a span of one hundred and ninety- four days, various measurements in the air – flow rates of the induced draft (I.D) fan and the emission measurements taken at the end of the electrostatic precipitator (ESP) were obtained.

The amount of the dust content thus released into the atmosphere per volume was calculated as:

$$\text{Dust content } (kg/Nm^3) = \frac{\text{The Emission measurement } (kg/hr)}{\text{Air – flow Rate } (Nm^3hr)}.$$

The dust content produced was calculated from those of the rotary kilns and cement mills.

3.4.3 KILN SHELL TEMPRATURE.

The kiln, which has five distinct zones namely:

(a) The cooling zone:

It has its mark from the meter mark to the eighteen-meter mark with a temperature range between 150^0c. to 278^0c.

(b) The burning zone:

This zone starts from the nineteen-meter mark to the thirty- meter mark with a temperature range between 270^0c to 302^0c.

(c) The calcining zone:

This is the zone where the main reactions for clinker formations occur between the thirty-nine meter mark to the eighty-meter mark with a temperature range between 280^0c to 330^0c.

(d) The pre- heating zone:

This zone stretches form the eighty-one meter mark to one hundred and fourteen Meter mark with a temperature range between 260^0c 360^oc

e) The Drying zone:

Its has at own mark from the one hundred and fifteen meter mark to the end i.e. one hundred and fifty- two meter mark, has its temperature range between 39°C-240°C .

However, in the rainy season, the temperature drop across the kiln shell length is about 10^0c. The kiln measurements were however possible with the aid of visual thermometers i.e. pyrometers.

4.1.2. AIR – FLOW AND EMISSION MEASUREMENT RESULTS.

TABLE 4.5. AIR- FLOW EMISSION MEASUREMENT.

Date	Time (days)	Venue	Air flow Rate (Nm^3/hr)	Emission Measurement (kg/hr).
15th Oct. 1999	1	Kiln 1	577, 064.4	3.33.38
27th Oct. 1999	13	Cement mill 1	17,277	2.55
28th Oct. 1999	14	Cement mill 1	16,453.2	2.41
		Kiln 2	744,762.6	43.58
9th Nov. 1999	21	Cement mill 1	29,151	54.01
		Cement mill 2	20,619.6	12.20
20th Nov. 1999	44	Kiln 2	714,768	51.66
		Kiln 1	666,339	278.36
27th Nov. 1999	51	Kiln 1	625,983.6	329.58
20th Dec. 1999	74	Kiln 1	705,804	254.46
23RD Dec. 1999	77	Kiln 2	754,903.2	68.75
13th Apr. 2000	189	Kiln 2	586,867.2	1. 529
19th Apr. 2000	195	Cement mill 1	24,154.2	50.93
		Cement mill 2	18,219	16 .90

Table 4.5 can be expressed in mass per volume and hence, presented in Table 4.6.

Table 4.6 Dust content released between October 1999 and April 2000

Time (days)	Venue of measurement	Dust Content (g/Nm3)
1	Kiln 1	0.58
13	Cement Mill 1	0.15
14	Cement Mill 1	0.15
	Kiln 1	0.059
21	Cement Mill 1	1. 853
	Cement Mill 2	1.592
44	Kiln 2	0.072
	Kiln 1	0.418
51	Kiln 1	0.526
74	Kiln 1	0.361
77	Kiln 2	0.009
189	Kiln 2	0.003
195	Cement Mill 1	2.11
	Cement Mill 2.	0.928

Total Number of Accidents/ Injuries with Hours lost In The various Departments of the cement

TABLE 4.4

YEAR	DEPARTMENT	PRODUCTION	QUARRY	TECHNICAL	MECHANICAL	ELECTRICAL	PROCESS CONTROL	MOBILE PLANT	ADMINISTRATION	TRANSPORT	STORE
1995	NO:- HOURS LOST	283 384	19 8	105 184	28 252	6 104	25 8	41 64	23 248	30 56	30 56
1996	NO: HOURS:	255 1016	22 264	104 344	19 -	– –	22 56	15 –	49 –	31 –	31 –
1997	NO:- HOURS:	198 1209	14 -	79 104	22 152	4 –	25 176	58 224	57 256	5 25	5 24
1998	NO:- HOURS:	177 590	16 -	102 364	22 –	11 –	17 32	25 8	15 112	23 –	23 –
1999	NO:- HOURS;.	24 24	1 -	14 40	– –	5 –	3 128	9 –	3 –	2 –	2 –

4.1.4 KILN SHELL TEMPERATURE

The kiln shell temperature average for a period of two years over the full length of the kiln compiling of its various zones are:

TABLE 4.7 Average kiln shell Temp.

Zone	Mark (m)	Temperature (^{o}c)
Cooling Zone	5	151
	6	250
	7	243
	8	263
	9	260
	10	268
	11	273
	12	273

ZONE	MARK (m)	TEMP. ^{o}C	ZONE	MARK (m)	TEMP. ^{o}C
cooling zone	13	275	calcining zone	67	299
	14	274		68	293
	15	278		69	284
	16	269		70	291
	17	269		71	283
	18	269		72	286
	19	265		73	286
burning zone	20	271		74	280
	21	278		75	279
	22	280		76	281
	23	293		77	281
	24	294		78	280
	25	289		79	276
	26	286		80	271
	27	282		81	267
	28	282		82	262
	29	273	preheating zone	83	264
	30	278		84	264
	31	286		85	255
	32	290		86	253
	33	281		87	250
	34	285		88	109
	35	117		89	245
	36	287		90	237
	37	278		91	244
	38	269		92	250
	39	267		93	246
	40	264		94	250
	41	266		95	249
	42	260		96	245
calcining zone	43	258		97	301
	44	255		98	306
	45	247		99	318
	46	244		100	316
	47	248		101	311
	48	263		102	301
	49	267		103	298
	50	271		104	284
	51	272		105	282
	52	273		106	277
	53	277		107	270
	54	279		108	273
	55	288		109	277
	56	301		110	273
	57	300		111	270
	58	303		112	265
	59	304		113	262
	60	305		114	260
	61	306		115	257
	62	314		116	249
	63	116		117	248
	64	300		118	095
	65	300		119	206
	66	296		120	194

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. RESULTS.

4.1.1. ACCIDENT STATISTICS

The results obtained from the historical data is presented in

Table 4.1 THE TYPES OF ACCIDENT AND OCCURRENCE.

ACCIDENT CCURENCE YEAR	BRUISES ABRASIONS	LACERATION	SPRAIN	SIMPLE FRACTURE	COMPOUND FRACTURE	CRUSHED/HEAD INJURY	BURNS	TRAUMA	DEAT
1995	313	143	24	3	1	-	29	-	1
1996	325	132	14	-	5	2	23	-	1
1997	235	117	35	1	2	8	24	-	-
1998	179	113	29	2	-	3	38	31	3
1999	116	69	35	2	1	7	26	11	1
	1168	574	117	8	8	20	140	42	6

Thus, from the below table, the total accident that occurred or the period of four years is two thousand, one hundred and four (2,104).

The percentage occurrence of each of these types of these types of accidents is presented in table 4.2

TABLE 4.2 ACCIDENT BREAKDOWNS FOR 1995 – 1999

Type of accident	Total occurrence	Percentage occurrence
Bruises / abrasions	1168	55.5
Lacerations	574	27.28
Sprain	137	6.51
Sample fracture	8	0.38
Compound fracture	9	0.42
Crushed/head injury	20	0.95
Burns	140	6.65
Trauma	42	1.995
Death	6	0.285.

The above ratio can be represent using a pie – chart (fig 4.1). The total number of all these accidents occurring during each year is given below is in Table 4.3; and shown using a bar chart in Fig 4.2.

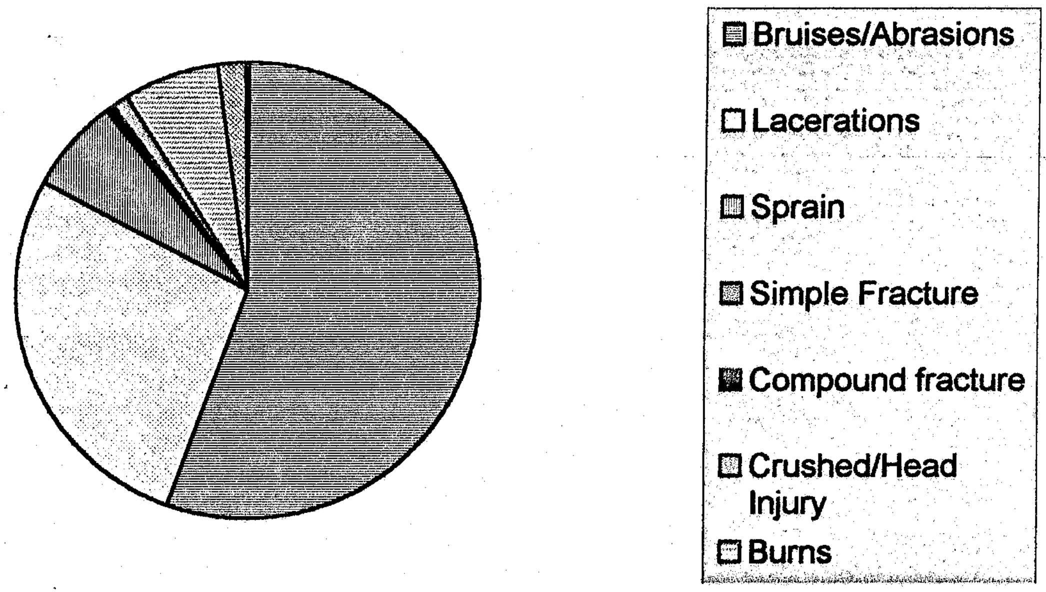
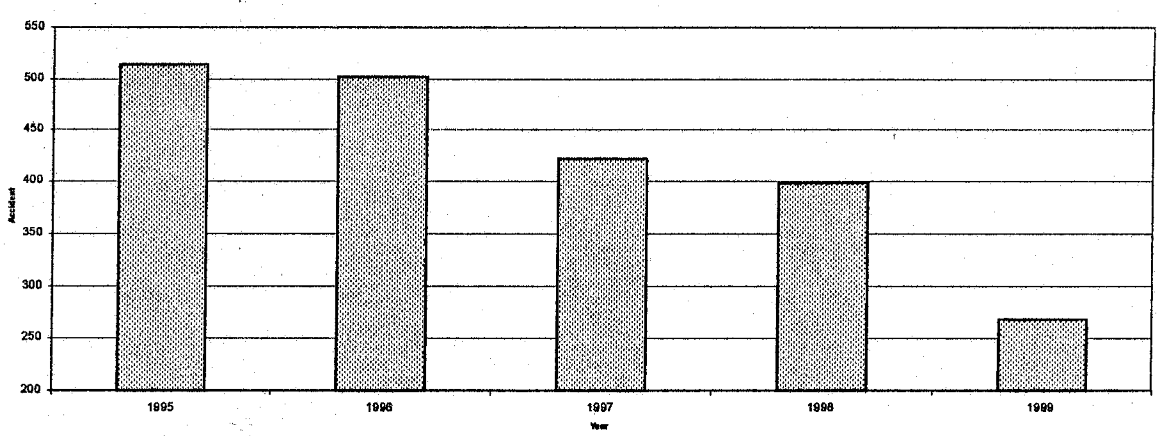


Table 4.3 total numbers of accidents.

YEAR: Y	1995	1996	1997	1998	1999
ACCIDENT: A	514	502	422	398	268.



Zone	Mark (M)	Temperature		Zone	Mark (M)	Temperature
Drying	121	183		Drying	137	161
	122	176			138	155
	123	173			139	149
	124	168			140	144
	125	165			141	139
	126	166			142	130
	127	161			143	050
	128	165			144	082
	129	162			145	073
	130	163			146	072
	131	166			147	067
	132	162			148	063
	133	159			149	059
	134	157			150	057
	135	168			151	055
	136	157			152	053

The average shell temperature is shown diagrammatically for each zone and collectively in fig 4.3 to 4.8 below using line graphs.

FIG. 4.3 DRYING ZONE

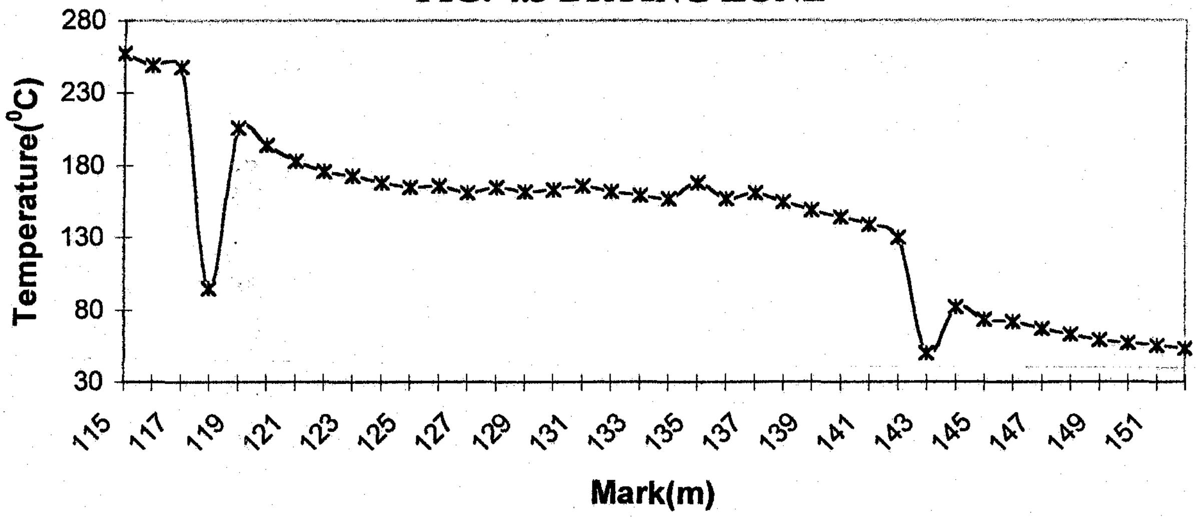


FIG. 4.4 PRE-HEATING ZONE

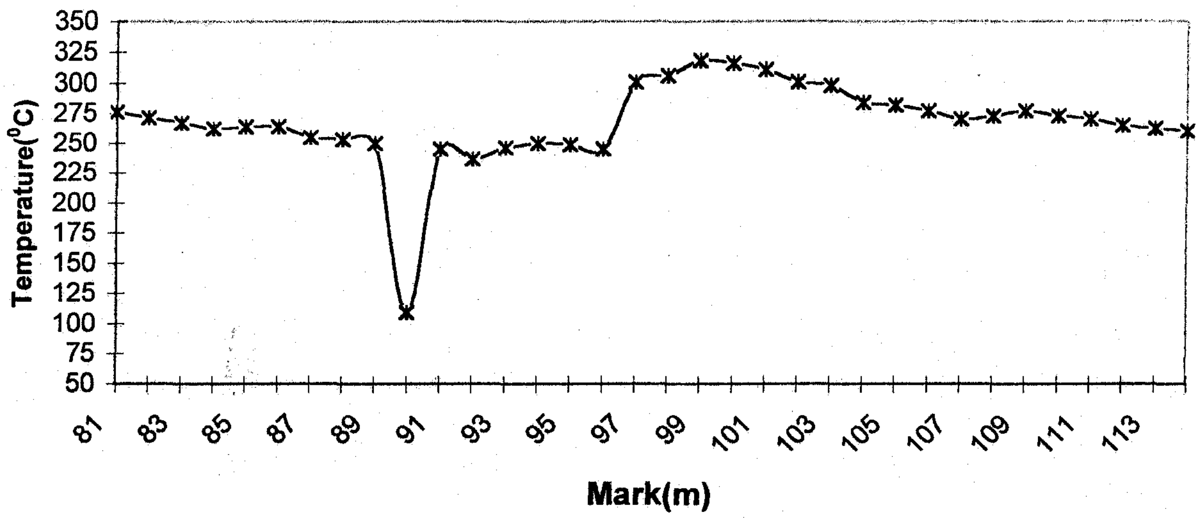


FIG. 4.5 CALCINING ZONE

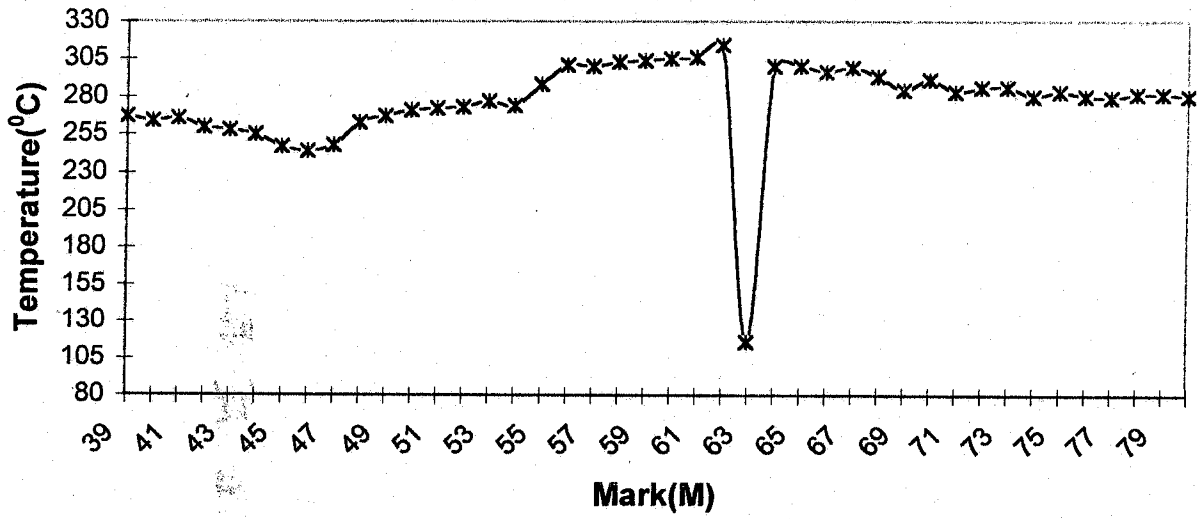


FIG. 4.6 BURNING ZONE

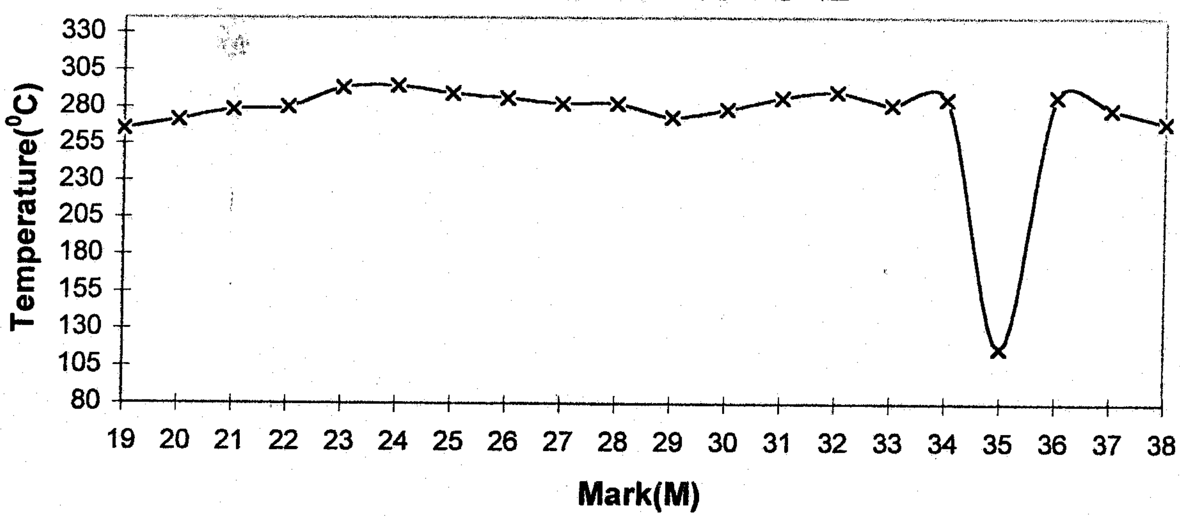


FIG. 4.7 COOLING

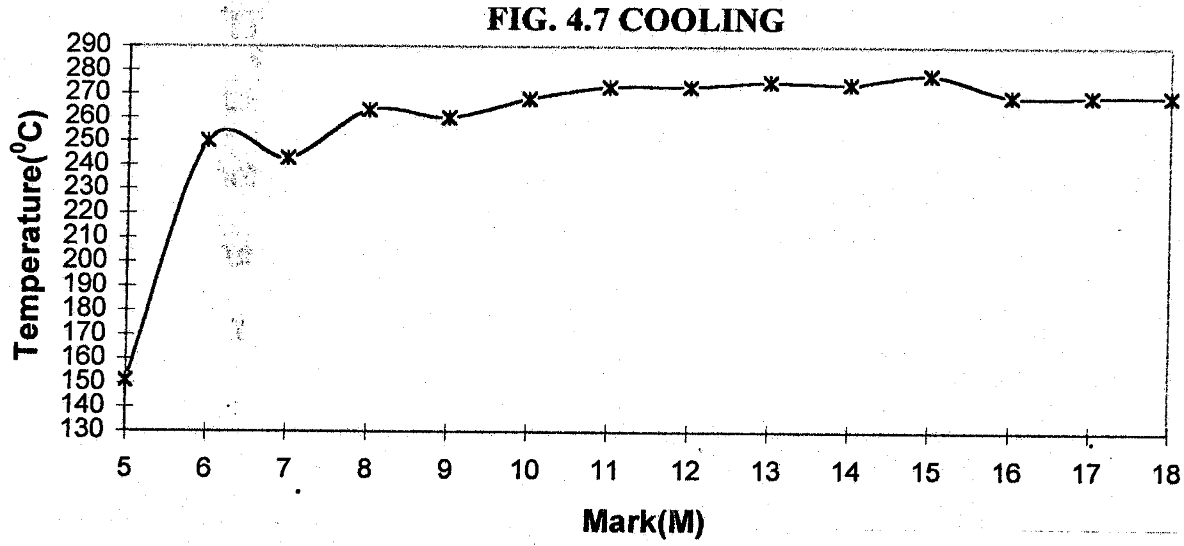
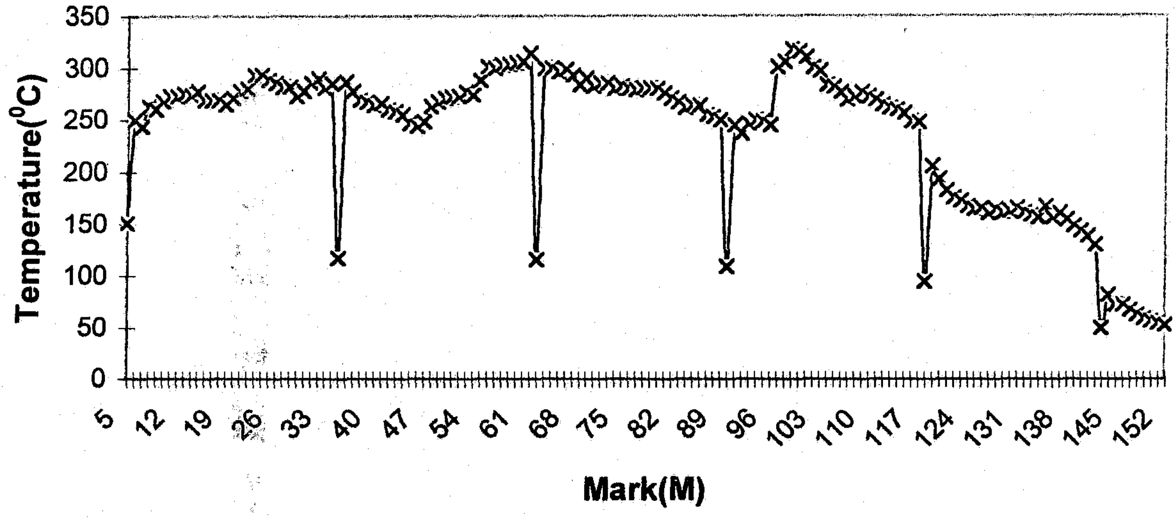


FIG. 4.8 OVERALL KILN LENGTH TEMP



4.2. DISCUSSION OF RESULT.

Every notified accident results not only in the official compensation of the victim, but also in a report or inquiry in the undertaking, whose purpose is prevention.

From the presented results in table 4.3, it was observed that the rate of occurrence of accidents decreased considerably over the period. However, the production department happened to have produced about 46% of the occurred accidents (table 4.4). Not surprisingly therefore, bruises and Abrasions are the most common which are due mainly from falls from altitudes e.g. from ladders or slips on wet or slippery floors.

Bums and scalds, which accounts for about 6.65% of the total accidents that occurred (table 4.2) is a thermal injury. These are caused when a portion of the body surface is exposed to either dry or moist heat carrier of sufficiently high temperature. It occurs mainly in the production and electrical unit of the company, due to increased probability of exposure to the hot kiln shell and shock from electrical appliances.

Trauma, which is caused mainly by the consequences of nerve injuries

(Osundosumu, 1999), are sensory in nature. They may also be due to vibration acts (Osundosumu, 1999), these never injuries in turn are sensory in nature and may result to persistent pains, faulty reception of sensations, disturbances in the nutrition of the parts supplied by the nerve affected and weakness or paralysis of muscles with corresponding impairment of functions. Traumatise. Injuries, which may manifest as shock, bleeding, fractures, dislocations and head/crushed injuries account for about 8.26% of the accidents.

Lacerations are caused by falling loads, stones, being run over, and accidental contact with machines such as milling cultures, toothed wheels and rollers. From the obtained statistics, laceration is about 27.28%.

No matter their type, accidents lead to production time-loss. From the available statistics, ble 4.4, the greatest hours lost was recorded in 1996 with total lost hours being one thousand, hundred and ninety-six (1,696), production department having the greatest of the hours lost in 97 with one thousand, two hundred and seven (1,209) hours. Actually, these hours lost can be s of the main causes of accidents are treated properly and the sources verified. For instance, ne fractures, dislocations; sprains are occasionally followed by nutritional disturbances of the tire section of the limb. Its delayed consequences include: stiffening of joints; withering of iscles and heightened sensitivity to cold. Also, for head injuries, with regard to facial area, there ybe masticatory troubles, if jaw bones have not being properly set, it may lead to dental nage; if the injury is related to the cavities (ILO encyclopedia, (1983) adjacent to the nose, it ds to lasting complaints as a result of compression or strangulation. Deafness and disturbances equilibrium may occur after a fracture of the base of the skill, which if extended to the temporal ne that harbours the middle, and inner ear and the organ of balance in man.

From table 4.3 a considerable decrease in the total number of accidents was noticed with h parting year. San in the regression equation (equation 3.12), negative regression line of iation, can be used to predict the possible number of accidents that can occur for a certain year. s would enable the concerned authorities to check the number of faults and easily identify the ses of these faults. Encouraging however is the fad that company has developed good safely asures trying inducing to inform the employees the regulatory safety rules and regulations. ong these is the educational measure adopted to increase employees awareness of the factories 1990 provisions by the federal government.

But, it was also noticed that trauma, (table 4.1) considerably in the last two years. These ild be attributed to increased vibrations actions due to the presence of more heavy machineries probably to ageing of the older equipment.

Another noticed hazard of this industry is the dust emissions these are released mainly from e kiln and cement mill. The emission consists mainly of limestone and cement dusts with condary emissions of gaseous products of combustion gases such as Cox, SOx, NOx, ketone, and dehydes e.t.c. (Industry and Energy Division, Environmental Dept. 1995).

From the results obtained, in table 4.6, the weight of the dust released per volume is said to considerably high. This is because the international labour organisation (ILO) recommends out 15-20mg per volume (ILO encyclopedia, 1983) for a wet – processing technology but the mpany though obtained its minimum dust released rate on the 189 day of testing at the kiln 2 h a value of 3mg per volume and the worst six days after i.e. 195 day at the cement mill 1. With alue of 2110mg per volume. The reason for this enormous discharge at the cement mill maybe e to duality dust collecting system i.e. the electrostatic precipitator (ESP).

The consequences of high dust emission on its employees and its environs are numerous. s could result to increase lung diseases e.g. bronchitis, silicosis from sand blasting undosumu, 1999), and skin diseases such as eczema (ILO encyclopedia, 1983).

Thermal pollution is one of the greatest problems of facing the world today. From the from results presented in table 4.7 and as shown in fig 4.4 to 4.9, a relatively cool environment is ced at the drying zone while the highest shell temperature is witnessed at the calcining zone. to the kiln shell temperature, the ambient temperature of the surrounding is raised by a few rees, sometimes by about 10°c at say, 5m from the kiln surface.

A trend however was also noticed on some of the marks i.e. on 35m, 63m, 90m and 118m, temperature there are greatly reduced due to the of presence of cooling lubricants close to e marks.

The emitted heat led to the total warning up of the environment by about $3^{O}C$. This is sed by the refused of hot, dense air of the kiln environment to mix with the cooler air of the iosphere. The consequence of this action leads to various kiln aliments such as prickle heat e on the people.

It should be noted that while this whole project is not to allocate responsibility and place nes on individual or organisation, there is need for more attention to be placed on these istry so that further hazards to lives and machineries are minimised.

CHAPTER FIVE

›NCLUSION AND RECOMMENDATION.

l CONCLUSION

In conclusion, safety on the general view is not only on life, but also on the environment. ›m the study, it has shown that considerable time and money is lost due to downtime (lost urs) and in compensation payment to employees. Investigations revealed that large emissions of nent dust and limestone are daily plunged into the atmosphere along with secondary emissions m combustible gases, an action that constitute great nuisance to the society.

The consequences of these action if not properly handled could lead to various health zards such as the respiratory – track diseases and skin diseases. These easily result in lost hours production and sometimes litigation expenses.

Due to the expense of these consequences, the management of safety in the industry nnot be left alone to employers, but also the employees. Also, in ensuring a high safety level ng old designs and machineries is the most challenging responsibility of the company and the ety manager in particular. This can be achieved through proper planning, organizing, executing l controlling a uniquely designed program that moves the organisation towards safety and alth objectives.

The company though international standard 1S0 9001 compliant in terms of the product ality still has to be international standard 1S0 14001 compactable with the environment.

2 RECOMMENDATIONS:

In ensuring safety measures of the cement company, the following recommendations are en:

Training of employees to achieve high standards of environment all performance by providing cessary awareness and giving specific training on the cement production.

Proper manager of its environmental impacts in particular by:

- Reducing emissions to atmosphere wherever practicable.
- Minimise waste arising and maximise recycling.
- Maintaining high standards of house – keeping and appearance at sites.

Carrying out regular environmental audits to monitor progress.

Carrying out regular overhauling of plants as at when due.

Regular medical check – ups to be carried out on their employees especially those at the dense lust related areas e.g. the packing plant.

The use of automated control devices such as alarms, to inform the people near the plants to y – off when there is going to be a start – up or shut – down of the machinery.

APPENDIX A

THE FACTORIES ACT 1990

The Factories Act, 1990 contains 89 sections and 5 schedules it is divided into 11 parts.

Part I:	Is on the registration of suitable premises as a factory (Section 1 – 6)
Part ii:	Contains the general provisions for securing and maintaining health conditions in the Factories (Section 7 – 13).
Part iii:	Deals with general provisions on safety (Section 14 – 39).
Part iv:	Deals with general requirement for welfare of persons employed (Section 40 – 44).
Part v:	Sets out the special provisions and regulations on Health, Safety And Welfare (Section 45 – 50).
Part vi:	Deals with the notification and investigation of accidents and Industrial diseases (Section 51 – 55).
Part vii:	Specifies special application of provisions of Act – (Section 56 – 57).
Part viii:	Is on record keeping in General Registers, duties of persons employed etc. (Section 58 – 62).
Part ix:	Deals with administration of the Act (Section 63 – 68).
Part x:	Contains offences, penalties and Legal proceedings – (Section 69 – 81).
Part xi:	Deals with the general application of the Act (Section 82 – 89).

This Act is meant to provide for the registration of Factories, for Regulation of both working conditions and use of machinery in the Factories.

HIGHLIGHT OF THE PROVISIONS OF THE FACTORIES ACT:-

1. MEANING OF FACTORY

The factories Act is applicable to only the premises constituting factory as expressed by Section 87 of the Act.

The expression "Factory" includes any premises where one or more persons are employed in any process of manufacturing, altering, repairing, ornamenting, finishing, cleaning or washing, breaking up or demolition, adopting for sale of any article. Others premises where ten or more persons are employed. In this category are mechanical workshop, dry dock, printing press, electric power generating station, works, laundry, and e.t.c.

Such work must be carried on as a business for purpose of profit or gain.

Open-air premises are not excluded even if there is no factory building or machinery being used.

The act equally applies to factories belonging to or in the occupation of the Government of the Federation or of a state.

2 It is illegal to occupy or use any premises as a factory without having been registered by the director of Factories (Section6).

3 The essential Health retirement include:

I. General cleanliness of the factory-section 7

ii. Avoidance of overcrowding so as not to cause risk of injury to the health of employees-section 8

iii. Adequate ventilation by the circulation of fresh air-section 9.

iv. Provision of sufficient lighting either natural or artificial (section 10.

v. Provision of sufficient and suitable sanitary accommodation separate for each sex section 12.

HIGHLIGHTS OF THE SAFETY REQUIREMENTS

i. Proper guarding of dangerous parts of machinery including transmission machinery, motors, lathes, etc.-section 14-17

ii. Provision of an efficient starting ands toping devices for power machinery section 16.

iii. Construction and maintenance of machinery – section 19.

iv. Construction and disposal of new machinery – section 20.

v. Adequate training and supervision of workers – section 23.

vi. Initial and periodic testing and examination of hoists, lifting machines; cranes, lifting tackles, etc – section 25 – 26.

vii. Provision of safe means of access and safe place of employment – section 28.

viii. Provision of life line, breathing apparatus and resuscitatory apparatus of work in confined space – section 29.

ix. Removal and control of explosive of inflammable dust gas or fumes – section 30.

x. Initial and periodic testing and examination of steam boiler, steam container air receiver and other pressure vessels – section 31 – 33.

xi. Provision and maintenance of adequate fire detector and suitable fire – fighting equipment – section 35.

xii. Careful storage of highly inflammable substances in fire resisting store – section 35.

xiii. Provision of sufficient emergency exits, well marked and unobstructured – section 36.

xiv. Construction of all doors affording mead of exit from the factory to open outwards – section 36.

xv. Power of inspectors to issue improvement and prohibition notices section 37 – 38

xvi. Provision of effective means for removal of injurious or effective dust or fumes – section 45.

xvii. Prohibits eating in rooms where poisonous or injurious dust or fumes are present – section 46.

xviii. Provision and maintenance of sufficient and suitable protective clothing and appliances for protection of person employed – section 47.

xix. Provision of suitable goggles or effective screen for certain scheduled processes such as welding, fettling, chipping, etc section 48.

xx. Provision of screening at arc welding area – section 48.

xxi. The obligation of factory occupies to notify the inspectorate of any industrial accidents and diseases. Section 51 – 53.

xxii. Keeping of record in the general register in the prescribed form – section 58 – 59

xxiii. Posting of abstract of Act, regulations and notices in a prominent position – section 60.

5. **THE ESSENTIALS OF WELFARE REQUIREMENTS INCLUDE:**

i. Provision of adequate supplies of wholesome drinking water at conveniently accessible places – section 40

ii. Provision and proper maintenance of adequate and suitable washing facilities at convenient places – section 41.

iii. Provision of suitable accommodation for clothing not won during working hours – section 42.

iv. Provision of first aid resuscitates as listed in the first aid Boxes (prescribed standards) order 1958 – section 43 – 44.

APPENDIX II

CHECKLIST FOR WORKPLACE INSPECTIONS

The inspection team while carrying out a workplace inspection must check the following.

Inspection records:

- General house keeping (cleanliness, exist free from obstacles, drainage etc.)
- Overcrowding
- Ventilation
- Lighting
- Guarding of machinery
- Electrical equipment
- Welding equipment
- Hoist and lifting equipment
- Ropes, chains and accessories.
- Air receivers and compressed air lines
- Dust, fumes, gases
- Fire detector and fire fighting equipment

- Fuel/ oil paint stores
- Noise.
- Chemicals in use.
- Personal protective equipment
- Individuals work areas.
- Trucks and transport vehicles.
- Welfare facilities (drinking water, washing facilities, cloakroom)
- First aid
- Sanitary accommodation.
- Work organisation problems
- Condition of the building (walls, floors, ceiling)
- Safety awareness.

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