CAUSES OF NEAR MISS AND MINOR OPERATING INCIDENTS AT SELECTED CHEMICAL ORGANISATIONS IN DURBAN AND THEIR IMPACT ON KEY FUNCTIONAL AREAS.

Submitted in fulfillment of the requirements for the degree of

Doctor of Technology in Business Administration

Entrepreneurial Studies & Management Department

In the faculty of Management Sciences

At the Durban University of Technology

Dan Nayager

March 2015

PROMOTER: Dr Marie de Beer

CAUSES OF NEAR MISS AND MINOR OPERATING INCIDENTS AT SELECTED CHEMICAL ORGANISATIONS IN DURBAN AND THEIR IMPACT ON KEY FUNCTIONAL AREAS.

by Dan Nayager

Submitted in fulfillment of the requirements for the degree of

Doctor of Technology in Business Administration

Entrepreneurial Studies & Management Department

In the faculty of Management Sciences

At the Durban University of Technology

March 2015

Approved for final submission

Promoter:……………………….. ……………………..

Dr Marie de Beer: MComm.; Ph.D. Date

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work, and that I have not previously, in its entirety or part, submitted it to any university for a degree.

…………………………

06th March 2015

DRT Nayager

ACKNOWLEDGEMENTS

I would like to express my gratitude to the following persons and institution:

- Dr Marie De Beer, promoterfor her time, support, guidance and encouragement from inception to completion of this study.

- Ms Gill Hendry for the professional analysis of all the research data.

- Mrs Helen Richter for the support and assistance in editingthe research.

- The Durban University of Technology for the financial assistance and opportunity.

Dedication

All things are possible through God Almighty "Na Ma Si Vaa Ya"

This study is dedicated to the special people in my life

To my family, especially my wife Ragani and daughter Shimona, for their never-ending encouragement, love and support throughout the long days and nights of my academic pursuit.

In the memory of my late parents,

Mr and Mrs Kid Nayager.

May your souls rest in eternal peace.I am grateful for your inspiration in the pursuit of knowledge and my standing in life today. I still remember clearly, my dad said, "I have no money to give you, but only the education that I can afford so that you may find your rightful place in society". I thank you daily for your sacrifice.

ABSTRACT

Near miss and minor incidents (NM&MI) have escalated into major global worst case disaster scenarios and have shut down organisations. The BP oil rig spill (Deepwater Horizon) in the Gulf of Mexico and the tsunami and nuclear disasters in Japan.

The purpose of this quantitative study was to evaluate the impact of near miss and minor incidents on safety in the workplace. On review of global literature espically in the chemical sector, it was found that research of this nature is limited due to NM&MI being regarded as a nuisance factor and given less importance. Generally major incidents are investigated more extensively. There were two sets of data used for the research, an employee survey and NM&MI databases. The employee survey was obtained through the use of questionnaires and the NM&MI databases were obtained from the organisations' incident databases reports. The representative sample of 349 respondents was surveyed, of a total of 950 supervisors, managers and workers, with the resultant response rate being 95 percent.

The research findings showed an extremely high NM&MI rate for the sampled organisations. Management commitment was evident but was reactive rather than being proactive and there were major differences in the perceptions of safety, health and environmental approaches. On analysing the NM&MI, including the financial losses incurred, it was found that NM&MI drastically impacted key functional areas of the organisations.

This research on NM&MI can be expanded to all organisations in KwaZulu Natal or South Africa. Quantitative research does have its limitations. Large samples are required, and the logistical difficulties inherent in gathering a sufficiently large sample can sabotage the study before it even gets off the ground. Narrowing sampling to Durban has a limiting effect on the overall thesis.

The Organisational Methodology tool developed could be used throughout the organisation, from the corporate sectors through to the plants. The economic impact would be astronomical of not sorting NM&MIs on time as was the case in the Bopal disaster which shut down the global operations of Union Carbide.

Management can no longer regards NM&MIs as just a nuisance factor but will have to carefully investigate and improve NM&MIs and safety in the workplace.

The Organisational Methodology developed in this research will add value to stakeholders in better managing all NM&MIs in the workplace.

Table of Contents

Chapter 3

Research design and methodology

Chapter 4

Field work and findings

Appendices:

List of Tables

Figures

CHAPTER 1
INTRODUCTION AND OVERVIEW OF THE STUDY

1.1 Introduction and background

This study sets out to examine how near miss and minor incidents (NM&MI) impact on key functional areas and, in turn, on the overall performance of chemical organisations. The outcome of this study would contribute in the development of a framework or methodology to better manage the NM&MIs. Unsafe incidents occur globally in all industries even though many organisations, especially those in the chemical industries, spend large amounts of money on corrective and preventative measures.

The preservation of safety, health and the environment is very important as the industries receive, issue and store highly hazardous chemicals and gasses. Organisations within the chemical industry have safety management programmes in place as part of the requirements of the Occupational Health and Safety and Regulations Act 85 of 1993 (OSH Act). There are, however, still a large number of incidents taking place daily. Some examples of the catastrophic chemical disasters of past and present caused by irresponsible incidents / accidents are:

Texas City Disaster

According to Schmidt (2005:423), the Texas City Disaster (Figure 1.1) in 1947, was one of the first 'modern' chemical disasters in the United States of America. Ammonium nitrate (AN) ignited in a barge - from a fire in the crew's quarters - resulting in over 561 fatalities, loss of two barges, two aeroplanes that flew over the incident and a sulphur plant. On investigation it was found that all the 'standard operating procedures' (SOP) were followed, but no one knew that AN, which was a fertiliser, would ignite with heat and no one did an experiment to test the explosivity of the substance. This major event started with a minor incident in the crew's quarters and no one understood the seriousness of this minor incident, or the emergency procedures required to stabilise the small incident.

Source: media.nbcdfw.com

Figure 1.1 Texas City Disaster

Bhopal Disaster (India)

The Bhopal disaster (Figure 1.2), which occurred on December 3, 1984, was the “worst industrial accident in history” (Long, 2008:1). The accident was caused by Methyl Isocyanate, or MIC gas, that was released when water leaked into one of the storage tanks. The main warning siren did not go off for two hours, with the resultant loss of at least 15,000 lives, thousands more have since died, and an estimated 50,000 people became invalids or developed chronic respiratory conditions as a result of being poisoned. In the subsequent investigations and legal proceedings, it was determined, among other things, that NM&MIs were ignored.

The findings concluded that:

- Staffing at the plant had been cut to save money, while workers who complained about codified safety violations were reprimanded, and occasionally fired.

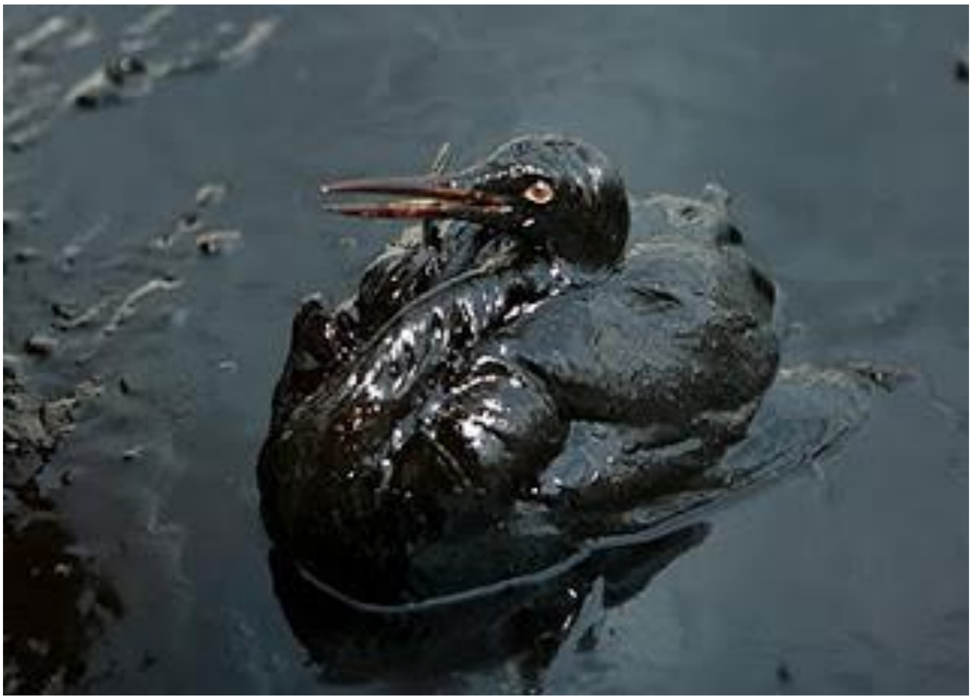
- No plan existed for coping with a disaster of this magnitude.
- Tank alarms that would have alerted personnel to the leak had not functioned for at least four years and other backup systems were either not functioning or non-existent.
- The plant was equipped with only a single back-up system, unlike the four-stage systems typically found in American plants.
- Tank 610 held 42 tons of MIC, well above the prescribed capacity (it is believed that 27 tons escaped in the leak).
- Water sprays designed to dilute escaping gas were poorly installed and proved ineffective.
- Damage, such as to piping and valves that was known to exist, had not been repaired or replaced because the cost was considered too high.
- Warnings about other shortcomings at the plant by American and Indian experts were similarly ignored.

Source: media.nbcdfw.com

Figure 1.2 Bhopal Disaster India

BP Deepwater Horizon (Mexico)

The BP drilling rig Deepwater Horizon Disaster as reported by Gold and Casselman (2010:1) on the Gulf of Mexico, the largest accidental release of oil into marine waters in history, resulted in severe environmental, health and economic consequences (Figure 1.3). The company pleaded guilty to 11 counts of felony manslaughter, two misdemeanours, and one felony count of lying to Congress, and agreed to pay more than $4.5 billion in fines and penalties, the largest criminal resolution in US history. Legal proceedings expected to conclude in 2014 are ongoing to determine payouts and fines under the Clean Water Act and the Natural Resources Damage Assessment. BP faces damages of up to $17.6 billion in the trial.



Source: media.nbcdfw.com

Figure 1.3 Deepwater Horizon Disaster

Timeline on other major chemical disasters worldwide as reported on Voice of Russia (2013)

1 June 1974 – Cyclohexane leak at Nypro Chemical Plant in UK's Flixborough caused an explosion, which killed 30 to 64 workers, injured 75 and cost the company 36 million pounds sterling.

1984 - a huge petrol-tank explosion destroyed a shantytown in Brazil's Cubatao, killing at least 500 people.

1984 – a methane blast at a mine near Mexico's city of Yautepec killed 500 people

1989 – a rupture in a cryogenic ammonia tank in Ionava, Lithuania. The 7,000 tonnes of poisonous chemicals contained in the tank spread over the ground forming a 10,000 square kilometres wide lake and produced a toxic cloud composed of ammonia vapour and products of the thermal decomposition of the fertilizer that spread over 30 kilometres.

1992 – an explosion in the sewer system of Mexico's second largest city, Guadalajara, killed 210 people.

1993 – a blast at Siberian Chemical Plant in Russia's Tomsk region produced a radioactive cloud. 1 946 people were exposed.

November 1995 - a blast in Río Tercero, Argentina, rocked a munitions factory killing seven people and injuring over 300.

21 September 2001 – An explosion in a storage hangar in which 300 tonne of ammonium nitrate granules were stored for recycling at Atofina's Grande Paroisse fertiliser plant in Toulouse in southwest France killed 30 people and injured 200 more.

16 July 2003 – a blast at Lithuania's Ukmerge reinforced concrete factory during welding work in the foam polystyrene shop injured12 workers, 2 were reported missing.

17 July 2003 – a fire at a chlorine plant in Spain's industrial zone of Les Franqueses released a massive toxic cloud that started drifting westwards. Officials warned residents not to leave homes and blocked off highway and railroad traffic to seal off the area. There were no casualties.

14 August 2003 – a Repsol Ypf Sa oil refinery saw oil tanks catch fire that raged on for three days running.

25 August 2003 – a fire broke out at a tyre factory in Enschede, the Netherlands.

19 September 2003 - three metalworkers died in explosion and fire at an Avesta Polarit steel plant in Tornio, Finland.

7 October 2003 – a leak of an underground gas pipeline near Washington Hospital Center triggered a fire that wounded a passing driver.

11 May 2004 – An explosion at Stockline Plastics' factory in the Maryhill district of Glasgow, UK, claimed nine lives and caused injuries to over 40 people.

17 August 2004 – over 30 people were injured in a bromomethane explosion and ensuing fire at Russia's Farmakon pharmaceutical factory in St. Petersburg.

6 April 2006 - an explosion hit a chemical plant in Harbin, Northeast China's Heilongjiang Province after a solvent reagent tank caught fire. The blast wounded two workers.

9 April 2009 – the second explosion at the chemical factory in China's Harbin led to a leak of 600 tonnes of benzyl.

1 June 2006 - several large chemical explosions rocked the Terra Nitrogen UK chemical plant in Billingham, England, causing a fire that involved "mixed gases" and led to an ammonia gas leak.

11 May 2007 – an explosion at a Chinese chemical factory in Cangzhou killed five and injured 80 people.

14 August 2007 - a blast occurred at Makhteshim Agan chemical plant in the Ramat Hovav industrial zone in Israel, wounding seven workers. The cause was overheated organic phosphate deposits stored at the factory.

23 March 2008 – a fire set off a series of explosions at a US meat packing plant in Booneville, Arkansas, destroying the factory and causing an ammonia gas leak that forced 180 people from their homes.

4 April 2008 – a rupture in the ammoniac pipeline at a St. Petersburg milk factory, owned by Wimm-Bill-Dann Foods OJSC, resulted in an ammonia leak that killed one and injured 17 workers.

10 December 2010 – an explosion was recorded at AL Solutions, a titanium and zirconium processing plant in New Cumberland, US. Three people were killed and one injured.

29 May 2011 – a blast killed three people at Shandong Baoyuan Chemical plant in China.

11 September 2011 – an explosion at France's oldest nuclear site in Marcoule killed one person and injured four.

5 January 2012 – a blast at a chemical plant in the Nanhu District of Jiaxing, east China's Zhejiang Province left three people dead.

23 August 2012 – an explosion erupted at Russia’s biggest alloy and powder plant in the Irkutsk region.

28 September 2012 - an explosion at the Hube Globe chemical plant released about eight tones of hydrofluoric acid. The leak killed five workers and injured 18 others. The entire nearby village was evacuated.

25 February 2012 - at least 21 people died and 29,000 were displaced after a chemical plant explosion in Baiyun district of Guiyang, capital of Southwest China's Guizhou Province. The blast led to a large spill of flammable liquids, such as toluene and carbinol. The pillar of fire stood at 100 meters, witnesses said.

17-18 April 2013 – an explosion at the fertilizer plant in the area of West in Texas, USA, killed between 5 and 15 and wounded some 200 people. Many homes, a local school and an elderly care house were torn down by the shock wave.

13 June 2013- A huge deadly blast at a Louisiana petrochemicals plant. The blast, which sent a fireball soaring into the air, accompanied by billowing smoke, killed two workers and injured at least another 76.

11 July 2013- The 30 people missing after a runaway train crash in Quebec over the weekend are presumed dead, police said Wednesday, in what has become Canada's worst railway catastrophe in almost 150 years. Several victims were vaporized in the intense heat.

19 Nov 2013 -A blast occurred in a steam pipe at the Total refinery Antwerp. Te explosion killed at least two people.

Nov 2013- (Beijing) – At least 35 people died and 166 injured in a blast at a new oil pipeline owned by China Petroleum & Chemical Corp. (Sinopec) in the eastern city of Qingdao. The blast occurred at 10 a.m. as workers were repairing the pipe leak.

Jan 2014- Crude 4-methylcyclohexanemethanol (MCHM) was spilled into the Elk River from a Freedom Industries plant in Charleston in the U.S. state of West Virginia. The chemical spill was the third chemical accident to occur in the Kanawha River Valley within the last five years (more examples - Appendix A).

The cost of workplace safety compromised

The size of the organisations in this study range from small to large and they handle petroleum and chemical products. According to Chang and Lin (2006:51), larger chemical storage tanks present greater safety risks. As these storage tanks contain large volumes of hazardous chemicals, it takes only a minor incident to incur millions of dollars in damages, with the resulting shut down of large organisations. However, despite strict engineering guidelines in design and safety management of chemical storage tanks, problems still occur.

Einarsson and Brynjarsson (2008:550) on the other hand, contend that although humans work more carefully in high-risk environments, incidents still take place when safety is compromised. The stress caused by the adverse relationships can also cause unsafe incidents. The authors emphasise the importance of very good relationships between managers, supervisors and workers. This directly impacts on workforce morale, forming the basis of the organisations' safety culture.

Increased risk- hazardous substances versus workplace safety

Whereas there was a concern for these high risk areas previously, there is today a greater need for a strong safety culture in the chemical industry, as this sector is processing ever more hazardous substances within densely populated areas (Reniers et al. 2006:604). All stakeholders are now exposed to a greater risk from these hazardous substances. To deal with these risks, a wide array of chemical risk management techniques have been developed, yet minor incidents still take place. It is imperative that the workforce recognizes and practices the techniques to reduce these incidents.

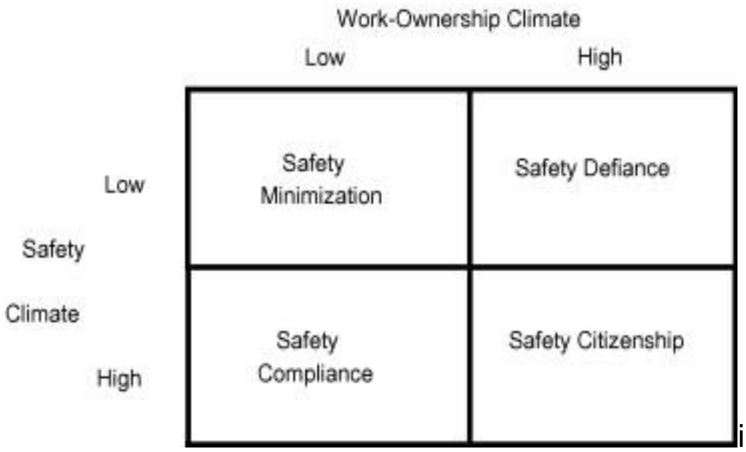
However, Nivolianitou, et al. (2006:630) point out that it is widely recognized that the chemical industry as a whole does not learn from past accidents; ignoring the learning process has had and is having a major impact on subsequent incidents. Judging from the time line of incidents / accidents, the inference is that there will be more incidents and accidents to follow.

An urgent need for research on workplace safety

With the global economy expanding and the increase in new organisational developments resulting in more workers being employed and increased production, which lead to more accidents / incidents, and a subsequent increase in negative impacts to worker safety and health. Organisations have to urgently set research priorities for occupational safety and health initiatives.

The USA, Britain, Netherlands, Italy, Japan, Malaysia, Europe and others working on global research on OHS had to compare, analyse and prioritise OHS standard for global use. It was difficult to get all the different countries to collaborate, due to funding and inconsistencies with research methodologies. Britain went alone and set up the British Occupational Health Research Foundation (BOHRF) in 1991. They used university experts in the various disciplines utilising the Delphi technique to prioritise the OHS research findings. The study was extended in 1996 to employers. The research assisted in standardising the eight OSH agendas of USA, Britain, Netherlands, Italy, Japan, Malaysia, Europe and others, to assist OSH globally (Lavicoli, et al.,2006: 169-178).

On the other hand, when high work-ownership is in line with a low safety climate, workers will deify safety, which raises the potential for accidents / incidents. Safety compliance develops when low work-ownership converges with a high safety-climate. Here workers consider safety a high priority and do work with safety in mind. This will be a stable organisation producing under safe conditions. The final aspect is safety minimisation, where both the climates are poor. This will be an unsafe / risky organisation, where the potential for accident / incidents is high. To measure the safety climate properly, a multi-level climate framework, including safety climate and work ownership climate, needs to be implemented at different levels of the organisation (Dov, 2008:376-387).



Source: Dov (2008:376-387)

Figure 1.4 A multi-climate framework for occupational safety.

Workplace safety in operations management has to be researched with links to product / service quality, cost, delivery and flexibility due to the alarming injury rate in the US. In addition the quality paradigm, new technology, new operational practices, worker diversity and organised labour practises further impact negatively on workplace accidents / incidents. This requires additional research in this area as identified by Brown (1996:157-171).

Boden, Biddle and Spieler (2001:398-402) argue that, with millions of occupational illnesses and injuries occurring a year in the US alone, there is no research done on the actual monetary loss to the worker or the employers. The employers know that there is a cost involved but it is not calculated in its entirety. It is suggested that research themes under the heading "Social and Economic Impacts of Workplace Illness and Injury and Future Directions of Research" as follows:

- Workers' costs of Workplace Illnesses and Injuries
- Employers' Costs of Occupational Illnesses and Injuries
- Improving Our Understanding of Return to Work
- Utilisation of Workers' Compensation
- Adequacy of Workers' Compensation Benefits
- Methodological and Data Issues

The crucial aspect, with the social and economic impacts of workers' illnesses and injuries, is that the overall impact will be researched on all stakeholders, including the families and communities at large. This costing will give the overall value to illness and injury to workers but is still not complete in ascertaining total costs, which should include total costs of incidents and accidents to the organisation. To this end, this research will review costs of NM&MIs and the impact to the organisation and more importantly, for the better control and management of NM&MIs. There is definitely an urgent need for the development of a comprehensive Organisational Methodology (OM) to support the chemical organisations.

1.2 Problem statement

It would appear that a high number of NM&MIs still occur regularly at the organisations being researched indicating that there is a gap in their understanding of and an urgency of better managing these incidents. Belke (2009:1) argues that recurring causes of these incidents include, among others,

- inadequate process hazards analysis,

– use of inappropriate or poorly-designed equipment and
– inadequate indications of process condition.

For instance, poor change management controls are put in place when new builds or modifications are made to the plant and equipment, which contributes to NM&MI. Belke (2009:1) further adds that some chemical organisations don't do thorough investigations of NM&MI and learn from them, to prevent reoccurrences or major accidents. This study sets out to examine the impact of these NM&MI on the selected chemical organisations; culminating in the development of an OM to better manage the NM&MIs, thus contributing to new knowledge.

1.3 Main research objective

The main objective of this research, was to review the causes of near miss and minor operating incidents at selected chemical organisations in Durban, by surveying the managers, supervisors and workers, to establish the respondents' perceptions on their attitudes to safety, health and environmental approaches; review the NM&MI held on the selected organisations' databases and determine their impact on key functional areas, in order to develop an OM to facilitate management of NM&MI, and further enhance the OM using comparative benchmarks.

1.3.1 Sub objectives

- To survey the perceptions of management, supervisory staff and workers of the functional areas of the selected chemical organisations, in order to establish respondents' attitudes to safety, health and environmental approaches.

- To identify and analyse the previous two years' NM&MI reports on the databases of those chemical organisations selected, in terms of their categorization, causes and the resultant management interventions taken, in order to assist in the management of the NM&MI.

- To develop a comprehensive OM, with which to facilitate the management of NM&MI and compare this with international and national benchmarks for further improvement.

- To characterize the operations and management of key functional areas and critically evaluate the impact of categorised NM&MI on the performance of these key functional areas, in terms of nature and trends.

1.3.2 The research questions

- What are the causes of NM&MI generation in the operating areas of chemical organisations?
- How can perception survey data be gathered on workplace safety from managers, supervisors and workers?
- How do NM&MIs impact key functional areas?
- Can NM&MIs lead to major and catastrophic disasters?
- Would better management of NM&MIs reduce major and catastrophic disasters?
- How can an OM be developed to assist in the better management of NM&MIs?

1.4 Scope and limitations

The chemical industry uses chemical reactions to turn raw materials, such as coal, oil and gas, into a variety of products; it plays a major role in the global economy. Some of the products are petrol, diesel, gas, pesticides, fertilizers, pharmaceuticals, synthetic dyes and fibres, soaps, plastics and paints (Columbia Electronic Encyclopaedia, 2013). A few of the major global chemical, oil and gas organisations are: Saudi Aramco, Gasprom, National Iranian Oil, Exxon Mobil, Petro China, BP, Shell, Pemex, Chevron and Kuwait Petroleum Corporation (Forbes, 2014).

The chemicals and petrochemicals sector in KZN, including Durban, industrial chemicals comprise a third, at Rand 1,1-billion, of the gross output, petroleum and coal products 30 percent at Rand 9.9million, chemicals 21 percent at ZAR 700-million, and rubber and plastic products the balance 16% equating to 528million (KZN Top Business Portfolio, 2014). Knegtering and Pasman (2009:162) argue that safety managers in chemical organisations agree that minor incidents offer opportunities to measure and manage safety incidents and prevent major disasters. The authors further state that, in most cases, only major incidents are thoroughly investigated, while NM&MI are not fully investigated. They argue that every incident that results or could have resulted in a major loss incident, should be thoroughly investigated by the operators.

Due to the hazardous nature of chemicals, the chemical industries generate a vast number of incidents / accidents. The definition of a minor incident, for the purposes of this research, is any unforeseen event or occurrence, which results in only minor injury or property damage (Wilson and Corlett, 2005:912). In this research, references to minor incidents would also cover near misses. The damage value for near miss (slight damage) and minor incident (minor damage) is the same in rand value of <R115, 000. The different types of incidents / accidents are differentiated in terms of their severity, impact on people, assets, environment and reputation. The severity rating could be from 0 = no impact; 1 = near miss (<R115,000); 2 = minor (<R115,000); 3 = localised (<R5,750,000); 4 = Major (<R115,000,000) and 5 = Extensive / Critical (>R115,000,000). For this research, NM&MIs will be reviewed and not localised, major or extensive/critical incidents (Figure 1.5) (Wai-Chee, HSE / 42:2005).

INCIDENT	CONSECQUENCES				INCREASING LIKLIHOOD				
SEVERITY	PEOPLE	ASSETS	ENVIRONMENT	REPUTATION	**A** Never heard of in industry	**B** Heard of in industry	**C** Incident has occurred in our company	**D** Happens several times per year in our company	**E** Happens several times per year in a location
0 Zero	No health effect/ injury	No Damage R00	No effect	No impact					
1 **Near Miss**	Slight health effect/ injury	Slight Damage <R115000	Slight effect	Slight impact			LOW RISK to MODERATE		
2 **Minor**	Minor health effect/ injury	Minor damage <R115000	Minor effect	Limited impact					
3 Localised	Major health effect/ injury	Localised damage <R5750000 to restart	Localised effect	Considerable impact			MODERATE to HIGH		
4 Major	PTD of 1 to 3 fatalities	Major damage <R115000000 2 weeks to restart	Major effect	National impact				HIGH to SEVERE	
5 Extensive/ Critical	Multiple fatalities	Extensive damage >R115000000 total loss of operations	Massive effect	International impact					

Source: (Wai-Chee, HSE/42:2005)

Figure 1.5 -Incident Classification and risk

There were two sources of data used for this research. The first was the *employee surveys* and the second source that of the *NM&MI databases of the selected organisations.* The research was limited to only the chemical industries and the study focuses on all NM&MI and not any other categories, for example localised, major and extensive / critical incidents.

This research is governed by the accuracy of the reports issued by the selected organisations involved in this study.

1.5 Target population and sample selection

A questionnaire was developed to survey the target population of 86 managers and supervisors and 263 workers (Table 3.1) of the selected seven chemical organisations. A purposive sampling technique was used.

1.6 Rationale for the Study

Many organisations still have problems managing their NM&MI. The proper management of safety, health and environmental programmes at chemical organisations is important, due to the stringent regulations that apply to the manufacturing, storage and handling of hazardous chemicals. With the strict regulatory requirements and management interventions in place, the occurrence of NM&MI should logically reduce, but it appears that these incidents are still occurring.

This indicates that there is a gap in better managing NM&MIs to prevent major disasters. The outcomes of this research will culminate in the development of an OM to assist management in improving their understanding of the causes, impacts and prevention of NM&MIs, in order to manage NM&MIs better. It is further important to consider the findings of Khan and Abbasi (1999:11) who maintain that, to understand the mechanisms of incidents and to develop prevention and control strategies, it is essential to know about and learn from past incidents. Industries are, however, generally reluctant to reveal what has happened and have a tendency to underplay their mistakes; hence many incidents of a similar nature are repeated.

The data was collected from two sources of information from the seven chemical organisations researched. The first was an employee survey, collected by the use of questionnaires and the second was by collecting the NM&MI from the incident databases of the selected chemical organisations in the south of Durban, KZN. The information was pooled together, categorised, edited, coded and analysed. The findings were cross tabulated, evaluated and presented in graphs and tables.

1.7 Structure of the thesis

Chapter One: An introduction and overview of the topic and research problem identified, with objective and sub-objectives for the research outlined.

Chapter Two: A literature review on incidents and their causes and how these impact on organisations. There are research findings from around the globe on associated problems and the academic theory underpinning these findings. The legislation and standards covering safety, health and environment are also reviewed. In addition, reported incidents / accidents at the chemical organisations in the Durban South Basin are included. This links back to the objectives and sub-objectives.

Chapter Three: The research methodology used in research design, including the biographical data of the respondents, is covered in this chapter.

Chapter Four: The research fieldwork and findings are reviewed, examined, cross tabulated and analysed in this chapter, with the focus centred on the key variables of the study. In addition, comparisons are drawn between this research and other research of a similar nature previously done.

Chapter Five: The findings of the study from chapter five are established, interpreted and analysed, with reference to the literature review and findings from previous chapters. The objectives and sub objectives are revisited for review of planned achievement.

Chapter Six: The research is reviewed and conclusions, implications, limitations and recommendation for further research are covered in this chapter.

1.8 Conclusion

To control NM&MI, many organisations have safety management systems including OHS Act guidelines, but incidents still occur. The storage and handling of hazardous chemicals is the main focus of chemical organisations, therefore NM&MIs need to be kept to a minimum. The information for the research was collected from two different sources i.e. data was obtained from surveys conducted with the employees of the chemical organisations. The second source was the NM&MI database, which is made up of the details of NM&MI, acquired from the databases of chemical organisations in the Durban South area of Kwa Zulu Natal (KZN).

In the next chapter, global literature on the contribution and potential of NM&MI to escalate to major incidents is reviewed. The literature review supports the objectives of this research.

CHAPTER 2
LITERATURE REVIEW

2.1 A summary of the literature review and motivation for research:

This chapter covers the origins of the OSH Act, a review of the South African context of safety and its management, a brief history of workplace safety incidents / accidents in the chemical industries, National Occupational Safety Association (NOSA), International Standards organisation (ISO) / Total Quality Management (TQM), Centre for Chemical Process Safety (CCPS). In addition, it also covers a broad focus on Safety, Health, Environmental and Quality (SHEQ), typical safety risks and hazards across industries, unique features of the chemical industries with respect to safety risks and hazards and incident / accident models and frameworks. In addition, some of the actual safety incident / accidents that have occurred in the Durban South Basin are included.

On examining the research done by others on workplace incidents / accidents that contributed to unsafe statistics globally, we can infer that the research surface is just being scratched and a lot of work still has to be done. In addition, a perfect "one size fits all" model / framework or methodology has not been developed Cox (1982: 249-260) that can accommodate all aspects of uncontrolled incidents / accidents. The status quo is that "accidents will happen" Pinto, Ribeiro and Nunes (2013: 410).

2.2 The link between safety, near miss and minor operating incidents

Safety in the workplace

The definition of safety in the workplace means having an environment that supports the freedom from hazards and accidental injury. To support a safe work environment, proper processes and procedures must be in place to allow employees to work without worrying about their safety (Richardson 2014:1).

Near miss incident

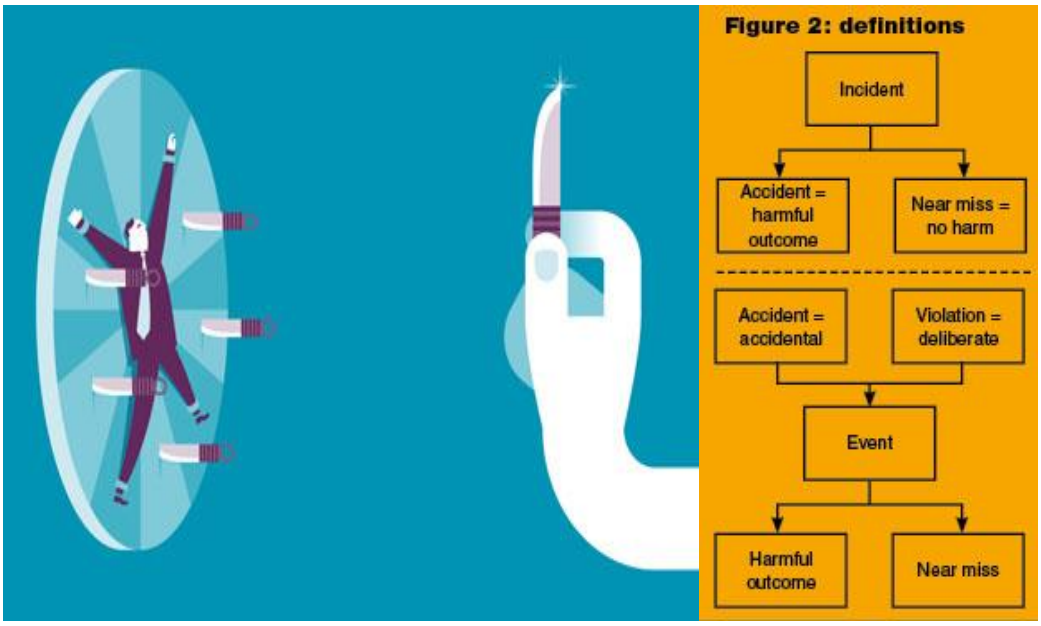
The definition of a "near miss" incident is where an incident occurred but no property was damaged and no personal injury sustained, but where, given a slight shift in time or position, damage and / or injury easily could have occurred" (U.S. OSHA definition: 2009). The clear message is that, despite no physical harm, something undesirable happened (Gardner 2014:1).

Minor operating Incident

Any incident (injury or property damage <R115,000) that is minor and not involving Reporting of Injuries, Diseases and Dangerous Occurrences Regulations,1995 (RIDDOR) or any incident which has been successfully controlled within the site boundaries and does NOT involve the attendance of the Local Authority Emergency Services and does NOT attract the interest of media or neighbours (Would 2011:1).

Incident and Near Miss Causation and the relationship to safety:

Minor operating incidents and near misses (Figure 2.1) are caused by unsafe acts, unsafe conditions, inadequate procedures and personal factors. An unsafe act is a specific action or lack of action by an employee that is under the employee's control. It is the performance of a task or other activity that is conducted in a manner that may threaten the health and / or safety of employees. The relationship between safety and near miss / minor incidents is a direct one and for safety to be properly maintained, near miss and minor operating incidents must be controlled and managed carefully (Yukon Government: 2014:1).



Source: (Leathley 2012:1)

Figure 2.1 Safety: near miss and minor operating incidents

It must be noted that there are many types of incidents / accidents, which are categorised according to their severity (Figure 1.5) and fall under the categories of Zero, Near Miss, Minor Incidents, Localised, Major and Extensive or Critical. This research is examining only NM&MIs. In the literature review, there was only one framework found, the Eight Step Process (ESP-Oktem 2002:1), which was developed for near misses and this does not cover minor incidents.

In addition, there is no costing done for NM&MIs but only for major / extensive or critical incidents / accidents. Most organisations ignore NM&MI (Nivolianitou, et al. 2006:630) and have not even analysed their data thoroughly or set tolerance levels to manage them better. The sad fact is that NM&MIs have contributed to some of the worst-case disasters in the world e.g. Bhopal Disaster India (Long, 2008:1) or the US Challenger disaster (Phimister et al. 2003:445).

The accident ratio by Frank Bird (1980) stipulates that for every 600 NM&MIs there will be one fatality and this dictates that careful management of

NM&MIs is necessary to avoid any fatalities. The proverb "take care of the pennies, and the pounds will take of themselves" makes a lot of sense and can be equated to the better management of NM&MIs, by inference, "take care of the NM&MIs, then the Major / Extensive / Critical disasters will take care of themselves". The literature exposes a huge gap in the knowledge and understanding of NM&MIs and offers an opportunity to examine NM&MIs, culminating in the development of a comprehensive OM, to assist organisations to better manage incidents / accidents.

2.3 Theory and theoretical framework underpinning this study

According to DeJoy (1994: 3-17) attribution theory is used as the basis for making decisions on safety incidents in industries. After a safety incident, the supervisor will investigate the incident using casual inferences or perceptions and take actions accordingly to manage these incidents. In many cases, the actions taken are not derived from the actual causes of the incidents.

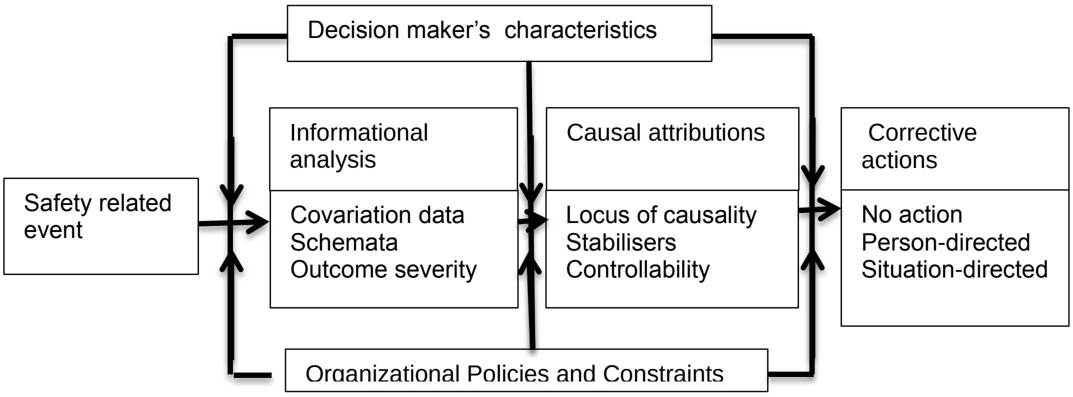
The MODEL (Figure 2.2) indicates that a safety-related incident (the first box on the left) occurs, which starts the process of causal thinking by the persons involved. The supervisor investigates the incident for clarity and action. The model suggests that that causes are typically characterised as three dimensions: locus of causality, stability, and controllability. The manner in which causes are categorized is important in the selection of the corrective actions. The employees are in many cases biased and give ambiguous and incomplete information, which makes the process complicated.

To help correct this situation, two categories of moderating factors are included in the model. The first category focuses on the individual or "decision-maker" and the experiences, beliefs, and motives that he or she brings to the attributional task. These decision-maker factors have the potential to influence how events are initially perceived, how causal attributions are formed, or how these attributions are categorized and translated into corrective actions. The second category pertains to organisational policies and other constraints that may place boundaries on how individuals process causal information and select remedies.

In response to most safety-related events, the observer tries to determine whether the incident or outcome was caused by the worker (person / actor), the task (entity), or by some set of circumstances related to the event (context). The individual examines co variations between causes and effects in arriving at attributions which uses three types of information in forming casual attributions i.e. distinctiveness, consistency, and consensus.

Suppose a worker's left hand is struck by a moving part of the machine he / she is operating. The causal inference drawn by this worker's immediate supervisor about this accident is likely to depend at least partially on (a) whether this worker has performed safely on other tasks (distinctiveness); (b) whether this worker has performed safely on this task in the past (consistency); and (c) whether other workers have performed this task without incident (consensus).

Affirmative answers to (a) and (b), combined with a negative answer to (c), should lead to the conclusion that the worker is a safe worker and that the event was caused by something related to the task or the environment (external attribution). In contrast, negative answers to (a) and (b), especially in combination with an affirmative answer to (c), would focus causality on the worker (internal attribution). Supervisors do appear to use co variation cues when making attributions about the safety performance of their subordinates.



Source: DeJoy (1994: 3-17)

Figure 2.2 An attributional model of the safety-management process

In addition, De Joy (1985: 61-71) examines the applicability of attribution theory to safety management in industry. He reviews how workers perceive personal risk associated with workplace hazards, how supervisors respond to safety incidents and how upper management influences the safety climate of the organisations.

It is believed that there is self-protective and self- other biases present in the attributional processes for the workers, supervisors and upper management. Theses biases may lead workers to misjudge potential safety risks and hence have conflicts with the supervisors. The supervisors with self-protective tendencies will be in favour of blaming the workers for safety incidents rather than doing a proper investigation and finding the root cause for corrective action. The upper management with self- other biases will also tend to blame the worker rather than finding the root cause. It is easier and less costly to blame a worker and give a new instruction rather than reviewing the environment and make costly changes to the plant and manufacturing process.

The author strongly believes that a pronounced self- bias by top management may be associated with a poor company safety record. Top management of companies, with successful safety programmes, do not have any internal biases but have a balanced view of accident causation and hence do proper root cause analysis, resulting in proper corrective action. It is suggested by the author that an external safety auditor should be used to audit the company's safety programme; the auditor will be able to provide a more objective analysis, which is free from attributional bias. DeJoy finally adds that near miss and minor incidents are a source of underutilised data, and steps should be taken to sensitise employees to the seriousness and predictive importance of the data, in curbing similar or major safety incidents in the future.

Bartunek (1981: 66-71) examines people's behaviour and believes that it is difficult to explain why some people behave in a certain way. Sometimes you can give a correct reason for behaviour but more often, we do not have all the information to give a reason as to a person's specific behaviour. Managers in organisations are mainly concerned in understanding their workers behaviour rather than the worker.

Attributional theory explains the way we perceive others behaviour. Researchers have found a number of factors that affect our perception of others and the reasons we assign for people's behaviour. We look for specific cues whether a person's behaviour is due to the situation or the person. One important aspect is that when people observe other's behaviour thus underestimating situational influences and overestimating personality traits. When the situation is reversed, we try to find good reasons for our own behaviour. We overestimate the importance of the situation and underestimate the importance of our own personality traits. Supervisors may hold workers accountable for serious outcomes, which may be due to external influences and the quality of the supervisor's management may be in question.

Workers on the other hand, attribute their successes to themselves (internal factors) and their failures to external causes; this directly impacts on their self-esteem. Most managers and workers are not fully aware of the attributional processes they use to determine causes of their own and other's behaviour and the way they respond to others. The theoretical framework for this research is the same as the Functional Methodology for NM&MI (basic) (Figure 2.3) (Attachment G).

The key concepts are:

- The large number of safety incidents (NM&MI) that occur in the industry.
- Minimise workplace safety, which is one of the key drivers in the industry.
- Investigate causes and impact of NM&MI and conduct perception surveys to better manage workplace safety.
- Develop an OM (framework) to minimise NM&MI.
- Treating NM&MI as a nuisance factor rather than a learning curve.

There is a direct link between the Attributional Theory Model (Figure 2.2) and the Theoretical Framework (Figure 2.3). When a safety incident occurs in both cases, an investigation is done to obtain a true corrective action; the role players would automatically use attribution in decision-making but should refrain and give factual information for the best results. The use of the OM will ensure that proper root cause analysis is done before drawing conclusions.

From the above review on attributional theory, it is evident that many of the near misses and minor safety incidents that have occurred in the industries involved in this research have been linked to attributional theory model (Figure 2.2). The Attributional Theory forms the theoretical prism underpinning the theoretical framework of this study.

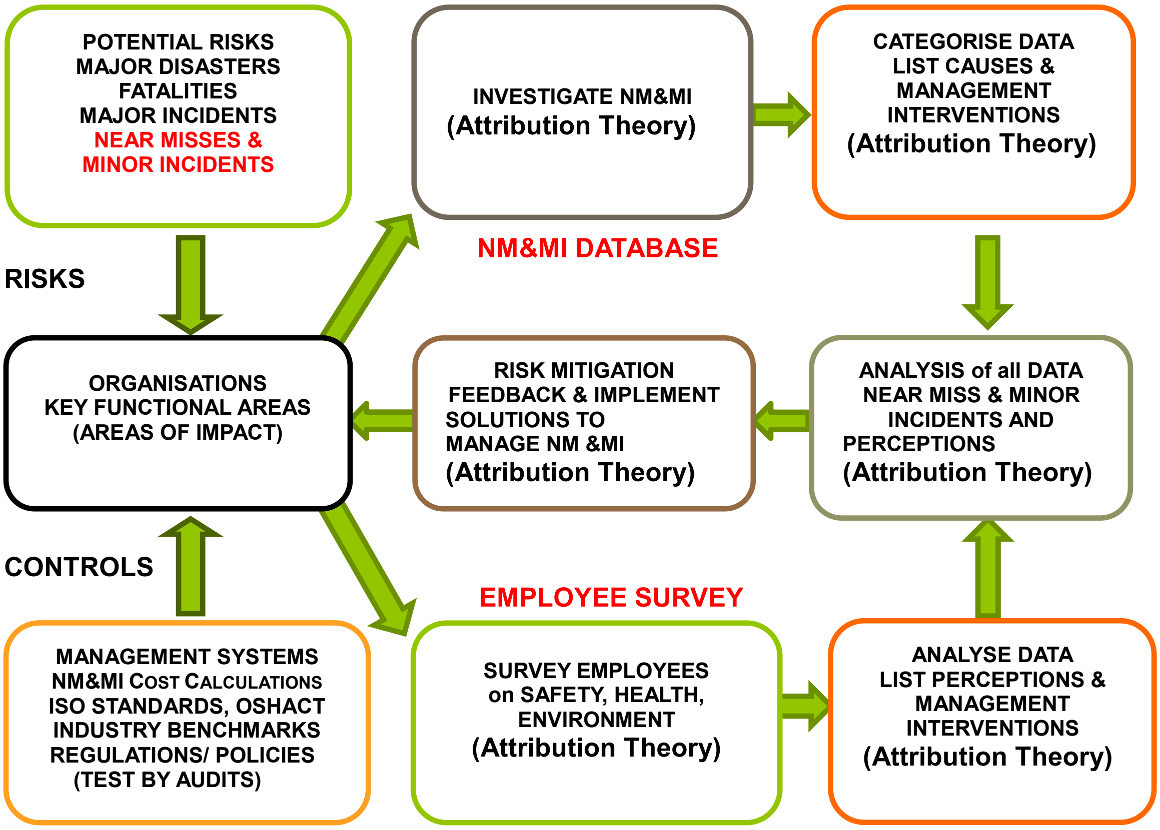


Figure 2.3 Theoretical framework (Source: Attachment G-Functional Methodology)

2.4 Typical safety risks and hazards across industries

Sorensen (2002: 189-204) argues that workers' attitude towards safety is key in improving on safety incidents but this cannot work in isolation. Over and above worker attitude, Sorenson believes that, for a "safety culture" to be developed and functioning properly, there must firstly be management and organisational factors for safety in place. The author further states that the US Nuclear Regulatory Commission (NRC), on investigating the Three Mile Island nuclear disaster, found deficiencies not in systems hardware but solely in management.

To prevent a repeat of the disaster, the NRC recommended the following:

– All employees working on nuclear sites must be fully trained and qualified to operate the plants,

- The nuclear facilities must have a full component of qualified staff to operate in a safe manner,
- The management of the nuclear facilities must provide a conducive working environment so that the operators are under minimal stress,
- The operators must have an expert understanding of the process equipment and environment so that their interface is seamless,
- The nuclear facilities must draw up emergency operating procedures, test operators on emergency drills and keep them current,
- Due to the critical operating standards and being a high risk facility, it is a requirement that all operators must be urrerly responsible to their jobs and
- The management of the nuclear facilities must ensure that there is total organisational effectiveness by following all the guidelines of the NRC .

There are definitely some common deficiencies when compared to the findings of Mengolini and Debarberis (2007:520-529), such as training, poor management and communications. IAEA published guidelines, called ASCOT (Assessment of Safety Culture in Organisations Team Guidelines), although used in assessing the safety culture of any organisation, provides no guidelines for the conclusion of the assessment Sorensen (2002: 189-204).

Some form of human and organisational bias helps in good safety performance, whereas too much bias contributes to a worker culture of not reporting incidents / accidents to avoid blame (Reiman and Rollenhagen, 2011: 1263-1274). The authors further argue that a “no-blame” culture may have some positive spin-offs, but contradicts with the approach “that people must be accountable for their actions”.

Belzer (2001:137-148) postulates that, in many cases significant resources are utilised where there is no proper risk assessment done, yet authorities accept decision-making based on lay risk perception. Citizens must vet management decisions carefully and should guard against open government encroachment on all decisions. He further states that, in the new information age, the internet spreads this poor quality information rapidly and decision makers use this high-risk information in making crucial decisions.

The Netherlands had 219 000 accidents / incidents in 2007 resulting in injuries (Venema et al., 2009). This puts severe pressure on workers, management and the national health care system. De Koster, Stam and Balk (2011: 753-765), on researching accidents at warehouses in the Netherlands, found that by focusing on safety, the financial impact to the organisations is reduced. They argue that all accidents / incidents must be registered, workers must follow a safety specific storage procedure, and managers must undergo transformational leadership training and then implement that style of leadership to improve on safety performance. The question is what is new here, as similar calls have been made by other researchers.

The study of safety culture has three approaches. Firstly, the academic approach looks at the organisations past to understand its present, in the second instance, the analytical approach looks at the current status of safety within the organisation and lastly, there is the pragmatic approach. The pragmatic approach looks at the current status, in preparation for the future. According to Guldenmund (2010:1466-1480), the pragmatic approach, on culture and its relationship to safety management, involves three aspects, viz. organisational structure, culture and processes (Figure 2.4).

The organisational structure involves the members of staff and their authority, responsibilities and duties to perform their jobs. Culture, on the other hand, is how we act and do basic things. The processes refer to the activities in the organisation at different levels, e.g. operations supported by other departments, and central to this is, the behaviour of the worker involved.

Source: Guldenmund (2010: 1466-1480)

Figure 2.4 The Organisational Triangle

The safety climate has to be measured at multi-levels of the organisation, i.e. at top and middle management, as well as supervisory and worker levels. The reason being that if top management sets safety climate procedures, they do not affect the procedures themselves but cascade these to middle management and supervisors, who then instruct workers. In the process, the supervisors might not sanction workers that employ short cuts, to meet production targets under pressure, which may result in unsafe incidents.

Guldenmund (2010) further believes that workers, who take ownership of their jobs and safe operations, reflect a combined high-safety, high-ownership climate. Safety citizenship should develop (Figure 2.4) when there is a climate of high work-ownership and a high safety climate. Workers in this block will implement safety as part of the job and will benefit chemical / nuclear organisations.

A relationship exists between perceived risk and the willingness to pay (WTP) for increased safety from hazardous incidents / accidents. McDaniels, Kamlet and Fisher (1992:495-503) argue that people will pay according to their income levels, and personal exposure for well-defined risks and less-defined risks, by dread and severity of the hazard. They further state that people have to be knowledgeable about perceived risks to increase their WTP responses. Their research was based on Lancaster's (1996:132-157) microeconomic theory demonstrating that consumers value the attributes of the goods rather than simply the goods. Here the question is, are people going to pay for their own safety due to risks emanating from external organisations? Are we saying that the people of Bhopal (Long, 2008:1) should have paid for their own safety when Union Carbide could not remedy NM&MIs that led to the catastrophic disaster?

According to Eigenhuis (2010), there is much to be gained in measuring potential effects of near miss incidents. He states that mere chance dictates the number of factors that align to cause minor or major incidents and feels that management systems should involve all employees in using NM&MI to reduce the factors that could increase the scale of loss incidents. It is important to use a tool or methodology that would enable a step-by-step investigation of the incidents.

Safe behaviour at the workplace is, furthermore, an important element of preventing incidents and managing organisational safety performance improvement. Managerial pressures on rushing and creating incidents can, according to Zwetsloot et al. (2006:769), be reduced by improving on business processes. According to the authors, this is very necessary, as the chemical industry operates internationally and is facing growing global competition. Zwetsloot et al (2006:769) have identified important factors for improving economic competitiveness and they are:

- Organisations must utilise the latest technological innovation and improve on safety in the operating zones,

- In addition the plants must be designed with a high level of automation to reduce manual operations thus reducing incidents,
- Organisations must streamline operations by focusing on core activities and reducing safety incidents,
- In order to improve on economic competitiveness, organisations must form strategic alliances with competitors, and introduce cost-saving programmes.

2.5 A review of the South African context of safety and its management

South Africa is an industrial powerhouse of Africa and is very technologically advanced in its mining, agricultural and industrial sectors. There are about 300,000 work-related accidents per year, of which over 2,500 are fatalities (Zwi et al. 1988:691) and 4,500 permanent disabilities (Hedlund 2013:149-159). The state, industrialists and the unions have a vetted interest in the safety of all stakeholders, hence the formation of the OSHAct in South Africa.

In the 1900's, poor health from mine dust prompted the passing of the Mines and Works Act in 1911, to prevent the large scale of miners dying (Zwi et al. 1988:692). In addition, the South African Institute for Medical Research was established in 1913, to assist in improving the general health of mineworkers. In 1918, the Factories Act was established to control working conditions in factories. Further to this, the Factories Act was improved in 1941 and replaced by the Factories, Machinery and Building Work Act followed by the Workmen's Compensations Act. The Gluckman Commission of Enquiry into the National Health of the Union of South Africa, recommended that the OSH services should be rolled out throughout the Union, in order to improve on health and safety of all stakeholders.

South Africa had still not sufficiently addressed the safety and health issues adequately in the mines, industries and in agriculture. Zwi et al. (1988:696) argue that there are contradictions in applying the OHS Act in small companies, as opposed to doing so in larger companies. The larger companies have the capital to better manage the OHS services and obtain better results. In 1948, the state introduced the National Occupational Safety Association (NOSA), who upheld the “loss control” approach in promoting health and safety in industries, giving rebates to industries that had a reduced their accident claim rate.

The Erasmus Commission of enquiry into Occupational Health was set up in 1974, after a mass strike by over 100,000 workers in Durban. The commission found an extensive shortfall in the OHS and its implementation, and tabled clear recommendations for a new direction in OHS activity. Hedlund (2013: 149-159) postulates that there are few studies done on accident statistics in South Africa, mainly due to poor availability of information. There are some accident statistics on the Workmen’s Compensation Commissioners (insurance) system and some on the Department of Labour (DOL) database.

The period from 1970 to 1982 (13 years) had full information on the number of workers, accidents / incidents and resulting permanent disabilities and fatalities. These are as follows:
Workers: 39.8 million
Accidents / incidents: 69,322
Permanent disability: 59,874
Fatalities: 9,448

2.6 The Occupational Safety and Health Act

The USA’s Department of Labour gives the history of the Occupational Health and Safety Act. President Richard Nixon signed the act into law on December 29, 1970 in the United States. The purpose of this law was to protect workers from hazards in and of the workplace, such as exposure to toxic chemicals, excessive noise levels, mechanical dangers, heat or cold stress, or unsanitary conditions.

Prior to the OHS Act (US Department of Labour, 2009), there was the Safety Appliance Act, established in 1893, which applied mainly to railroad equipment and did not protect workers from incidents and accidents. The thinking at that time was that dead workers were easier to replace than expensive safety interventions. In 1910, there were major mining fatalities in the United States and research on mine safety was conducted. Thereafter, worker unions were instrumental in calling for and establishing the workers compensation laws (US Department of Labour, 2009).

During World War II industrial production increased rapidly in the United States and, at the same time, industrial incidents and accidents increased significantly. The OHS Act legislation was passed into law after there were about 14,000 deaths and about two million workers were disabled or injured annually from the hazards in industry. In addition, the discovery and manufacture of chemicals further increased the incidents and accidents. The harmful characteristics of these chemicals were poorly understood (US Department of Labour, 2009). Major areas, which the OHS Act standards currently cover, are:

Toxic substances

Toxic substances are dangerous to life and must have a material safety data sheet giving all the risks and safety precautions that need to be adhered to, to prevent injury or death.

Electrical hazards

Any electrical energy that has the potential to harm, injure or kill, must be completely isolated and made safe for the person working in the area.

Fall hazards

A person working at height needs to protect him / herself from falling and being injured or dying. Suitable safety equipment, for example a safety harness or scaffold, is to be used for protection.

Hazards associated with trenches and digging

During trenching or digging the danger is that the walls can easily collapse and kill the person inside the trench. The excavation has to be secured, with suitable shutter proofing boards, to prevent any collapse of the trench walls.

Hazardous waste

Hazardous waste is generated through various processes and must be treated as dangerous, removed and disposed of by specialists, so that there is no harm to life or the environment. Proper labelling must be used.

Infectious disease

Persons suffering from infectious disease have to be isolated and treated accordingly. Caregivers must also protect themselves from being contaminated.

Fire and explosion dangers

Chemical dust particles can promote major fires and explosions. All ignition sources are kept away from explosive mixtures. Training and signage are used to discourage persons from creating ignition.

Dangerous atmospheres

There might be a release of hazardous chemicals, which pollutes the atmosphere. Persons would not be able to breathe and will have to use special gas masks or breathing apparatus.

Machine hazards

Industries have all types of machinery and most are dangerous when in operation. There are safety devices that protect workers from harm but many workers are killed or injured in accidents. There must be sufficient safeguards and notices warning of danger to prevent injury and deaths.

Confined spaces

Confined spaces are areas that are restrictive and cannot support life. There is some inherent danger. If persons are to enter a confined space, the area has to be tested, made safe, and safety equipment has to be worn.
(US Department of Labour, 2009).

2.7 A broad focus on safety, Health, Environment and quality

Chen and Zorigt (2013: 2321-2331) postulate that industrial nations around the globe and governments are adopting stringent safety, health, environmental and quality management practices to manage the risks, hazards and reduce incidents and accidents. Pinto, Ribeiro and Nunes (2013: 410) argue that in the real world it is impossible to prevent all incidents and accidents. Incidents and accidents contribute to massive loss of lives and property damage. Chen and Zorigt (2013: 2321-2331) believe that safety management systems comprising of standards, procedures and monitoring systems promote the safety, health and environment to protect all stakeholders. The above is applicable across all industries from petro-chemicals to mining, motor industries and others.

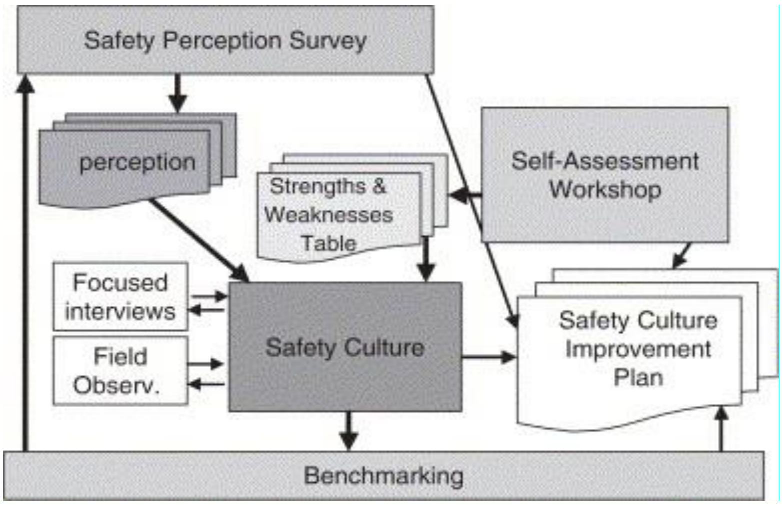
For example, more than 200 people lose their lives each year, in Britain, with a further 150 000 injuries reported and two million people suffer from ill health at work (Health and Safety Executive, 2008/09). The critical question here is why so many people are still losing their lives and so many injured; this goes totally against Chen and Zorigt’s argument of safety management protecting all stakeholders.

Coal mining, on the other hand, is an old process, with lots of knowledge available on safe mining. Yet, due to unsafe operations (formation of gas) in the coal mines in China, which has killed many miners, investment targets fell short by three to four billion Yuan in the key Heilongjiang Province alone (Pringle & Frost, 2003). The critical question here, is whether gas monitoring is being done, as well as what, if any, checks and balances are in place to minimise unsafe operations?

Then there is India, which has a more complex issue with SHEQ management, child labour, a huge informal sector and poor safety standards. About 300 inspectors monitor safety, health and the environment in this vast country, compared to 3, 000 factory inspectors in a small country such as Japan (Agnihotram, 2005). It is evident from the poor resources that the fatalities in the Indian manufacturing sector are close to 20 per 100 000 workers, in comparison with a figure of 1-6 in first world countries (DGFASLI, 2006). Here the question raised, is why children have to work in India, when the government can rectify the situation by putting proper controls in place.

Mengolini and Debarberis (2007:520-529) have utilised the International Atomic Energy Agency [IAEA] guidelines, in order to enhance safety culture at the High Flux Reactor [HFR] at Petten, in the Netherlands. The authors state that the Safety Culture Working Group developed the enhancement process (Figure 2.5), which produced results under the headings: visible management, management commitment, safety versus production conflict, safety culture recognised value, learning organisation, communication and openness, and constructing views of mistakes. They argue that the research, using International Atomic Energy Agency [IAEA] guidelines, have to an extent produced positive safety culture improvements.

However, dedicated safety training must still be improved on, in order to motivate staff to recognise the role of sub-cultures, establish clear communication lines, and more importantly, have a visible and clear leadership, with management acting as good role models. The key outcome rests with management leading from the front, guiding and making good decisions on safety and associated risks.



Source: Mengolini and Debarberis (2007: 520-529)

Figure 2.5 Safety Enhancement Methodology

2.8 Link between workforce safety and organisational methodology

Bowles (2004) feels that management should track the NM&MIs so that they may study the accident propensity, thus preventing serious accident consequences, and determine the impact on key functional areas. However, Mannan et al., (2007) suggest that it is only a matter of chance that low severity consequences result from incidents, which could otherwise, under suitable conditions, easily have resulted in outcomes that are more serious. They suggest that the key functional areas will be impacted to a greater extent.

On the other hand, Zhong, et al. (2006: 762) postulate that the legal intermediary agency offering technical service for safety work, should put a safety evaluation responsibility system into practice to reduce incidents, rather than having to investigate them. The authors further state that the agency should also assist production and business operation units and provide technical services for these units to work safely in accordance with laws, administrative regulations and rules on business operations. The work safety authorities must, additionally, carry on supervision, with the strict enforcement of auditors, who should bear the responsibility for any accidents according to related laws, which will impact all departments or functional areas of business.

Einarsson and Brynjarsson (2008:550) maintain that, by addressing human factors and analysing human interactions, as well as the risks relating to communication and emotions, there is potential to improve the safety management system. These form the major part of the findings for root cause analysis. Chemical organisations often do not conduct root cause analysis for NM&MI. This allows these incidents to repeat themselves. Organisations that do not have an entrenched safety culture are, according to Erickson (2006:4), found to evaluate and report NM&MI poorly. Erickson (2006:4) also states that it is essential that corporate culture underpins management commitment, employee involvement, communication and treatment of employees, to make a success of safety, health and environmental programmes.

It is important to consider the article by Sampson (2009:19), who wrote, after discussions with Martin Anderson (HSE specialist inspector for human and organisational factors: BP / Texas refineries accidents), on priority for safety and health. Anderson stated that most of the incidents / accidents in chemical organisations’ accidents were management failures, e.g. getting the job done at all cost, cost cutting, inadequate safety management, and poor safety culture.

Vavra (2007: 33-43) reports that the management team of Ocean Spray's Bordentown supported the idea of the vice president of operations, who said, “Nothing we do is worth getting hurt over.” Management told the employees they were serious about their (employees) safety and upgraded the plants. The employees bought into the message and were rewarded with the plant surpassing one million hours without a lost time accident. Organisations that are serious with the priority of safety and health find that they perform well in SHE approaches. According to Nouri, Azadeh and Fam (2008:319), authorities must carry out proper safety audits in order to manage incidents of unsafe behaviour. They point out that the results of current research in a gas treatment organisation shows that the behaviour of a large number of employees is unsafe (26.7 percent).

The authors also maintain that there must be an effective method to manage and control the acceptance, use and maintenance of safety equipment by all employees. On the other hand, Woods (2006:237) advises that good interpersonal skills are a key factor in improving on NM&MI. He goes on to say that these skills include proper communication, which involves writing and speaking correctly, answering all questions properly, listening attentively, this includes focusing attention on the speaker, showing respect and acknowledging the speaker, and building and maintaining trust. Good relationships, according to Woods (2006), are built on trust and good interpersonal skills should therefore be part of the OM.

Nevertheless, Kim, Kim and Moon (2006:705) claim that, although current technologies are used in safer designed plants, there are still incidents. They also maintain that these incidents have to be investigated thoroughly and state that the accident scenario approach is widely used in safety analysis and as a top event in emergency planning. Olson-Buchanan and Boswell (2009:12) consider the mistreatment of workers as detrimental to safe performance of his or her job. They further add that other aspects, for example, a poor wage increase, negative performance evaluation, no training or promotion, the absence of praise from management, no recognition or favouritism would negatively impact their work performance.

According to Knegtering and Pasman (2009), the Senior Group Vice President of the Texas City Refinery, John Mogdorf said, after an explosion on April 24, 2006, that: “This was a preventable incident. It should be seen as a process failure, a cultural failure and a management failure.” The authors argue that their first observation regarding the accidents of the last decade is that these were not due in all instances to unknown physical or chemical process hazards, the chemical substances involved in all cases and the hazardous characteristics had been known for a long time.

In addition, the authors' second observation was that the causes of these accidents were not attributed to a single problem or failure but caused by a magnitude of flaws, lacks and deficiencies, which together formed a "bedding" for the accident to occur. According to Shore et al. (2009: 117-133), diversity programmes support and strengthen a diverse workforce in producing desired outcomes.

On the other hand, Sandberg and Targama (2007: 159) believe that managers should lead by stimulating workers to use their vision, ideas and inherent capabilities; this will in turn liberate their capacity in giving off their best performances. They further add that the workers will produce desirable work, reduce NM&MI and strengthen the organisations' competitive advantage. In addition Wu, Chang, Shu, Chen and Wang (2011:716-721) suggest that safety can be managed better if management / leadership strictly focus on the following factors:

- Management must train employees on improving their attitudes towards safety,
- Organisations must ensure that management improves on the leadership style to reduce safety incidents,
- Management must trust their employees to work safely and turn the employees will trust management to lead them,
- All employees including management must have a commitment to safety,
- For an organisation to work safely, all employees must be the involved in safety,
- Safety must have the highest priority in the organisation for minimising safety incidents,

- To improve safety an organisation must have proper communication channels, and humanistic management practices and reduce stress amongst the employees.

Vinodkumar and Bhasi (2010: 2082-2093) postulate that the direct influence of management commitment on safety compliance assists workers to develop a better attitude towards safety. Additional causes to incidents include that of having multicultural teams working together without harmony, which creates serious stress. Luthans (2008:262) states that, while a little stress and conflict may assist performance within an organisation, high levels of stress and conflict result in serious problems. This directly affects both the behaviour of individuals in the organisations and them doing their jobs properly, which leads to loss of focus and hence the potential for NM&MI.

According to Al-Mutair, Suardin, Mannan and Halwagi (2008:543), people lose focus in their jobs because of stress and when coupled with poorly designed plants, the increase of incidents is significant. They maintain that the term “inherently safer design” started appearing in safety discussion after Trevor Kletz (1999) introduced this concept as an identifiable element of process safety in one of his most famous phrases: “What You Don’t Have Can’t Leak”. Kletz (1999) believes that plants must be made safe by designing them with safety in mind, rather than having employees use layers of personal protection equipment to safeguard themselves.

Mannan, West and Berwanger (2007:644), state that chemical plants should use current technology in designing safer plants. The distributed control system / supervisory control and data acquisition (DCS/SCADA) alarm system lead to better plant management and Mannan et al (2007:644) maintain that the operator should know what action is required when the alarm is triggered, or the alarm will serve no purpose. Pinto, Ribeiro and Nunes (2013: 409-419) in their research on the use of occupational safety risk assessment (OSRA) argue that the quality of the OSRA audit will depend on the following aspects:

- Completeness- the OSRA results must have all the pertinent characteristics satisfying the audit.
- Accuracy- the OSRA results must be correct and exact.
- Fidelity- the audit criteria must map the workplace system.
- Fitness for use- the OSRA results must satisfy audit objectives and requirements and its intended use as per OSRA.

The above aspects will underpin the following six-step process of OSRA:

- The planning of the OSRA audit must be be done completely
- Te audit structure must put in place for full compliance
- The auditors must Identify all of hazards found during the audit
- All risks must be assessed fully and interventions put in place
- Safety barriers (SB) must be checked for completeness and rectified
- All documentation must be prepared and completed for recors and follow up actions.

The authors believe that for OSRA to work well, the following aspects need to considered:

- The use of skilled analysists / auditors (team leader is key)
- All documentation must be complete
- Accurate estimation of hazard identification and consequences
- Inaccuracy of models used
- Difficulties in checking final results
- Incomplete analysis
- Complexity and laboriousness of techniques used
- Subjectivity in every step of the OSRA process
- The OSRA process and results must be collaborated and communicated to all stakeholders

- A team of three to five people must carry out the OSRA audit.
- Each OSRA analysis session must be restricted to two to three hours.
- Include a new step of implementation in the OSRA process.
- Ensure that there is timely collaboration from all stakeholders.

The points above must be considered to obtain quality OSRA results is a bit daunting in the approach; this is not a perfect tool. According to Cox (1982: 249-260) there is no safety methodology that will cater for all risks identified.

It is held that in the structure of an accident (Accident Causation Models and Theories, 2012), the following aspects are responsible for the cause of the incident or accident:

- *Lack of control:* poor systems, inadequate programmes, standards, compliance and *monitoring for a*ll regulations of safety concerned.
- *Basic causes:* the absence of a proper system in place to control immediate unsafe *acts and unsa*fe conditions.
- *Contributing / immediate factors:* no system in place to control substandard acts and practices, poor working conditions.

In absence of the above an incident may happen and if not noticed in time with proper remedial actions, it may incubate into a disaster.

2.9 National Occupational Safety Organisation (NOSA)

The South African Government established the National Occupational Safety Organisation (NOSA) as a not-for-profit organisation, modelled on the Industrial Accident Prevention Association of Ontario (Canada). NOSA has, over the years been a major actor on the OHS scene is South Africa. It has developed a broad range of training courses offered to industry. The curriculum, developed by NOSA for its own people, was eventually taken over by the Department of National Education and so the National Diploma in Safety Management was established.

NOSA has also published safety magazines and organised annual safety conferences (Hedlund, 2011). The Association developed the NOSA 5-Star Safety Management System, which directed companies' accident prevention activities and offered recognition for excellence in safety management achievements. The 5-Star System comprises 72 elements, organised under five main sections. Elements are subdivided into about 300 components, sometimes also referred to as NOSA Minimum Standards. In order to guide the audit procedure each component is further specified into a number of Items for consideration. A maximum point score is allocated to each of the 300 components.

During the audit procedure, the NOSA auditor team assesses the level of compliance with each component and assigns a point score accordingly. The programme score is computed as the sum of actual scores, divided by the maximum point score, which gives the effort rating, a number between 0 and 100 percent. The Disabling Injury Incident Rate (DIIR) is computed as the number of "disabling incidents" per 200,000 h worked, which gives the experience rating (Hedlund, 2011).

The South African Public Commission of Inquiry into Safety and Health in the Mining Industry concluded that, although safety management systems may have contributed to improving safety at some mines, they had become largely discredited in the eyes of those employed at the mines and in public perception. This is because of the very large disasters that continued to occur at mines with high Star ratings, and their imperceptible impact on the overall level of fatal and major injuries in South African mines.

2.10 International Standards Organisation (ISO) and Total Quality Management (TQM)

The International Organisation for Standardization (ISO) set up the ISO standards as a global benchmark after World War II, so that organisations globally could compete on an equal footing, in terms of quality service and delivery of their products and services. According to the ISO, at the end of 2006 there were 897,866 certified companies in the world (www.iso.org). With an annual growth rate of 20 percent during 1995–2006, more companies were ISO certified, than the economic growth.

Terziovski, Samson and Dow (1997), in their article in the Journal of Operations Management, found that ISO 9000 had little or no impact on company performance. Costa, et al. (2009:495-511) argue that the new version of ISO 9001/ 2000 had elements of Total Quality Management (TQM). One consensus in the literature has been that TQM affects company performance significantly.

The new ISO 9001/2000 version has four major sections and covers:

- management responsibility,
- resource management,
- product and service realization, and
- measurement, analysis and improvement.

The sections link to each other and improve customer satisfaction, which is the bedrock of TQM philosophy. Many researchers conclude that companies applying TQM have reached better results (Adams, McQueen, and Seawright, 1999:595-604). Quinlan and Bohie (1991) point out that total quality management (TQM) has gained global acceptance and should be integrated with safety management to create a synergy in achieving better SHEQ success.

2.11 Safety incidents resulting from poor corrective action

According to Phimister, et al. (2003:445), organisations allocate less importance to near miss or minor incidents. They add that, due to management not focusing proper attention on the near miss and minor safety incidents, this has led to other major accidents, such as the 1986 space shuttle Challenger's explosion. Engineers had identified and reported poor o-ring seals to prevent fuel leaks in 1982 and it was overlooked.

Phimister et al. (2003) point out that the second major incident was the 1997 Hindustan refinery explosion in India, where more than 60 people died and more than 10 000 tons of products burned. Reports of leaking and corroded pipelines were ignored and not repaired, which led to the disaster. Jacobsson, Ek, and Akselsson (2011:333) state that the term 'learning from incidents' means the capability of an organisation to extract experiences from incidents that happen in the organisation and convert them into measures and activities, which will help in avoiding future incidents and in improving safety overall. They maintain that the learning process seemingly stops at the reporting step, whereas the goal should be to achieve organisational learning for all employees. Additionally, root cause analyses need to be done in detail, to ascertain the true problem of each incident.

Maintenance in the process industry is, according to Hale et al. (1998:21), connected with a significant proportion of the serious accidents occurring in the industry. They further add that studies by the British Health and Safety Executive (1987) of deaths in the chemical industry, show that some 30 percent of accidents were linked to maintenance activities, taking place either during maintenance actions or as a result of faulty maintenance and 38.5 percent of these accidents involved the release of dangerous materials during maintenance.

A study by Hale et al. (1998), of 900 accidents involving pipe-work failure in chemical plants, found 38.7 percent to have their origins in the maintenance phase of plant operations. This study shows that around 40 percent of serious accidents in the industry are related to maintenance, 80 percent of those occurring during the maintenance phase itself, and 20 percent during normal operations, as a result of deficiencies in maintenance management.

This finding of the dominance of maintenance accidents serves to confirm the many reports from major chemical organisations about the markedly greater accident risk (often more than five times higher) for contractors' personnel, when compared with their own personnel. Grasa, et al. (2002:525) postulates that any industrial activity entails risks. They maintain that, in most industries the associated risk is known, however, in some industries it is not so obvious, as in the chemical and nuclear industries.

According to Grasa et al (2002), although there are disaster management systems at these industries, NMTER emergencies will impact all stakeholders in a wide area and it will give little comfort to those citizens who lived through the accidents of Flixborough, Seveso and Bhopal. This would indicate that many of these serious accidents indicate that NM&MI were not sorted on time, which led to the disasters.

Risk assessments, according to Armstrong (2009: 112), are concerned with the identification of hazards and the analysis of linked risks. He states further that risk is the chance of a minor or major incident or accident taking place, due to the risk not being analysed and eliminated. Jones, Kirchsteiger and Bjerke (1999:59) submit that any unexpected event, for example an accident, near miss or minor incident, should be regarded and treated as an important warning that an accident may occur. They also maintain that the internal investigation of near misses should be an integral part of a safety management system for a major hazard facility. The authors add that the internal reporting and investigation of a near miss should aim to prevent accidents and the occurrence of similar events in the future.

Lindberg, Hansson and Rollenhagen (2010:714) maintain it is essential to learn from previous accidents and incidents in order to prevent accidents. They state that much learning from accidents occurs spontaneously. However, in other cases, learning from accidents has to be institutionalized in order to overcome various social barriers and to disseminate information, so that new insights in accident prevention are applied as widely as possible.

Furthermore, learning from accidents would be to take out, put together, analyse and also communicate and bring back knowledge on accidents and NM&MI, from discovery of event, damage and cause, to all who need this information (Lindberg et al., 2010).

It is held by O'Dea and Flin (2003), that occupational hazards and safety performances are affected by complex reasons. They explore relevant factors associated with positive safety outcomes for incidents, accidents, and near misses, finding several basic contributory factors under senior management, management, supervisory staff and workers. Under senior management, the contributing factors include safety attitude, leadership style, and trust.

Management factors were divided into seven items, which included commitment to safety involvement in safety, priority of safety, leadership style, interaction, communication, and humanistic management practice. Supervisory factors include supportive supervision, supervisor involvement, supervisor autonomy, and participative supervision (O'Dea and Flin 2003). Biech (2010:388) explains that worker factors are divided into five items, which cover worker involvement, worker autonomy, worker risk perception, worker cohesion, and worker motivation. These factors encompass a wide range of aspects, including safety leadership (at senior, middle, and first-line management levels), safety culture / climate, and employee behaviour. According to Biech (2010), diversity and inclusion of employees are key elements in organisational success today and in the future.

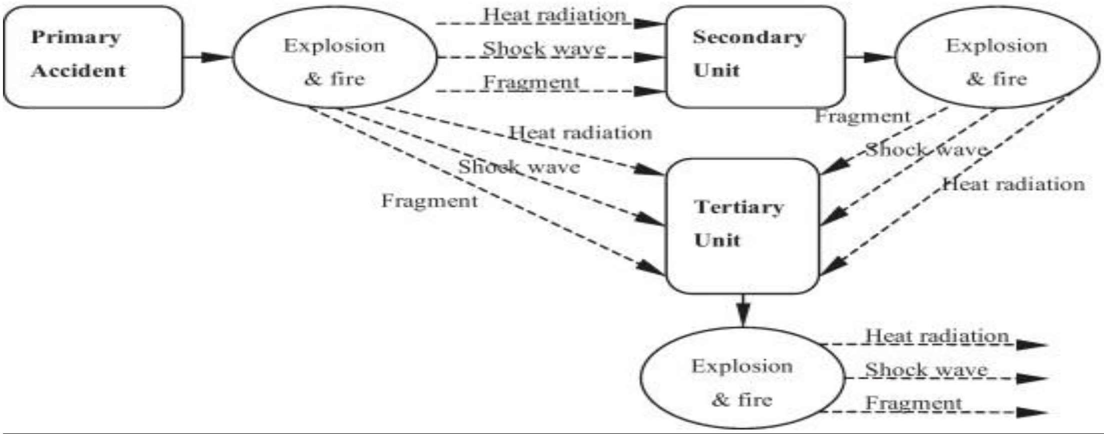
2.12 Unique features of chemical industries, with respect to safety risks and hazards

Each of these factors triggers changes in the key functional areas of the chemical industries (Zwetsloot et al 2006). Swuste, Albrehtsen and Hovden, (2012:1983-1992) state that chemical industries fall under a high-risk industries categorisation, due to their handling and storage of chemicals, which are unique by nature in being hazardous and flammable. They are defined as industries whose work processes imply considerable risk for people and the environment, regarding large potential for either major accidents, as in aviation, nuclear power generation, or chemical production.

Zhang and Chen (2013:79-85) argue that the trend, currently in global petrochemical industries, is to centralize their plants, tank farms and installations. This is evident in China, as new chemical industrial zones have been developed. The very nature of bulk storage of different types of chemicals, gas and oil in vast quantities at these zones escalates the potential risks and hazards. The authors believe that these chemical zones promote escalation scenarios (unique to chemical industries) when there is an accident resulting in an explosion or fire.

Accident Escalation

Many studies concur that heat radiation, blast overpressure and explosion fragments are the three main energy carriers leading to an escalation scenario and the domino effect (Cozzani, Gubinelli and Antonioni, 2005:14-30 and Cozzani, Gubinelli, and Salzano, 2006:1-21). The accident escalation of the heat radiation, blast and fragments in chemical industry zones is complicated and the escalation process of an accident is shown in Figure 2.6. The primary accident escalates to a secondary and then probably into a tertiary accident / incident as part of the domino effect; this is unique to the chemical industries.



Source: Zhang and Chen (2013: 79-85)

Figure 2.6 Accident escalation process in the chemical industry

Definition of hazardous chemicals

The International Labour Organisation (ILO, 1993) gave the following scope and definitions, in order to improve understanding and prevent major disasters involving hazardous substances, which are unique to the chemical industry:

- “hazardous substance” - a substance, or mixture of substances which, by virtue of chemical, physical or toxicological properties, either singly or in combination, constitutes a hazard;
- “threshold quantity” - for a given hazardous substance or category of substances that quantity, prescribed in national laws and regulations by reference to specific conditions, which if exceeded, identifies a major hazard installation;
- “major hazard installation” - one which produces, processes, handles, uses, disposes of or stores, either permanently or temporarily, one or more hazardous substances or categories of substances, in quantities which exceed the threshold quantity;
- “major accident” - a sudden occurrence — such as a major emission, fire or explosion — in the course of an activity within a major hazard installation, involving one or more hazardous substances and leading to

a serious danger to workers, the public or the environment, whether immediate or delayed;

- “safety report“ - a written presentation of the technical, management and operational information covering the hazards and risks of a major hazard installation, and their control, as well as providing justification for the measures taken for the safety of the installation;
- “near miss” - any sudden event involving one or more hazardous substances which, but for mitigating effects, actions or systems, could have escalated to a major accident.

In respect of each major hazard installation, employers shall establish and maintain a documented system of major hazard control, which includes provision for:

- the identification and analysis of hazards and the assessment of risks, including consideration of possible interactions between substances;

- technical measures, including design, safety systems, construction, choice of chemicals, operation, maintenance and systematic inspection of the installation;

- organisational measures, including training and instruction of personnel, the provision of equipment in order to ensure their safety, staffing levels, hours of work, definition of responsibilities, and controls on outside contractors and temporary workers on the site of the installation;

- emergency plans and procedures, including:

(i) the preparation of effective site emergency plans and procedures, including emergency medical procedures, to be applied in case of major accidents or threat thereof, with periodic testing and evaluation of their effectiveness and revision as necessary;

(ii) the provision of information on potential accidents and site emergency plans to authorities and bodies responsible for the preparation of emergency plans and procedures for the protection of the public and the environment outside the site of the installation;

(iii) any necessary consultation with such authorities and bodies;

- measures to limit the consequences of a major accident;

- consultation with workers and their representatives;

- improvement of the system, including measures for gathering information and analysing accidents and near misses. The lessons so learnt shall be discussed with the workers and their representatives and shall be recorded in accordance with national law and practice (ILO:1993).

2.13 The history of incidents / accidents in the chemical industries in South Africa

The history of incidents / accidents in the chemical industries in Durban South Basin KZN, are reported by GroundWork (2012: Newsletter). Incidents that have occurred over the past five years are as follows:

- On May 19, 1998, a refinery alkylation unit malfunctioned, resulting in the release of five tons of hydrogen fluoride into the atmosphere. Exposure to large amounts of hydrogen fluoride can cause death. Inhaling hydrogen fluoride can damage the lungs and heart. Long-term exposure can lead to a condition called skeletal fluorosis.

- In February 2000, the refinery management admitted that they under reported their sulphur dioxide emissions to Government authorities by up to 12 tons a day, since 1995.

- On January 23, 2001, a fire occurred at the Crude Distillation Unit number 2. On the same day, 1000 litres of bunker fuel spilled into the Durban Bay.

- On March 22, 2001, a tetra ethyl lead (TEL) tank failure resulted in 25 tons of TEL leaking out of the tank. It leaked for four days.

- On June 19, 2001, a flare failure resulted in the release of unburnt gases, including a substantial amount of hydrogen sulphide onto the surrounding communities.

- On July 7, 2001, a petrol pipeline leak resulted in the release of more than one million litres of petrol into the soil under residents' houses. The leak was discovered and reported by residents.

- On the 1st of August, a second pipeline leak was discovered, resulting in residents demanding an immediate inspection of the pipeline. The South Durban Community Environmental Alliance, a coalition of community organisations from residential areas in Durban south, has called on refinery to replace all its pipelines as a matter of urgency. Most of the pipelines, the same as the refinery, are 40 years old.

- On August 15, 2001, the Bitumen plant malfunctioned, resulting in the release of soot, smoke and hydrocarbons.

- On the 14th October 2001, during a ship refuelling, fuel oil spilled into the harbour. The Refinery claimed that only 20 litres of fuel leaked, but the harbour authorities claim that closer to 2,000 litres of fuel oil leaked into the harbour.

- On the 30th December 2001, 15,000 litres of fuel oil spilled from a refinery pipe into the harbour.

- On the 9 July 2002, during refinery excavation activities, a diesel pipeline developed a leak, resulting in 1,000 litres of diesel spilled into a south Durban residential area.

- On the 19th November 2002, 15,000 litres of crude oil were released from the refineries' offshore facility into the ocean.

- On the 4th February 2003, during a maintenance test on a fuel oil pipeline, 1,000 litres of fuel oil leaked into a concrete tunnel near Island View. The fuel oil was then pumped into Durban harbour.

Case Studies:

The largest petrol spill in South African history took place in July 2001. Residents living in the Bluff, a community in the Durban south Basin, complained about a strong petrol smell emanating from storm water drains in the area. A leak was then discovered in an underground refinery pipeline, which transports 10 million litres of petrol a day through residential areas. The leak is close to a wetland, called the Bluff Nature Reserve along Tara Road in the Bluff. The leak, from a four millimetre hole in the pipeline, was the result of external rusting of the pipeline, due to exposure to moisture.

The refinery, after initially claiming that only 500,000 to 750,000 litres of petrol leaked from the hole, readjusted their estimate to between one million to 1,5 million litres of petrol that leaked. The refinery has thus far recovered more than a million litres of petrol form the soil. Remediation was expected to continue until 2004. With regard to health risks, the refinery informed residents that they might periodically experience burning eyes, coughing, dizziness and nausea, as a result of the petrol vapours. Remedial work, to extract the petrol from the soil, resulted in high concentrations of benzene, toluene, ethylbenzene and xylene in the air. Benzene exposure is linked to leukemia.

Two months after the spill, five families living closest to the spill, were temporarily relocated by the refinery. On the 27th August 2001, one month after the Tara Road incident, the refinery reported another leak in their fuel oil pipeline between Badulla Drive and Grays Inn Road, Durban South. The fuel oil pipeline was shut down for inspection, which revealed 98 defects involving 70 percent or more decrease of wall thickness, 42 defects involving between 60 to 70 percent decrease of wall thickness, and 98 defects of 50to 60 percent decrease of wall thickness. The refinery then repaired patches of the pipeline over a length of 11 km. Two kilometres of pipeline was replaced completely. Six months later, on the 14th January 2002, tests revealed new oil spills on the same pipeline.

The refineries research into its other six pipelines, reveal eight defects, involving 70 percent or more deterioration of pipeline wall thickness, four defects involving between 60 to 70 percent deterioration of wall thickness and 19 defects of between 50 to 60 percent deterioration of wall thickness. In November 2007, one of the storage tanks (Figure 2.7) at the refinery, an 180,000 barrel-a-day operation, caught fire in a lightning storm and burned for five days before it was brought under control by fire fighters, causing the evacuation of thousands of residents.

Photo: Bill Corcoran/IRIN
Source: Looking for a solution IRIN (2008)

Figure 2.7 Fuel tank on fire at the refinery

26 September 2008 (IRIN) - After years of calling on the owners of South Africa's oil refineries in Durban to upgrade their facilities to reduce pollution, local residents of the eastern port city decided to take their case to the courts, to secure a legal remedy. For more than a decade, concerned citizens and environmental groups have complained that Durban's two refineries spew out dangerous noxious chemicals, despite pleas to clean up their act.

The South Durban Community Environmental Alliance (SDCEA) chairperson, Desmond D'sa, told IRIN they were in the process of preparing a class action lawsuit against the refinery - in a bid to make the companies accountable. The SDCEA has recorded more than 120 accidents and pollution incidents at the two installations since 1998, ranging from large oil spills and work-related employee deaths, to accidental fires and explosions in the refineries' compounds.

2.14 Incident / Accident causation models and frameworks

The structure of accidents, covering the details of immediate causes, contributing causes, types of accidents and results of accidents, forms the basic causes to incidents or accidents (Figure 2.8). An understanding of the "cause and effect" relationship of the accident-causing factors is required before continuous improvement of safety processes can be undertaken (Accident Causation Models and Theories, 2012).

Source: Accident Causation Models and Theories (2012)

Figure 2.8 Basic structure of accident causation

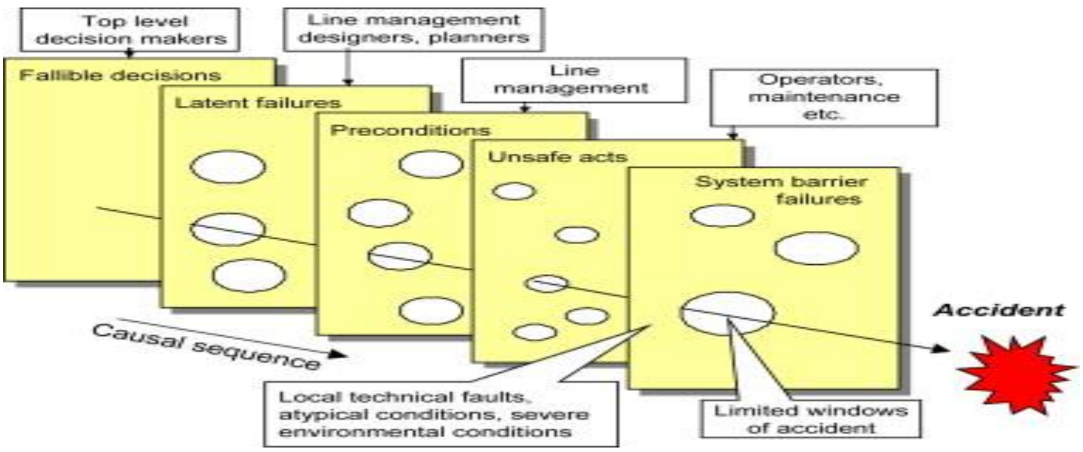
In the development of the tripod method, Groeneweg, Lanconi and Metaal (2002) identified the failure types and renamed them as 'Basic Risk Factors' (BRF). The tripod method of investigation is an approach to safety, aimed at analysing the causes that lead to incidents. The tripod theory, and the applications that have developed from it, are the result of research by the Universities of Leiden and Manchester, sponsored by Shell. The research into the tripod concept started in 1988, with the idea being that organisational failures are the main factors in accident causation. These factors are more "latent" and, when contributing to an accident, are always followed by a number of technical and human errors (Tripod Beta-Tripod Foundation: 2008). The tripod theory lists 11 Basic Risk Factors (Figure 2.9) that work in the accident causation chain.

Ergonomically poor workplace design
Error enforcing conditions
Inadequate maintenance
Incompatible Goals
Ineffective communication
Insufficient defenses.
Insufficient training
Low quality or availability of procedures
Poor housekeeping
Poor quality of hardware (tools, equipment etc.)
Shortcomings of organisation

Source: Groeneweg et al (2002)

Figure 2.9 Basic risk factors (BRF)

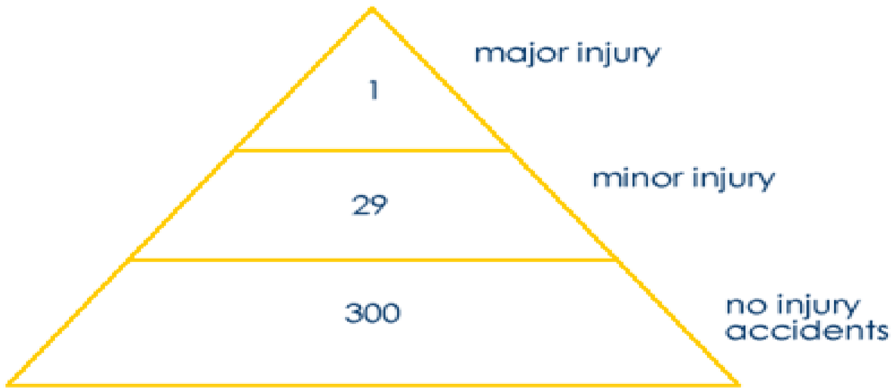
Reason (1990:1) describes, in a “model” how accidents could be seen as the result of a multitude of interrelations / coincidences, for instance between failing system barriers, “unsafe acts” by front line operators prior to the event and latent conditions consisting of preconditions, such as stress. He also adds latent failures by designer faults and fallible decisions by management, as contributing factors. Reason’s (1990) model depicts slices of cheese forming barriers, which leave open holes that, at a moment of line-up, leave the event to happen, (Figure 2.10). This model was later named the Swiss Cheese Model (SCM) and shows how alignment of failures in various safety layers or defences, can cause an accident to happen.



Source: Reason (1990)

Figure 2.10 The Swiss cheese model (SCM)

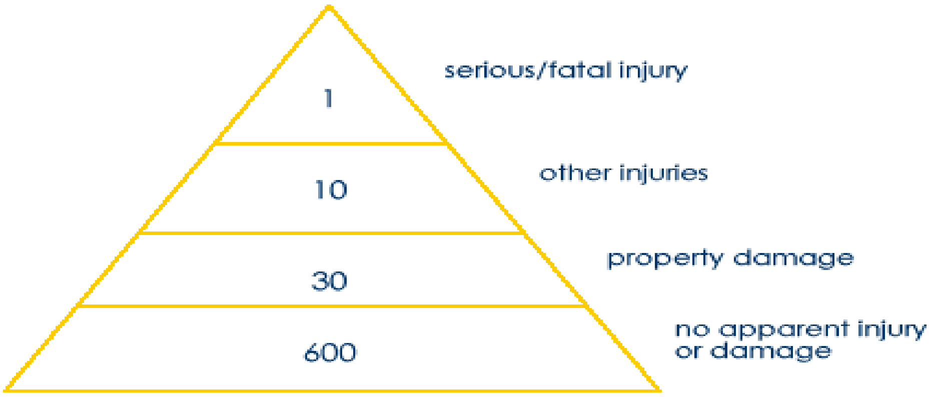
Heinrich (1959), a safety engineer in America, used statistics in the 1920's to construct an accident pyramid framework (Figure 2.11). His description of the relationship between major, minor and no-injury accidents, was an attempt to show how important the injury potential is in the process of accident prevention. Based on the domino theory, Heinrich (1940) proposed his safety pyramid, stating that it was important to limit the NM&MI to reduce the number of subsequent major incidents. More than one million facilities were surveyed by Heinrich (1940), who then recorded the accident consequence ratio of 1:29:300 for major injuries, minor injuries, and no-injury incidents (Bowles, 2004).



Source: Bowles (2004)

Figure 2.11 Heinrich's accident pyramid

During the 1960's, another U.S. insurance industry specialist, Frank Bird (1980), brought Heinrich's (1959) theory up to date. He did this through a survey of 1,700,000 accidents and devised his "accident ratio" (Figure 2.12) which, although not identical to Heinrich's, showed that the same pattern applied.



Source: Bowles (2004)

Figure 2.12 Bird's accident ratio

Bird's (1980) pyramid is now accepted as the standard example because it not only shows more clearly the number of "hidden" accidents, but also indicates the huge loss potential of property damage incidents. To correctly apply any techniques of accident prevention, Bird (1980) points out that it is vital to properly identify weaknesses, within the organisational system, that have the potential for loss. Not controlling minor incidents, including near misses, and allowing them to grow, can lead to fatal incidents, as Bird's (1980) accident ratio shows (Bowles, 2004). Heinrich's accident pyramid and Bird's accident ratio are safety standards used in industry to measure incidents.

Teo and Ling (2005:1584) describe 14 main, safety management elements in their model (Figure 2.13), with which to measure effectiveness of management safety systems.

These elements are:

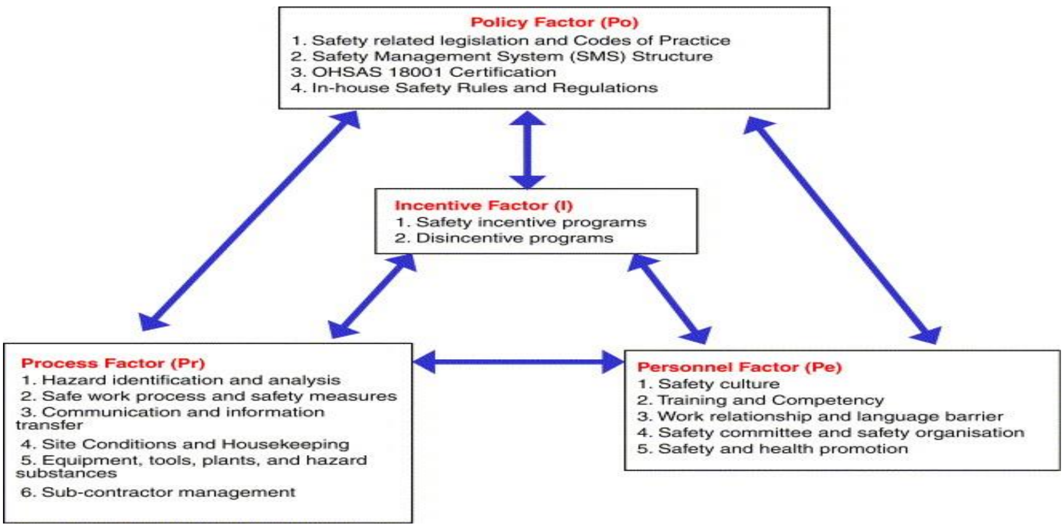
- The organization must have safety policy for all stakeholders;
- Safe work practices must be written in standard operating procedures;
- It is critical that all employees must under go full safety training;
- Management must facilitate group safety meetings;
- Incident investigation and analysis must be completed in full;

- All employees must follow all in-house safety rules and regulations;
- Safety promotion must be done regularly to uphold safety;
- Evaluation, selection and control of sub-contractors is crucial in improving on safety incidents;
- Safety inspections must be carried out on a regular basis;
- Maintenance regime for all machinery and equipment;
- Hazard analysis must be done before any plant maintenance is done;
- Movement control and use of hazardous substances and chemicals;
- Emergency preparedness and occupational health programmes must be in place for any emergencies.

Their analysis produced four principal components, labelled as:

– Policy Factor,
– Process Factor,
– Personnel Factor, and
– Incentive Factor.

It is held that NM&MI are to be evaluated to establish nature and trends (Teo and Ling, 2005). These patterns will cast some light on the effectiveness of management interventions taken, in order to reduce the number of NM&MI.



Source: Teo and Ling (2005)

Figure 2.13 Model: Effectiveness of management safety systems

Michael, et al. (2006:469-477) argue that, although safety communication is very important, but is not sufficient on its own, to ensure a low safety incident rate. They further state that, communication should be part of a much larger picture, including factors such as safety climate, culture, and management commitment to safety, that have been shown to interact to affect accident rates. Fagotto and Fung (2003:63-68) believe that safety communications, by means of the use of Material Safety Data Sheets (MSDS), helps only those workers who can read and understand them but not all workers.

Many workers only tend to consult the MSDS when an incident has occurred. The authors further suggest that symbols and pictograms should be used widely and a rigorous training plan should be followed, in order for all workers to understand the safety communication on chemicals properly. Perception surveys are by far the most commonly used data collection method for evaluating safety climate (O'Connor et al., 2011) and are commonly used to measure employee perceptions on the status of safety, health and environmental aspects of the safety programme. Statistical studies, according to Carder and Ragan (2003:157) indicate that Safety Perception Surveys are both reliable and valid as a measurement tool.

The surveys measure important components of the management system including:

- Management's demonstration of commitment to safety,
- Education and knowledge of the workforce,
- Effectiveness of the supervisory process, and
- Employee involvement and commitment.

Donald and Canter (1994:203) maintain that a survey questionnaire is made up of a set of questions (Q) and a set of scales, with which to measure safety attitudes in the chemical industry. They developed a question set comprising 10 scales. The results showed that the scales were reliable measures of safety attitude. Nivolianitou et al. (2006:630) claim that chemical organisations do not learn from past incidents. The authors go on to say that they are also supportive of sharing information about past incidents, so that all industry stakeholders can learn from them. They further mention the following, as key management interventions, that need to be considered:

- the use of safety management systems in assisting the safety management programmes;
- training on how to improve employee behaviour and attitude in reducing incidents;
- removing the basic risk factors, and
- reviewing of accident databases for improving safety.

Khan and Abbasi (1999:11) point out that any incidents in the chemical industry would be damaging. Therefore, the categorisation of incidents and accidents is very important for their future analysis and understanding.

Accident databases typically require the reporting of accident details such as:

- the type of chemicals and quantity released;
- the cause of incident;
- the number of people fatally injured;
- the number of people hospitalised with serious injuries;
- the number of people sustaining minor injuries and
- the number of evacuation areas and / or shelters in place.

However, the authors state that it seems little effort has been made to utilise the information contained in the databases, such as to analyse, understand and use this information in incident prevention. Carter and Menckel (1990:125) also stress the importance of accident investigation and the use of historical accident information, in order to learn as much as possible from each accident to prevent future incidents. They go on to say that, harnessing the wealth of information contained in accident databases, can assist in the organisations better understanding the large number of incidents, their consequent losses and causes.

According to Angela (2008:1), the proper use of personal protective equipment (PPE) will improve incident frequency, resulting in a reduction of minor injuries. She adds that safety is necessary, due to the injury and associated costs of injured employees, and many corporations rightly view small scrapes and near misses as symptoms of a deeper problem that could later manifest itself in a serious incident. Angela (2008) goes on to say that safety training is a difficult and arduous task for managers, and in the case of an incident, one of the popular root causes is stated to be managerial pressure to rush production.

Abudayyeh, Fredericks, Butt and Shaar (2006: 167-174) in research work on their NM&MI tool, further recommend that a clear commitment from management on safety can be materialized and demonstrated by having the following elements:

- *Safety budget*: that helps management enhance safety.
- *Safety management position* (on-site): The safety manager or director must build a successful team that is safety conscious.
- *Communication skills*: continuous education and training followed by feedback and evaluating results.
- *Safety culture:* safety is on the mind of all personnel from the worker to the supervisor to middle and upper management levels.
- *Empowerment*: When people feel empowered, safety becomes their own personal goal and responsibility.
- *Continuous monitoring and improvement*: Monitoring the performance of the workers to improve their safety programs and techniques.
- *Involvement*: Workers and employees that participate in policymaking are more motivated to carry that policy and improve on it through personal responsibility and continuous feedback.

The Responsible Care Global Charter (Responsible Care: 2005) describes the global chemical industry's environmental, health and safety initiative to drive continuous improvement in performance. It is understood that the Charter achieves this objective by meeting and going beyond legislative and regulatory compliance and by adopting cooperative and voluntary initiatives with government and other stakeholders. This Responsible Care Global Charter contains nine key elements:

- the adoption of a global responsible care core principles
- implementing fundamental features of national responsible care programmes
- commitment to advancing sustainable development
- continuous improvement and reporting performance
- enhancing the management of chemical products worldwide – product stewardship
- championing and facilitating the extension of responsible care along the chemical industry's value chain
- actively supporting national and global responsible care governance processes
- addressing stakeholder expectations about chemical industry activities and products
- providing appropriate resources to effectively implement responsible care.

The Center for Chemical Process Safety (CCPS) was established in 1985 by the American Institute of Chemical Engineers (AIChE), for the express purpose of assisting industry in avoiding or mitigating catastrophic chemical accidents (CCPS:2010). The CCPS committee identified that a key breakthrough opportunity for industry was the development of an industry lagging metric, that would become the benchmark across the chemical and petroleum industry for measuring process safety performance. To achieve this objective, representatives and members from each of the major chemical and petroleum trade associations, as well as other key global stakeholders were engaged. In 2007 a guideline book was launched for the development and use of Leading and Lagging Process Safety Metrics.

The definitions (CCPS: 2010) of these metrics are:
‘*Lagging’ Metrics* – a retrospective set of metrics based on incidents that meet the threshold of severity that should be reported as part of the industry-wide process safety metric.

‘*Leading’ Metrics* – a forward looking set of metrics which indicates the performance of the key work processes, operating discipline, or layers of protection that prevent incidents

‘Near Miss’ and other internal Lagging Metrics – less severe incidents (below the threshold for inclusion in the industry lagging metric), or unsafe conditions, that will activate one or more layers of protection. Although these events are actual events (a ‘lagging' metric), they are generally considered to be a good indicator of conditions which could ultimately lead to a more severe incident (CCPS, 2010).

An example of the benchmark is:
Near Miss Total Event Rate (NMTER)
The NMTER (Figure 2.14) is calculated using the total NM&MI for the year, multiplied at 200,000 hours per year - as standard for total employee and contractor hours worked, including overtime. The product is used as a benchmark for NM&MI.

$$\text{NMTER} = \frac{(\text{Total Near Misses}) \times 200,000}{\text{Total employee and contractor work hours}}$$

Source: CCPS (2010)
Figure 2.14 Near miss total event rate

This calculation for NMTER (Figure 2.15) does not allow for a maximum tolerable level calculation for NM&MI. The NMTER formula was adapted to calculate near miss and minor incident rates (NM&MIR) as follows:

The new benchmark for Near Miss & Minor Incident Rate (NM&MIR) is:

$$\text{NM\&MIR} \quad \frac{\text{NM\&MI x 200,000hrs}}{\text{Total employee and contractor work hours}}$$

Source: adapted from CCPS (2010) NMTER

Figure 2.15 Near miss and minor incident rate

Example of calculation:

For instance, where the total NM&MI is 208 and the total hours are 2,311,111 then the benchmark NM&MIR will be 18

Maximum Tolerable Level

Each organisation can set their own maximum tolerable level depending on the number of NM&MI they generate. The eventual goal is a tolerable rate of zero, which will equate to nil NM&MI. The tolerable rate for this research will be set at one, to test the NM&MI collected from the seven organisations.

OM development

The only other management tool identified to improve on near misses, is the Eight Step Process (ESP-Oktem 2002:1) and it does not cover minor incidents (Chapter 6). From the literature reviewed, it is evident that there is only one management tool (ESP-Oktem:1) to improve the management of near misses and it is not comprehensive. To improve on the management of NM&MI, a new OM will be developed to fulfil this gap. This OM will cover both NM&MI, including a comparison with the ESP and international/ national bench marks. The resultant OM will be comprehensive, to improve on the management of NM&MIs. Prem, Dedy, Ng, and Mannan (2010:549)

contend that history repeats itself due to some of the major disasters that have developed from NM&MI not having been properly investigated and managed.
The Tactical Methodology is the second tier of the OM and elements of the TM are taken form the employee survey (appendix E) and forms the template for management, supervisors and workers to use in maintaining safe, healthy and environmentally friendly chemical organisations (Employee survey responses-Appendix E).

The following are key elements:
Management commitment: the reference is on how committed the management team is in making safety work at the organisations. The SHE policy can be very well constituted, but unless there is sufficient management commitment to action the strategic policy, the policy is worthless.

Supportive culture: the question is, whether top management just pays lip service to SHE approaches or if they are truly supportive. Is the safety culture fully entrenched to support and make safety approaches work?

Communications: safety communications is crucial in maintaining SHE approaches on the chemical plants. All employees working in the operations must be kept informed on safety, health and environmental issues all the time.

Safety priority: the important question is whether all levels of the chemical organisations give the highest priority to safety approaches in ensuring that safety comes first.

Safety rules and regulations: are safety rules and regulations updated regularly; are they reflective of the operations? Do the rules and regulations make the operations more cumbersome and risky or are they just there for the auditors?

Involvement: it is crucial that all workers, supervisors and management are fully involved to make a success of all safety approaches. The safety representative and supervisors must check whether all workers understand all aspects of safety approaches taking place at the organisations. Are the workers full participants or are they just standing on the sidelines?

Supportive environment: do workers receive the necessary support from their supervisors and managers on all safety approaches or are they blamed for all the safety issues at their plants?

Behaviour and attitude: are behaviour and attitude counter productive to the safety approaches at the organisations? Are the workers, supervisors and managers behaving poorly?

Competency and training: do all the organisations have good training programmes to cover all approaches for safety training? Are the workers, supervisors and managers competent?
The elements of TM form the basis of the questionnaire for gathering of the employee survey (Appendix E).

Functional Methodology (advanced)

The FM (advanced) was developed with information from employee surveys, (Employee survey - Appendix C), categorized NM&MI from the seven organisations, (NM&MI database - Appendix E) and the comparison with international benchmarks on the FM (basic).

Step A - shows all the risks and incidents that organisations are exposed to including NM&MI. The NM&MI could lead to major incidents and disasters resulting in fatalities.

Step B - indicates the management systems in place to mitigate the risks and incidents. Some incidents are controlled yet many NM&MI still occur. NM&MI costs should be calculated to give a true reflection of the actual value of the NM&MI.

FM 1 – The process flow starts at this point where all the key functions are at the organisations which bears the impact of the NM&MI.

FM 2 - an employee survey should be done on an annual basis or sooner depending on the level of severity of NM&MI. The employee survey will show inside safety occurrences not readily apparent to management

FM 3 - near miss and minor incident data should be collected from the organisations' databases. Root cause analysis should be done of data that show problematic trends. Best solutions can only be found when the true cause of incidents is identified.

FM 4 - NM&MI should be categorized and the causes and management interventions listed. This step will assist in identifying specific trends for immediate action.

FM 5 - data from employee surveys (FM2) should be analysed and management interventions listed for review and action.

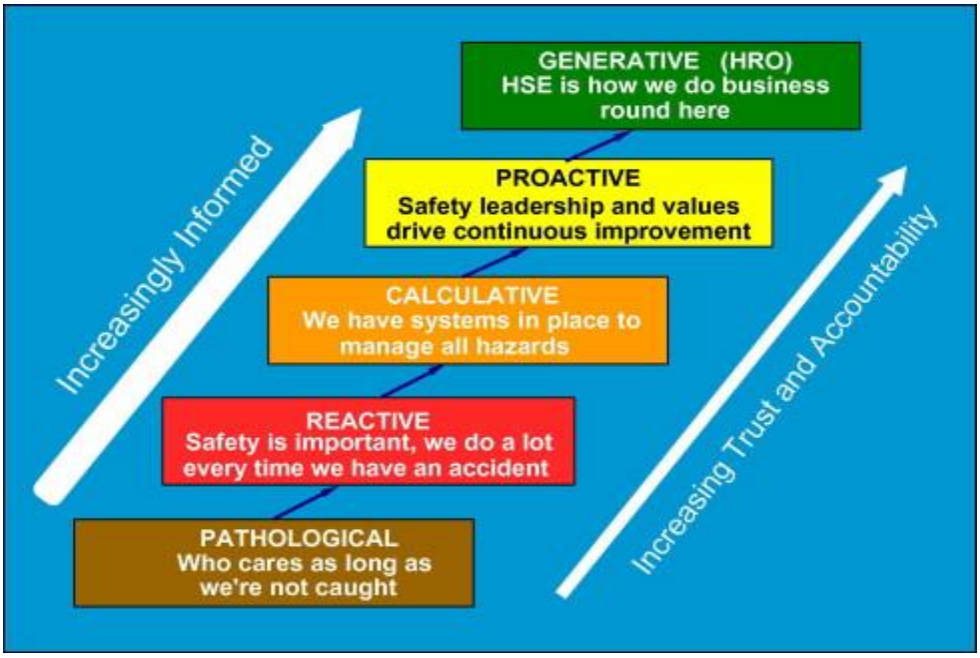
FM 6 – calculate the NM&MIR and check against the tolerable rate of 1. Also check root cause analysis. Management interventions and employee surveys. The best solutions should be developed and used for management of the NM&MI

FM 7 – compare the current tolerable rate to previous period. Work out best fit long lasting solutions.

M 8 - all the best solutions developed/ selected would be used to mitigate the risks and manage the NM&MI. This step leads back to the key functional areas of the organisations (step 1). All stakeholders must be trained and made aware of the NM&MI, their solutions and the resultant corrective actions implemented.

Safety, Health and Environment Culture Ladder

Hudson (2007:697-722) introduced a culture ladder, which describes the development of a health, safety and environmental (HSE) culture as pivotal in maintaining the SHE approaches in an organisation. The HSE Culture ladder (Fig. 2.16) assists in mapping out the pathway from a basic HSE culture to a full HSE culture. Hudson (2007) also states that organisations that are serious in developing a good HSE culture, would follow the steps of the HSE model. The author is of the opinion that both the five main stages of the change model, which the employees should be made aware of, and this new behaviour, should be maintained as the new culture of the organisation.



Source: Hudson (*2007:697-722)*

Figure 2.16 HSE culture ladder

This change model has 14 steps, which should be followed to facilitate the new HSE culture change.

Pre-contemplation to contemplation – AWARENESS

- *Awareness* – simple knowledge of a 'better' alternative than the current state
- *Creation of need* – active personal desire to achieve the new state
- *Making the outcome believable* – believing that the state is sensible for those involved
- *Making the outcome achievable* – making the process of achieving the new state credible for those involved
- *Personal vision* – definition by those involved of what they expect the new situation to be
- *Information about successes* – provision of information about others who have succeeded

- *Contemplation to preparation – PLANNING*
  - *Plan construction* – creation by those involved of their own action plan
  - *Measurement points* – definition of indicators of success in process
  - *Commitment* – signing-up to the plan of all involved

- *Preparation to action – ACTION*
  - Do – start implementing action plan
  - *Review* – review progress with concentration upon successful outcomes
  - *Correct* – reworking of plan where necessary

- *Maintenance – MAINTENANCE*
  - *Review* – management review of process at regular (and defined
  - in advance) intervals
  - *Outcome* – checks on internalisation of values and beliefs in outcome state

Hudson further states that top managements' involvement is critical, in making the new HSE culture work. Kreitz, (2008; 101-120) maintains that 21st century organisations are living with and being challenged by diversity on three levels; an increasingly diverse workforce, a multicultural customer base, and a growing challenge for market share from international competitors.

In order to take advantage of the benefits diversity can bring to an organisation and minimize its potentially negative effects, an organisation must manage diversity strategically: with data-driven planning, carefully articulated goals, judiciously applied organisational changes, and soundly gathered and ruthlessly analysed metrics (Kreitz, 2008). Senior managers must support diversity initiatives and be willing to commit sufficient resources to the effort. Managers must recognize that effectively implementing workplace diversity requires sustained commitment to organisational change.

2.15 Social constructivism

In attempting to make sense of the social world, social constructionists view knowledge as constructed as opposed to created. Social constructionism places great emphasis on everyday interactions between people and how they use language to construct their reality. It regards the social practices people engage in as the focus of enquiry (Andrews 2012:1550-1556). Social constructivism is based on learning by social contact and the belief that reality is constructed through human activity. Reality cannot be discovered: it does not exist prior to its social invention is the belief of Social Constructivists. Individuals create knowledge by their interactions with other people (Beaumie 2001-1)

2.16 A review of the questionnaire

The questionnaire for this research was adapted and refined from the measurement tool complied by Sample Safety Survey (2014). Each question in the questionnaire is analysed in detail, in order to explain the reasoning of why the question was asked and the type of response expected. This also fulfils the requirements of the sub-objective "*to survey the perceptions of management, supervisory staff and workers of the functional areas of the selected chemical organisations, in order to establish respondents' attitudes to safety, health and environmental approaches.*

Management Commitment

The perceived level of organisational commitment to health and safety is a major influence on health and safety performance in practice. The series of questions in this questionnaire seeks employees' opinions of this commitment, as evidenced, for example, by their views on senior management's interest in health and safety, the provision of resources for health and safety, and the relative status of health and safety.

An important indicator of an organisations commitment to health and safety is how workers regard the importance their immediate superior places on health and safety. Most workers attempt to deliver what they think is important to their immediate superior. The questions explore workers views of the extent to which their immediate superior promotes health and safety and reacts to health and safety issues which may be raised. Supervisors have an important part to play in promoting safe behaviour. These questions also seek the workers views on the contribution and effectiveness of their supervisors.

1. In my workplace management acts immediately to correct safety incidents

-

The situation is different here because there is immediate action on safety issues. There will be trust between workers and management, as management takes safety seriously. This is good safety culture and safety incidents should reduce here.

2. Management acts decisively when a safety concern is raised -

This is to see how committed management is, and whether they take immediate action when told of safety issues. The respondents will state if it is true or not in their organisations. This will also shape the type of safety culture in the organisation.

3. Corrective action is always taken when management is told about unsafe incidents -

Here is an organisation that takes action when told of safety issues. They are not proactive in safety but take necessary action. This might not be done immediately.

4. In my workplace management turn a blind eye to safety incidents -

This situation is problematic, as the workers will feel that their lives are not valued due to management non-action. The safety risks will be very high and result in a poor safety culture at this organisation.

5. In my workplace managers / supervisors show interest in my safety -

This is positive for the worker, as there is interest shown in worker safety. The worker will feel safe to work. This is conducive to good worker motivation and safety culture.

6. Managers and supervisors express concern if safety procedures are not adhered to -

The management team checks on the workers to see whether they are following required procedures. If they do not, management make the workers know that they are not happy and take the necessary action. The workers will be more careful in their jobs, knowing that the superiors are keeping an eye on them.

7. Management acts only after accidents have occurred -

Here the management has a wait-and-see attitude; they will only spend money if there is an accident. We need to find out if management is reactive or proactive in terms of safety.

Communication

Do the safety advisors, safety representatives and committees have a high status, operate proactively, work and communicate effectively? Do managers, supervisors and team leaders regularly communicate safety-related messages?

8. Management operates an open door policy on safety -

This determines whether management will allow workers to discuss safety issues openly, without being victimised. In most cases, workers are frustrated that they cannot take up the safety concerns to top management. This is a poor safety climate.

9. My line manager / supervisor does not always inform me of current concerns and incidents -

Here is a situation that the communication channel is not working, as current safety issues are not communicated effectively. This will contribute to many incidents.

10. I do not receive praise for working safely -

All employees require some form of motivation and praise allows for good motivation. Workers can become frustrated if they work hard on resolving safety incidents and do not get the required recognition.

11. There is good communication on safety in our organisation -

This statement reinforces the previous one and the communication is good. This is conducive to good safety management; we want to establish if it exists in the organisation.

Priority of Safety and Health

12. I believe that safety issues are not assigned a high priority -

The organisation cares less about safety incidents / issues. Safety takes a back seat. We want to determine if safety management is poor or good.

13. Management clearly considers the safety of employees of great importance -

This is the direct opposite, in that management cares for the safety of the employees. They have safety interventions in place that protect the employees; we want to establish whether this is true.

14. Safety rules and procedures are carefully followed -

The safety culture works in this organisation. Everyone follows the safety rules and regulations. There should not be safety incidents.

15. Management considers safety to be equally as important as production -

Here management pays equal respect to safety and production. Each one relies on the other. We want to establish if this is true or does production take first place.

Safety Rules and Procedures

16. Sometimes it is necessary to depart from safety requirements for production's sake -

Here, it seems that production takes centre stage and safety is neglected. This is not good safety management. If there is an incident or accident then the production suffers.

17. Some health and safety rules and procedures are not really practical -

If this is the case, then the rules and procedures must be revisited and made user friendly so that all can use them.

18. Some safety rules and procedures do not need to be followed to get the *job done safely -*

This is a sad state of affairs, it is said that safety comes first. Workers must be taught that safety must always be adhered to. Do the organisations preach and act safely?

Supportive Safety Culture

19. I am strongly encouraged to report unsafe conditions -

If staff are encouraged to report unsafe conditions then the basic aspect of safety is working. Is this a true reflection in the industry?

20. A no-blame approach is used to persuade people acting unsafely that their behaviour is inappropriate -

This will assist in bringing staff, who are not within the safety culture, on board in reporting poor safety habits.

Involvement

21. I am never involved in the ongoing review of safety -

All employees must be informed of safety issues and reviews. We want to know if the company is operating without involving employees on safety reviews.

Personal Priorities and Need for Safety

22. I understand my role and responsibilities for health and safety -

Employees have a clear understanding of their responsibility for safety. Do all the employees of other organisations have the same understanding?

Work Environment

23. Operational targets often conflict with safety measures -

Does this organisation go for production and not worry about safety?

24. Sometimes conditions here hinder my ability to work safely -

Is the organisation set up properly to work safely? Is this a problem in other organisations?

25. Sometimes I am not given enough time to get the job done safely -

Is there a constant time constraint in completing the jobs safely? Is this common in other organisations?

Behaviour and Attitude

26. Some employees display a poor attitude towards their job -

This is to establish whether employees are motivated in doing their jobs or whether they do not care.

Competence / Training

27. Safety reports are poorly written -

This is to establish whether employees are competent in writing reports.

28. Contract labourers are not competent -

Are they competent? Do they receive the same training as regular employees?

29. My safety training is adequate -

This will reveal whether employees have sufficient safety training.

30. There are too many inexperienced staff in our workplace -

This is to establish whether the organisation has enough experienced employees.

2.17 Conclusion

The literature review examines global research done, regarding the topic of this research and its objectives. It covers a broad focus on safety, health, environment and quality aspects, the nature of safety, and typical risks and hazards impacting across industries. The focus shifts to the chemical industry and the safety incidents specifically relating to NM&MI. Some of the areas covered include the history of the OHS Act and the impact it has on safety, health and environmental aspects for business, local chemical

industry and incidents/ accidents contributed, and. safety management Systems, i.e. NOSA, ISO and TQM.
In addition, a review is done on worker, supervisor and management surveys, in order to verify compliance with safety, health and environmental approaches. It also dealt with the categorisation, causes and management interventions to NM&MI. Frameworks and models were reviewed to develop a comprehensive OM for the facilitation of controlling NM&MI. International and national benchmarks were appraised to improve the OM and NM&MI were analysed to determine the impact on key functional areas of the business. The adaptation and development of the survey questions for the research were also discussed.

It can be concluded from the literature review, that the chemical organisations continuously improve on safety management programmes but many minor incidents are nonetheless occurring often. It clearly indicates that there is still a problem in managing the NM&MI and improving on the reduction of the numbers.

The next chapter deals with the research design, setting out the details of the methodology for the research.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In chapter two, the exploratory research done was covered to review the history of the management of safety, health and environmental incidents and also to identify the necessity to do research in that area. The history uncovered major unsafe and minor incidents, after which the OSH Act was established to safeguard workers.

The development of the CCPS was reviewed including the learning aspects from NM&MI. Another factor studied was that of risks within the chemical industries. It was found that limited research was previously done on NM&MI. Knegtering and Pasman (2009:162) state that it has become apparent that many organisations pay no or very little attention to NM&MI, which in some cases have resulted in major incidents and accidents taking place.

This chapter describes the research design, methodology and research measuring instrument used. The research paradigm and philosophy is based on Mouton's (2001:138) description of "world 1" which is real life, "world 2" covering methodical approaches (quantitative) and "world 3", which falls under meta sciences as described below:

World 1: This is the everyday life and the use of general knowledge. This is the life of ordinary human beings such as family, work, school, church and the acts of daily life. We produce and use different kinds of knowledge referred as lay knowledge. We use lay knowledge to solve problems and reach agreement in daily life.

World 2: This is the world of science as facts from world1 is selected to research in world 2. The research unfolds the truth or truthful knowledge.

World 3: This covers meta-disciplines such as philosophy and methodology of science, research ethics and the sociology and history of science. These are reflections of science and scientific research.

Data collection involved in the gathering of two sources of information, one being the employee survey collected from the employee survey on safety, health and environment. The second was the NM&MI database collected from organisations' near miss and minor incident databases. The questionnaires and NM&MI database in tables 3.3 and 3.4 were reviewed for suitability with the objectives. Data analysis included descriptive statistics, Chi-Square, Cronbach's Alpha, reliability and validity. Additionally, the development of the OM and review of international and national benchmarks for improvement of the OM were also noted.

3.2 Research framework

The research methodology is based on theory testing which covers surveying a large-scale sample of the target population (Employee Surveys) and triangulating with NM&MI data analysed from the archives of the organisations (NM&MI Database review). Triangulation allows for the questionnaires and analysis of data from the organisations archives (Voss Tsikriktsis, and Frohlich, 2002: 195-219). The research process framework has five stages (Figure 3.1) explained below (Stuart et al. 2002: 419-433).

Stage 1: Defining the research question (Figure 3.1)

The research process involves defining the research question which was done in chapter one (1.3-1.3.2). The research question contributes to good theory building and to building a sound body of knowledge (Stuart et al. 2002:419-433)

Stage 2: Instrument development and site selection (Figure 3.1)

The second step in the research process, is the development of a research instrument and selection of the appropriate field sites, to capture the data for future analysis. The protocol encompasses the principal documentation needed to provide the researchers with the necessary focus, organize the visits and ensure that the trail of evidence is thoroughly documented. Providing focus is important not only for setting the parameters of the study. At a more practical level, reminders of the study's purpose helps the researchers to stay on target and keep information gathering as efficient as possible. Focus and ultimate success is further enhanced if the study's basic questions are translated into propositions (Stuart et al. 2002:419-433).

Site selection

The influences of prior scientific training, culture, system of beliefs (attribution theory) and the choice, number of organisations selected for surveys and a biased sample will surely affect the way that observations are interpreted, and will therefore, also affect parameter estimation. This problem was noted by Kaplan (1964) in his paradox of sampling, which states that the sample is of no use if it is not truly representative of its population (Stuart et al. 2002:419-433).

Employees Surveys:

Target population

The target population consisted of the workers, supervisors and managers of the chemical organisations who were surveyed. The unit of measure for this research was identified as NM&MI. The research design covers the target population, the sample selection, size of the sample, data collection methods, the questionnaire and the reasoning for the type of questions asked. The study type for this research was quantitative, which was conducted using questionnaires.

Sample (selection and techniques)

A purposive sampling technique was used, which allows for the selection of specific characteristics of the population of interest and the individuals who match those characteristics, are the group managers, supervisors and workers. The condition of selection, was that the respondents must have worked within the industry for a minimum of one year, as this experience was deemed to give the survey more credibility. Seven of the chemical organisations from the Durban South areas in KZN were approached to have the employee surveys conducted.

Size of sample

Andersen, Sweeney and Williams (2005: 259) point out that a sample represents an estimate of a population mean and a sample proportion is an estimate of a population proportion. The organisations selected have a total workforce of 950 employees. A sample of managers, supervisors and workers was surveyed. The representative sample size was obtained from the table for determining sample size, as described by Sekaran (2003:253), for this research, which was 86 managers / supervisors and 263 workers (Table 3.1). The response rate was 95 percent of the total sample of 349 respondents, which consisted of 332 responses.

Table 3.1 Number of respondents per organisation

Organisation	Managers/Supervisors	Workers
1	20	188
2	8	90
3	6	30
4	12	140
5	50	300
6	10	50
7	6	40
Totals	112	838
Sample Size	**86**	**263**

Source: Seven Chemical Organisations

NM&MI database review

The NM&MI database was taken from the databases of chemical organisations researched. The combined number of NM&MI of 415 was collected over a two-year period (Table 3.2). Table 3.2 also shows that the second organisation was the largest and the sixth was the smallest in terms of their NM&MI contribution.

Sample (Selection and techniques)

A five year value of the database was gathered and only the last two year value as NM&MI database was used for the research.

Size of sample

The sample size is a combined number of 415 NM&MI for a two year period from the seven organisations. The average of NM&MI for two years are 207.5, which was rounded up to 208 (Table 3.2).

Table 3.2 Combined number of NM&MI

Organisation	Near Miss & Minor Incidents	
	Two year value	One year value
1	28	14
2	224	112
3	53	26.5
4	34	17
5	51	25.5
6	4	2
7	21	10.5
Totals	415	207.5 (208)

Source: seven chemical organisations (NM&MI database)

Stage 3: Data gathering

Data gathering includes carrying out perception surveys, the use of archival records (NM&MI databases) of the environment being studied. This multi-faceted approach to gaining the complete picture is consistent with the ethnographic data gathering approach and concepts of triangulation (Stuart et al. 2002:419-433)

Employee surveys

A questionnaire was used for data collection (Voss et al. 2002:195-219) and the respondents had to answer the questions as requested. In preparation of the distribution of the questionnaires, the finer details on data collection was discussed with the management of the respective organisations. To obtain consent, respondents were given the cover page of the questionnaire, which explained the reason for the survey. They were given the full questionnaire and requested to indicate their level of agreement or disagreement with the questions by placing a cross (x) in the appropriate box. The respondents were at ease during the survey.

The research questionnaires were administered at the selected organisations during the day, after lunch, in the training rooms and canteens, and collected on completion. Necessary assistance was given to the respondents about any queries in completing the questionnaires.

Development of the questionnaire (Appendix B)

The questionnaire was adapted and refined for this research from the measurement tool complied by Sample Safety Survey (2014). The preliminary analytical steps of editing, coding and tabulating the data, which are common to most studies, were used in this study. This process was applied to ensure that the data set was accurate, so that the capturing of errors is minimised and to eliminate all poorly completed questionnaires. Data was presented in table form and bar graphs to show relationships between variables, as described by Aaker, Kumar and Day (2007:663). All the questionnaires were pre-coded. The questionnaire was divided into two sections.

The Questionnaire

Section 1: Demographics (Q1-7) - covering biographical data of the organisations.

Section 2: Quantitative analysis (Q1-30) - this section was further split into 2A and 2B. Section 2A covering Likert Scale (Q1-23) and 2B covering Dichotomous scale (Q24-30).

The questions were set out under the following headings:

Section 1: Demographics (Q1-7)

- Gender
- Race group
- Age
- Department
- Position
- Highest level of education
- Years service

Section 2A: Likert scale (Q1-23)

- Management commitment (Q1 to6)
- Communication (Q7)
- Priority of safety and health (Q8 to 11)
- Safety rules and procedures (Q12 to 13)
- Supportive environment (Q14)
- Involvement (Q15)
- Work environment (Q16 to 18)
- Behaviour and attitude (Q19)
- Competence / training (Q20 to 23).

Section 2B: Dichotomous scale (Q24-30)

- Management commitment (Q24 to 30)

The respondents' answers to the dichotomous questions will be either a yes or no.

The questions are listed below, with brief explanations given for their use in the research and the outcomes expected.

no	Question	What the question intends to show	Justification from literature	Position of literature
	Demographics			
1	Gender	The respondents were asked for their gender to determine if there are specific trends in terms of their contributions to NM&MI that may be linked to a respective gender. This will also determine the percentage of males and females in the group of respondents.	European Commission Women And Gender In Research (2014)	To ensure gender equality in research and to produce better quality research, equal consideration must be given to the life patterns, biological differences, needs and interests of both women and men.
2	Race Groups	This could indicate if there are any particular trends linked to a specific race group and whether that race group has the potential to contribute to the NM&MI.	Shore et al (2009:1176-133)	Diversity programmes work properly to obtain the best outcome of a diverse workforce working as a team
3	Age	The response will determine if age makes any difference in the contribution to minor incidents and near misses. In cross tabulation of the findings, this will also answer which age group contributes most to the incidents.	Canadian Centre for Occupational Health & Safety. 2014	Many studies are looking at the effects older workers have on the workforce. They are also looking at the effects different types of work have on older workers' bodies, and how to keep them safe and free of injury.
4	Department	This will show the main department that contributes to the incidents. In the analysis it will indicate the extent to which the respective departments will contribute to the minor incidents.	Guldenmund (2010:1466-1480)	The processes refer to the activities in the organisation at different levels, e.g. operations supported by other departments, and central to this, is the behaviour of the worker involved.
5	Position	The respondents were required to indicate the various positions they	Guldenmund (2010:1466-1480)	The organisational structure involves the

		occupy in their organisations. Further analysis will also show if the position of an employee makes any difference in the contribution of NM&MI.		members of staff and their authority, responsibilities and duties to perform their jobs/ positions.
6	Highest level of education	The findings of this question could establish whether there is a link to education levels and the contribution to minor incidents or near misses. It will, in addition, show the different levels of employees' education.	Woods (2006:237)	Education is important if developing good interpersonal skills which are a key factor in improving on NM&MI. These skills include proper communication, which involves writing and speaking correctly, answering all questions properly, listening attentively, this includes focusing attention on the speaker, showing respect and acknowledging the speaker, and building and maintaining trust.
7	Years of Service	This response will indicate if the respondents in the sample are young or old. Certain trends associated with experienced and inexperienced staff will also be made known.		
	Management commitment			
1	In my workplace management usually acts immediately to correct safety incidents.	The purpose of this question was to find out if the management in these organisations correct safety incidents once they are informed of them.	Sorensen (2002: 189-204)	for a "safety culture" to be developed and functioning properly, there must firstly be management and organisational factors for safety in place.
2	Management usually acts decisively when a safety concern is raised.	The purpose of this question was to see how committed management is when informed of safety concerns. It was queried whether management takes decisive action when told of safety issues. The respondents were required to answer yes or no.	Carder and Ragan (2003:157)	Managements demonstration of commitment to safety

3	Corrective action is taken when management is told about unsafe incidents.	The response to this question could be positive or negative and would indicate the degree of management commitment in the respective organisation.	Yukon Government: (2014:1).	The relationship between safety and near miss/ minor incidents is a direct one and for safety to be properly maintained, near miss and minor operating incidents must be controlled and managed carefully
4	In my workplace some superiors turn a blind eye to safety incidents.	The purpose of this question was to establish if managers take action on safety incidents. The answer could be positive or negative.	Long, (2008:1) Phimister et al (2003:445).	The sad fact is that NM&MIs have contributed to some of the worst case disasters in the world e.g. Bhopal Disaster India or the US Challenger disaster
5	In my workplace managers/supervisors show an interest in workers' safety.	The responses to this question could be either positive or negative. A positive response would indicate that managers and supervisors do show interest in the workers safety.	Pinto, Ribeiro and Nunes (2013: 410)	In the real world it is impossible to prevent all incidents and accidents
6	Managers and supervisors express concern if safety procedures are not adhered to.	The response to this question would indicate if the managers and supervisors are concerned when safety procedures are not followed.	Erickson (2006:4)	It is essential that corporate culture underpins management commitment, employee involvement, communication and treatment of employees, to make a success of safety, health and environmental programmes.
	Communication			
7	My superior always informs me of current concerns and incidents.	The response to this question would show whether the safety advisors, safety representatives and committees have a high status, operate proactively and work and communicate effectively. The	Groeneweg et al (2002)	Ineffective communications

		answers could be either positive or negative.A positive response would indicate that the safety communication is working or there might be poor safety communication.		
	Priority of Safety and Health			
8	Safety rules and procedures are carefully followed.	Respondents would show if, in their opinion, safety rules and procedures are carefully followed in their organisation.	Nivolianitou, et al. (2006:630)	It is widely recognized that the chemical industry as a whole does not learn from past accidents; ignoring the learning process has had and is having a major impact on subsequent incidents.
9	I believe that safety issues are assigned a high priority.	The response would denote whether, in the opinion of the respondents, the organisations ensure that the solving of safety incidents/issues is given top priority.	Lavoli et al (2006: 169-178).	With the global economy expanding and the increase in new organisational developments resulting in more workers being employed and increased production, which lead to more accidents/ incidents, and a subsequent increase in negative impacts to worker safety and health. Organisations have to urgently set research priorities for occupational safety and health initiatives.
10	I believe management considers the safety of employees of great importance.	The response would reveal if the management, in the opinion of the respondents, cares for the safety of the employees. The answer can fall either way.	Vavra (2007:33-43)	The vice president of operations stated "Nothing we do is worth getting hurt over" management was serious about the workers well-being and they worked over

				a million man hours safely
11	I believe management considers safety to be equally as important as production.	The response would show whether, in the opinion of the respondents, management pays equal respect to safety and production or if they sacrifice safety and worry more about production. The respondents could agree or disagree.	Mengolini and Debarberis (2007:520-529)	The key outcome rests with management leading from the front, guiding and making good decisions on safety and associated risks.
	Safety Rules and Procedures			
12	I believe some health and safety rules and procedures are not really practical.	The responses could be positive or negative and would determine what the perception is within the organisations. If the response is negative, then the employees do not understand the rules and procedures or they cannot implement them because they are not practical.	James and Zorigt (2013: 2321-2331)	Safety management systems comprising of standards, procedures and monitoring systems promote the safety, health and environment to protect all stakeholders. T
13	I believe some safety rules and procedures do not need to be followed to get the job done safely.	The response would establish whether, in order to do the job safely, procedures are not followed. The responses would indicate if, in the respondents' view, some safety rules negatively impact industry safety.	Guldenmuind (2010:1466-1480)	If top management sets safety climate procedures, they do not affect the procedures themselves but cascade these to middle management and supervisors, who then instruct workers. In the process, the supervisors might not sanction workers that employ short cuts, to meet production targets under pressure, which may result in unsafe incidents.
	Supportive Environment			
14	A "no-blame" approach is used to persuade people who are	The response would reveal if the organisation uses the "no blame" approach in dealing with inappropriate staff behaviour.	Reiman and Rollenhagen, (2011: 1263-1274).	The authors further argue that a "no-blame" culture may have some positive

	acting unsafely, that their behaviour is inappropriate.			spin-offs but contradicts with the approach "that people must be accountable for their actions".
	Involvement			
15	I am sometimes involved in the on-going review of safety.	The response would point out whether the organisation involves staff in its on-going review of safety.	Abudayyeh et al (2006:167-174)	Employees that participate in policy making are more motivated to carry that policy and improve on it in the workplace
	Work Environment			
16	Operational targets sometimes conflict with safety.	The respondents would answer negatively or positively depending on what is perceived to happen at their organisations.	Samson (2009:19)	HSE inspector for BP Texas stated that most of the safety incidents occurred through management's failures in getting the job at all costs, cost cutting, inadequate safety management and a poor safety culture.
17	Sometimes conditions here hinder my ability to work.	Respondents' perceptions would convey whether their organisations have poorly designed plants and equipment with no safety considerations. The answer would indicate if this is the case in this organisation.	Al-Mutair et al (2008:543)	Employees lose focus in their jobs because of stress due to poorly designed plants which increases safety incidents.
18	Sometimes I feel I am not given enough time to get the job done safely	The answer would indicate if, in the opinion of respondents, the worker has little time to complete his job safely and if this is the case at these organisations.	Richardson (2014:1).	To support a safe work environment, proper processes and procedures must be in place to allow employees to work without worrying about their safety
	Behaviour and Attitude			
19	Some employees display a poor attitude towards their job.	The response would show whether employees display poor attitudes towards their jobs. The reply would establish whether, in the	Eigenhuis (2010)	-Safety and behavior and attitude at the workplace are important in

		respondents' opinion, this is true or not.	Sorensen (2002: 189-204)	preventing safety incidents. -workers' attitude towards safety is key in improving on safety incidents but this cannot work in isolation.
	Competence/ Training			
20	Safety reports are generally well written.	The response would convey if, in the opinion of the respondents, safety reports are generally well written. The answer could be negative or positive.	Erickson (2006:4)	Organisations that do not have an entrenched safety culture are found to evaluate and report NM&MI poorly.
21	Contract labour is generally competent.	Contract labour could be, in the opinion of the respondents, considered competent or not.	Nivolianitou et al (2006 ;630)	Training on how to improve employee behaviour and attitude in reducing incidents
22	My safety training is adequate.	The response would indicate whether safety training is, in the respondents' opinion, done properly and completely. If there are deficiencies in the training then the answer would be negative.	Carder and Ragan (2003:157)	Education and knowledge of workforce
23	There are many inexperienced staff in our workplace.	The response would be an indication as to whether, in the respondents opinion, there are many inexperienced staff working in the organisations. Should there many inexperienced staff the respondents would agree in reply to the question.	Sorensen (2002: 189-204)	Three Mile Island nuclear disaster, found deficiencies not in systems hardware but solely in management. To prevent a repeat of the disaster, the NRC recommended the following: Urgent operator qualifications and training,
	Management Commitment			
24	Management acts only after accidents have occurred.	Here the answer would show whether the management has a wait-and -see attitude. The respondents would answer either	Grasa et al (2002)	The major disasters that occurred at Flixborough, Seveso and Bhopal were

		positively or negatively, depending on what happens at the organisation.		directly due to near miss and minor incidents not corrected on time.
	Communication			
25	Management operates an open door policy on safety issues.	This determined whether management will allow workers to discuss safety issues openly with them. The respondents would indicate if this is true at their organisations.	Zwi et al.(1988:691) Hedlund (2013:149-159).	There are about 300,000 work-related accidents per year, of which over 2,500 are fatalities and 4,500 permanent disabilities The state, industrialists and the unions have a vetted interest in the safety of all stake holders, hence the formation of the OSHAct in South Africa.
26	I receive praise for working safely.	Should employees receive some form of motivation and praise from their management for a job well done regarding safety, it would be indicated in their response. The respondents would answer either positively or negatively.	Olson et al (2009:12)	The mistreatment of workers, poor wages, negative performance evaluation, no praise or no training and promotion are demotivating to the workforce.
27	Generally there is good communication on safety in our organisation.	The respondents would indicate if safety communication is good or not.	Michael el al (2006:469-477)	Safety communication is very important but still requires a proper safety climate, culture and top management commitment to work properly
	Safety Rules and Procedures			
28	Sometimes it is necessary to depart from safety requirements for production's sake.	The response would point out if, in the opinion of the respondents, production takes priority and safety is neglected. The respondents would indicate if this is true at their organisations.	Zwetsloot et al (2006 ;769)	Managerial pressure on rushing production and creating NM&MIs must be reduced by improving on manufacturing processes.
	Supportive Safety Culture			
29	I am strongly	The reply would show whether	Reiman and Rollenhagen, (2011:	Some form of human

	encouraged to report unsafe conditions.	workers are encouraged to report unsafe conditions.	1263-1274).	and organisational bias helps in good safety performance, whereas too much bias contributes to a worker culture of not reporting incidents/ accidents to avoid blame
	Involvement			
30	I understand my role and responsibilities for health and safety	An indication of the workers understanding of their health and safety risk would be shown	Guldenmuind (2010:1466-1480)	Workers who take ownership of their jobs and safe operations, reflect a combined high-safety, high-ownership climate and safety citizenship should develop.

Section 2A: Likert scale (Q 1 to 23)

Management Commitment: - (Q1 to 6)

In the previous section, under demographics, the questions relate to how gender; race group; age; department; position; education and years of service impact on the contribution of NM&MI in the respective organisations. In the following questions the respondents were questioned on management commitment and how it impacts on the contribution to NM&MI. In this section the respondents' opinions on the commitment of senior managements' interest in health and safety were measured, as well as the provision of resources for health and safety, and the status of health and safety in the respective organisations.

Pilot study of the questionnaire

The purpose of the pilot test, as set out by Lewis, Saunders and Thornhill (2007:386), is to refine the questionnaire so that respondents will have no problems in answering the questions and there should then also be no problems in recording the data. The questionnaire was tested for accuracy in the pilot study. A total of 20 employees, selected from the daily time register, completed the questionnaire drawn up for this study. These employees were not part of the group of respondents. They were gathered in the training room at the organisation and requested to fill in the pilot questionnaires. The forms were reviewed with the respondents and later corrected against any weaknesses on ambiguity. The findings and corrections included changing seven questions, which had ambiguous responses from Likert to dichotomous scale, which required factual yes or no responses, rather than the five levels of agree, disagree or neutral responses given on the Likert scale. The pilot study was instrumental in reducing any delays caused by ambiguity that might have occurred in the main survey.

NM&MI database review

The second source of data for this research (NM&MI database) was obtained from the seven chemical organisations' databases. The chemical organisations gather data on SHE incidents as part of the management reporting process. The NM&MI database, which was gathered electronically and in hard copy from the organisations, was captured on a spreadsheet.

Stage 4: Analyzing data

The researcher's job is to collect and record data in a systematic manner at organisations sites. To determine if the frequencies on a nominal variable (e.g. for gender) are statistically, significantly related to an ordinal variable, that they are not caused by chance (Welman, Kruger and Mitchell, 2005: 229). The Chi Square test is done to test the significance of the results and Cronbach's Alpha was used to test the reliability and validity of the data.

Descriptive statistics

Graziano and Raulin (2000:12) define descriptive statistics as procedures that describe the characteristics of a sample of scores. Under data analysis, descriptive and inferential statistics were used and presented in graphs.

Frequency and percentage

Frequencies are used to establish a rate of repetition of an object, for example the combined number of NM&MI in table 3.2 where the object is the NM&MI. Whereas percentages establish the rate or proportion per hundred of an object.

Chi-Square test

The Chi-Square test, as described by Struwing and Stead (2001:481), is used to test the significance of the results. The test of significance verifies the strength of the evidence against the assumption that there is no significant association between the dependent variable and the factor whose strength is being tested. When the alpha is at 0.05, then there are five chances in 100 that the hypothesis will be rejected. The closer the obtained chi-square is to zero, the more similar the two sets of frequencies are - or, stated another way, the better the observed data fit the expected pattern. This interpretation is where the term "goodness of fit" originates. This is the test statistic for the comparison of the observed and expected frequencies. As with other test statistics, we compare the obtained value with the critical value to determine whether to reject or retain the null hypothesis. For a Chi-Square test, the null hypothesis is that the two sets of frequencies (i.e., observed and expected) are equal. The Chi- Square goodness of fit is most suitable as opposed to other tests for the analysis of data in this research and will be applied to all the questions in the questionnaire to test for accuracy.

Reliability, validity and Cronbach's Alpha

According to Leedy and Ormrod (2005:29), a test result can be reliable but not valid; however, a test result cannot be valid without first being reliable. This is the relationship between reliability and validity of results. Cronbach's Alpha measures the reliability of the test results and was used in this research. Cronbach's Alpha indicates how well the items in a set are positively correlated to one another. A result of 0.7 on the Cronbach's Alpha test is accepted as a reliable result. The aim of reliability is to reduce the errors and biases in the study (Yin, 2009:45).

Stage 5: Disseminating the research findings

The findings of the research should be disseminated to all role players that could benefit in its use and implementation. There is currently little knowledge of research done on Near Miss and Minor Incidences in industry.

Source: Stuart et al. (2002:419-433)

Figure 3.1 Research process framework

3.3 OM development

The employee survey and NM&MI databases, including national and international benchmarks, would be used to develop the OM. The OM comprises of a Strategic Methodology (SM), Tactical Methodology (TM) and Functional Methodology (FM). The FM has two levels in its development i.e. basic and advanced and it will be necessary to allow for the FM (basic) based on local benchmarks, to be compared with international benchmarks, which should result in an FM (advanced) with increased activities.

This FM (basic) first level (Figure 3.2) will be given to a random sample of respondents from the organisations for review and comment on the methodology's usefulness as a NM&MI management tool. In addition, respondents would have accepted or rejected additional suggestions made for further improvements to the methodology (Appendix G).

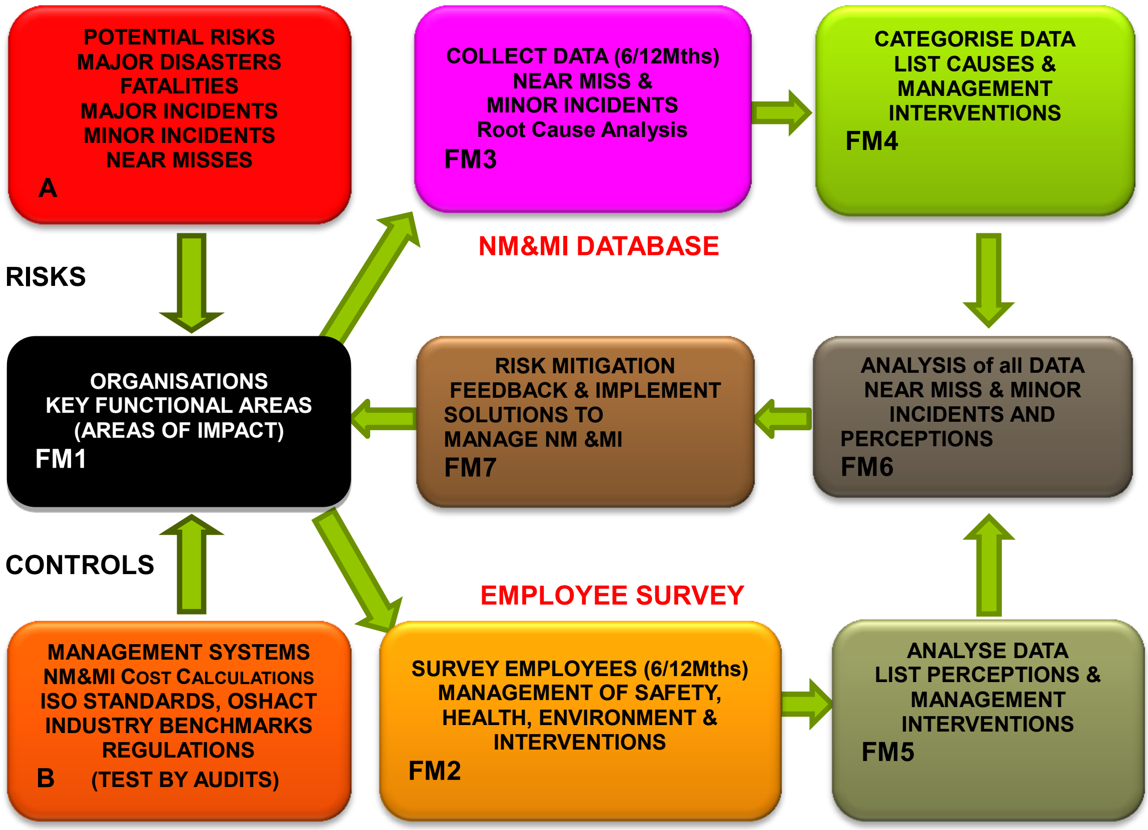


Figure 3.2 FUNCTIONAL METHODOLOGY for NM&MI (basic)

3.4 International benchmarks and other research done in support and comparison to this research.

International, national benchmarks and other similar research have been reviewed in support of this research.

International and national benchmarks

Center for Chemical Process Safety

The Center for Chemical Process Safety (CCPS) was established in 1985 by the American Institute of Chemical Engineers (AIChE) for the express purpose of assisting industry in avoiding or mitigating catastrophic chemical accidents. The CCPS committee identified the development of a lagging metric system for the chemical industry as a key breakthrough opportunity for industry. This became the benchmark across the chemical industry for measuring process safety performance. To achieve this, representatives and members from each of the major chemical trade associations, as well as other key global stakeholders, were engaged. In 2007 a guideline book was launched for the development and use of Leading and Lagging Process Safety Metrics (CCPS, 2010).This process assisted in the improvement of the FM (basic) into a FM (advanced) for the better management of near miss and minor safety incidents.

Near miss eight step process (ESP) of Oktem

Oktem (2002:1) of the Wharton School, University of Pennsylvania Risk Management and Decision Processes Centre, describes eight steps that are necessary for the management of a Near-Miss process and its implementation as a tool for integrated safety, health, environment and security management. The Near Miss Eight Step Process (ESP) will be analysed and compared with the OM developed for this research. The ESP comprises of the following eight steps:

- Identification
- Disclosure (Reporting)
- Prioritization
- Distribution
- Identification of courses (Casual analysis)
- Solution identification
- Dissemination
- Resolution (Tracking)

3.5 Conclusion

This chapter detailed the research methods employed for this research, including the measuring instrument used for collecting the research data. The basics for the purposes of the questions for the employee survey were explained, along with various statistical methods employed for data analysis, such as Chi Square and Cronbach’s Alpha. For the NM&MI database, the target population, the sample selection and data collection were covered. The aspects of research design and methodology used, included the quantitative study type, while sample selection was purposive. The size of the representative sample was 349 respondents of the total population of 950 employees, resulting in a response rate of 95 percent. The development of an OM, introduction to international benchmarks and comparison to similar global research were also done.

The next chapter deals with the findings of the research and fieldwork.

CHAPTER 4
FIELD WORK AND FINDINGS

4.1 Introduction

Chapter three addressed the design and methodology used to conduct the research. A quantitative study type was used, with the target population of workers, supervisors and managers selected as respondents. The basics of the questionnaire and the pilot study were covered, including that of employee surveys and NM&MI databases from the selected organisations.

This chapter deals with the details of the fieldwork and findings. For the employee survey, the findings of each question in the measuring instrument are reviewed, cross tabulated and illustrated by means of tables. These include the biographical data, management approaches to safety, health and environment, and the categorisation of the NM&MI database.

Data on NM&MI were collected and categorised into incident groups. The minor incidents, their causes, management interventions and employee input were used to develop the OM for managing NM&MI risks. The OM focuses on the following three aspects: Strategic, Tactical and Functional Methodologies, which will be used for organisational sustainability and future analysis. The OM (FM - basic) was compared with international / national bench marks and improved to an FM (advanced). The OM was further cross tabulated with ESP, a similar global research was done by Oktem (2002:1), to compare the value adding aspects of the OM.

The findings regarding the cost calculation and impact of NM&MI, on the performance of key functional areas, and the additional statistical analysis of the NM&MI database (Appendix E), are reviewed. No tables are included for dichotomous questions 24 to 30, only the results are indicated under each question.

4.2 Employee surveys

The questionnaires were taken to each of the organisations and the surveys were conducted in the training centres. In the larger organisations the employees could not all be released at once and had to complete the questionnaires in smaller groups.

4.2.1 Section 1: Demographics (Q 1 to 7)

Gender / race (Q1-2)

It was found that the majority (86 percent) of the respondents in the sample are males. Dominated by Blacks (56 percent) followed by Indians (27 percent) and a few Whites (nine percent) and Coloureds (eight percent) (Figure 4.1).

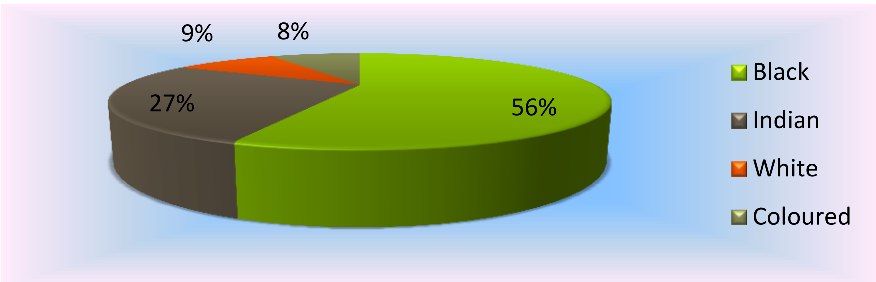


Figure 4.1 Race Group (Q2)

Age (Q3)

Most (70 percent) of the respondents were comparatively a younger group 40 and below and only a few (14 percent) were older than 50 (Table 4.1).

Table 4.1 Age (Q3)

Under 25	20%	40yrs & below
26-30	23%	40yrs & below
31-35	16%	40yrs & below
36-40	11%	40yrs & below
41-45	8%	
46-50	8%	
51-55	7%	
56-60	4%	
61-65	2%	
66 and older	1%	

Department (Q4)

The operations department employed most (62 percent) of the workers, whereas finance, HR and IT had only four percent (Table 4.2).

Table 4.2 Department (Q4)

Operations	62%
Maintenance	13%
Compliance/ safety	8%
Training	4%
Customer Services	3%
Administration	3%
Other	3%
Finance	2%
IT	1%
Human Resources	1%

Position (Q5)

Blue collared workers (operators) made up the majority (35 percent) of the respondents, followed by a lesser number (24 percent) of contractors, a few supervisors (16 percent) and less (nine percent) managers (Table 4.3).

Table 4.3 Position (Q5)

Operator	35%
Contractor	24%
Supervisor	16%
Clerk	10%
Manager	9%
Other	6%

Highest level of education (Q6)

Most (58 percent) of the respondents have grade 12 but only a quarter (24 percent) have diplomas and degrees and a few (one percent) have a primary education (Table 4.4).

Table 4.4 Highest level of education (Q6)

Primary	1%
Grade 8-11	17%
Grade 12	58%
Diploma	18%
Degree	6%

Years service (Q7)

The staff turnover is practically low. Over half (52 percent) of the staff has an average of one to five years' experience, while a small proportion (12 percent) of the staff has more than 20 years' experience (Table 4.5).

Table 4.5 Years service (Q7)

1-5years	52%
6-10	16%
11-15	12%
16-20	8%
21-25	7%
26-30	3%
31-35	1%
36 or more	1%

4.2.2 Section 2A: Likert scale (Q 1 to 23)

Management commitment (Q1 to 6)

Most (>70 percent) of the respondents agree that management is committed to the safety measures taken, this is evidenced by a strong consensus, except for Q4 where there appears to be doubt by some (between 60 and 70 percent) that some superiors react to safety incidents. It is however, of concern that quite a few (between 10 and 20 percent) of the respondents did not answer the question (Table 4.6).

Cronbach's Alpha

The value of Cronbach's Alpha for questions Q1 to 6 was 0.757, which indicated that most of the respondents agreed with managements' commitment to safety. The results also indicated that there is a high degree of consistency and inter-correlation in the measure of the items together in a common construct. Generally, an alpha value of 0.7 or more is considered good and the questions can be grouped to measure one idea. A strong correlation (greater than 0.7) indicates that there is internal consistency and reliability of the measuring instrument (Santos, 1999).

Chi-Square

The Chi-Square goodness-of-fit for questions Q1 to 6 was <.0005 each P-value, which showed significant agreement amongst the respondents. This indicates no bias for a particular question and was selected by the respondents equally. One sample Chi-Square Test assesses the goodness of fit between the observed and the theoretically expected values when scores are categorised on only one variable or dimension (Israel, 2008:1).

SD – Strongly disagree
D - Disagree
N - Neutral
SA – Strongly agree
A - Agree

Table 4.6 Management commitment (Q1-6)

Q No.	Enquiry Percentages	SA	D	N	A	SA
1	Management quickly corrects safety incidents	4	6	11	40	39
2	Management acts decisively on safety issues	4	6	18	39	33
3	Management acts quickly on reported incidents	3	4	14	45	34
4	Some superiors ignore safety incidents	7	15	16	28	34
5	Managers and supervisors are keen on workers safety	2	4	13	40	41
6	Managers and supervisors ensure safety procedures are followed	2	3	11	47	37
Cronbach's Alpha						0,757
Chi-Square – each P value						<.0005

Communication: (Q 7)

Safety concerns and incidents are known by all (Q7)

Very few respondents (six percent) disagreed that there was good communications, and although a large number (80 percent) agreed with the statement, quite a few (14 percent) of the respondents did not answer this question (Table 4.7).

Cronbach's Alpha

The Cronbach's Alpha for Communications is 0.656. Although the value of 0.656 is below 0.7, it is not too low and still acceptable for the groups to be joined to measure one idea.

Chi-Square

The Chi-Square value for Q7, Q25-27 is tested under a null hypothesis, it is assumed that the respondents will choose any question equally. Each of the questions had a p-value of <.0005, which showed a significant agreement to these questions.

SD – Strongly disagree
D - Disagree
N - Neutral
SA – Strongly agree
A - Agree

Table 4.7 Communications (Q7)

Q No.	Enquiry Percentages	SA	D	N	A	SA
7	Safety concerns and incidents are known by all	2	4	14	41	39
Cronbach's Alpha						0,656
Chi-Square – each P value						<.0005

Priority of safety and health: (Q 8 to 11)

The majority (>80 percent) of the respondents believe that management is committed to priority of safety and health (Table 4.8).

Cronbach's Alpha

The Cronbach's Alpha value for Priority of Safety and Health Q8-11 is 0.764, which is above the standard value 0.7. This is acceptable for this group to be joined to another group with a similar idea.

Chi-Square

The Chi-Square value for Q8-11 showed a significant agreement to these questions. The P-value for each question was <.0005, again showing significant agreement.

SD – Strongly disagree	SA – Strongly agree

D - Disagree	A - Agree

N - Neutral

Table 4.8 Priority of safety and health (Q8-11)

Q No.	Enquiry Percentages	SA	D	N	A	SA
8	Safety rules and procedures are carefully followed.	3	4	12	44	37
9	I believe that safety issues are assigned a high priority.	2	3	8	42	45
10	I believe management considers the safety of employees of great importance.	2	4	10	41	43
11	I believe management considers safety to be equally as important as production.	3	6	16	40	35
Cronbach's Alpha						0,764
Chi-Square – each P value						<.0005

Safety Rules and Procedures: (Q 12 to 13)

Over half of the respondents (57 percent) believe that some safety rules and procedures are not practical and need not be followed to get the job done safely, on the other hand, 26 percent of the respondents don't agree (Table 4.9).

Cronbach's Alpha

The Cronbach's Alpha for Safety rules and procedures, Q12 and Q13, is 0.604 and is below 0.7, which is low and unacceptable.

Chi-Square

The Chi-Square value for Q12 and 13 is tested under null hypothesis. For Q12 the respondents agree and disagree not too strongly but equally. For Q13 there was very strong agreement.

SD – Strongly disagree   SA – Strongly agree

D - Disagree   A - Agree

N - Neutral

Table 4.9 Safety rules and procedures (Q12-13)

Q No.	Enquiry Percentages	SA	D	N	A	SA
12	I believe some health and safety rules and procedures are not really practical.	8	26	22	26	18
13	I believe some safety rules and procedures do not need to be followed to get the job done safely.	5	13	12	24	46
Cronbach's Alpha						0,604
Chi-Square – each P value						<.0005

Supportive environment: (Q 14)

A large number (37 percent) of the respondents believed that management follows a "no blame" safety approach yet, the same number (37 percent) disagrees with the statement (Table 4.10).

Chi-Square

The Chi-Square value for Q14 is tested under null hypothesis. The same number of respondents (37 percent) chose to agree and disagree with question Q14, others were neutral.

SD – Strongly disagree   SA – Strongly agree

D - Disagree   A - Agree

N - Neutral

Table 4.10 Supportive safety culture (Q14)

Q No.	Enquiry Percentages	SA	D	N	A	SA
14	A "no-blame" approach is used to persuade people, acting unsafely, that their behaviour is inappropriate.	17	20	26	26	11
Chi-Square – each P value						<.0005

Involvement: (Q 15)

More than half (59 percent) of the respondents agreed that all employees review safety information (Table 4.11).

Chi-Square

The Chi-Square value for Q15 is tested under null hypothesis. The respondents chose to agree strongly to the questions. The P-value was <.0005, which showed significant agreement.

SD – Strongly disagree   SA – Strongly agree
D - Disagree   A - Agree
N - Neutral

Table 4.11 Involvement (Q15)

Q No.	Enquiry Percentages	SA	D	N	A	SA
15	I am sometimes involved in the on-going review of safety.	7	12	22	37	22
Chi-Square – each P value						<.0005

Work environment: (Q 16 to 18)

Nearly half (46 percent) of the respondents agreed that operational targets conflicted with safety, there are poor work conditions and there was no time to work safely on the other hand (40 percent) disagreed (Table 4.12).

Cronbach's Alpha

The Cronbach's Alpha for Work environment Q16-18 is 0.450. This value is below 0.7 and unacceptable for the groups to be joined to measure one idea.

Chi-Square

The Chi-Square value for Q16-18 is tested under null hypothesis; it is assumed that the respondents will choose any question equally. The respondents chose as follows: Q16 disagree but not strongly, for Q17 they agreed and disagreed not too strongly and for Q18 they agree and disagree.

SD – Strongly disagree SA – Strongly agree
D - Disagree A - Agree
N - Neutral

Table 4.12 Work environment: (Q16-18)

Q No.	Enquiry Percentages	SA	D	N	A	SA
16	Operational targets sometimes conflict with safety.	13	34	19	20	14
17	Sometimes conditions here hinder my ability to work.	10	28	20	27	15
18	Sometimes I feel I am not given enough time to get the job done safely.	11	24	15	27	23
Cronbach's Alpha						0,450
Chi-Square – each P value						<.0005

Behaviour and attitude: (Q 19)

Almost a third (29 percent) of the respondents agreed that employees displayed poor behaviour, however, a large number (57 percent) disagreed with that statement (Table 4.13).

Chi-Square

The Chi-Square value for Q19, shows that over 50 percent of the respondents chose to disagree with the question. The P-value is <.0005, which indicates that there is significant disagreement.

SD – Strongly disagree SA – Strongly agree
D - Disagree A - Agree
N - Neutral

Table 4.13 Behaviour and attitude (Q19)

Q No.	Enquiry Percentages	SA	D	N	A	SA
19	Some employees display a poor attitude towards their job.	19	38	14	16	13
Chi-Square – each P value						<.0005

Competence / training: (Q 20 to 23)

The majority of the respondents (69 percent) agreed that good safety reports are written, that contract labour is competent and that safety training was adequate. On the other hand, more than a third (36 percent) of the respondents agreed that there are many inexperienced workers, however, a larger proportion (44 percent) disagreed with that statement (Table 4.14).

Chi-Square

The Chi-Square value for Q20-23 is tested under a null hypothesis; it is assumed that the respondents will choose any question equally. Each of the questions had a p-value of <.0005, which showed a significant agreement to these questions. The respondents agreed for Q20, they agreed but not strongly to Q21, while for Q22 there is agreement and for Q23 the respondents disagreed.

SD – Strongly disagree
D - Disagree
N - Neutral

SA – Strongly agree
A - Agree

Table 4.14 Competence / training (Q20-23)

Q No.	Enquiry Percentages	SA	D	N	A	SA
20	Safety reports are generally well written.	2	4	15	49	30
21	Contract labour is generally competent.	4	14	25	40	17
22	My safety training is adequate.	3	10	14	51	22
23	There are many inexperienced staff in our workplace.	14	30	20	23	13
Chi-Square – each P value						<.0005

4.2.3 Section 2B: Dichotomous scale (Q 24 to 30)

Management commitment (Q24)

Although over half (58 percent) of the respondents agreed that management acts immediately after the accidents have occurred, a large number (42 percent), on the other hand, believes that management acts only after an accident has occurred, this casts doubt on management commitment about safety (Table 4.15).

Chi-Square

The response to Q24 had a p-value of 0.002 and was not significant.

Table 4.15 Management commitment (Q24)

Q No.	Enquiry	Percentages	Yes	No
24	Management acts only after accidents have occurred.		42	58
Chi-Square – each P value			.0002	

Communications

The majority (78 percent) of the respondents believed that management operates an open door policy on safety, praises workers and generally communication well. The other 22 percent believe that management communications is poor (Table 4.16).

Cronbach's Alpha

The Cronbach's Alpha for Q25-27 is 0.656. This value is below 0.7 and unacceptable which indicates that the construct validity of the factors is problematic.

Chi-Square

The Chi-Square value for Q25-27 had a p-value of <.0005, which showed a significant agreement to these questions. The respondents agreed strongly for Q25 to 27.

Table 4.16 Communications (Q25-27)

Q No.	Enquiry	Percentages	Yes	No
25	Management operates an open door policy on safety issues.		82	18
26	I receive praise for working safely.		65	35
27	Generally there is good communication on safety in our organisation.		87	13
Cronbach's Alpha			0.656	
Chi-Square – each P value			<.0005	

Safety rules and procedures

Nearly three quarters (70 percent) of the respondents agree that safety rules and procedures are followed, whereas 30 percent believe that this is not true (Table 4.17).

Chi-Square

The Chi-Square value for Q28 is tested under null hypothesis; it is assumed that the respondents will choose any question equally. Although the question had a p-value of <.0005, it showed no significant agreement to these questions.

Table 4.17 *Safety rules and procedures (Q 28)*

Q No.	Enquiry Percentages	Yes	No
28	Sometimes it is necessary to depart from safety requirements for production's sake.	30	70
Chi-Square – each P value		<.0005	

Supportive environment and culture

The majority (91 percent) of the respondents believe strongly that there is a good. supportive environment for SHE approaches (Table 4.18).

Chi-Square

The Chi-Square value for Q29 is tested under null hypothesis; it is assumed that the respondents will choose any question equally. Each of the questions had a p-value of <.0005, which showed a significant agreement to these questions. The respondents agreed strongly to the question.

Table 4.18 *Supportive environment and culture* (Q29)

Q No.	Enquiry Percentages	Yes	No
29	I am strongly encouraged to report unsafe conditions.	91	9
Chi-Square – each P value		<.0005	

Involvement

For Q30, nearly all of the respondents (96 percent) strongly agreed that all are involved in safety at the organisations (Table 4.19).

Chi-Square

The Chi-Square value for Q30 had a p-value of <.0005, which showed a significant agreement to the question.

Table 4.19 *Involvement* (Q30)

Q No.	Enquiry	Percentages	Yes	No
30	I understand my role and responsibilities for health and safety.		96	4
Chi-Square – each P value			<.0005	

4.2.4 Summary for employee survey (Appendix C)

Demographics (Q1-7) (Figure 5.2)

The majority (86 percent) of the respondents are 50 years and younger, many are matriculated and most (56 percent) are black males, working in the operations department (35 percent). A few of the employees are older than 50 (14 percent) and almost a quarter (24 percent) have diplomas and degrees. The majority (52 percent) have an average of one to five years' service and some (12 percent) have more than 20 years' service.

Management commitment (Q1-6 & 24):

It was found that management is, to a large extent (70 percent), perceived to be committed to supporting all safety initiatives within their organisations (Q1-6). However, almost a third (30 percent) of the respondents disagreed. In addition, nearly half (42 percent) of the respondents were also unhappy that management only acts on safety after an accident occurs (Q24) (Figure 4.2).

The same was found for communications (Q7, Q25, Q27), with the majority (83 percent) of the respondents indicating that there is good communications on all safety matters within the organisations, while a few (12 percent) did not agree. A significant number (35 percent) of the respondents stated that they do not receive any praise from management for working safely (Q26). The majority (81 percent) of the respondents agreed that there is management commitment for priority of safety and health matters (Q8-11), however, a few (seven percent).of the respondents were in disagreement

Most (44 percent) of the respondents agreed that certain health and safety rules and procedures are not really practical (Q12), while some (30 percent) stated that it is sometimes necessary to depart from safety requirements for production's sake, (Q28). However, quite a large number (70 percent) believe that some safety rules and procedures do not need to be followed to get the job done safely (Q13). A significant (37 percent) number of respondents believe that management blamed them for all the safety incidents in the organisations (Q14), whereas a large (91 percent) number believe that management strongly encourages them to report unsafe conditions (Q29).

The majority (78 percent) are satsified with their involvement in safety matters however, a few (12 percent), (Q15, Q30) did not agree with management (Figure 4.2). This is also evident from the respondents' replies on work environment (Q16-18), where nearly half (42 percent) of the respondents feel that management do not create a safe work environment. This supports the findings (Q19), where more than a quarter (29 percent) of the respondents agreed that some workers display bad behaviour and have a poor attitude towards their organisations. With competence and training (Q20-23) being the pillars for safety, health and environmental matters, a large (63 percent) number were happy and only a few (19 percent) did not agree that training was any good.

Summary of Chi Square test results (Appendix I)

The results for chi square test of independence cross tabulated with departments for the following questions are:

Q8- Safety rules and procedures are carefully followed. The customer services; administration and training departments disagree.

Q13- I believe some safety rules and procedures do not need to be followed to get the job done safely. The IT department disagrees.

Q16- Operational targets sometimes conflict with safety. The following departments, operations disagrees and customer services, HR, admin, and other agrees.

Q17- Sometimes conditions here hinder my ability to work. The operations department disagrees whilst Finance, training and other agrees.

Q24- Management acts only after accidents have occurred, operations department agrees and customer services and other disagrees.

Cross tabulation with positions for the following questions are:

Q4- Some superiors ignore safety incidents and persons occupying clerical positions disagree.

Q5- Managers and supervisors are keen on workers safety whilst the operators in their positions disagree.

Q6- Managers and supervisors ensure safety procedures are followed operators disagree.

Q16- Operational targets sometimes conflict with safety. Employees working in the positions as clerks/ others agree and contractors disagree.

Q17- Sometimes conditions here hinder my ability to work. The positions of managers and clerks agree and operators disagree.

Q18- Sometimes I feel I am not given enough time to get the job done safely. The positions of others and clerks agree and contractors disagree.

Q22- My safety training is adequate. The positions of operators disagree.

Q24- Management acts only after accidents have occurred. Employees in the contractors position agree and managers and others disagree.

Q25- Management operates an open door policy on safety issues. The position of managers agree and operators disagree.

Q26- I receive praise for working safely. The supervisory position, clerks and others agree and operators disagree.

Q27- Generally there is good communication on safety in our organisation. The contractor positios disagree.

Q28- Sometimes it is necessary to depart from safety requirements for production's sake. The positions of operators and contractors agree and managers, clerks and others disagree.

Q29- I am strongly encouraged to report unsafe conditions. The position of contractors disagree.

Q30- I understand my role and responsibilities for health and safety. The contractor positions disagree.

Cross tabulation with service for the following questions are:

Q20- Safety reports are generally well written. Employees in long services of 21-25/36+ disagree

Q21- Contract labour is generally competent. Employees in services of 21-25/3135/36+ disagree

Q24- Management acts only after accidents have occurred. Employees in the service of 1-5 agree and 16-20 disagree

Q26- I receive praise for working safely. Employees in the service of 16-20 agree and 6-10 disagree

Employee surveys- new findings (Appendix I)

The first sub-objective which covered the demographics, management commitment, communications, priority of safety and health, safety rules and procedures, supportive environment, involvement, work environment, behaviour and attitude, competence and training of respondents was successfully completed through a questionnaire (Appendix B).

Demographics

It was found that the cultural mix in the workforce of the seven chemical organisations appeared to work well, except for an indication of some friction between operators and supervisors and contractors, which was picked up from the list of NM&MI (Appendix I). It is held that multicultural teams working together without harmony creates stress and that while some stress and conflict may assist performance in the organisations, high levels of stress and conflict could result in serious problems in the organisations. In the working environment, workers of different race groups have conflict amongst themselves and with supervisors. Some of these conflicts could be of a serious nature and result in a complete breakdown of trust and team spirit, which has the potential to impact NM&MI (Luthans, 2008:262).

According to Shore et al. (2009: 117-133), diversity programmes work properly to get the best outcome of a diverse workforce working together. Kreitz, (2008; 101-120) states that organisations today are being challenged by an increasingly diverse workforce, a multicultural customer base, and a growing challenge for market share from international competitors.

This creates a potential opportunity to improve and implement racial diversity programmes globally and especially in the New South Africa, as the country is in its infancy in growth towards enhancing diversity to its maximum.

Management commitment

Operators not in favour of managements' commitment are of major concern. There would appear to be a clear atmosphere of discontent concerning management commitment, which is considered to be reactive rather than proactive, where safety, health and environmental issues and full management commitment to operators' well-being in their place of work are concerned. The management commitment is questionable due to the regular reporting of a high number of NM&MI by the chemical organisations (Appendix D). Given the hazardous nature of the industry, management commitment is very important.

Erickson (2006:4) believes that the following key management elements, management commitment, employee involvement, communication, and treatment of workers need to work properly so that safety incidents can be reduced. According to Sandberg and Targama (2007: 159) managers should lead by stimulating workers to use their vision, ideas and inherent capabilities; this will in turn liberate their capacity in giving of their best performances. They further add that the workers will produce desirable work, reduce NM&MI and strengthen the organisations' competitive advantage.

In addition, Wu, Chang, Shu, Chen and Wang (2011:716-721) suggest that safety can be managed better if management / leadership strictly focus on the following factors: safety attitude, leadership style, trust, commitment to safety, involvement in safety, priority of safety, interaction, communication, and humanistic management practices.

Vinodkumar and Bhasi (2010: 2082-2093) postulate that the direct influence of management commitment on safety compliance can be considered as a result of individual wisdom of the employees, earned from the overall interest shown by the managements towards the safety of their employees, to protect themselves from accidents.

Abudayyeh et al., (2006: 167-174) further recommend that a clear commitment is required from management on safety.

Communications

Good SHE communications are critical for the better management of SHE approaches in chemical organisations. Many of the respondents from the seven chemical organisations believed that there was good communications. On the other hand, a significant number felt that management does not praise them for working safely. Operators did not agree that management operates an open door policy on safety (Appendix I). It was also found that operators did not agree with supervisors that they receive praise for working safely (Appendix I). It is evident that safety communication is understood differently by three groups, namely operators, supervisors and managers.

According to Woods, (2006:237), interpersonal skills, such as proper communications, including good listening skills, showing respect and building relations by trust, will assist in minimising unsafe incidents. Additionally, Olson-Buchanan and Boswell (2009:12) believe that the mistreatment of workers is detrimental to safe performance of his or her job. They further add that other aspects, for example, a poor wage increase, negative performance evaluation, no training or promotion, the absence of praise from management, no recognition or favouritism, would negatively impact their work performance.

Michael, et al. (2006:469-477) suggest that safety communication is very important but is not sufficient on its own, to ensure a low safety incident rate. They further state that communication should be part of a much larger picture, including factors, such as safety climate, culture, and management commitment to safety, that have been shown to interact to affect accident rates.

An issue regarding communications, especially in the South African context, relates to concerns regarding the reading and understanding of the Material Safety Data Sheets (MSDS) and Fagotto and Fung (2003:63-68) believe that safety communications, through the use of MSDS, helps only those workers who can read and understand them. For instance, many workers tend to consult the MSDS only when an incident has occurred. The authors further suggest that symbols and pictograms should be used widely and a rigorous training plan should be followed, so that all workers understand the safety communication on chemicals properly. Workers' competency should be tested to ensure that the safety communication was successful or they might not take the necessary preventative action.

Priority of safety and health

As part of the SHE management plan in chemical organisations, priority of safety and health plays a vital role in the control of NM&MI. The priority of safety and health is perceived by a large percentage of respondents to be good. Although some of the respondents preferred to be neutral, the fact that there were others who felt threatened is of concern. It is important to consider the article written by Sampson (2009:19), after discussions with Martin Anderson (HSE specialist inspector for human and organisational factors BP / Texas refineries accidents) on priority for safety and health. Anderson states that most of the incidents / accidents in chemical organisations' accidents were management failures, e.g. getting the job done at all cost, which could involve cost cutting, inadequate safety management and poor safety culture.

Safety rules and procedures

Chemical organisations operate in hazardous environments and rely on safety rules and procedures to function efficiently. With regard to safety rules and procedures, some of the respondents agreed that certain health and safety rules and procedures are not, in actual fact, practical; with others stating that it is sometimes necessary to depart from safety requirements to meet production targets. However, a very large number believe that some safety rules and procedures do not need to be followed, to get the job done safely. A large number of the respondents did not agree that safety rules and procedures are followed. Safety rules and procedures are the backbone to working safely in operational areas in these chemical organisations. This casts doubt on the appropriateness and quality of safety rules and procedures, making them redundant and a mere tool to be used for auditing purposes.

In maintaining good SHE approaches, Teo and Ling (2005; 1584) describe the safety rules and regulations as important elements in maintaining safety, health and environmental approaches. The format in which procedures are written, is very cumbersome and difficult for users to comprehend (not user friendly) and many workers do not follow them. This is a grave situation, as the organisations want the workers to follow the procedures so that there will be no NM&MI created.

Another approach on the use of safety rules and procedures is given by Hopkins (2011: 110-120), who believes that safety rules and procedures should be followed to have safe operational outcomes. There are periods that the rule or procedure becomes outdated. In these circumstances, workers need to request management to change / update them. This requires workers to remain risk aware and to not simply follow rules blindly. Hopkins further indicates that accidents have occurred in many cases, due to workers not following rules properly.

Edwards and Jabs (2009: 707-723) state that some workers were not happy with management picking on them about not following safety rules, which made them feel like children and not trusted to act maturely on issues of safety. They also find that many workers felt alienated from their jobs and safety and they wanted management to empower them, so that they could work safely and produce good results. It is important for management to stop using harassment and find new methods to motivate and encourage workers to follow rules and procedures.

Supportive environment

A large number of the respondents believe that management does not create a supportive environment and that the supervisors and workers are blamed for all the incidents that occur at their organisations. The respondents perceive that management blames them mostly for NM&MI. This negative approach must have a disconcerting influence on the workers and this could invariably contribute to the number of NM&MI. O'Dea and Flin (2003) state that management should use humanistic management practices, in order to bring out positive safety outcomes, which includes "blame free" safety approaches.

The top seven needs that are critical in good relationship building, as researched by Bacon (2006:2-3), are trust, growth, feeling good, competent and skilled, being appreciated, feeling excited about what you are doing and being involved in activities. These are the critical needs in sustaining a supportive environment. Granerud and Rocha (2011: 1030-1039) believe that the OHSAS 18001 standard requires organisations to support and commit to fulfilling legal requirements, formulate targets for health and safety protection and appropriate work environment conditions, and design management systems to improve performance and practices, while reducing risks. Sepeda (2012: 26-33) states that management review and continuous improvement are important factors that underpin a supportive safety environment. This process will assist in auditing the current safety systems and their effectiveness and / or improving effective systems even further.

Involvement

The majority of respondents believe that they are involved in all aspects of safety and health in their organisations. This is in direct contrast with findings of discontentment under the questions relating to management commitment, as well as conflicting views of managers, supervisors and workers regarding communication. This also applies to safety rules and procedures. Workforce involvement provides management with a formalised mechanism in tapping into the valuable expertise of the workers, in their understanding of all the nuances related to each and every operational aspect of the job. It is important that management encourages workforce involvement in reinforcing risk assessments and enhancing a sound process, safety culture (CCPS: 125). Windbichler (2005: 507-537) points out that employee involvement in SHE approaches is very important for safety programmes to be successful. A skilled and loyal workforce may be the most valuable asset of the organisation. Frick (2011: 974–987) states that worker involvement is critical in attaining maximum safety improvement in chemical plants. He further finds that worker participation in the OHS management system can influence it positively.

Work environment

Many employees believe that operational targets conflict with safety, almost half of the respondents believe there is a poor work environment, and half believe that there is no time to work safely. The contractors did agree that operational targets conflict with safety measures (Appendix I). Whereas managers did not agree that there were poor work conditions to work safely, operators were of a different opinion (Appendix I). The contractors felt that they were not given enough time to get the job done safely (Appendix I).

These are very serious concerns, as the contractors and operators work in operations and should not have conflicting views. There is consensus that the work environment is not conducive to eradicating NM&MI. This is evidenced by the significant consideration that operational targets conflict with safety, the perception of having a poor work environment and not having enough time to complete jobs safely. Once again, there are conflicting opinions between operators and managers on working conditions (Appendix I).

Reason (1990:1) describes, in his 'model', how accidents could be seen as the result of coincidences between failing system barriers, "unsafe acts" by operators, latent conditions, designer faults and fallible decisions by management. It was thus modelled as slices of cheese, forming barriers, leaving open holes which, at a moment of line-up, leave the event to happen. This model was later named the Swiss Cheese Model (SCM), showing how alignment of failures in various safety layers or defences, can cause an accident to happen. According to Øien, Utne, Tinmannsvik, and Massaiu (2011:162-171), many organisations, in an effort to improve on work environments, have now installed safety indicators into their chemical plants, to warn of danger and that the necessary preventative action can be taken.

Behaviour and Attitude

A third of the respondents agreed that employees behave badly and have a poor attitude towards their organisations. O'Dea and Flin (2003) maintain that the managers, supervisors and workers should develop a good safety behaviour and attitude, in order to have positive safety outcomes. Jones and Preziosi (2009:41-60) state that safety attitudes make up personal beliefs about risk and safety, personal involvement, individual responsibility, evaluations of safety measures, and evaluation of work environment. They further indicate that the link between attitude and behaviour is underlined by consequences for behaviour, which can be measured. Safety improvement plans for attitude and behaviour should be implemented and measured for improvement.

DeJoy (2005: 105-129) suggests that, for behaviour-based safety management to be successful, a positive or supportive culture needs to be in place first. He further states that the new changed safety behaviour will permeate the other workers, which will eventually change the safety culture of the organisation. The management team should also set behaviour and attitude training sessions and support the supervisors in the culture change process of the workers.

Competence and training

Although some of the respondents did not agree that management trained the staff, the majority were satisfied with the training programme. Training does take place but there are some workers that are not receiving the necessary training. This is disconcerting, as training is a key element in improving on safety, health and environmental initiatives.

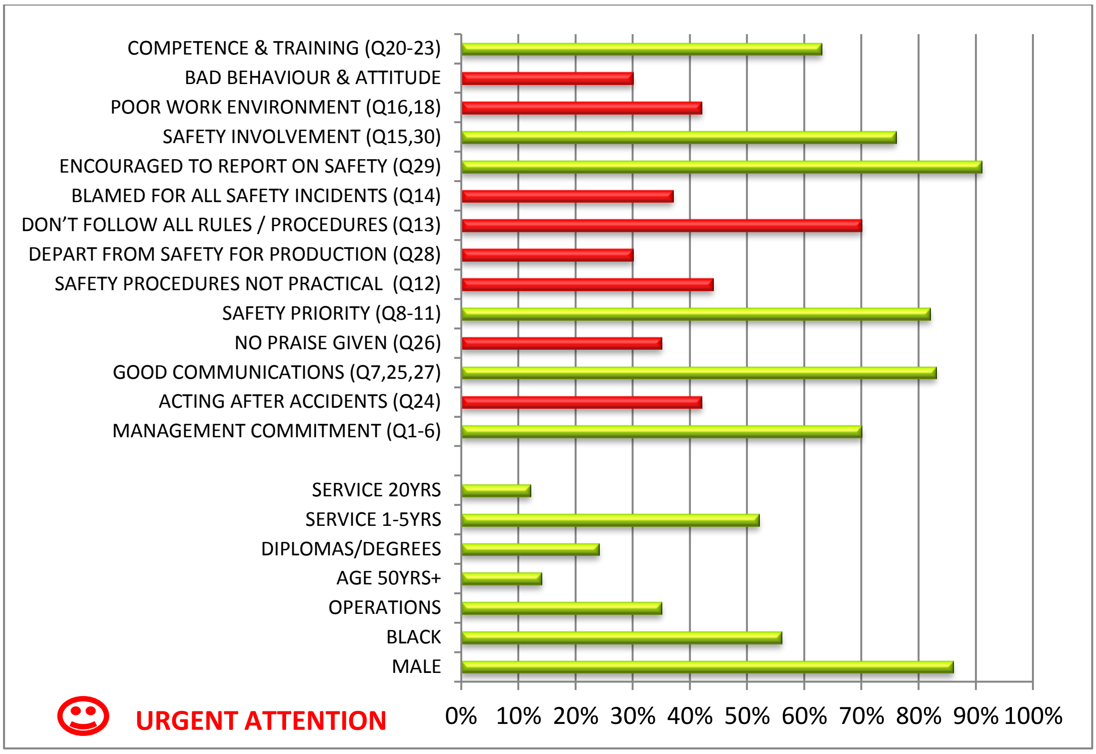
According to Sparrow and Knight (2009:46), candidates are trained on knowledge and skills when using conventional training methods. They add that the candidates generally show an interest in specific aspects of the training and after a few weeks, they act as if they did not go for training. The authors further state that the candidates should also be trained on changing poor attitudes and habits, for them to utilise the new knowledge and skills properly.

Fivizzani (2005: 11-15) suggests that students or employees today have knowledge of many learning styles and their own life experiences. These workers have different cultural and educational backgrounds. It is important to survey the candidates and employ media that will ensure the message is transferred appropriately, so that training should not be considered as a painful exercise. Galbraith and Fouch (2007:35-40) state that adult learners should be allowed to contribute to the training, as they have knowledge that they bring into the class and work environment. The candidates should be trained in bite-sized chunks. This prevents them from becoming overwhelmed and allows an opportunity for mastery. The importance is to get the message across, so that the worker is competent to do the job.

4.3 NM&MI databases reviewed (Appendix E)

Introduction:

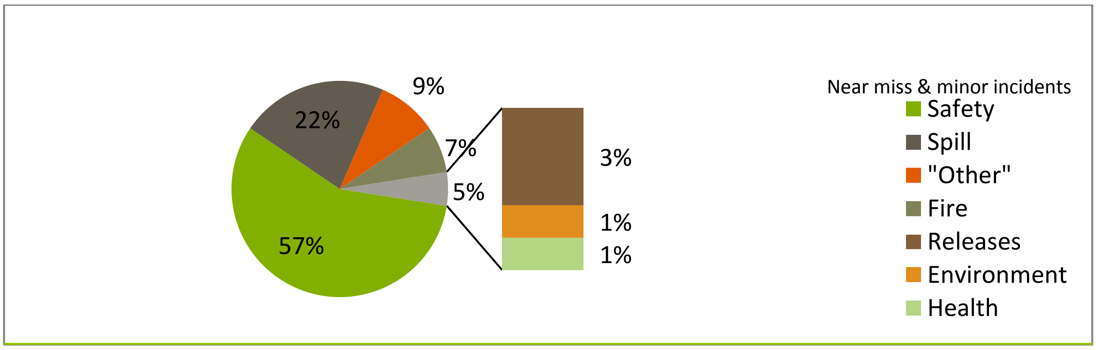
The NM&MI database for the research consisted of details of NM&MI gathered from the databases of the seven organisations who participated in the research. These NM&MI were listed under each category and shown as follows: Safety (57 percent); Spills (22 percent); “Other” (nine percent); fire (seven percent); releases (three percent) and environment and health (one percent each) (Figure 4.3) and NM&MI database (Appendix E).



Source: Employee response to questionnaires (Appendix C)

Figure 4.2 Summarised responses to questionnaires, employee survey

The causes of these NM&MI and management interventions applied, were further analysed. Only causes greater than 10 percent per category were used in the analysis.



Source: Chemical organisations databases (Appendix D)

Figure 4.3 NM&MI database

4.3.1 Causes of NM&MI (Figure 4.4)

Safety- has the most (57 percent) minor incidents. The employees believe that most (70 percent) of the underlying causes for safety are due to accidental injury and only a few (17 percent) are due to negligence.

Spills- has the second (22 percent) highest number of minor incidents. The highest (40 percent) of the underlying causes is negligence, followed by poor operations (32 percent) and poor maintenance (25 percent).

"Other"- has the third highest (nine percent) occurrences of minor incidents. The underlying causes are negligence (30 percent), theft (13 percent), poor operations (10 percent) and poor maintenance (10 percent).

Fire- has the fourth (seven percent) highest occurrence of minor incidents, with the underlying causes being that of negligence (63 percent) and poor operations (25 percent).

Releases- has the fifth (three percent) highest occurrence of minor incidents. The underlying causes are poor operations (50 percent), poor maintenance (34 percent) and negligence (16 percent).

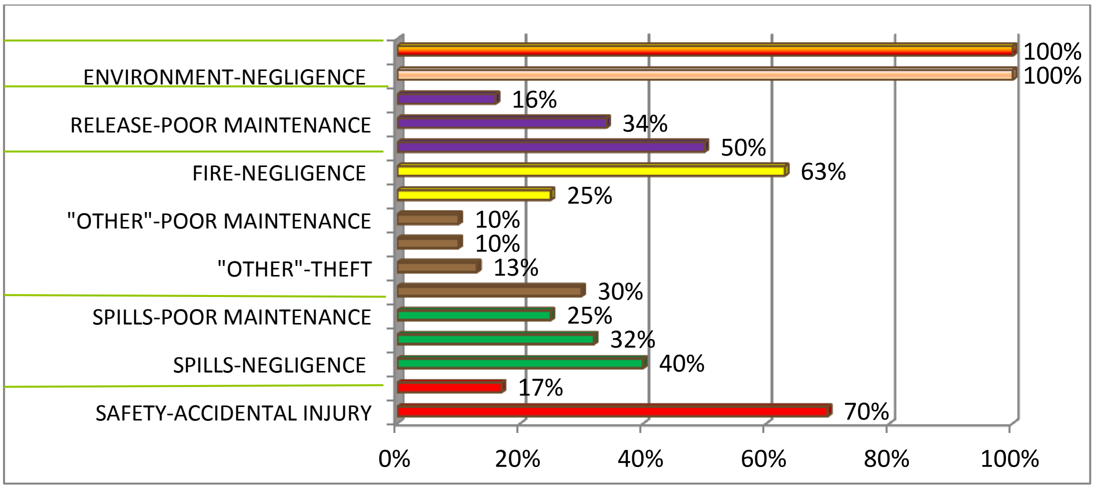
Environment- has the lowest occurrence (one percent) of which the cause is negligence (100 percent).

Health- has the seventh lowest occurrence (one percent), of which the cause is ill health (100 percent).

4.3.2 Underlying reasons for NM&MI

Negligence:

Negligence is the main (33 percent) underlying cause responsible for impacting nearly all the NM&MI, barring that of health incidents. The impact of negligence on fire NM&MI is an alarming 63 percent of the 32 incidents, being seven percent of the total incidents (Table 4.20).



Source: Chemical organisations' databases (Appendix E)

Figure 4.4 Causes of NM&MI

Poor Operations:

Poor operations were responsible for causing 10 percent of the NM&MI under the categories of spills, "other" and releases.

Poor maintenance:

The common cause is that of poor maintenance, at eight percent, which was responsible for impacting on spills, "other" and releases.

Table 4.20 Underlying reasons for NM&MI

Near miss & minor incidents (by category)	**Negligence**		**Poor operations**		**Poor maintenance**	
	Per category	All (415) incidents	Per category	All (415) incidents	Per category	All (415) incidents
Safety (57%)	17%	10%				
Spills (22%)	40%	9%	32%	7%	25%	6%
"Other" (9%)	30%	3%	10%	1%	10%	1%
Fire (7%)	63%	5%				
Release (3%)	16%	5%	50%	2%	34%	1%
Environment (1%)	100%	1%				

Source: Chemical organisations' databases (Appendix E)

4.3.3 NM&MI data analysis

Chi-Square (Appendix J)

It was found that for each of the following aspects: category; cause; impact and seriousness, analysis was done to ascertain the frequency thereof. It is expected that each of these aspects will be equally likely to occur. The Chi-Square goodness-of-fit test was applied and found to be significant.

A large number of incidents fell under the ‘safety’ category. Most of the incidents were caused by human error, both accidentally and through a poor standard of work. Many incidents impacted on personal injury or an interruption to production / damage to the businesses. Most of the incidents have a seriousness rating of ‘four’, which is the least serious rating. This indicates that the incidents were either near misses or very minor.

Cross Tabulations (Appendix J)

Many of the incidents in the ‘safety’ category were caused by accidental, human error. The incidents in the environmental category were caused by mechanical failure or ‘poor quality work by humans’. The incidents in the ‘other’ category were caused by negative behaviour or poor quality work. Under the ‘safety’ category, many of the incidents resulted in personal injury. Incidents in the environmental category resulted in interruptions to production or damage to business, while the incidents in the ‘other’ category resulted in damage to property, interruption to production and damage to business. There was no relationship between category and seriousness for the incidents.

Many of the incidents were caused by accidental human error, resulting in personal injury; incidents caused by poor quality work resulted in an interruption to production, damage to business or near misses; incidents caused by negative behaviour resulted in damage to property; and those caused by mechanical failure resulted in damage to property , interruption to production or damage to business. Numerous incidents that caused damage to property, had a seriousness indication of one (very serious); compared to those impacted by interrupting production or doing damage to business, with a level of four, while near misses had a level of three.

4.3.4 Management interventions applied to NM&MI

These interventions are set out under this section and the details are shown in Appendix D, items 1 to 415

Safety

It was found that these interventions are programmes applied to improve safety. The organisations thoroughly investigated poor operating practices of the operations and maintenance departments, disciplined the employees involved and dismissed defaulters. Training was also reviewed and improved where necessary (Appendix D – 86 to 325).

Spills

The findings showed that the organisations investigated all aspects of negligence and poor operations and disciplined all employees involved. The maintenance departments fixed and also had the contractors redo all the poor maintenance work that had previously been done. In addition, all hoses used in the operations department for product movement were pressure tested at regular intervals and certified fit for use and damaged hoses replaced (Appendix D - 326 to 415).

"Other"

The findings indicated that the organisations investigated all aspects of negligence and employees who failed to follow procedures were disciplined. Procedures were set up and it was ensured that all staff followed them. Security was also improved in order to control theft. In addition, the operations and maintenance department investigated and closed all gaps that existed. Customer / transporter relationships and services were improved on, by reducing the number of customer complaints, resolving customer / transporter related issues speedily. The quality of products was improved on and product failures were reduced. The organisations also had regular inspections on document control for product movement done and planning was improved so that there are no problems in the production of services (Appendix D - 35 to 73).

Fire

Plant managers and supervisors thoroughly checked out all plant and equipment preparation before handing over to the maintenance department or contractors for maintenance. Fire blankets / tarps were used to cordon off locations or equipment from hot work areas and safety watchers were used to keep control (Appendix D -2 to 32).

Releases

Managers and Supervisor did regular checks on operational activities so that safety incidents are minimised. They also ensured that their staff is appraised so they can be trained in skills that they are weak in (Appendix D – 74 to 85).

Environment

Computer systems and tanks of poor quality products are locked out. The plant designs are improved to accommodate the latest in best, global safe handling and storage practices in chemical industries (Appendix D - 0 to1).

Health

Employees have first aid treatment when they become ill at the plants. They then go to their doctors for proper medical attention (Appendix D - 33 to 34).

4.4 OM development

The OM includes Strategic, Tactical and Functional Methodologies (Figure 4.5) and was developed from categorised minor incidents, employee surveys, management interventions and external sources. The OM was developed to assist in the management of NM&MI throughout the organisation, from the corporate division to plant level.

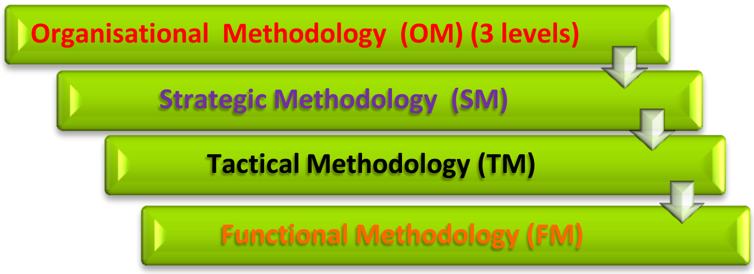


Figure 4.5 Organisational Methodology flow

Strategic methodology (Appendix N – Figure 4.6)

The Strategic Methodology is at level one of the OM and promotes the basis of managing all MN&MI. Management elements in this strategy are:

– *Policy:* guides the organisations in dealing with and controlling potential risks.

– *Legal:* deals with the respective legislation, standards, rules and regulations.

– *Plan:* steps to facilitate the strategy for risk management at the organisations.

– *Train:* train relevant role players in order to make the strategy work.

– *Implement:* once the role players have been trained and briefed on the plan, the next step on making the strategy work will be implementation.

– *Monitor:* role players to action plans and strategy for success.

– *Control:* rigorously control SM to ensure that it keeps on track with the plan.

- *Review:* a management done to consider the pros and cons of the strategy, so as to review the value adding aspects to the SM for managing risk (NM&MI).

Tactical methodology (Appendix O – Figure 4.6)

The TM is the second level of the OM on managing risk. The elements of the TM are pivotal elements for management, supervisors and workers to use in maintaining safe, healthy and environmentally friendly chemical organisations. The following are key elements:

- *Management commitment:* management team committed to making safety work at the organisations.
- *Supportive culture:* top management must be committed to supportive SHE.
- *Communications:* safety communications are crucial in maintaining SHE approaches.
- *Safety priority:* highest priority to safety approaches so that safety comes first.
- *Safety rules and regulations:* are safety rules and regulations updated regularly; are they reflective of the operations?
- *Involvement:* it is crucial that all workers, supervisors and management are fully involved to make a success of all safety approaches.
- *Supportive environment:* do workers receive the necessary support from their supervisors and managers on safety?
- *Behaviour and attitude:* Are the workers, supervisors and managers behaving poorly?

– *Competency and training:* Are the workers, supervisors and managers competent?

Functional methodology (advanced) (Appendix P – Figure 4.8)

The FM (advanced) was developed with information from employee surveys, (Appendix C), categorised NM&MI from the seven organisations, (Appendix E) and international benchmarks. The steps are:

FM 1 – The process flow starts at the chemical organisations' key functional areas.

FM 2 - an employee survey should be done on an annual basis or sooner, depending on the level of severity of NM&MI.

FM 3 – collect NM&MI data from the organisations' databases. Root cause analysis should be done of data that show problematic trends.

FM 4 - NM&MI should be categorised and the causes and management interventions listed.

FM 5 - employee surveys should be analysed.

FM 6 – NM&MI databases should be analysed.

FM 7 - all the best solutions developed / selected would be used to mitigate the risks and manage the NM&MI.

FM 8 – Mitigate risks by implementing solutions to manage NM&MI.

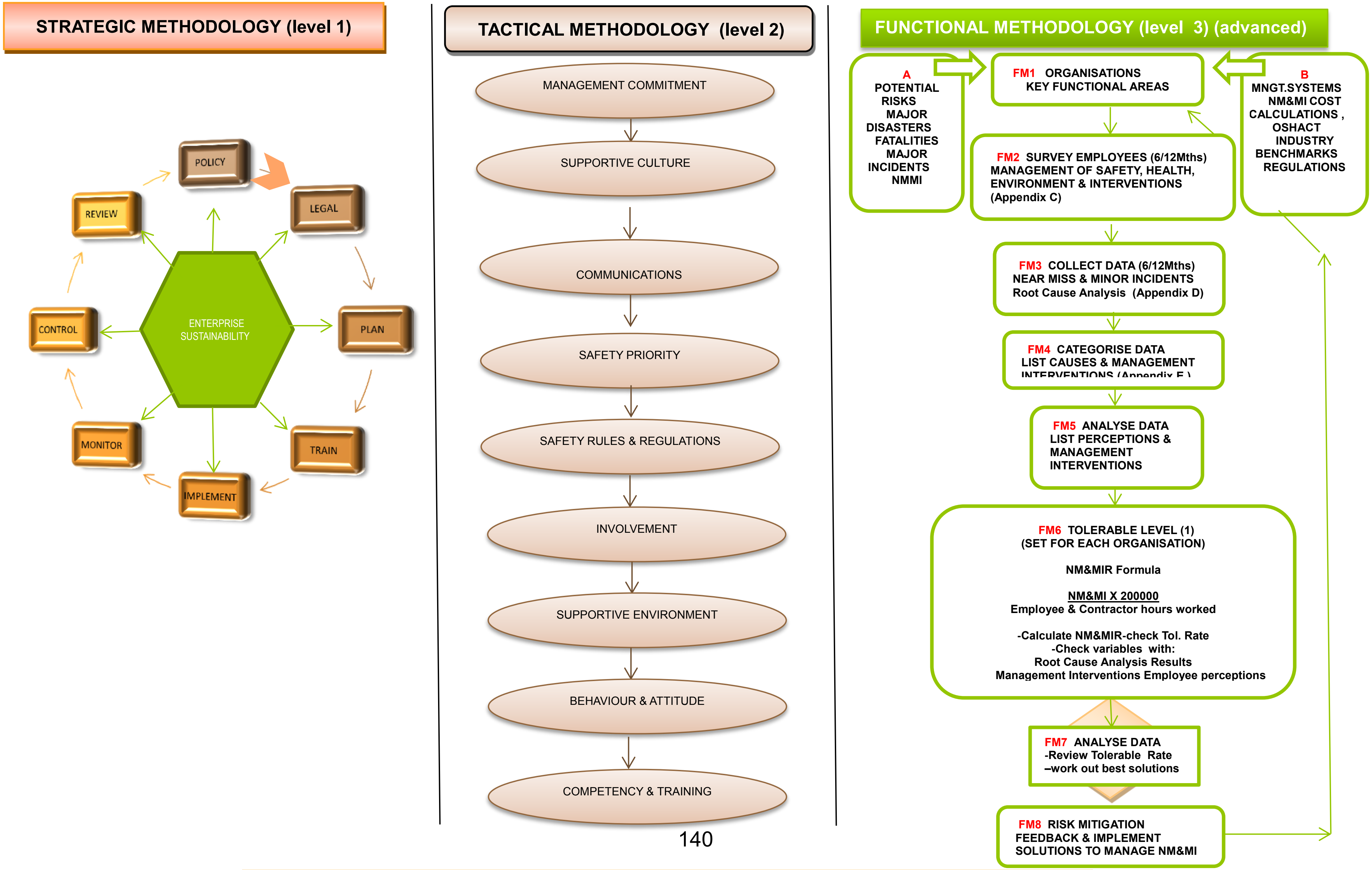


FIGURE 4.6: ORGANISATIONAL METHODOLOGY FOR THE MANAGEMENT OF NM&MI

4.5 International & national benchmarks

Introduction

The international and national benchmarks are industrial standards set for better management of SHE incidents. Each organisation should calculate NM&MIR (Figure 4.7) and set their own tolerable level as their standard. Thereafter, the organisations should monitor the NM&MIR and keep the rate below the tolerable level (CCPS, 2010).

4.5.1 Establish near miss and minor incident rate (NM&MIR)

$$\text{NM\&MIR} = \frac{\text{Total near miss \& minor incidents X 200,000}}{\text{Total employee and contractor worked hours}}$$

Source: Adapted from CCPS (2010) NMTER

Figure 4.7 NM&MIR

> *Most chemical organisations gather NM&MI details annually for reporting in terms of ISO standards. To calculate the NM&MIR, the total annual incident data is multiplied by 200 000 hours, divided by the total employee and contractor hours worked, including overtime, arriving at the Total Near Miss and Minor Incident Rate (NM&MIR).*

An organisation can set its' own tolerable level depending on the number of NM&MI. For instance, as a starting point, the tolerable level can be set at one and reduced progressively to zero, when the NM&MI reduce towards zero. The NM&MI result may then not exceed the Maximum Tolerable Level of one, which is set so that the NM&MI for that year can be controlled properly.

As a control measure for the organisations, the NM&MI are compared to the standard tolerable level of one. When the rate is above one, it will indicate how serious the problem is within the specific organisation. Individual organisations can set the tolerable level even lower, when their NM&MI counts are progressing towards the zero level. Above a level of one, organisations should take immediate action to reduce the minor incidents and near misses, in order that the rate can be brought down below one.

Total NM&MIR calculation for this study

The actual number of NM&MI per annum for the seven organisations is 208 (Table 3.2).

Calculation:

$$\frac{\text{Total NM\&MI X 200,000}}{\text{Total employee and contractor worked hours}}$$

$$= \frac{\text{208 X 200,000hrs}}{\text{2,311,111hrs}}$$

$$= \frac{41{,}600{,}000}{2{,}311{,}111}$$

NM&MIR = **18**

It is of dire significance that the NM&MIR result of **18** is extremely high, in comparison to the tolerable level of **ONE** set for the seven organisations involved in the research. Furthermore, the rate of **18** covers all seven organisations and will equate to a rate of about three per organisation. There is no doubt that drastic measures are required to reduce the NM&MI for the NM&MIR to below the tolerable level of one.

4.5.2 Improved OM for NM&MI management

The OM was further enhanced by introducing improvements to the previous FM (basic - Figure 4.1) after reviewing international benchmarks. An ad hoc inquiry (Table 4.21) on the usefulness and improvement to the FM (basic) showed that the methodology or a similar tool has not been used in most organisations and the NM&MI have not been successfully managed. The respondents (Appendix G) believe that this tool will be useful in better managing NM&MI in their organisations. They also believe that the improvements suggested on the use of the root cause analysis and setting a tolerable level for each organisation, will add value to the methodology and their organisations.

Table 4.21 Ad hoc inquiry (FM - basic)

RESULTS OF FUNCTIONAL METHODOLOGY (BASIC) INQUIRY:

QUESTIONS	YES	NO
Q1 Currently in your organisation is the NM&MI managed properly	**4**	**16**
Q2 Have you used the Methodology or a similar tool in resolving or reducing NM&MI	**4**	**16**
Q3 Would this Methodology assist you in reducing and controlling NM&MI	**20**	**0**
Q4 Would adding an additional step with root cause analysis and a tolerable rate improve this Methodology?	**20**	**0**

This methodology was matched with:

- international and national benchmarks.
- a calculation for NM&MI rate (NM&MIR), based on the NMTER (CCPS).
- a tolerable level of one has been set for this research.
- management systems are reviewed as part of audits and management reviews to ensure that all the necessary failsafe safety, health and environmental systems are in place.
- the methodology outlines the steps that an organisation may follow so that NM&MI are better managed.

Functional Methodology (advanced) flow:

There are eight steps to the improved FM (advanced) in Figure 4.8 (Appendix P), the first five steps and the eighth steps are the same as FM (basic). The inclusion is FM6 - calculate the NM&MIR and check against the tolerable rate of one. Also check root cause analysis, as well as management interventions and employee surveys. The second inclusion is FM7 - Compare the current tolerable rate to the previous period. Select best fit and long lasting solutions for the NM&MI.

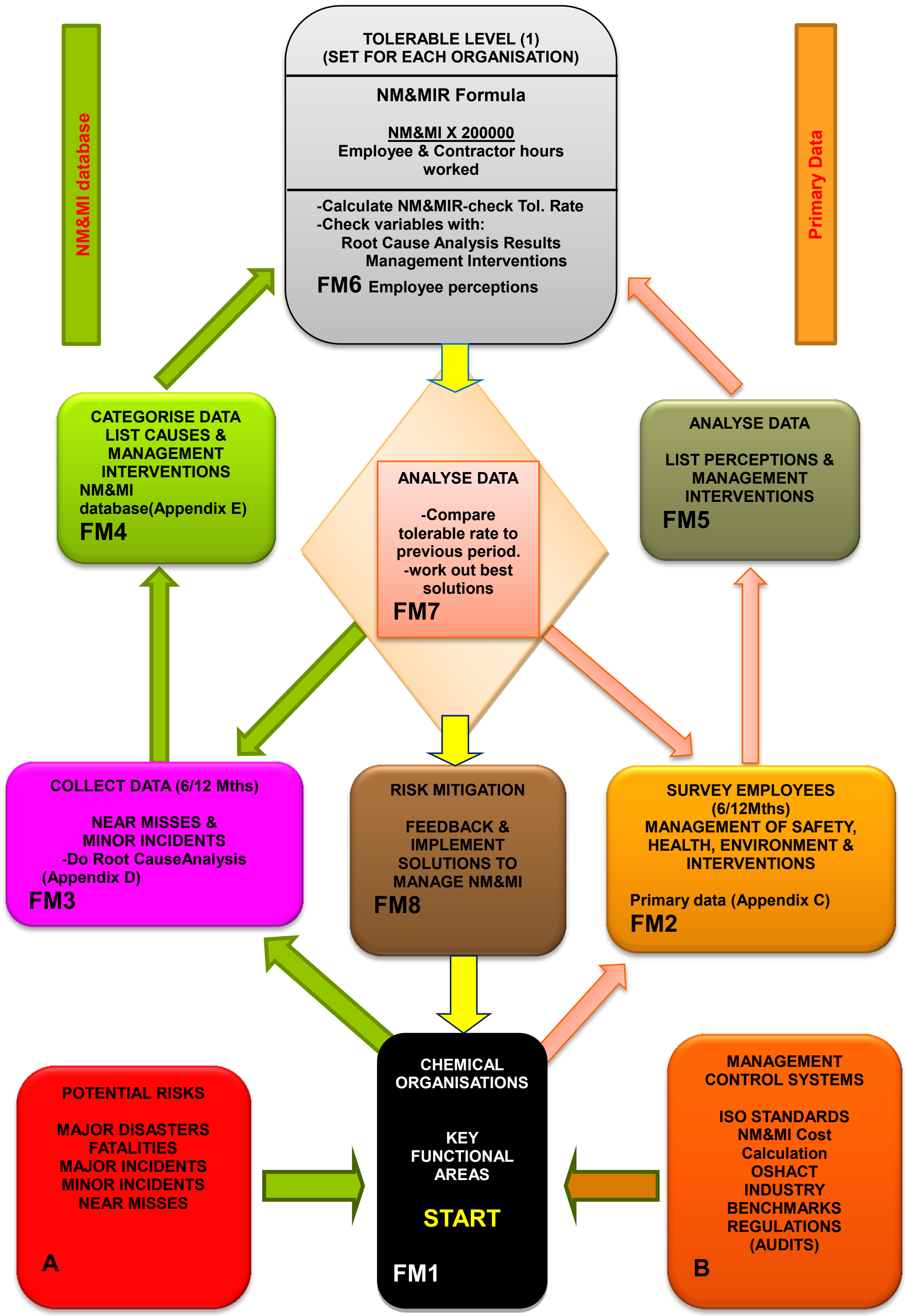


Figure 4.8 Functional Methodology for NM&MI (advanced)

4.5.3 Characterization of the operations and management of the key functional departments (Appendix L)

Operations department

The operations department is the key functional area and will be responsible for the production and services. Some of the functions will include operating plant and equipment, maintaining safety, health and environmental approaches, cost effective supervision and management, developing plant personnel and also budgetary control. In addition, the operations department also generates most of the NM&MI in an organisation.

Maintenance department

This department is responsible for the safe, on time maintenance, repair or replacement of plant equipment and systems, in order to ensure maximum production quantity and quality. It also ensures that maintenance technicians are adequately trained, equipped, and motivated, so that the maintenance programme can be accomplished.

Compliance department (SHE)

Develops and manages a comprehensive SHE compliance auditing programme at plants, along with follow-up, tracking corrective actions for deficiency and findings at all plants. Applies OSHA (US Department of Labour, 2009) regulations, ISO 9001, 14001, 18001 and NEMA.

Despatch department

Consults with customers to understand their distribution networks and determines the logistics resources required to support equipment, safety, personnel and maintenance. Responsible for all logistics, operations and support, across all distribution channels.

Security department

Responsible for providing leadership, advice and counsel to line management on security policy and practices. Identifies exposure and recommends and develops corrective plans, as appropriate.

Customer Service department

The purpose of the customer services department is to maintain customer satisfaction by providing problem-solving resources to the customers.

Administration Department

The administration department is responsible for the general clerical and administration functions for the organisations.

Laboratory department

Perform quality tests and ensure the company meets quality assurance standards.

Finance department

The finance department is key in the inflows and outflows of finance. Annual organisational budget control is crucial to this department. Furthermore, the finance department oversees monthly and quarterly assessments and forecasts of the organisation's financial performance against budget, financial and operational goals. It is also responsible for reconciling monthly activity, generating monthly and annual reports, and fulfilling tax related requirements. Additional roles include administering payroll and employee benefits, as well as organisational insurance, developing long-range forecasts and maintaining long-range financial plans.

Human Resources department

The Human Resources department guides and manages the overall provision of Human Resources services, policies, and programmes for organisations, which include recruiting and staffing; performance management and improvement systems; training and development for the entire organisation; employment and compliance with regulatory concerns.

4.5.4 The impact of NM&MI on the performance of key functional areas (Appendix F)

A total of 415 NM&MI were analysed (Appendix D) to establish the impact on the key functional areas. It was found that these areas were directly impacted by the NM&MI (Figure 4.9- Appendix F). Operations, being the main functional area, has the highest (52 percent) impact, which shows that there are a significant number of NM&MI that will slow production down and increase costs. To compound the high operational cost, maintenance follows with the second highest (26 percent), this will also add a detrimental workload and cost to the organisations. In addition, Compliance follows with 13 percent, Dispatch at three percent and other departments are affected to a lesser extent.

It was also shown that the nature and trend of operational impacts were safety (50 percent), spills (32 percent) and fires (11 percent); while maintenance impacts consisted of safety (86 percent) and fires (six percent), with compliance impacts made up of safety (36 percent), spills (27 percent) and releases (23 percent) (Table 4.22). It should be noted that all these costs are an unnecessary cost burden to the organisations and could have been prevented, if the NM&MI were managed better.

Table 4.22 Impact of key functions by NM&MI categories (Appendix F)

IMPACT OF NM&MI CATEGORIES ON KEY FUNCTIONS				
KEY FUNCTIONS	SAFETY	SPILLS	FIRES	RELEASES
OPERATIONS	50%	32%	11%	
MAINTENANCE	86%		6%	
COMPLIANCE	36%	27%		23%

Source: Appendix F

4.5.5 Calculating the basic cost of NM&MI (Appendix K)

The cost of NM&MI should be calculated, as this will give the cost breakdown of the potential incidents that could have happened. For the cost calculation, each NM&MI was investigated carefully and the steps under each main investigation category followed as required. The final cost of the

NM&MI gives the actual impact in value, against the key functional areas of the organisations. The calculation for this research is shown in Appendix K.

The average cost of all 415 NM&MI (Appendix K) has been calculated to establish the impact of NM&MI on the functional areas of the seven organisations. The research also showed that some of the NM&MI impacted on a variety of departments. However, for this research, each NM&MI has been linked to one functional area, depending on the actual impact.

The total average cost calculated for the 415 NM&MI in this research is R84 735 530, across all seven organisations (Appendix K). The findings show the total average cost contributed by each key functional department that was impacted by the NM&MI (Appendix F).

The chemical industry regularly does costing of major disasters, which runs into millions of rand or dollars (Table 4.23-Appendix M). These NM&MI, in many cases, lead up to major costly disasters and no cost calculation was done for them.

Table 4.23 Cost of major chemical disasters (Appendix M-full table)

IchemE Loss Prevention Bulletin April 1998 no 140- Costs of Major Chemical disasters		
Date	**Location**	**Cost**
23/10/89	Pasadena, Texas	$ 1,456m
11/09/92	La Mede, France	458m
14/11/87	Pampa, Texas	396m
07/03/89	Antwerp, Belguim	356m
24/02/86	Thessaloniki, Greece	300m
05/05/88	Norco, Louisiana	293m
04/13/91	Sweeny, Texas	264m
23/07/84	Romeoville, Illinois	241m

Source: Fewtrell, (1998:6) - Full table under Appendix M

Operations department cost impact

It was calculated that the impact of NM&MI on Operations is R44 062 475

(52 percent) (Figure 4.9). This is broken down further to an average of about R6 294 639 (7.42 percent) for each of the seven organisations. The Operations Department is the largest functional area of the organisation and the impact of NM&MI on the key functional area of Operations is severe.

This finding supports the main objective of the research, which is to evaluate the impact of NM&MI on the performance of key functional areas, within selected chemical organisations. This is the impact of NM&MI on only one key functional area. There are ten departments that will be reviewed in total.

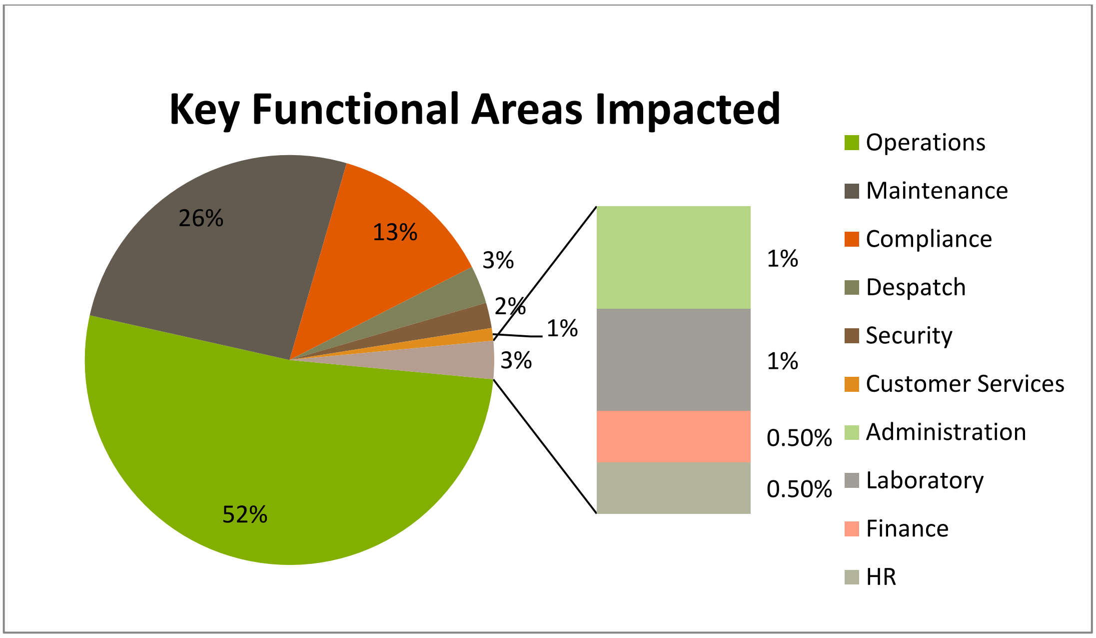
Maintenance department cost impact

The impact of NM&MI on the Maintenance area is R22 031 237 (26 percent) (Figure 4.9). The individual average cost for NM&MI for the seven organisations is R3 147 320 (3.71 percent). This incident cost is again very extensive and definitely severely impacts on this key functional area of the organisation.

Compliance department cost impact (SHE Risks)

The impact of the NM&MI on the Compliance Department is R11 015 618 (13 percent). The average cost, for each of the seven organizations, amounts to R1 573 660 (1.85 percent). Another, sizeable amount for a key functional area impacted by NM&MI.

The rest of the functional areas are impacted by R7 626 198 (nine percent) (Figure 4.9). NM&MI also impacted the following departments: Dispatch, Security, Customer Services, Laboratory, Administration, Human Resources and Finance by R 1 089 457 (1.28 percent) per organisation. It must also be noted that the Finance Department has to eventually deal with all financial impacts from all the key functional areas by the NM&MI. The consequences of the seven organisations having 415 NM&MI have had a devastating impact of about R12 105 075 (14.28 percent) out of R84 735 530 (Appendix K) to their key functional areas. This devastating impact by the NM&MI on the key functional areas of the organisations supports the findings of this research fully in satisfying the main research objectives.



Source: Impact of NM&MI on functional areas (Appendix F)

Figure 4.9 Key functional areas impacted by NM&MI

4.6 Conclusion

In this chapter the field work and findings of the research were evaluated and the results of the questionnaires and the NM&MI cross tabulated, reviewed and summarised. On review of the employee survey (Appendix C), the findings covered the enquiry of management approaches to safety, as well as health and environmental aspects of the chemical organisations.

The NM&MI database (Appendix E) gathered from the organisations was categorised and, together with input from the respondents and management interventions, used in the development of an OM for the control and management of NM&MI. The OM (FM) was compared with international benchmarks and modified for further improvements. In addition, a detailed comparative analysis was done between the OM developed for this research and the ESP developed by Oktem (2002:1).

The NM&MI database also covered the categorisation and analysis of the causes and management interventions taken to correct minor incidents. The impact of NM&MI on key functional areas was evaluated and an incident cost calculation done to support the findings.

In the next chapter, the analysis of the fieldwork and findings will be further interpreted.

CHAPTER 5
ANALYSIS AND INTERPRETATION

5.1 Introduction

In chapter four, the field work and findings are analysed. The findings of the questionnaires, as well as the NM&MI were categorised, cross tabulated and analysed in detail. The findings of this research were used to develop an OM, which includes the Strategic, Tactical and Functional Methodologies for the better management of NM&MI. The OM was compared with international / national benchmarks and similar global research done. The impact of NM&MI on the performance of key functional areas of the business was evaluated.

In this chapter the findings of this research were further analysed and interpreted under the respective objectives, as set out in chapter one. In the first part, the biographical results were examined, together with employee surveys (Appendix C), and NM&MI from the databases (Appendix E). The research findings were examined in detail and integrated with global literature reviews, to find gaps in the management of SHE approaches, so as to better manage these NM&MI that have an impact on the key functional areas of the business.

5.2 Main research objectives revisited

The main objective of this research was to review the causes of NM&MI at selected chemical organisations in Durban, by surveying the workers, supervisors and managers, to establish their perceptions on their attitudes to safety, health and environmental approaches. In addition, a review of the NM&MI held on their databases and the impact of NM&MI on key functional areas was done, in order to develop an OM to facilitate the management of NM&MI and further enhance the OM using comparative benchmarks.

The main objective was achieved with the completion of a perception survey using questionnaires, by respondents of the seven chemical organisations, on the probable causes of NM&MI (Appendix C). In addition, the NM&MI databases (Appendix E) from the seven organisations were gathered, categorised and their causes and management interventions reviewed. The impact of the NM&MI on the key functional areas of the business was evaluated and an OM developed. The supporting objectives expose the detailed analysis and interpretation of the findings, to support the main objective.

5.2.1 Employee surveys

There were some disagreements between workers and supervisors which impacted the team dynamics. Although it was found that management was generally committed to safety, health and environmental approaches, there were still issues regarding management only acting after incidents/accidents occur. Management were more reactive rather than being proactive. Operators were not completely satisfied with managements' commitments.

Good safety communication existed, whereas operators indicated that they were blamed for unsafe incidents. It was evident that managers, supervisors and operators had divergent views on safety communications. There was generally good management of priority of safety and health. NM&MI are sadly viewed with less importance than other SHE incidents. Safety rules and procedures were not practical to carry out and were not followed. Management did not create a supportive safety environment for workers to work in. The workers were of the opinion that they are not involved in all aspects of safety. Safety is compromised by catching up with production targets and there is no time to work safely. There were again divergent views amongst managers, operators and contractors working in the same area. Employees generally behaved very poorly.

5.2.2 NM&MI databases reviewed

Analysis and interpretation of NM&MI, NM&MI database (Appendix E)

It is reported by Eigenhuis (2010) that chemical safety managers agree that NM&MI offer opportunities to measure and manage health and safety, and prevent major disasters. However, Nivolianitou et al. (2006:630) claim it is widely recognised that the chemical industry does not learn from past accidents. They point out that the industry must take up the challenge to address the dissemination of information on past incidents and, if possible, of NM&MI. This should be done in such a form that the latter can be easily recalled, so that lessons are not forgotten.

A two-year value of the NM&MI was analysed from the organisations. Only causes of 10 percent and above were used from the NM&MI database.

Causes of NM&MI, NM&MI database (Appendix E)

It was found that safety incidents were the highest of the 415 NM&MI (Appendix D) of the seven chemical organisations. On the categorised near miss and minor database (Appendix E), the main causes were accidental injury and negligence. Management has to reduce the causes through an in-depth enquiry of the causes and then corrective action has to be implemented to improve on safety. Health incidents were at one percent of the total of NM&MI databases, with the main cause being that of illness.

Erickson (2006:4) maintains that corporate culture underpins management commitment, worker involvement, communication and treatment of workers, to make a success of safety, health and environmental programmes. The Spills category was second highest after safety, with the causes mainly attributed to negligence, poor operations and poor maintenance.

Zwetsloot, Gort, Steijger and Moonen (2006:769) state that managerial pressures on rushing production and creating incidents can be reduced by improving on business processes. They further add that the process industry operates internationally and is facing growing global competition. “Other” incidents then follow in the NM&MI database. The main causes being that of negligence, theft, poor maintenance and poor operations. Fires were caused mainly by negligence , followed by poor operations.

Knegtering and Pasman (2009:162) postulate that chemical safety managers agree that minor incidents offer opportunities to measure and manage safety incidents and prevent major disasters. Root cause analysis must be done by plant operators in managing minor incidents. In most cases, only the major incidents are thoroughly investigated, while the NM&MI are not investigated fully. The main causes for releases were poor operations, poor maintenance and negligence.

Al-Mutair et al. (2008:543) state that the term “inherently safer design” started appearing in safety discussions after Trevor Kletz (1999) introduced this concept as an identifiable element of process safety, in one of his most famous phrases “What You Don’t Have Can’t Leak”. Plants must be made safe by designing them with safety in mind. Environmental incidents were caused by negligence. The causes were negligence, poor operations and poor maintenance, which were the underlying reasons for the majority of the NM&MI (NM&MI database - Appendix E).

Management interventions applied to NM&MI (Appendix E)

Introduction

It was found that, in general, the organisations investigated all aspects of negligence, poor operations and poor maintenance on all incidents and took the necessary corrective action where necessary.

Management interventions:

It was clear in the research that the organisations thoroughly investigated poor operations and poor maintenance of the respective departments and disciplined defaulters (Appendix D). Einarsson and Brynjarsson (2008:550) postulate that, by addressing human factors and analysing human interactions, as well as the risks relating to communication and emotions, there is potential to improve the safety management system.

The research also showed that management often reviewed and improved safety training for all employees. They furthermore, also improved on customer / transporter relationships and services, by reducing the number of customer complaints. Planning was likewise improved, in order that there may be no problems in the production of services (Appendix D).

The maintenance departments in the various organisations fixed and redid all the poor maintenance work that had been done and, in addition, all hoses used in the operations departments for product movement, were pressure tested at regular intervals and certified fit for use. Damaged hoses were also replaced (Appendix D).

The findings indicated that the organisations investigated all aspects of negligence and disciplined employees who failed to follow them. Security was improved in order to control theft.

Plant managers and supervisors were shown by the findings, to have thoroughly checked out all plant and equipment preparation, before handing over to the maintenance department or contractors for maintenance to be done. Fire blankets / tarps were used to cordon off environments or equipment from hot work areas and safety watchers were used to keep control.

Hale et al. (1998:21) state that maintenance in the process industry, is connected with a significant proportion of the serious accidents that take place in the industry.

5.2.3 OM development

Organisational Methodology

The OM (Figure 5.6) was developed to facilitate the management of NM&MI.

The OM comprises of the SM, TM and FM (advanced). The OM is a new methodology, developed to facilitate management of NM&MI. Prem, et al. (2010:549) believe that major chemical disasters have, on many occasions, developed from NM&MI which were not investigated and managed properly, for example the Bhopal Disaster (Long, 2008:1). The strategic methodology (Appendix N) is the first level of the OM and facilitates the management of all types of organisational risks.

The next level of the OM is the Tactical Methodology (TM) (Appendix O), which expands on the Strategic level. The key elements of the TM are taken directly from the questionnaire (Appendix B) and they cover the many aspects of management commitment. These elements linked to TM have been analysed in detail under the employee survey. On the other hand, Einarsson and Brynjarsson (2008:550) maintain that, by addressing human factors and analyzing human interactions, as well as risks relating to communications and emotions, there is greater potential to improve on SHE approaches. In addition, Erickson (2006:4) strongly advocates that organisations should have an entrenched, supportive safety culture for proper SHE management.

The third level of the OM is the FM (advanced) (Figure 5.8), which was the result of comparisons done with international benchmarks and the FM (basic). The steps in FM are supported by Knegtering and Pasman (2009:162), as they postulate that NM&MI should be investigated thoroughly by plant operators, using all the steps to prevent major incidents. The safety advisor, Eigenhuis (2010), believes that NM&MI must be investigated step-by-step, by using a tool or methodology.

Review of international and national benchmarks to improve OM

A new NM&MIR (Figure 4.7) was established for this research and adapted from Near Miss Total Event Rate (NMTER), which now also covered minor incidents (CCPS:2010). The NM&MIR allows the organisation to set their own maximum tolerable rate, to better control the number of NM&MI. The formula for the NM&MIR is now included in the new FM (advanced), as part of the improvement to the OM.

In addition, respondents were requested to fill in an ad hoc inquiry, on the usefulness and improvement to the FM (basic - Figure 3.1). The results (Table 4.21) indicated that the methodology or a similar tool, have not been used in most organisations and the reduction of the NM&MI has not been successfully managed. The respondents believe that this tool will be useful in better managing NM&MI in their organisations (Appendix G). The improvements were made to FM (basic), resulting in the FM (advanced).

The OM was also compared with similar global research done. The only other research found (ESP - Oktem 2002:1) covered near miss incidents. The OM (Figure 4.6) developed for this research for (NM&MI) could be applied at all levels of the organisation. The ESP only has eight steps, compared to the OM, with 25 steps, which covers the Strategic, Tactical and Functional levels of the organisation. The ESP and OM have critical elements that will assist in the better management of NM&MI but the OM has many more steps that will drive the reduction of NM&MI even further. In addition, OM also has the cost calculation benefit and the luxury of calculating Tolerable Levels, so as to keep the NM&MI down to a manageable level.

Comparison between OM and the ESP of Oktem (2002:1).

The OM (Figure 4.6) has three levels, the Strategic, Tactical and the Functional Methodologies. The ESP of Oktem (2002:1) is summarized and compared only with the FM, which is the third level of the OM.

Table 5.1 Comparison summary of OM (FM) and ESP

OM (FM- advanced)	***ESP*** Oktem (2002:1)	***Comparison***
CHEMICAL ORGANISATIONS KEY FUNCTIONAL AREAS NM&MI databases	*Identification* All employees need to understand and identify a near- miss incident.	The ESP introduces identification of near misses as the first step and the FM has identified all the key functional departments as the starting point in order to gather or to source all the NM&MI for the organisation to net all the NM&MI. The FM has the identification of NM&MI in the training and the categorisation step of the electronic Non Conformance Reporting system (NCR).
SURVEY EMPLOYEES (6/12Mths) MANAGEMENT OF SAFETY, HEALTH, ENVIRONMENT & INTERVENTIONS (Appendix C)	*Disclosure (Reporting)* All near-misses once identified must be disclosed, preferably in a written form.	The ESP uses disclosure of the near misses as the second step. The FM has the surveying of employees on the causes and management interventions (employee survey) applied to NM&MI as the second step. This step will give additional knowledge to deal with the NM&MI final solutions. Once the NM&MI are entered in the NCR system, it is then disclosed to all the relevant stakeholders.
COLLECT DATA (6/12 Mths) NEAR MISSES & MINOR INCIDENTS -Do Root CauseAnalysis (Appendix D)	*Prioritization* The near misses have to be reviewed and investigations will be done in order of preference.	The next step in the ESP is prioritisation of the incident to get the necessary attention. The step for FM is to collect near miss and minor incident data that the organisations gather as part of the NCR system (NM&MI database) to carry out root cause analysis for the best solutions.
CATEGORISE DATA LIST CAUSES & MANAGEMENT INTERVENTIONS NM&MI database(Appendix E)	*Distribution* The near misses will be distributed to the relevant departments depending on the severity of the near misses for investigations to be done.	ESP talks about distribution to all stakeholders as the next step. This step is part of the NCR system as it is electronically sent to the relevant departments for action or on their watch list. The incident will be discussed in the plant to create safety awareness. The step for FM is the categorisation of data for further analysis to establish trends and solutions.
ANALYSE DATA LIST PERCEPTIONS & MANAGEMENT INTERVENTIONS	*Identification of Causes (Causal analysis)* The causes are reviewed and the basic or root cause investigations are done depending on the severity.	The next step for FM is a critical one, where a formula is used to calculate the Tolerable Level of the primary and NM&MI database and checked against the set Tolerable Level for the organisation. This step acts as a regulator for the NM&MI. The step for ESP is only the identification of the causes of NM&MI but ESP does not include any Tolerable Level for the organisation.
TOLERABLE LEVEL (1) (SET FOR EACH ORGANISATION) NM&MIR Formula NM&MI X 200000 Employee & Contractor hours	*Solution Identification* The investigations and solutions are analysed in depth and the best	The following step for ESP is solution identification where a solution is found for each cause. The step for FM is to review all the root cause results and the potential solutions are rigorously tested for the most

worked -Calculate NM&MIR -check Tol. Rate -Check variables with: Root Cause Analysis Results Management Interventions Employee perceptions	solutions are implemented.	suitable permanent solutions for the NM&MI. At this stage, if there are issues with the solutions, the NM&MI are sent back through the FM process for better solutions.
ANALYSE DATA -Compare tolerable rate to previous period. -work out best solutions	*Dissemination* Once the decisions are made then the information has to be disseminated to all parties to ensure that the solution is implemented.	Dissemination of information is the next step for ESP where the solution is communicated to the responsible people to execute. The step for FM is risk mitigation, feedback and implementation of the best solutions.
RISK MITIGATION FEEDBACK & IMPLEMENT SOLUTIONS TO MANAGE NM&MI	*Resolution (Tracking)* The solutions once implemented, must be tracked and checked to establish whether they are working well and the results given to all role players.	The tracking of the solutions is part of the ESP, in order to check if the necessary changes have been made for the required results. In addition the FM allows for the calculation of all the costs for NM&MI. The ESP does not allow for the use of the costing tool for NM&MI on their impact on the organisations.

The ESP has eight steps, similar to the FM (advanced). There are a total of 25 steps for OM, broken down to eight steps for the SM and FM, with another nine steps for the TM. The SM was developed from external and internal sources. The TM and the FM were developed from the categorised NM&MI, employee surveys and management interventions.

The SM describes the steps required to underpin the corporate managements' role and responsibilities, in managing and implementing the steps for management of NM&MI. The steps are set out in more detail in Appendix N. The policy will spell out the requirements and guidelines that have to be followed. Thereafter, the legal aspects, planning, training, implementation, monitoring of the whole methodology, control of any changes and the review of value adding aspects of SM are done. The steps of SM can be used for other risks that impact the organisations.

The TM is the second level of OM and covers management commitment required, supportive culture of the organisation, proper communications, safety priority, safety rules and regulations, involvement, a supportive environment, good behaviour and attitude and competency and training. These elements are also detailed under Appendix O. It should be noted that for the OM to function properly, it is important that all stakeholders participate fully at all levels of the organisation and make it part of the organisational culture. The ESP and OM have salient elements that will assist in the reduction and control of NM&MI but OM has 17 more steps than the ESP that will drive the reduction of NM&MI even further. In addition, OM also has the cost calculation benefit and the luxury of calculating Tolerable Levels to keep the NM&MI down to a manageable level, which makes the OM a formidable management tool.

5.2.4 Evaluate the impact of NM&MI

Characterization of the operations and management of the key functional departments (Appendix L)

The key functional areas of the organisations cover operations, finance, maintenance, compliance, human resources, customer services, dispatch, laboratory and security. Of these areas, the operations department is the largest and performs the key functions of the organisation, most of the NM&MI occur in the operations department.

The finance department manages the inflows and outflows of finance. Annual budgeting is key to this department, in developing long-range forecasts and maintaining long-range financial plans. Maintenance is responsible for the safe maintenance, repair or replacement of plant equipment and systems, in order to ensure maximum production quantity and quality. Compliance manages a comprehensive SHE audit program, audit follow up, and tracking corrective actions for deficiency findings at all plants.

The human resources department guides and manages the overall provision of human resources services, policies, and programmes for organisations, which include: recruiting and staffing; performance management and improvement systems; organisation development; employment and compliance with regulatory concerns regarding employees. Customer satisfaction is maintained by the customer services department, through the provision of problem-solving resources to the customers. The dispatch function allows for the distribution of products and services to the customers, while the laboratory performs quality tests and ensures the company meets quality assurance standards and the Security department manages the security requirements for the organisation. The characterisation of the operations and management of the key functional areas was achieved. Full details in Appendix L.

The impact of NM&MI on performance of key functional areas (Appendix F)
A total of 415 NM&MI of the seven organisations were analysed (Appendix D) to establish the impact on significant, functional areas. It was found that the NM&MI (Figure 4.9- Appendix F) directly impacted the key functional areas. Operations, being one of these areas, has the highest (52 percent) impact; the operations department is burdened with an unnecessary workload and added costs. Maintenance follows, with the second highest (26 percent); maintenance is a strategic department in keeping operations functioning. It is unacceptable that maintenance should be burdened by this additional workload and costs, which will only compound the impact of NM&MI. Compliance also contributes, with 13 percent, which is unacceptable, while dispatch (three percent) and other departments are affected to a lesser extent.

It was also shown that the nature and trend of operational impacts were safety (50 percent), spills (32 percent) and fires (11 percent); while maintenance impacts consisted of safety (86 percent) and fires (six percent), with compliance impacts made up of safety (36 percent), spills (27 percent) and releases (23 percent). The findings indicate that NM&MI affect the key functional areas of the organisations and this is an unnecessary burden, signiufying that NM&MI should be resolved immediately to minimise its drastic impact.

Zwetsloot, Gort, Steijger and Moonen (2006:769) maintain that management pressure on rushing production creates NM&MI, which can be reduced by improving on business processes. Improvement of business processes might help in some cases but globally, organisations still report ongoing NM&MI daily.

Calculating the basic cost of NM&MI

This calculation tool (Appendix K) was used for NM&MI cost calculation to support and give emphasis to the impact that NM&MI have on the performance of key functional areas of the business. Organisations can now track all incidents more thoroughly by using the cost calculation tool. The total average cost calculated for the 415 NM&MI in this research, is R84 735 530, for all seven organisations (Appendix K). The findings indicated the total average cost, contributed to each key functional department, as impacted by the NM&MI (Appendix F). Costing of major disasters is regularly done by the chemical industry, which runs into millions of rand or dollars (Table 4.23 - Appendix M). These NM&MI, in many cases, lead up to major, costly disasters, for which no cost calculation was done.

Operations department

The impact of NM&MI on Operations is R44 062 475 (52 percent) (Figure 4.9). This is broken down further to an average of about R6 294 639 (7.42 percent) for each organisation.

Maintenance department

The impact of NM&MI on the Maintenance area is R22 031 237 (26 percent) (Figure 4.9). The average cost for NM&MI for the seven organisations individually, is R3 147 320 (3.71 percent).

Compliance department (SHE Risks)

The cost calculated for the impact of the NM&MI on the Compliance Department, is R11 015 618 (13 percent). The average cost for each organisation, amounts to R1 573 660 (1.85 percent).

The rest of the functional areas are impacted by R7 626 198 (nine percent) (Figure 4.9). NM&MI impact the following departments: Dispatch, Security, Customer Services, Laboratory, Administration, Human Resources and Finance, by and R1 089 457 (1.28 percent) per organisation. The consequences of the seven organisations having 415 NM&MI have had a devastating cost impact of about R12 105 075 (14.28 percent) to their key functional areas. This effect, of the NM&MI on the key functional areas of the organisations, supports the findings of this research fully in satisfying the main research objectives.

5.3 Conclusion

In this chapter the main and sub objectives were reviewed for achievement. The findings of the employee survey (Appendix C) and NM&MI database (Appendix E) were analysed and interpreted. In addition, the developed OM was compared with international benchmarks and improved for use as a versatile tool for future investigations. The operation and management of the key functional areas of the organisations were characterised. The cost calculation tool was used in this research, to highlight the severe impact of NM&MI on the performance of key functional areas.

The next chapter covers the conclusions and recommendations of the research into near misses and minor incidents.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The previous chapter dealt with the analysis and interpretation of the various elements of the employee survey findings (Appendix C). The categorisation and analysis of NM&MI databases from the seven organisations (Appendix E) were also done, as well as a comparison of international and national benchmarks, and improvement of the OM for NM&MI (Figure 5.6). In addition, the OM was compared with other international research done of a similar nature and a review of the impact of NM&MI on the key functional areas discussed.

The main findings of the research are reviewed and conclusions are drawn, by revisiting the objectives of the study, if and how these have been achieved, as well as the highlights of the study and the overall findings. Opportunities for future research are identified, limitations discussed and recommendations are made against the contributors. Finally, a summary is presented in conclusion of the study.

6.2 Main findings

The main objective of this research was to review the causes of near miss and minor operating incidents at selected chemical organisations in Durban, by surveying the managers, supervisors and workers. This was done to establish the respondents' perceptions on their attitudes to safety, health and environmental approaches. The NM&MI held on their databases were reviewed, as was their impact on key functional areas, in order to develop an OM to facilitate management of NM&MI, and further enhance the OM using comparative benchmarks.

The main objective of the research was achieved by conducting an employee survey, surveying the workers, supervisors and managers on the organisations' compliance to safety, health and environmental approaches, including statistical analysis and interpretation (Appendix C).

This was achieved through the categorisation and review of a two year value of the NM&MI databases, including the causes and interventions taken (Appendix E). This also entails the development of an OM, inclusive of Strategic, Tactical and Functional Methodologies, for the better management of NM&MI. In addition to this, the OM was compared to international and national benchmarks and further improved for final use (Figure 4.6). The characterization of the operations and management of key functional areas was completed, as was a critical analysis of the impact of NM&MI on the performance of the functional areas of the chemical organisations (Appendix F).

6.3 Important factors

Employee surveys

There were some disagreements between workers and supervisors, which impacted the team dynamics. Although it was found that management was generally committed to safety, health and environmental approaches, there were still issues regarding management only acting after incidents / accidents occur. Management were more reactive, rather than being proactive and operators were not completely happy with managements' commitments.

Good safety communication existed, whereas operators indicated that they were blamed for unsafe incidents. It was evident that managers, supervisors and operators had divergent views on safety communications. There was generally good management of priority of safety and health. NM&MI are sadly viewed with less importance than other SHE incidents. Safety rules and procedures were not practical to carry out and were subsequently, not followed. Management did not create a supportive safety environment for workers to work in. The workers were of the opinion that they are not involved in all aspects of safety. Safety is compromised by catching up with production targets and there is no time to work safely. There were again divergent views amongst managers, operators and contractors working in the same area. Employees generally behaved very poorly.

NM&MI database review

The majority of the NM&MI from the databases fell under the safety category. The causes were mainly contributed by human error, further broken down into accidental injury, negligence and poor standard of work. Environmental incidents were caused mainly by mechanical failures. The weakness of these chemical organisations, is that they generate a constant stream of NM&MI (Appendix D). The result for the NM&MIR for this research was 18 for the NM&MI database (Appendix E). This result was much higher than the set Maximum Tolerable Level of one.

OM development

The OM was developed with three levels, i.e. SM, TM and FM (Figure 5.6). The OM was reviewed against international benchmarks and only a few organisations were found to be using NM&MIR to calculate a Maximum Tolerable level. The FM was improved, by adding an additional step, which included root cause analysis, calculation of NM&MIR, as well as a Maximum Tolerable Level and a cost calculation of NM&MI. A comparison was done between the eight-step ESP of Oktem and the OM (Figure 4.6), which consists of 25 steps, is more comprehensive to the ESP and adds more value.

Evaluate the impact of NM&MI

To thoroughly investigate the impact of NM&MI on key functional areas, the Incident Cost Calculator (Appendix K) was used to calculate the average cost of NM&MI database. The findings were an average of R84 735 530 (100 percent) for the seven organisations and broken down by each key functional area (Figure 4.8) as follows:

- Operations 52 percent;
- Maintenance 26 percent;
- Compliance 13 percent;
- Dispatch; Security; Customer Services; Laboratory; Administration; Human Resources and Finance - nine percent.

Chemical organisations do not carry out cost calculations of NM&MI, due to them being regarded as a nuisance factor. However, the calculation in this research proves that NM&MI have a significant impact on the cost incurred by key functional departments.

6.4 Recommendations

The findings *under management commitment* (Appendix C) showed that management has to build a positive safety, health and environmental culture within the organisations and the first step will be to stop blaming employees for all safety issues. The work environment raised many concerns and management has to work diligently in resolving all the concerns, so that an accident can be averted. The idea is that organisational failures are the main causes of incidents / accidents.

Management should give their full commitment to safety concerns and should take proactive steps in correcting unsafe situations before an accident takes place. In addition, the findings under *management interventions* (Appendix C) indicated that management have to review safety and health carefully and reduce the causes of human error, which includes accidental injury, negligence, poor operations and poor maintenance, proof enough that management should run major safety campaigns, in addition to retraining, disciplining and ensuring that employees follow procedures.

Organisations should utilise more effort in managing the NM&MI and keep them to a bare minimum; major incidents will, in this way, be managed to a minimum or eradicated altogether. Management should also work on improving or removing conflicting views by the workers, supervisors and managers. It was found that employees are seeking praise for working safely; management should satisfy this need as there are potential benefits. They should include competitions for the best run department and best performance / contribution by an individual.

Although *SHE communications* are relatively good (Attachment C), it is recommended that management should carefully review the situation for full compliance. Communications and especially safety, health and environmental communications, are of utmost importance in improving safety approaches. *SHE Training* on cultural diversity should be arranged for employees; to improve group dynamics, so that they work in harmony. Training on improving worker behaviour and attitude is another requirement idenitfied. The data mining of accident databases is recommended for use of information in improving safety learning.

It is further recommended that, with employees generally being young, they need to be trained and grouped with older team leaders, who can act as mentors to pass on knowledge to the young employees. The *Attitude and behaviour (Appendix C) of* managers and supervisors need to be proactive and not reactive and they should also show concern for matters relating to safety, health and environmental issues. *SHE Audits will* assist in removing basic risk factors.

Another recommendation proposed, is that management should audit all safety rules and procedures for compliance to the actual job. They should further investigate the non-compliance of safety for production and in addition, management must check whether all safety rules and procedures are practical for application. In addition, proper *root cause analysis* should be conducted to identify the root cause in the NM&MI, so that permanent solutions can be found.

Management should, furthermore, use the opportunity to carry out worker surveys to determine the workers' involvement in safety, health and environmental approaches. The survey will give a good indication of the safety perceptions of the employees. Globally, there are some organisations that use these surveys, while many are, unfortunately, not. All stakeholders should be serious in making safety work and use surveys as a viable tool in improving the management of NM&MI.

The OM (Figure 4.6) specifically developed for this research, should be used to facilitate the management of NM&MI. This methodology is comprehensive and should be used at all levels of the organisations, from the corporate departments through to the plants, so that a culture for safety, health and the environment is developed and maintained. It is very important that issues are resolved quickly. The proverb "Take care of the pennies and the pounds will take of themselves" makes logical sense and the same principle should be followed with NM&MI, to avoid major incidents. It is further recommended that the OM model proposed be implemented and tested in organisations that require to improve on NM&MIs. The OM model could be further improved and hence advance the contributions made to greater heights.

6.5 Limitations of the study

Of the 20 organisations interviewed, only seven agreed to participate in the research. Although safety, health and environmental issues are prevalent in all industries, the study was mainly conducted in chemical organisations in the Durban South Basin. Obtaining samples from organisations in Durban places some limitation on expanding the study, in terms of Universalist perception of management practice.

The incident database collected from the Department of Labour was not used in the study, due to the diverse cross section of industries not matching the chemical industry profile. The study was limited to only NM&MI and no other incident types. Quantitative research does have its limitations. Large samples are required, and the logistical difficulties inherent in gathering a sufficiently large sample, can sabotage the study before it even gets off the ground. Larger samples also tend to be more expensive. The dataset collected is much narrower and sometimes superficial.

Quantitative research, by virtue of its short (usually 20 minute) interviews and rigid structure, is not the most flexible method of market research and, when handled improperly, is especially vulnerable to statistical error. The results are limited, as they provide numerical descriptions rather than detailed narrative and generally provide less elaborate accounts of human perception The misuse of sampling and weighting can completely undermine the accuracy, validity, and project ability of a quantitative research study. The research is often carried out in an unnatural, artificial environment, so that a level of control can be applied to the exercise. This level of control might not normally be in place in the real world, yielding laboratory results, as opposed to real world results

The internal validity changes due to history, while influences take place due to time outside of experimental treatment, including that of maturation when a person changes. In addition, preset answers will not necessarily reflect how people really feel about a subject and in some cases, might just be the closest match. Consideration has to also be given to scores that, over time, regress towards the mean. This inlcudes people who have certain characteristics that predispose them to have certain outcomes, as well as participants that leave or quit the study; outcomes are thus unknown. The development of standard questions by researchers can lead to 'structural' bias and false representation, where the data actually reflects the researcher’s view instead of the participating subject.

Communication between members of different groups has an effect on scores. Additionally, benefits may be unequal when only the experimental group receives the treatment. The control group's participants may feel devalued, compared to those in experimental groups. Moreover, participants may become familiar with outcome measures and remember responses for later testing. Instruments may also change between the pre and post test, which further impacts scores in the outcome. External validity would also change due to interaction of selection and treatment.

Researchers can neither generalise to individuals who do not have the characteristics of participants, nor can they generalise the results to past or future situations. A sample size has to be big enough to ensure the smallest worthwhile effect or relationship between variables is detected. More than 95% of the time, a value for the effect is found, which is numerically smaller than what was observed, if there was no effect at all in the population (in other words, the p value for the effect has to be less than 0.05). *Smallest worthwhile effect* means the smallest effect that would make a difference to the lives of research subjects or to the interpretation of whatever is being studied. Should there be too few subjects in the study and a statistically significant effect is obtained, most people regard the findings as publishable. However, should the effect not be significant, with a small sample size, most people regard it (erroneously) as unpublishable.

6.6 Future research on NM&MI

This research can be expanded by doing research on NM&MI, conducted for all chemical organisations in Kwa Zulu Natal. In addition, similar major research on NM&MI should then be done for all chemical organisations operating in South Africa. Research on NM&MI can also be done for other industries in Kwa Zulu Natal or South Africa. Similar research should be done using qualitative analysis and thereafter quantitative analysis should be done to verify validity. Global research should also be done on NM&MI in chemical industries. Thereafter global research should be done on NM&MI in all industries. Data from the Department of Labour should be used when researching safety across all industries. All the respondents should be screened properly and the questions should be correctly framed to reflect the survey. The sample techniques and the accuracy of the sampling process should be above question, so that the results are statically significant.

6.7 Conclusion

In summary, research has been done over a long period on safety, health and the environment at chemical companies but there are still many NM&MIs occurring. The key is for organisations to manage these incidents and keep all stakeholders safe. Literature reviewed shows, and is supported by this research, that the human element is by far the major contributor to unsafe incidents, therefore management interventions over safety, health and environmental approaches should be managed successfully to control unsafe incidents. Plant designs are also reviewed to incorporate global best practices and the call is for more automation and less human intervention. The fact is that chemical plants are here to stay but they must uphold safety, health and environmental approaches, support all the stakeholders and not cause damage to the environment and life.

In the final analysis, all these NM&MI inadvertently have a major impact on the sustainability of these organisations. It is therefore imperative that these organisations improve on the management of these NM&MI. The chemical organisations need to urgently use OM in aggressively managing the NM&MI.

In addition, this research contributed to new knowledge, by determining the impact of these NM&MI on the performance of key functional areas, as well as the calculation of the NM&MI costs; the development of the OM for improved management of NM&MI; the use of international and national benchmarks, resulting in an improved OM; the results of the comparison between the OM and the ESP of Oktem (2002:1); the results of the findings, and analysis of the NM&MI databases.

The main objective of this study has been achieved and it can be concluded that NM&MI have a major impact on the performance of the key functional areas of the chemical organisations operating in the South of Durban, KZN.

REFERENCE LIST

Abudayyeh, O., Fredericks, T. K., Butt, S. E., and Shaar, A. 2006. An investigation of management's commitment to construction safety International Journal of Project Management, [Online] Volume 24, Issue 2, February 2006, Pages 167-174. http://www.sciencedirect.com/science?_ob=ArticleListURL&_method=list&_ArticleListID=2075003143&_sort=r&_st=13&view=c&_acct=C000055460&_version=1&_urlVersion=0&_userid=1936639&md5=5a164dbfa505e33845752b54da71a0bc&searchtype=a. (Accessed 03 August 2012)

Accident Causation *Models and Theories* – Management. 2012. [Online]. Available at: www.hrdp-idrm.in › Key Concepts › IDRM Training Modules (Accessed 27January 2012)

Aaker, D., Kumar, V. and Day, G. 2007. Marketing Research. 9th Edition. New York: Wiley.

Adams, G., McQueen, G. and Seawright, K. 1999. Revisiting the price impact of quality awards. Omega, 27 (1999), pp. 595–604. [Online] Available at: http://www.sciencedirect.com/science/article/pii/S0305048399000250. (Accessed 18 February 2014).

Agnihotram, R. V. 2005. An overview of occupational health research in India. Indian Journal of Occupational and Environmental Medicine, 9 (1) (2005), pp. 10–14. [Online] Available at: http://www.ijoem.com/article.asp? Issn =0019- 5278;year=2005;volume=9;issue=1; spage=10;epage=14; aulast =Agnihotram. (Accessed 11 February 2014)

Anderson, D. R., Sweeney, D. J. and Williams, T. A. 2005. Statistics for Business and Economics. Ohio: Thompson- South-Western.

Al-Mutair, E., Suardin, J., Mannan, M. and El-Halwagi, M. 2008. An optimization approach to integration of inherently safer design and process scheduling. *Journal of loss prevention in the process industries* [Online], Vol.21: 543-549. Available at: WWW: (http://www.sciencedirect.com).
(Accessed 02 February 2010).

Andrews, T., 2012. *What is Social Constructivism. University College Cork* [Online] Current issue, Issue 1, June 2012, Volume 11 .Available at: http://groundedtheoryreview.com/2012/06/01/what-is-social-constructionism/
(Accessed 25 August 2014).

Angela. 2008. *Workplace Safety.* [Online] Available at: WWW: http://www. workplace safety (thing) @Everything2_com.htm (Accessed 10 January 2010).

Armstrong, M. 2009. Armstrong's Handbook of Management and Leadership. 2nd Edition. London: Kogan Page Limited.

Bacon, T. R. 2006. What People Want - A Manager's Guide to Building Relationships that Work. 1st Edition. CA-USA: Davies-Black Publishing.

Bartunek, J. 1981. Why did you do that? Attribution theory in organisations, Business Horizons, Volume 24, Issue 5, pages 66-71.

Belke, J. 2009. *Recurring causes of recent chemical accidents*. [Online] Available at: WWW: http://www.plant-maintenance.com (Accessed 19 December 2011).

Belzer, R. B., 2001. "Getting beyond 'grin and bear it' in the practice of risk management" Reliability Engineering & System Safety, Volume 72, Issue 2, Pages 137-148. [Online] Available at: http://www.sciencedirect.com/ science/article/pii/ S0951832001000151. (Accessed 26 February 2014).

Beaumie, K. 2001. Social Constructivism. The University of Georgia [Online] Available at: http://epltt.coe.uga.edu/index.php?title= Social_Constructivism. (Accessed 24 August 2014).

Biech, E. (Editor) 2010. The American Society for Training & Development. 1st Edition. United States of America: Sheridian Books, Inc.

Boden, L. I., Biddle, E. A. and Spieler, E. A. 2001. "Social and Economic Impacts of Worker Illness and injury: Current and Future Directions for Research", American Journal of Industrial Medicine, Volume 40, Issue 4, Pages 398-402. [Online] Available at: http://www.ncbi.nlm.nih.gov/ pubmed/11598990. (Accessed 07 March 2014).

Bowles, M. 2004. *The institute for working futures*. [Online] Available at: www.marcbowles.com/courses/adv_dip/.../amc5_ch6_one1.htm. (Accessed 11 June 2011).

Brown, K. A. 1996. "Workplace Safety: A call for research", Journal of Operations Management, Volume 14, Issue 2, Pages 157-171. [Online] Available at: http://www.sciencedirect.com/science/article/pii/ 0272696395000429. (Accessed 26 February 2014).

Canadian Centre for Occupational Health & Safety. 2014. [Online] Available at: http://www.ccohs.ca/oshanswers/psychosocial/aging_workers.htmlWhy should a workplace look at issues concerning aging workers? (Accessed 16 August 2014).

Carder, B. and Ragan, P. W. 2003. A survey-based system for safety measurement and improvement. [Online] Journal Safety Research. 2003;34 (2):157-65 Available at: http://www.ncbi.nlm.nih.gov/pubmed/12737954 (Accessed 22 July 2010).

Carter, N. and Menckel, E. 1990. Group routines for improving accident prevention activities and accident statistics. [Online] *International Journal of Industrial Ergonomics*, 5 2 (1990), pp. 125–132. Available at: http://www.sciencedirect.com/science/article/pii/016981419090003K (Accessed 18 June 2010).

CCPS Process Safety Metrics American Petroleum Institute, ANSI/API *Recommended Practice 754, Process Safety Performance Indicators for the Refining and Petrochemical Industries*, First Edition, Washington D.C., 2010. [Online]. Available at: www.aiche.org/.../CCPS/Metrics/CCPS_ Process Safety_Metrics_201_. (Accessed 18 May 2011).

CCPS, 2010. Guidelines for Risk Based Process Safety. New Jersey: John Wiley & Sons, Inc.

Chang, J. and Lin, C. 2006. *A study of storage tank accidents. Journal of loss prevention in the process industries* [Online], Vol.19: 51-59. Available at: http://www.sciencedirect.com. (Accessed 16 February 2010).

Chen, K. C. J. and Zorigt, D. 2013. Managing occupational health and safety in the mining industry. Journal of Business Research. Volume 66, Issue 11, November 2013, Pages 2321–2331. [Online] available at: *www.sciencedirect.com/science/article/pii/S014829631200121X* (Accessed 05 February 2014)

Columbia Electronic Encyclopedia® Copyright © 2013, Columbia University Press. Licensed from Columbia University Press. All rights reserved. [Online] Available at: http://encyclopedia2.thefreedictionary.com/Chemical+Industry. (Accessed 25 February 2014).

Costa, M. M., Choi, T. Y., Martínez, J. A. and Angle, R. 2009. ISO 9000/1994, ISO 9001/2000 and TQM: The performance debate revisited. *Journal of*

Operations Management, Volume 27, Issue 6, Pages 495-511. [Online] Available at: http://www.sciencedirect.com/science/article/pii/ S0272696309000321. (Accessed 18 February 2014).

Cox, R. A. 1982. Improving Risk Assessment Methods for Process Plant. Journal of Hazardous Materials, Volume 6, Issue 3, Pages 249-260. [Online] Available at: http://www.sciencedirect.com/science/article/pii/ 0304389482800137. (Accessed 07 March 2014).

Cozzani, V., Gubinelli, G. and Antonioni, G. 2005. The assessment of risk caused by domino effect in quantitative area risk analysis. J. Hazard. Mater. 127 (1-3) (2005), pp. 14–30 [Online] available at:| http://www.sciencedirect.com/science/article/pii/B9780444506993500409. (Accessed 14 February 2014).

Cozzani, V., Gubinelli, and Salzano, E. 2006.Escalation thresholds in the assessment of domino accidental events. J. Hazard. Mater., 129 (1–3) (2006), pp. 1–21. [Online] available at: http://www.sciencedirect.com/science/ article/pii/ S0304389405004693. (Accessed 14 February 2014).

David, M., DeJoy, D. M. 2005. Behaviour change versus culture change: Divergent approaches to managing workplace safety. Safety Science. Volume 43, Issue 2, February 2005, Pages 105–129. [Online] Available at: http://www.sciencedirect.com/science/article/pii/S092575350500007X. (Accessed 13 September 2012)

De Joy, D 1994. Managing safety in the workplace: An attribution theory analysis and model. Journal of safety research, volume 25, Issue 1, pages 3-17.

De Joy, D 1985. Attributional processes and hazard control management in industry. Journal of safety research, volume 16, Issue 2, pages 61-71.

De Koster, R., Stam, D. and Balk, B. 2011. “Accidents happen: The influence of safety-specific transformational leadership, safety consciousness, and hazard reducing systems on warehouse accidents”, Journal of Operations Management, Volume 29, Issue 7-8, Pages 753-765. [Online] Available at: 6http://www.sciencedirect.com/science/article/pii/S0272696311000921. (Accessed 26 February 2014).

DGFASLI, (2006) Directorate General Factory Advice Service & Labour Institute. Ministry of Labour and Employment, Government of India. Standard Reference Note. [Online] Available at: http://www.dgfasli.nic.in/ std_ref/std_ref06.pdf. (Accessed 25 February 2014).

Donald, I. and Canter, D. 1994. Employee attitudes and safety in the chemical industry [Online] *Journal of Loss Prevention in the Process Industries*, *Volume 7, Issue 3*, *1994*, *Pages 203-208 Available at:* http://www. science direct.com (Accessed 01 August 2010).

Dov, Z. 2008. “Safety climate and beyond: A multi-level multi-climate framework”, Safety Science, Volume 46, Issue 3, Pages 376-387. [Online] Available at: http://www.sciencedirect.com/science/article/pii/ S092575350700032X. (Accessed 27 February 2014).

Edwards, M. and Jabs, L. B. 2009. When safety culture backfires: Unintended consequences of half-shared governance in a high tech workplace. The Social Science Journal. Volume 46, Issue 4, December 2009, Pages 707–723. [Online] Available at: http://www.sciencedirect.com/science/ article/pii/S0362331909000597. (Accessed 12 September 2012)

Eigenhuis, B. 2010. Sheq Africa Safety Journal- Minor incidents flag process safety [Online] Available at: http//www.sheqafrica.com/minor-incidents-process-safety (Accessed 23 March 2101).

Einarsson, S. and Brynjarsson, B. 2008. *Improving human factors, incident and accident reporting and safety management systems in the Seveso industry. Journal of loss prevention in the process industries* [Online], Vol. 21: 550-554. Available at: http://www.sciencedirect.com (Accessed 23 November 2010).

Erickson, J. 2006. Survey Uncovering Employees Views about Safety. *Occupational Hazards Journal*: 4 [Online]. Available at: http://www. occupationalhazards.com. (Accessed 05 March 2010).

European Commission Women and Gender In Research 2014. [Online] Available at: http://ec.europa.eu/research/science-society/index.cfm? fuseaction=public. topic&id=1283. (Accessed 16 August 2014).

Fagotto, E. and Fung, A. 2003. Improving workplace hazard communication. Issues in Science and Technology [Issues Sci. Technol.]. Vol. 19, no. 2, pp. 63-68. 2002 - 2003. [Online] Available at: http://search.proquest.com.dutlib. dut.ac.za:2048/docview/195919391.(Accessed : 16 April 2014)

Fewtrell, P. 1998. A Review of high-cost chemical/petrochemical accidents since. [Online] Available at: IchemE Loss Prevention Bulletin no 140. www.hse.gov.uk/comah/ lossprev.pdf (Accessed 02 April 2012).

Fivizzani, K. P. 2005. The evolution of chemical safety training. Chemical Health and Safety Journal. Volume 12, Issue 6, November–December 2005, Pages 11–15 [Online] Available at: http://www.sciencedirect.com/science/ article/pii/S1074909805001206. (Accessed 10 September 2012).

Forbes. 2014. The world's 25 biggest oil companies. [Online] Available at: http://www.forbes.com/pictures/mef45glfe/12-sonatrach-2-7-million-barrels-per-day-3/**.** (Accessed 25 February 2014).

Frick, K. 2011. Worker influence on voluntary OHS management systems – A review of its ends and means Original Research Article. *Safety Science*, *Volume 49, Issue 7*, *August 2011*, *Pages 974-987.* [Online] Available at: http://www.sciencedirect.com.dutlib.dut.ac.za: 2048/science?_ob= ArticleListURL&_method=list&_ArticleListID=2113314050&view=c&_acct=C000055460&_version=1&_urlVersion=0&_userid=1936639&md5=3b8c072dd43cd309905cd99c0acf33de&searchtype=a. (Accessed 16 September 2012).

Galbraith, D. D and Fouch, S. E. 2007. Principles of Adult Learning: Application to safety training Professional Safety 52. 9 (Sep 2007): 35-40. [Online] Available at: http://search.proquest.com.dutlib.dut.ac.za:2048/ docview/200415451/abstract. (Accessed 13 September 2012)

Gold, R. and Casselman, B. 2010. BP decision set stage for disaster. *Wall Street Journal* [Online], page1. Available at: http://online.wsj. com/article/SB10001424052748704026204575266560930780190.html (Accessed 30 April 2010).

Granerud, R. L. and Rocha, R. S. 2011. Organisational learning and continuous improvement of health and safety in certified manufacturers. Occupational Health and Safety Management, issues and challenges. Safety Science. Volume 49, Issue 7, August 2011, Pages 1030–1039. [Online] Available at: http://www.sciencedirect.com/science/article/pii/S0925753511000178. (Accessed 12 September 2012).

Grasa, G., Navarro, V., Rubio, O., Peña, JA. and Santamaria, J. 2002. Comparative study of risk perception in small and large communities where chemical industries are present *Journal of Loss Prevention in the Process Industries*, Volume 15, Issue 6, November 2002, Pages 525-530. [Online] Available at: http://www.science direct.com/science?_ob= ArticleList URL&_ method=list&_ArticleListID=1827282498&_sort=r&_st=13&view=c& _acct=C000055460&_version=1&_urlVersion=0& userid=3077866&md5= 300cf11 c1f99cea254d0b36ac300f 40&searchtype=a. (Accessed 29 September 2011).

Graziano, A. M., and Raulin, M. L. 2000. Research Methods: A Process of Inquiry, 4th Edition. Boston: Allyn and Bacon.

Groeneweg, J., Lanconi, G. E. and Metaal, N., 2002. Motivating for Safety, Leading by Example: Moving from Compliance to Competence. *Profshore Management Motivation Module, Stavanger* [Online]. vol. 47 pages 786-793. Available at: http://www.sciencedirect.com/science/article/pii/S09257535 08000325. (Accessed 11 April 2011).

Ground Work - the Southern African branch of Friends of the Earth International. 2012 Newsletter [Online] Available at http://www.groundwork. org.za/FOESA.html. (Accessed 17 February 2014).

Guldenmund, F. W. 2010. "(Mis)understanding Safety Culture and its Relationship to Safety Management", Risk Analysis, Volume 30, Issue 10, Pages 1466-1480. [Online] Available at: http://www.ncbi.nlm.nih.gov/pubmed /20626685. (Accessed 26 February 2014).

Hale, A. R., Heming, B. H. J., Smit, K., Rodenburg, F. G., Leeuwen, N. D. 1998. Evaluating safety in the management of maintenance activities in thechemical process industry Safety Science, Volume 28, Issue 1, February 1998, Pages 21-44. [Online] Available at: http://www.sciencedirect.

com/science?_ob=ArticleListURL&_method=list&_ArticleListID=1827282498&_sort=r&_st=13&view=c&_acct=C000055460&_version=1&_urlVersion=0&_userid=3077866&md5=300cf11c1f99cea254d0b636ac300f40&searchtype=In Press, Corrected Proof, (Accessed 22 June and 29 September 2011).

Health and Safety Executive UK (2008/09). Health and safety Statistics 2008/2009. [Online] Available at: http://www.hse.gov.uk/statistics/overall/hssh0809.pdf (Accessed 12 February 2014).

Health and Safety Executive UK (2010). The Incident Cost Calculator. [Online] Available at: http://www.hse.gov.uk/costs/costs_overview/costs_overview.asp. (Accessed 03 March 2012).

Hedlund, .F. H. 2013. Recorded fatal and permanently disabling injuries in South African manufacturing industry – Overview, analysis and reflection *Safety Science*. Volume 55, June 2013, Pages 149–159. [Online] Available at:http://www.sciencedirect.com/science/article/pii/S0925753513000118 (Accessed 16 February 2014).

Hedlund .F. H. 2011. The relationship between the implementation of voluntary Five-Star occupational health and safety management system and the incidence of fatal and permanently disabling injury. *Safety Science* Volume 63, March 2014, Pages 94–103. [Online] Available at: http://www.sciencedirect.com/science/article/pii/S0925753513002580. (Accessed 03 February 2014).

Hopkins, A. 2011. Risk-management and rule-compliance: Decision-making in hazardous industries. Safety Science Volume 49, Issue 2, February 2011, Pages 110–120. [Online] Available at: http://www.sciencedirect.com/science/article/pii/S092575351000202X. (Accessed 11 September 2012)

Hudson. P. 2007. Implementing a safety culture in a major multi-national [Online] *Safety Science*, *Volume 45, Issue 6*, *July 2007*, *Pages 697-722*. Available at: http://www.sciencedirect.com/science/article/pii/ S0925753507000227. (Accessed 29 August 2012)

ILO. 1993. ILO Convention concerning the Prevention of Major Industrial Accidents, 1993. 80th Session, 2nd June 1993. [Online] Available at: http://www.ilo.org/oshenc/part-vi/disasters-natural-and- technological/item/ 1237. (Accessed 18 February 2014).

IRIN. 2008. Humanitarian news & analysis. South Africa-Takes on big polluters (The South Durban Community Environmental Alliance) [Online] Available at: http://www.irinnews.org/report/80600/south-africa-community-takes-on-big-polluters. (Accessed 17 February 2014).

Israel, D. 2008. Data Analysis in Business Research. Thousand Oaks, California: Sage Publications Inc.

Jacobsson, A., Ek, A. and Akselsson, R. 2011. Method for evaluating learning from incidents using the idea of "level of learning" *Journal of Loss Prevention in the Process Industries*, Volume 24, Issue 4, July 2011, Pages 333-343. [Online] Available at: http://www.sciencedirect.com/ science? (Accessed 29 September 2011).

Jones, S., Kirchsteiger, C., Bjerke, W. 1999. The importance of near miss reporting to further improve safety performance. *Journal of Loss Prevention in the Process Industries*, [Online] Volume 12, Issue 1, January 1999, Pages 59-67. Available at: http://www.sciencedirect. Com. (Accessed 29 September 2011).

Jones, J. M. and Preziosi, R. C. 2009. The Impact Of Demographic Variables On The Perceptions Of A Behavioural Safety Process In Manufacturing.

Journal of Business & Economics Research 7. 12 (Dec 2009): 41-60. [Online] Available at: http://search.proquest.com.dutlib.dut.ac.za:2048/docview/194913344. (Accessed 13 September 2012).

Khan, F. and Abbasi, S. 1999. Risk assessment in the chemical industries advanced techniques. *Journal of loss prevention in the process industries* [Online], Vol.45: 769-789. Available at: http://www.sciencedirect.com (Accessed 24 January 2010).

Kim, D., Kim, J. and Moon, L. 2006. Integration of accident scenario generation and multi-objective optimization for safety-cost decision making in chemical processes. *Journal of loss prevention in the process industries* [Online], Vol.19: 705-713. Available at: http://www.sciencedirect.com. (Accessed 10 January 2010).

Kletz, T. 1999. *What Went Wrong?* Woburn: Butterworth-Heinemann.

Knegtering, B. and Pasman, H. 2009. Safety of the process industries in the 21st century: A changing need of process safety management for a changing industry. *Journal of loss prevention in the process industry* [Online].vol. 22 pages 162-168. Available at: http://www.sciencedirect.com/science/article/pii/ S0950423008001484 (Accessed 02 February 2009).

Kreitz, P. A. 2008. Best Practices for Managing Organisational Diversity. The Journal of Academic Librarianship, Volume 34, Issue 2, March 2008, Pages101-120. [Online] Available at: http://www.sciencedirect.com/science?_ob=ArticleListURL&method=list&_ArticleListID=2074931411&_sort=r&_st=13&view=c&_acct=C000055460&_version=1&_urlVersion=0&_userid=1936639&md5=27196c24978c92735d42f5429ab333c2&searchtype=a *(*Accessed 03 August 2012).

KZN Top Business Portfolio. 2014. [Online] Available at:

http://kzntopbusiness.co.za/site/manufacturing. (Accessed 05 March 2014).

Lancaster, K. 1996. A New Approach to Consumer Theory. Journal of Political Economy. Issue 74, Pages 132-157. [Online] Available at: https://www.iei.liu.se/nek/730g83/artiklar/1.328858/Lancaster2.pdf. (Accessed 01 March 2014).

Lavicoli, S., Rondinone, B., Marinaccio, A. and Fingerhut, M. 2006. “Research Priorities in Occupational Safety and Health: A review”. *Industrial Health*, Volume 44, Pages 169-178. [Online] Available at: http://202.241.32.9/en/indu_hel/pdf/indhealth_44_1_169.pdf. (Accessed 28 February 2014).

Leedy, P. and Ormrod, J. 2005. Practical Research: Planning and Design. 8th Edition. Upper Saddle River: Merrill Prentice Hall.

Lewis, P. A., Saunders, M. and Thornhill, A. 2007. Research Methods for Business Students. 4th Edition. New York: Prentice Hall.

Lindberg, A. K., Hansson, S. O. and Rollenhagen, C. 2010. Learning from accidents – What more do we need to know? *Safety Science*, [Online] *Volume 48, Issue 6*, *July 2010*, *Pages 714-721* Available at: http://www.sciencedirect.com/science?_ob=ArticleList URL&_method=list& _articleListID=1827282498&_sort=r&_st=13&view= c&_acct=C000055460& _version=1&_urlVersion=0&_userid=3077866& md5=300cf11c1f99cea254 d0b 636ac 300f40&searchtype=a (Accessed 29 September 2011).

Long, T. 2008. Dec. 3, 1984: *Bhopal*, 'Worst Industrial *Accident* in *History*' [Online] Available at: www.wired.com/science/discoveries/news/2008/12/ day in tech _1203 (Accessed 03 January 2012)

Luthans, F. 2008. *Organisational Behaviours*. Singapore: McGraw-Hill.

Mannan, M., West, H. and Berwanger, P. 2007. Lessons learned from recent incidents: Facility siting, atmospheric venting, and operator information systems. *Journal of loss prevention in the process industries*, Vol.20: 6-21;644-650. [Online] Available at: http://www.sciencedirect.com. (Accessed 06 January 2010).

Safety and Environmental Protection, http://www.sciencedirect.com/science. (Accessed 03 August 2012)

McDaniels, T., Kamlet, M. and Fisher, G. 1992. “Risk Perception and the value of Safety” Risk Analysis, Volume 12, Issue 4, Pages 195- 503. [online] Available at: http://www.ncbi.nlm.nih.gov/pubmed/1480797. Accessed on 01/03/2014.

Media.nbcdfw.com.[Online] Available at: https://www.google.co.za/search?tbm=isch&q=photos+of+texas+disaster&hl=en&safe=active#hl=en&q=photos+of+deepwater+horizon+disaster&safe=active&tbm=isch&facrc=_&imgdii (Accessed 05 March 2014).

Mengolini, A. and Debarberis, L. (2007). “Safety culture enhancement through the implementation of IAEA guidelines”, Reliability Engineering & System Safety, Volume 92, Issue 4, Pages 520-529. [Online] Available at: http://www.sciencedirect.com/science/article/pii/S0951832006000275. Accessed on 25/02/2014.

Michael, J. H., Guo, Z. G., Wiedenbeck, J. K. and Ray, C. D. 2006. Production supervisor impacts on subordinates' safety outcomes: An investigation of leader-member exchange and safety communication. Journal of Safety Research Volume 37, Issue 5, 2006, Pages 469–477. [Online] Available at: http://www.sciencedirect.com.dutlib.dut.ac.za:2048/science/article/pii/S0022437506001010. (Accessed 09 September 2012)

Nivolianitou, Z., Konstandinidou, M., Kiranoudis, C. and Markatos, N. 2006. Development of a database for accidents and incidents in the Greek petrochemical industry. *Journal of loss prevention in the process industries* [Online], Vol.19: 630-638. Available at: http://www.sciencedirect.com. (Accessed 03 December 2010).

Nouri, J., Azadeh, A. and Fam, I. 2008. The evaluation of safety behaviors in a gas treatment company in Iran. *Journal of loss prevention in the process industries* [Online], Vol.21: 319-325. Available at: http://www.science direct .com. (Accessed 18 January 2010).

O'Connor, P., Buttrey, S., O'Dea, A. and Kennedy, Q. 2011. Identifying and addressing the limitations of safety climate surveys. *Journal of Safety Research*. [Online] Available at: http://www.science direct .com (Accessed 10 October 2011)

O'Dea, A. and Flin, R. 2003. The role of managerial leadership in determining workplace safety outcomes, HSE Books, Suffolk (2003). [Online] Available at: www.abdn.ac.uk/.../The_role_of_managerial_leadership _in_ determi_HSE. Health & Safety Executive. (Accessed 25 October 2011)

Oktem, U. G. 2002. Near-Miss: A Tool for Integrated Safety, Health, Environmental and Security Management. [Online] Available at: www.opim.wharton.upenn.edu/risk/ downloads /03-03-UO.pdf Similar Block all opim.wharton.upenn.edu results You +1'd this publicly. File Format: PDF/Adobe Acrobat - Quick View by - Cited by 4 - Related articles (Accessed 04 January 2012)

Olson-Buchanan, J. B., and Boswell, W. R. 2009. 1st Edition. United Kingdom: Wiley-Blackwell.

Phimister, R., Oktem, U., Kleindorfer, P. and Kunreuther, H. 2003. Near-Miss Incident Management in the Chemical Process Industry, *Risk Analysis*, Vol.

No3 2003 445-459. [Online] Available at: WWW.opim.wharton. upenn.edu/risk/ downloads/ 03-01-JP.pdf. (Accessed 27 September 2011).

Pinto, A., Ribeiro, R. and Nunes, I. 2013. “Ensuring the Quality of Occupational Safety Risk Assessment”, *Risk Analysis*, Volume 33, Issue 3, Pages 409-419. [Online] Available at: http://www.ncbi.nlm.nih.gov/ pubmed/23020531. (Accessed 07 March 2014).

Prem, K. P., Dedy, Ng M. and Mannan, S. 2010. Harnessing database resources for understanding the profile of chemical process industry incidents. Journal of Loss Prevention in the Process Industries. [Online] Volume 23, Issue 4, July 2010, Pages 549-560 Available at: http://www.sciencedirect.com/science/article/ pii/S0950423010000446#sec1. (Accessed 18 February 2010)

Quinlan, M. and Bohie, P. 1991.Managing occupational health and safety in Australia: A multidisciplinary approach, Macmillan Press, Australia (1991), pp. 64–66

Reason, J. 1990. *Human error*. Cambridge University Press (UK), 1992. Accident Causation Model, *Journal Aviation Knowledge*. page1 [Online]. Available at: WWW.aviationknowledge.wikidot.com/aviation:accident-causation-model.(Accessed 30 April 2010).

Reiman, T. and Rollenhagen, C. 2011. “Human Organisational biases affecting the management of safety” *Reliability Engineering & Systems Safety*, Volume 96, Issue 10, Pages 1263-1274. [Online] Available at: http://www.researchgate.net/publication/236597701_Human_and_organisati onal_biases_affecting_the_management_of_safety. (Accessed 26 February 2014).

Reniers, G., Ale, B., Dullaert, W. and Foubert, B. 2006. Decision support systems for major accident prevention in the chemical process industry: A developers' survey. *Journal of loss prevention in the process industries*, Vol.19: 604-620. [Online] Available at: http://www.sciencedirect.com (Accessed 15 February 2010).

Responsible Care. 2005. [Online] page1, Available at: http://www. americanchemistry.com/s_responsiblecare/sec_members.asp?CID=1300&DID=4843- (Accessed 25 October 2010).

Vavra, B. 2007. It starts with safety. Plant Engineering 61. 10 (Oct 2007): 33-43. [Online] Available at: http://search.proquest.com.dutlib.dut.ac.za:2048/ docview/221078407. (Accessed 11 September 2012)

Sample safety survey-risk control online-2014.[Online] Available at http://www.riskcontrolonline.com/.../sample safety survey. (Accessed on 20/02/2015)

Sampson, B. 2009. Safety First. Professional Engineering*; Jul 8, 2009; 22,* 12; Pro Quest Central.[Online] Available at: http://search.proquest.com. dutlib.dut. ac.za:2048/docview/218377731. (Accessed 11 September 2012)

Sandberg, J. and Targama, A. 2007. Managing Understanding in Organisations. London: SAGE Publications Ltd

Santos, J. R. A. 1999. Cronbach's Alpha: A Tool for Assessing the Reliability of Scales. *Journal of Extensions*.37(2).

Schmidt, L. D. 2005. The Engineering of Chemical Reactions.2nd Edition. New York: Oxford University Press.

Sekaran, U. 2003. Research Methods for Business. New York: Wiley.

Sepeda, A. L. 2012. Understanding Process Safety Management. *Chemical Engineering Progress*. Volume 106. 8 (Aug 2010): 26-33. [Online] Available at:http://search.proquest.com.dutlib.dut.ac.za:2048/docview/745968660. (Accessed 13 September 2012)

Shore, L. M., Chung-Herrera, B.G., Dean, M. A., Ehrhart, K. H., Jung, D. I., Randel, A.E., and Singh, G. 2009. *Human Resource Management Review*., Diversity in organisations: Where are we now and where are we going? Volume 19, Issue 2, June 2009, Pages 117–133. [Online] Available at: http://www.sciencedirect.com/science/article/pii/S1053482208000855. (Accessed 04 September 2012)

Sorensen, J. (2002). "Safety Culture: a survey of the state-of–the-art", *Reliability Engineering & System Safety*, Volume 76, Issue 2, Pages 189-204. [Online] Available at: http://www.sciencedirect.com/science/article/pii/ S0951832002000054. (Accessed 25 February 2014).

Sparrow, T. and Knight, A. 2009. Applied EI, The Importance of Attitudes in Developing Emotional Intelligence. West Sussex, England: John Wiley & Sons Ltd.

Stuart, I., Mc Cutcheon, D., Handfield, R., Mc Lachlin, R. and Samson, D. 2002. Effective case research in operations management: a process perspective, *Journal of Operations Management*. Volume 20, pages 419-433.

Swuste, P., Albrechtsen, E. and Hovden, J. 2012. Safety management in different high-risk domains – All the same? *Safety Science* Volume 50, Issue 10, December 2012, Pages 1983–1992. [Online] Available at: http://www.sciencedirect.com/science/article/pii/ S0925753511001706. (Accessed 17 February 2014).

Teo, E. and Ling, F. 2005. Developing a model to measure the effectiveness of safety management systems of construction sites. Department of Building, School of Design and Environment, National University of Singapore, 4 Architecture Drive, Singapore 117566, Singapore. Volume 41, Issue 11, Pages 1584-1592 [Online] Available at: WWW. linkinghub.elsevier. com/retrieve/pii/ S0360132305002362- (Accessed 05 October 2011).

Tripod Beta - Tripod Foundation. 2008. [Online] Available at: www.tripod foundation.com/.../Tripod%20Beta_User%20guide_02a (Accessed 25 January 2012)

Terziovski, M., Samson, D., Dow, D. 1997. The business value of quality management systems certification. Evidence from Australia and New Zealand. *Journal of Operations Management*, 15 (1997), pp. 1–18. [Online] Available at: http://www.sciencedirect.com/science/article/pii/ S0272696396001039. (Accessed 18 February 2014).

U.S. Department of Labor, Occupational Safety and Health Administration 2009 OSHA 3360 Reflections on OSHA's History [Online] Available at: www.osha.gov/history/OSHA_HISTORY_3360s.pdf (Accessed 28 September 2011).

Venema, A., Nijman, S., Stam, C., Ybema, J. F. and Roozeboom, M. B. 2009 Diverse Cultures at work. [Online] Available at: *bookshop.europa.eu/.../TEWE13001ENN_002.pdf;...* EU Bookshop – Europa. (Accessed 05 March 2014).

Vinodkumar, M. N., and Bhasi, M. 2010. Safety management practices and safety behaviour: Assessing the mediating role of safety knowledge and motivation. *Accident Analysis & Prevention*. Volume 42, Issue 6, November 2010, Pages 2082–2093 [Online] Available at:

http://www.sciencedirect.com/science/article/pii/S0001457510001855. (Accessed 07 September 2012).

Voice of Russia. 2013. Timeline-of-major-chemical-disasters-worldwide. [Online] Available at: http://voiceofrussia.com/2013_04_18/Timeline-of-major-chemical-disasters-worldwide-289/.18 April 2013, 17:12. (Accessed 20 January 2014).

Voss, C. A., Tsikriktsis, N. and Frohlich, M.. 2002. Case research in operations management. *International Journal of Operations & Production management* Volume 22, Page 195-219.

Wai-Chee. L. 2005. Incident Classification and Reporting, module 30, procedure 1621 [Online] Available at: SHELL Brunei Sendirian Berhad: https://www.bsp.com.bn/main/hse/hse_documents/procedures/BSP-02.01.05-Procedure-1621%20-Incident Classification and Reporting (Mod 30,Rev.4.1).pdf

Welman, C., Kruger, S. and Mitchell, B. 2005. Research Methodology. Cape Town, South Africa: Oxford University Press.

Windbichler, C. 2005. Cheers and Boos for Employee Involvement: Co-Determination as Corporate Governance Conundrum. European Business Organisation. Law Review 6. 4 (Dec 2005): 507-537. [Online] Available at: http://search.proquest.com.dutlib.dut.ac.za:2048/docview/216270181. (Accessed 13 December 2012)

Woods, D. 2006. Successful Trouble Shooting for Process Engineers. Weinheim: Wiley.

Wu, T. C., Chang, S. H., Shu, C. M., Chen, C. T., and Wang, C. P. 2011. Safety leadership and safety performance in petrochemical industries: The mediating role of safety climate. *Journal of Loss Prevention in the Process*

Industries. Volume 24, Issue 6, November 2011, Pages 716–721. [Online] Available at: http://www.sciencedirect.com (Accessed 07 September 2012).

Yin, R. K. 2009. Case Study Research Design and Methods. Thousand Oaks, California: Sage Publications.

Zhang, X. and Chen, C. 2013. Mechanism analysis and risk assessment of escalation scenario in chemical industry zones. *Process Safety and Environmental Protection*. Volume 91, Issues 1–2, January–March 2013, Pages 79–85. [Online] Available at: http://www.sciencedirect.com/science/article/pii/ S0957582012000213. (Accessed 14 February 2014).

Zhong, M., Liu, T., Deng, Y., Shi, Y., Fu, T. and Hu, X. 2006. Safety evaluation: Important safeguard of work safety for enterprises in China. *Journal of loss prevention in the process industries* [Online], Vol.19: 762-768. Available at: http://www.sciencedirect.com. (Accessed 15 January 2010).

Zwetsloot, G., Gort, J., Steijger, N. and Moonen, C. 2006. Management of change: Lessons learned from staff reductions in the chemical process industry *Journal of loss prevention in the process industries* [Online], Vol.45: 769-789. Available at: http://www.sciencedirect.com. (Accessed 24 January 2010).

Zwi, A., Fonn, S. and Steinberg, M. 1988. Occupational health and safety in South Africa: The perspectives of capital, state and unions. *Social Science & Medicine*. Volume 27, Issue 7, 1988, Pages 691–702. . [Online] Available at: http://www.sciencedirect.com/science/article/pii/0277953687903297. (Accessed 17 February 2014).

LIST OF ACRONYMS

ACC	- American Chemistry Council
AIChE	- American Institute of Chemical Engineers
AFE	- Annual financial expenses
AN	- Ammonium Nitrate
ANSI	- American National Standards Institute
API	- American Petroleum Institute
BRF	- Basic risk factors
CCPS	- Centre for Chemical Process Safety
CMMS	- Computerized maintenance management system
CSB	- Chemical Safety and hazard investigation Board
DCS	- Distributed control system
ESP	- Eight Step Process
FM	- Functional Methodology
GAS	- General accident scenario
GMR	- General machinery regulations
ISO	- International Standards Organisation
MHIR	- Major hazardous installation regulations
MD	- Managing Director
MF	- Modified framework
MOC	- Management of change
MTL	- Maximum Tolerable Level
NCR	- Non Conformance System
NEMA	- National Environmental Management Act
NMR	- Near miss rate
NMTER	- Near miss total event rate
NM&MIR	- Near miss and minor incident rate
OM	- Organisational Methodology
OSHAct	- Occupational Safety and Health Act
PFD	- Process flow diagrams
PPE	- Personal protective equipment

PSA	- Process safety advisor
PSMS	- Process safety management systems
PSTIR	- Process safety total incident rate
Q	- Questions
SACDA	- Supervisory control and data acquisition alarm system
SCM	- Swiss cheese model
SHE	- Safety, health and environment
SM	- Strategic Methodology
SMS	- Safety management systems
SRS	- Severity rating system
TM	- Tactical Methodology
TRIR	- Total recordable incident rate
UNDGL	- United Nations dangerous goods listing

GLOSSARY

Accident - An unplanned or unintended but sometimes predictable event leading to injury, in traffic, industry, or a domestic setting, or such an event developing in the course of a disease. (http://www.definition-f.net/advanced - word-searches.aspx?q=environment&match =starts&lang=en)

Environment - surroundings, setting, conditions, situation, medium, scene, circumstances, territory, background, atmosphere, context, habitat, domain, milieu, locale, habitat, home, surroundings, territory, terrain, locality, natural home the maintenance of a safe environment for marine mammals natural world, world, nature, creation, living world persuading people to respect the environment. (http://www.definition-of.net/advanced-word-searches.aspx?q=environment&match=starts&lang=en).

Health - a feeling of well-being, and freedom from the risk of disease and untimely death. A state of dynamic balance in which an individual's or a group's capacity to cope with all the circumstances of living is at an optimal level. (http://www.definition-of.net/advanced-word-searches.aspx?q=health&match=starts&lang=en)

"Lagging" Metrics – a retrospective set of metrics based on incidents that meet the threshold of severity that should be reported as part of the industry-wide process safety metric. Source: CCPS (2010)

"Leading" Metrics – a forward looking set of metrics which indicate the performance of the key work processes, operating discipline, or layers of protection that prevent incidents (CCPS, 2010).

Management - The collective body of those who manage or direct any enterprise or interest; the board of managers. (http://thinkexist.com/ dictionary/ meaning/management/)

Minor Incident - The definition of a minor incident for the purposes of this research is any unforeseen event or occurrence, which results in only minor injury or property damage. A single minor incident will be anything from low to moderate in terms of risk (Wilson and Corlett, 2005).

"Near Miss" and other internal Lagging Metrics – the description of less severe incidents (i.e., below the threshold for inclusion in the industry lagging metric), or unsafe conditions which activated one or more layers of protection. Although these events are actual events (i.e., a "lagging" metric), they are generally considered to be a good indicator of conditions which could ultimately lead to a more severe incident. (CCPS, 2010).

Near-miss total event rate (NMTER)
The NMTER is a complement to the PSTIR (process safety total incident rate) that will help to identify those incidents that had the potential to become process safety incidents. The calculation is all the near misses for the year multiplied by 200,000hours as a standard, divided by the total employee and contractor hours including overtime worked for that year (CCPS, 2010).

Safety -The condition or state of being safe; freedom from danger or hazard; exemption from hurt, injury, or loss. (http://ardictionary.com/ Safety/308)

Tripod - Tripod is an approach to safety aimed at analysing the underlying problems that lead to incidents.

APPENDICES

Appendix A: Covering letter for the research questionnaire:

Dear Respondent

RESEARCH QUESTIONNAIRE ON ALL MINOR INCIDENTS TO DATE

I am currently conducting research for my Doctoral Degree in Technology in management studies at the Durban Institute of Technology. In terms of the programme, a research project needs to be conducted.

I have chosen to research the impact and the causes of minor incidents on the performance of your organisation so that management can use the results in minimizing the incidents. Your participation in the study will take about 20 minutes and will involve completing a questionnaire with 30 questions.

I have listed all the likely variables that could have contributed to the minor incidents and would like you to carefully consider the incidents and then select a number from 1 to 5 in section A and select Yes or No in section B. Place a cross (X) in the box selected.

All of your answers will be kept confidential and anonymous. Your participation is voluntary. Should you have any questions about this study, please feel free to contact me.

Thank you in advance for your co-operation.

Sincerely

D.R.T. Nayager

Appendix B: QUESTIONNAIRE

Please tick the appropriate box below in questions 1 to 7:

1. Gender:

Male	Female

2. Race Group:

Black	Indian	White	Coloured

3. Age:

Under 25	26 – 30	31 – 35	36 – 40	41 - 45
46 – 50	51 – 55	56 – 60	61 – 65	66 and older

4. Department:

Operations	Customer Services	Maintenance	Compliance & Safety	Human Resources
IT	Finance	Admin	Training	Other Detail:_____________

5. Position:

Manager	Supervisor	Operator	Clerk	Contractor	Other Detail:_____________

6. Highest Level of Education:

Primary School	Grades 8 – 11	Grade 12	Diploma	Degree

7. Years Service:

1 – 5	6 – 10	11 – 15	16 – 20
21 – 25	26 – 30	31 - 35	36 or more

Section A
Please indicate your level of agreement with the following statements by placing a cross (x) in the appropriate box. Please give careful thought before indicating your choice.

1- Strongly Disagree
2- Disagree
3- Neutral
4- Agree
5- Strongly Agree

Statement: THE ACTUAL CONTRIBUTORS TO MINOR INCIDENTS ARE:

ANSWERS	**1**	**2**	**3**	**4**	**5**
Management Commitment:					
1) In my workplace management usually acts immediately to correct safety					
2) Management usually acts decisively when a safety concern is raised					
3) Corrective action is taken when management is told about unsafe incidents					
4) In my workplace some superiors turn a blind eye to safety incidents					
5) In my workplace managers/supervisors show an interest in workers' safety					
6) Managers and supervisors express concern if safety procedures are not					
Communication					
7) My superior always informs me of current concerns and incidents					
Priority of Safety and Health					
8) Safety rules and procedures are carefully followed					
	1	2	3	4	5
9) I believe that safety issues are assigned a high priority					
10) I believe management considers the safety of employees of great importance					
11) I Believe management considers safety to be equally as important as production					
Safety Rules and Procedures					
12) I believe some health and safety rules and procedures are not really practical					
13) I believe some safety rules and procedures do not need to be followed to get					
Supportive Safety Culture					
14) A "no-blame" approach is used to persuade people, acting unsafely, that their					
Involvement					
15) I am sometimes involved in the on- going review of safety					

Work Environment					
16) Operational targets sometimes conflict with safety measures					
17) Sometimes conditions here hinder my ability to work safely					
18) Sometimes I feel I am not given enough time to get the job done safely					
Behaviour and Attitude					
19) Some employees display a poor attitude towards their job work					
Competence/ Training					
20) Safety reports are generally well written					
21) Contract labour are generally competent					
22) My safety training is adequate					
23) There are many inexperienced staff in our workplace					

Section B

Please indicate your agreement or disagreement with the following statements by placing a cross (x) in the appropriate box. Please give careful thought before indicating your choice.

Statement: THE ACTUAL CONTRIBUTORS TO MINOR INCIDENTS ARE:

	Yes	No
Management Commitment		
24) Generally management acts only <u>after</u> accidents have occurred		
Communication		
25) Management operates an open door policy on safety		
26) I receive praise for working safely		
27) Generally there is good communication on safety in our organisation		
Safety Rules and Procedures		
28) Sometimes it is necessary to depart from safety requirements for production's sake		
Supportive Safety Culture		

29) I am strongly encouraged to report unsafe conditions		
Involvement		
30) I understand my role and responsibilities for health and safety		
Additional Comments:		

APPENDIX C : EMPLOYEE SURVEY RESPONSES

LIKERT SCALE (Q1-23) AND DICHOTOMOUS SCALE (Q24 -30)

No	Enquiry	Percentages		
		Disagree	Neutral	Agree
	MANAGEMENT COMMITMENT:			
1	Management quickly corrects safety incidents	10	11	79
2	Management acts decisively on safety issues	10	18	72
3	Management acts quickly on reported incidents	7	14	79
4	Some superiors ignore safety incidents	22	16	62
5	Managers and supervisors are keen on workers safety	6	13	81
6	Managers and supervisors ensure safety procedures are followed	5	11	84
24	Management acts only after accidents have occurred.	58	-	42
	COMMUNICATION:			
7	Safety concerns and incidents are known by all	6	14	80
25	Management operates an open door policy on safety issues.	18	-	82
26	I receive praise for working safely.	35	-	65
27	Generally there is good communication on safety in our organisation.	13	-	87
	PRIORITY OF SAFETY & HEALTH:			
8	Safety rules and procedures are carefully followed.	7	12	81
9	I believe that safety issues are assigned a high priority.	5	8	87
10	I believe management considers the safety of employees of great importance.	6	10	81
11	I believe management considers safety to be equally as important as production.	9	16	75
	SAFETY RULES & PROCEDURES:			
12	I believe some health and safety rules and procedures are not really practical.	34	22	26
13	I believe some safety rules and procedures do not need to be followed to get the job done safely.	18	12	70
28	Sometimes it is necessary to depart from safety requirements for production's sake.	70	-	30
	SUPPORTIVE ENVIRONMENT & CULTURE:			
14	A "no-blame" approach is used to persuade people, acting unsafely, that their behaviour is inappropriate.	37	26	37
29	I am strongly encouraged to report unsafe conditions.	9	-	91
	INVOLVEMENT:			
15	I am sometimes involved in the on-going review of safety.	19	22	59
30	I understand my role and responsibilities for health and safety.	4	-	96
	WORK ENVIRONMENT:			
16	Operational targets sometimes conflict with safety.	47	19	34
17	Sometimes conditions here hinder my ability to work.	38	20	42
18	Sometimes I feel I am not given enough time to get the job done safely.	35	15	50
	BEHAVIOUR & ATTITUDE:			
19	Some employees display a poor attitude towards their job.	57	14	29
	COMPETENCE & TRAINING:			
20	Safety reports are generally well written.	6	15	79
21	Contract labour is generally competent.	18	25	57
22	My safety training is adequate.	13	14	73
23	There are many inexperienced staff in our workplace.	44	20	36

Appendix D: NM&MI DATABASE (SEVEN CHEMICAL ORGANISATIONS)

No	Incidents	MI or NM	Cat	Cause	Interventions
1	Contaminated drumming off product.	Minor Incident	environment	negligence	Lock out IT systems & Tanks
	Total		1		
2	While welder was busy with argon welding melthoid on sewer started to smolder	Near Miss	Fire	negligence	Investigate and discipline
3	Sub 3, No 1 power factor panel has a 3 phase flashover in the panel and caused the main capacitor breaker to trip on instantaneous overcurrent. The front and rear panel door damaged due to explosion.	Minor Incident	Fire	poor operations	Investigate and discipline
4	Tank X had a carbon build up around the seal and ignited	Minor Incident	Fire	poor maintenance	Follow maintenance programme
5	Mixer switchgear M10 for tank H mixer developed a electrical fault and cause flash inside the switchgear housing.	Minor Incident	Fire	poor maintenance	Follow maintenance programme
6	Electrician tried to reset trip switch at lighting DB box when sparks were emitted from the DB box	Minor Incident	Fire	poor operations	Investigate and discipline
7	During heavy downpour Soaker inlet flange caught alight.	Minor Incident	Fire	poor operations	Investigate and discipline
8	There was an explosion in the sewer system.	Minor Incident	Fire	accident	Investigate maintenance preparation
9	Sulphur fire under incinerator 54	Minor Incident	Fire	poor operations	Investigate and discipline
10	While welder was busy with argon welding melthoid on sewer started to smolder	Near Miss	Fire	negligence	Investigate and discipline
11	Control room Fire alarm sounded and we lost power to some lights in the control room and all the lights on the plants	Minor Incident	Fire	power failure	Switch on emergency power
12	There was a small fire on Pump 11 non drive end bearing	Minor Incident	Fire	poor maintenance	Investigate and discipline
13	Reactor Outlet Flange Fire	Minor Incident	Fire	negligence	Follow procedure
14	General Waste bin located at Plant Satellite Station - a small content of the waste started smoldering.	Near Miss	Fire	negligence	Investigate and discipline
15	The inlet spool piece was being preheated in preparation for welding. Smoke was noticed at the heating pads.	Minor Incident	Fire	negligence	Investigate and discipline
16	The unit operator observed smoke emanating from the diesel compressor and the compressor was taken down. The cover was lifted by and there was a fire at the rear end of the compressor.	Minor Incident	Fire	negligence	Investigate and discipline
17	While welding on 24" line, the grinding sparks caused a small piece of sulphur crete to start smoldering.	Near Miss	Fire	negligence	Investigate and discipline
18	Oil soaked insulation caught a light at T60	Minor Incident	Fire	negligence	Investigate and discipline
19	Crude unit on startup mode .Tank N caught alight at the seal area.	Minor Incident	Fire	poor maintenance	Follow maintenance programme
20	Fire at hot crude pumps G3	Minor Incident	Fire	accident	Review maintenance preparation

No	Incidents	MI or NM	Cat	Cause	Interventions
21	A fire blanket was used to contain the sparks. The fire blanket caught alight.	Minor Incident	Fire	negligence	Investigate and discipline
22	Flange at Tank Q draw ignited.	Minor Incident	Fire	negligence	Investigate and discipline
23	The air conditioner in the chemical store was releasing smoke .	Minor Incident	Fire	negligence	Investigate and discipline
24	A small fire below valve flange to crude inlet.	Minor Incident	Fire	negligence	Investigate and discipline
25	A flash fire occurred in strainer spool after strainer was removed for cleaning	Minor Incident	Fire	negligence	Investigate and discipline
26	Inlet flange ignited resulting in a flange fire which was immediately extinguished using a nearby fire water monitor.	Minor Incident	Fire	negligence	Investigate and discipline
27	Lagging at Tank B caught a light.	Minor Incident	Fire	negligence	Investigate and discipline
28	Sulphur smoldering at draw off line from catch pots to degassing vessel.	Minor Incident	Fire	negligence	Investigate and discipline
29	while cutting bolts from bellows on NE side of boiler hot slag fell onto acetylene gas supply tubing and tubing caught alight.	Minor Incident	Fire	negligence	Investigate and discipline
30	Flash fire at Tank E while Instrument Dept were draining gauge glass into a bucket.	Minor Incident	Fire	negligence	Investigate and discipline
31	Q10 (lubricating oil) container caught alight at Pump 37 suction blockvalve bonnet	Minor Incident	Fire	negligence	Investigate and discipline
32	Sparks from the cutting torch landed on the rubber seal and started to smolder whilst cutting the shell of Tank L.	Minor Incident	Fire	negligence	Investigate and discipline
33	A contractor working in laydown area noticed a fire at the disel pump and immediately informed the Plant. Fire put off. Diesel engine pin came through block and caused a fire.	Minor Incident	Fire	accident breakdown	Review maintenance preparation
	Total		32		
34	worker collapsed- first aid administered	Near Miss	Health	ill health	First aid given
	Total		1		
35	Safety glasses fell into solvent pail	Near Miss	Other	negligence	Investigate and discipline
36	Damage of SPL Roller Door	Minor Incident	Other	accident	Follow maintenance programme
37	Escavayor isolator isolated and relay removed in panel	Minor Incident	Other	electrics	Repair
38	shortage of drums	Minor Incident	Other	poor planning	Improve on planning
39	Truck hit the overlap steps on the Gantry	Minor Incident	Other	driver negligence	Investigate and discipline
40	A Fork lift Truck damage a roller door cover.	Minor Incident	Other	negligence	Investigate and discipline
41	Filling Hall found one of motor oil.40 pallet could not go through the pallet was to big	Near Miss	Other	no checks done	Follow procedures
42	The seal on Pump 72 has failed and the operator was using the pump but because it kept loosing 'prime' he was	Minor Incident	Other	poor maintenance	Follow maintenance programmes

No	Incidents	MI or NM	Cat	Cause	Interventions
43	Males, drunk and disorderly, pushed the green sanitech toilet over at the Island. They were drunk and making a lot of noise. The guard did not want a conflict, on Saturday the contractors removed the toilet and cleaned the mess. The matter was reported to the environmental department.	Minor Incident	Other	alcohol abuse	Test and discipline
44	Missing material-n-Butyl Acetate 20 drums	Minor Incident	Other	theft	Improve security
45	Tank 1 leaking at roof	Minor Incident	Other	poor maintenance	Follow maintenance programmes
46	Product to be deleted from system	Minor Incident	Other	theft	Improve security
47	Off-spec product sent thru plant line	Minor Incident	Other	negligence	Investigate and discipline
48	Truck overloaded	Minor Incident	Other	negligence	Investigate and discipline
49	Product drums overfilled	Minor Incident	Other	negligence	Investigate and discipline
50	Product off-spec on distil Range.	Minor Incident	Other	negligence	Investigate and discipline
51	Invoice with delivery	Near Miss	Other	negligence	Investigate and discipline
52	Disagreements between operators and supervisors	Minor Incident	Other	Poor team dynamics	Discipline and diversity training
53	Delivery Complaint	Minor Incident	Other	negligence	Investigate and discipline
54	Nissan New Flush - contamination	Minor Incident	Other	negligence	Investigate and discipline
55	Customer survey	Minor Incident	Other	negligence	Investigate and discipline
56	No COA with delivery	Minor Incident	Other	negligence	Investigate and discipline
57	Toluene off-spec on purity	Minor Incident	Other	poor operations	Investigate and discipline
58	LATE DELIVERY CAR	Minor Incident	Other	poor logistics	Investigate and discipline
59	Bulk product: Sludge in prod	Minor Incident	Other	poor operations	Investigate and discipline
60	Hexane tanker leaking in Zimbabwe (test)	Minor Incident	Other	customer complaint	Investigate and discipline
61	Rust contaminated - product	Minor Incident	Other	customer complaint	Investigate and discipline
62	Wrong batch numbers on Product	Minor Incident	Other	customer complaint	Investigate and discipline
63	Product dirty	Minor Incident	Other	poor operations	Investigate and discipline
64	Batch meter not recording correct qty	Minor Incident	Other	poor maintenance	Follow maintenance programmes
65	Incorrect paperwork supplied with del	Minor Incident	Other	poor admin	Investigate and discipline
66	Damage to retracting stairs	Minor Incident	Other	poor operations	Investigate and discipline
67	Guardhouse windows broken by stone	Minor Incident	Other	accident	Investigate and discipline
68	Failure of Pump A/B seal system	Minor Incident	Other	poor maintenance	Repair
69	Filling of grease into 5kg containers-Containers picked up from the floor, placed on top of a drum for filling and then placed on to pallets.	Minor Incident	Other	lack of training	Improve training

No	Incidents	MI or NM	Cat	Cause	Interventions
70	Petty Cash box, containing about R2500 in cash and supporting documents, went missing from a locked fire-proof safe between 16h30 and 08h30 next day.	Minor Incident	Other	theft	Improve security
71	Camera went missing from the HSE Manager's desk drawer.	Minor Incident	Other	theft	Improve security
72	Contractor found with company property, nails wrapped in plastic in is bag	Minor Incident	Other	theft	Improve security
73	Termco reversed onto a stationary tanker Service truck	Minor Incident	Other	accident	Investigate and discipline
	Total		39		
74	During the HF Acid transfer of Tank A to Tank B, hydrocarbon vapour was observed at the top of the Settler Tank B, from a passing valve through the bar plug.	Minor Incident	Release	poor maintenance	Follow maintenance programme
75	During a routine unit check the Tank PT observed hydrocarbon vapours emanating from the cable gland of a thermocouple.	Minor Incident	Release	poor maintenance	Follow maintenance programme
76	Product vapour release to Atmosphere	Minor Incident	Release	poor operations	Follow procedures
77	Fitters open flange at mixer 20, ASO and some acid vapours release	Minor Incident	Release	poor operations	Follow procedures
78	Pump 52 was being prepared for mitech installation. Whilst removing the blank flange there was a vapour release.	Minor Incident	Release	poor operations	Follow procedures
79	The off spec LPG line to the vaporizer which was not in use developed a leak.	Minor Incident	Release	poor maintenance	Follow maintenance programme
80	The Butane make up line developed a leak under the culvert at the intersection of two roads.	Minor Incident	Release	poor maintenance	Follow maintenance programme
81	The unit Process Technician observed vapours being emitted from Pump B seal	Near Miss	Release	negligence	Investigate and discipline
82	During the start up of the Plant, vapours and product ended up on the roof of Tank H.	Minor Incident	Release	poor operations	Follow procedures
83	Pump A1 was being prepared for mitech installation. Whilst removing the blank flange there was a vapour release.	Minor Incident	Release	negligence	Investigate and discipline
84	Strong product smell at offloading/loading gantry	Minor Incident	Release	poor operations	Follow procedures
85	Boiler emitting large amounts of black smoke into atmosphere.	Minor Incident	Release	poor operations	Follow procedures
	Total		12		
86	Worker tripped on temporary cable. Finger injured	Minor Incident	Safety	Accidental injury	Programme to improve safety
87	Worker injured left eyebrow on door	Minor Incident	Safety	Accidental injury	Programme to improve safety
88	Scaffold used to paint Escavayors fell over this was built as a mobile	Minor Incident	Safety	poor operations	equipment damage
89	Operator was injured on arm when splashed by Hot additive	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
90	Contractor grazed shin of right leg while going up stairs to plant	Minor Incident	Safety	Accidental injury	Programme to improve safety
91	Operator injured on right hand forefinger	Minor Incident	Safety	Accidental injury	Programme to improve safety
92	An operator was wrapping pallet of plastic pails with clear tape to hold pails.	Near Miss	Safety	poor operations	Follow procedures
93	An operator was walking down the steps, and slipped off.	Minor Incident	Safety	Accidental injury	Programme to improve safety
94	Chemical additive - truck in plant without wheel chocks.	Near Miss	Safety	poor operations	Investigate and discipline
95	Hurt right hand thumb	Minor Incident	Safety	negligence	Programme to improve safety
96	Washing under the Flexible line and he was cut under the left thumb	Minor Incident	Safety	Accidental injury	Programme to improve safety
97	Operator have a cut on his right hand middle finger.	Minor Incident	Safety	Accidental injury	Programme to improve safety
98	Minor laceration to second finger	Minor Incident	Safety	Accidental injury	Programme to improve safety
99	Contractor fell and injured his arm	Minor Incident	Safety	Accidental injury	Programme to improve safety
100	Operator was closing a drum on station 7 and the nozzle came down on his finger.	Minor Incident	Safety	Accidental injury	Programme to improve safety
101	Tanker tipped onto it's side	Minor Incident	Safety	damaged tanker	lost production
102	Scaffolder burnt by spurt of hot steam whilst walking past a steam trap	Minor Incident	Safety	Accidental injury	Programme to improve safety
103	While artisan was working on a scaffold, tightening bolts on firewater line the spanner slipped and fell on top of the	Minor Incident	Safety	Accidental injury	Programme to improve safety
104	Spanner slipped whilst applying pressure to loosen rusted bolt, resulting in fitter knocking his hand against the bottom of tank stairs	Minor Incident	Safety	Accidental injury	Programme to improve safety
105	Whilst jumping off the bakkie, he fell and balanced on his right hand	Minor Incident	Safety	Accidental injury	Programme to improve safety
106	Pulled & picked up approximately 10kg tumbler with one hand	Minor Incident	Safety	Accidental injury	Programme to improve safety
107	Whilst water flushing Tank E, he bumped his knee on a piece of pipe	Minor Incident	Safety	Accidental injury	Programme to improve safety
108	Whilst scaffolding was being erected on top of Tank roof; a section of the roof collapsed.	Minor Incident	Safety	Accidental injury	Programme to improve safety
109	Contractor strained lower back whilst trying to secure himself on the scaffold when the legs of Tank E floating roof collapsed	Minor Incident	Safety	Accidental injury	Programme to improve safety
110	He fell off the bike whist rushing to call the supervisor after the tank collapsed	Minor Incident	Safety	Accidental injury	Programme to improve safety
111	Whilst opening the inspection port, the port slipped and burnt his finger	Minor Incident	Safety	Accidental injury	Programme to improve safety
112	Contractor tripped on metal grating as she walked between Firehouse & Admin block hurting elbow & knee	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
113	Fitter sprayed with product and sustained burns whil'st loosening flange bolts to Remove a blank flange from Pump 56 discharge.	Minor Incident	Safety	Accidental injury	Programme to improve safety
114	Whilst opening door it jammed, injuring his finger on applying force to push open the door	Minor Incident	Safety	Accidental injury	Programme to improve safety
115	Valve broke in fresh air mask, resulting mask removal & subsequent H2S inhalation	Minor Incident	Safety	Accidental injury	Programme to improve safety
116	Electrical trainee fell when ladder moved after his colleague released the ladder to fetch the new bulb which was not within his reach.	Minor Incident	Safety	Accidental injury	Programme to improve safety
117	Bumped head against scaffolding whilst attempting to avoid a swaying pressurized hose	Minor Incident	Safety	Accidental injury	Programme to improve safety
118	Injured himself on a pallet whilst attempting to avoid a swaying pressurized hose	Minor Incident	Safety	Accidental injury	Programme to improve safety
119	Scaffolding contractor sustained injury to right leg whilst dismantling scaffolding, missed- stepped, catching his leg on the edge of the pallet	Minor Incident	Safety	Accidental injury	Programme to improve safety
120	An employee walking in block J and noticed cleaners cleaning out offices. Injured foot	Minor Incident	Safety	Accidental injury	Programme to improve safety
121	Developed chafing rash after using boots for 4 days	Minor Incident	Safety	Accidental injury	Programme to improve safety
122	Electrician was called to Tank H, lights tripped. when the electrician got onto site he found 220v floodlights inside. Injured hand	Minor Incident	Safety	Accidental injury	Programme to improve safety
123	Contractor burnt his thigh with steam tracing after the asbestos lagging was removed.	Minor Incident	Safety	Accidental injury	Programme to improve safety
124	While opening the drain line valve with a wheel spanner PT caught finger between the drum boot and the wheel spanner handle.	Minor Incident	Safety	Accidental injury	Programme to improve safety
125	Whilst packing paint in the store, his finger got jammed between two tins	Minor Incident	Safety	Accidental injury	Programme to improve safety
126	Employee sustained an injury when a splinter of wood poked his finger	Minor Incident	Safety	Accidental injury	Programme to improve safety
127	While Electrical employees placing a metal sheet into the Waste Tech bin, it got stuck and injured him on the upper lip.	Minor Incident	Safety	Accidental injury	Programme to improve safety
128	While working at Tank K contractor attempted to remove a welding tin from scaffolding that was above him, small particles of dust fell from the scaffolding board onto his face and in between his safety glasses and eyes.	Minor Incident	Safety	Accidental injury	Programme to improve safety
129	Bruise to toe while erecting pull-up banner	Minor Incident	Safety	Accidental injury	Programme to improve safety
130	Whilst attempting to move a hydro blasting tumbler at Tank L employees burnt their lower legs with the hot water.	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
131	When a passenger exit from the car and closed the front passenger door, she went to the rear door to reach for bag and tyre ran on toes.	Minor Incident	Safety	Accidental injury	Programme to improve safety
132	Sustained burn whilst erecting scaffolding needed to repair a burst steam pipe	Minor Incident	Safety	Accidental injury	Programme to improve safety
133	Contractor sustained burns to neck by a steam pipe whilst hydroblasting in a fairly restrictive area	Minor Incident	Safety	Accidental injury	Programme to improve safety
134	Contractor bruised left upper eyelid after he was struck by a G-brick by the use of a human chain	Minor Incident	Safety	Accidental injury	Programme to improve safety
135	Employee hit his hand with a four pound hammer whilst attempting to force a pipe within a pipe	Minor Incident	Safety	Accidental injury	Programme to improve safety
136	Operator fell into the draining pit at the East Pond whilst isolating a valve when the grating gave way	Minor Incident	Safety	Accidental injury	Programme to improve safety
137	Pump became loose on the pump stand and fell onto the floor hitting the artisan on the left leg	Minor Incident	Safety	Accidental injury	Programme to improve safety
138	Struck hand against the emblem on floor mat whilst cleaning	Minor Incident	Safety	Accidental injury	Programme to improve safety
139	Operator sustained superficial burns on the lower part of his face and his beard got singed.	Minor Incident	Safety	Accidental injury	Programme to improve safety
140	Process Technician splashed with an alkaline solution from the sump.	Minor Incident	Safety	Accidental injury	Programme to improve safety
141	Process Technician sustained superficial burns to his left lower leg when he stepped into a steam trap manifold.	Minor Incident	Safety	Accidental injury	Programme to improve safety
142	Employee sustained slight bruising to his left hand whilst offloading scaffolding from vehicle	Minor Incident	Safety	Accidental injury	Programme to improve safety
143	Contractors were excavating area for projects for installation of water line North east of substation P when the	Minor Incident	Safety	Accidental injury	Programme to improve safety
144	Employee felt burning sensation after doing a repetitive type task in a C class suite	Minor Incident	Safety	Accidental injury	Programme to improve safety
145	Employee complained of a backache and stiffness to back after he lifted a 25 kg bag of Sodium Bicarbonate	Minor Incident	Safety	Accidental injury	Programme to improve safety
146	Employee slipped with plate in her hand, as she fell, plate disintegrated thus cutting the employee left hand index finger.	Minor Incident	Safety	Accidental injury	Programme to improve safety
147	Employee was in the process of loading hand rails for the LPG Bullet in the yard whilst conducting the task employee sustained laceration to his right hand ring finger.	Minor Incident	Safety	Accidental injury	Programme to improve safety
148	As soon as the Electrician switched the selector on Pump A switchgear after racking it in, the motor started running	Minor Incident	Safety	negligence	Investigate and discipline

No	Incidents	MI or NM	Cat	Cause	Interventions
149	Asphalt cartoning warehouse metal light fitting and spot lights corroded and fell to the ground. This has also	Minor Incident	Safety	negligence	Follow maintenance programme
150	While opening the bypass valve around Pump D103 using a wheel spanner employee sustained injury to thumb	Minor Incident	Safety	Accidental injury	Programme to improve safety
151	Process Technician was splashed with acidic water while shutting off Pump 35 make up to acid day tank.	Minor Incident	Safety	Accidental injury	Programme to improve safety
152	Walked into a hole which had been covered by grass in plant.	Minor Incident	Safety	Accidental injury	Programme to improve safety
153	Employee attempted to break a cracked cup before discarding the cup, sustained Laceration when cup fell apart	Minor Incident	Safety	Accidental injury	Programme to improve safety
154	While working on pipe modification at asphalt contractor cut into hot oil line without authority.	Minor Incident	Safety	negligence	Investigate and discipline
155	While isolating a suction bv-pass on Pump1B north strainer, using a wheel spanner, he bumped his left forefinger against the open spindle on Pump71 south suction bv-pass.	Minor Incident	Safety	Accidental injury	Programme to improve safety
156	Employee sustained injury to his left wrist whilst dismantling scaffolding material at Tank103.	Minor Incident	Safety	Accidental injury	Programme to improve safety
157	The employee kicked the grating in front of the door resulting in her falling and bruising her left knee on the grating.	Minor Incident	Safety	Accidental injury	Programme to improve safety
158	HP hose separated from the sealed fitting while the machine was running nearly hitting the gunman.	Minor Incident	Safety	Accidental injury	Programme to improve safety
159	Minor laceration of fingers on the left hand. While doing a presentation in T-2, employee brushed fingers against a sharp piece of a drawing pin that was stuck into one of the tables	Minor Incident	Safety	Accidental injury	Programme to improve safety
160	Mechanical fitter was opening a plugged spool piece at Pump1A outlet when condensate sprayed on his forearms - plant turnaround.	Minor Incident	Safety	Accidental injury	Programme to improve safety
161	Contractor sustained first aid injury to his right arm and upper right leg while HP cleaning a Plant exchanger at the cleaning slab - plant turnaround.	Minor Incident	Safety	Accidental injury	Programme to improve safety
162	While offloading caustic crest chemical driver attempted to readjust the coupling when seeing a drip.	Minor Incident	Safety	negligence	Investigate and discipline
163	Contractor was working at sub 12 removing sand via conveyer, the employee pull the conveyer belt in doing so the conveyer started moving and catching the employee's finger on the roller resulting in him sustaining a abrasion to his left index finger.	Minor Incident	Safety	Accidental injury	Programme to improve safety
164	Contractor fainted while climbing locomotive stairs	Near Miss	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
165	Operator was walking in the xmas tree area ,and put her foot into a hole covered by grass thus injuring her right ankle	Minor Incident	Safety	Accidental injury	Programme to improve safety
166	Whilst reversing the crane, the driver accidentally hit into a unit boundary pole with the front wheels. There was no	Minor Incident	Safety	negligence	Investigate and discipline
167	Whilst preparing for a transfer, a gasket on an adjacent line blew and sprayed gasoline onto her.	Minor Incident	Safety	negligence	Investigate and discipline
168	First aid muscular strain	Minor Incident	Safety	Accidental injury	Programme to improve safety
169	Operator bumped his left leg on the unit.	Minor Incident	Safety	Accidental injury	Programme to improve safety
170	First aid incident	Minor Incident	Safety	Accidental injury	Programme to improve safety
171	Slipped and banged forearm	Minor Incident	Safety	Accidental injury	Programme to improve safety
172	Whilst pushing scaffolding on a trolley over a ramp, scaffolder lost control of the trolley and was caught between trolley and junction box.	Minor Incident	Safety	Accidental injury	Programme to improve safety
173	Tripped whilst entering the container and was cut by a wire attached to the container door	Minor Incident	Safety	Accidental injury	Programme to improve safety
174	Employee from contractor was conducting piping inspection when his wrist touched the steam tracing on the piping and he sustained a burn. The employee sustained burns at approximately 16h00	Minor Incident	Safety	Accidental injury	Programme to improve safety
175	T/A contract employee was working on PF50, he put pneumatic chipper on the wall as safety precaution. It fell onto his left foot and went through bruising the foot.	Minor Incident	Safety	Accidental injury	Programme to improve safety
176	Gang box lid fell on contract employees arm.	Minor Incident	Safety	Accidental injury	Programme to improve safety
177	The technician was doing wall thickness testing on a pipe. While descending, he needed to unclip his sling, he then removed his gloves to undo his karabiner. While doing this he cut his hand on a protruding piece of bandit strapping.	Minor Incident	Safety	Accidental injury	Programme to improve safety
178	contract employee was placing a precast concrete fence slat, assisted 2 employees. Due to this miscommunication the slat fell and struck his hand when it came loose.	Minor Incident	Safety	Accidental injury	Programme to improve safety
179	While contractor was grinding inside Bund 27 he lifted the visor on his face shield and a foreign body entered his eye causing irritation to the eye.	Minor Incident	Safety	Accidental injury	Programme to improve safety
180	While erecting a scaffolding at unit 44 , a two meter ledger fell to the ground as it was in the process of being moved	Near Miss	Safety	negligence	Programme to improve safety
181	The employee was moving a welding screen at his work station unaware of a protruding wire on the frame of the screen which resulted in him sustaining a cut on his finger.	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
182	While two employees were working on top of Tank E, one of the employees accidentally dropped a pipe.	Near Miss	Safety	negligence	Programme to improve safety
183	Fitter flogging flange - spanner slipped and fell	Minor Incident	Safety	negligence	Programme to improve safety
184	Whilst attempting to close the cab door on the drivers side. The contractor accidentally closed the door on his index fingers thereby causing bruising to his fingers.	Minor Incident	Safety	Accidental injury	Programme to improve safety
185	Three contract workers de-sludging the alky cooling tower basin received minor product burns when an injection line was disturbed dislodging its contents.	Minor Incident	Safety	negligence	Programme to improve safety
186	Trainee Mechanical Fitter accidently activated a 9kg dry powder extinguisher whilst attempting to keep her permit in	Minor Incident	Safety	negligence	Programme to improve safety
187	Due to the lockout procedure not being followed there was a high risk of a major accident that could happen.	Minor Incident	Safety	negligence	Programme to improve safety
188	Whilst a contract employee was working between the Fourth Stage Separator and the structure a 1" reducer fell on his hard hat and then his right shoulder.	Minor Incident	Safety	Accidental injury	Programme to improve safety
189	Mechanical Fitter injured by pipe.	Minor Incident	Safety	Accidental injury	Programme to improve safety
190	While scaffolders were working at tank D a scaffolding clamp fell 5 meters from platform to the ground and landed	Minor Incident	Safety	Accidental injury	Programme to improve safety
191	Mechanical Fitter subsequently pulled a muscle on his right arm whilst tightening flange.	Minor Incident	Safety	Accidental injury	Programme to improve safety
192	Contractors were preparing to sand blast the snuffing steam line to Furnace 302 when a clamp on the air hose came loose	Minor Incident	Safety	Accidental injury	Programme to improve safety
193	MVA. Vehicle drove into temporary contractor offices and injured one employee.	Minor Incident	Safety	Accidental injury	Programme to improve safety
194	A strong wind swept through the valley and over the main warehouse building and dislodged a roof vent air	Minor Incident	Safety	Accidental injury	Repair
195	A worker was struck on lower back by a falling nut.	Minor Incident	Safety	Accidental injury	Programme to improve safety
196	Whilst wheeling the machine into the unit, his foot got caught between the jockey wheel of the welding machine and an outrigger pad from a nearby crane	Minor Incident	Safety	Accidental injury	Programme to improve safety
197	An employee lost his footing and fell into a pool of water at the bottom of the pit. In his attempt to stabalise himself his legs came into contact with a hot steam pipe causing superficial burns to the lower part of his legs.	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
198	An employee sustained contusion to ring finger on left hand whilst opening cupboard in valve area in workshop	Minor Incident	Safety	Accidental injury	Programme to improve safety
199	An employee sustained a superficial thermal burn to his right arm in an attempt to retrieve a flogging spanner	Minor Incident	Safety	Accidental injury	Programme to improve safety
200	Process technician sustained injury to his left hand while using a valve spanner to isolate compressor valve.	Minor Incident	Safety	Accidental injury	Programme to improve safety
201	Operator came down a scaffold ladder at Tank E. At the 3 rd step from the bottom he jumped to the ground. He turned his upper body to move and he felt his right leg knee give way.	Minor Incident	Safety	Accidental injury	Programme to improve safety
202	Fractionator bottoms rundown temperature was high due to the bottoms exchangers kept plugging up.	Minor Incident	Safety	poor maintenance	Follow maintenance programme
203	A contract worker got burnt with condensate on his leg.	Minor Incident	Safety	Accidental injury	Programme to improve safety
204	While boxing the flange of the off gas line, the left hand of the trainee mechanical fitter was caught in between the off gas line which was falling and the pilot gas line which was below.	Minor Incident	Safety	Accidental injury	Programme to improve safety
205	Metal inspector was inspecting Tank B internals. He felt a pain in his back	Minor Incident	Safety	Accidental injury	Programme to improve safety
206	Nitrogen was filled into our permanent storage tank (reformer tank).	Minor Incident	Safety	Accidental injury	Programme to improve safety
207	While the employee was removing cable cover slab hooks in the unit, a piece of fire proofing fell from above and struck him on the left shoulder.	Minor Incident	Safety	Accidental injury	Programme to improve safety
208	An assistant was burnt on the left thumb while handling a steel bracket.	Minor Incident	Safety	Accidental injury	Programme to improve safety
209	A contractor accidentally bumped his right knee on the door post of a container and sustained an injury.	Minor Incident	Safety	Accidental injury	Programme to improve safety
210	Whilst contractor was installing toe board, the employee did not check the clamp on the opposite side and whilst pushing	Minor Incident	Safety	negligence	Programme to improve safety
211	Whilst proceeding to fire training grounds with fire engine the rear right side shaft came adrift damaging the vehicle.	Minor Incident	Safety	negligence	Follow maintenance programme
212	While opening a valve, using a wheel spanner, the process Technician sprained her left shoulder .	Minor Incident	Safety	Accidental injury	Programme to improve safety
213	Contractor personnel injured his left ankle while descending from scaffolding platform at Tank X.	Minor Incident	Safety	Accidental injury	Programme to improve safety
214	Soft tissue injury on left top foot. The foot was bruised and started swelling.	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
215	Operator pulled his rain suit from the top of his locker in the change room and felt a foreign body enter his eye.	Minor Incident	Safety	Accidental injury	Programme to improve safety
216	Whilst repairing the Air-line dust got into his eye	Minor Incident	Safety	Accidental injury	Programme to improve safety
217	Whilst cleaning under pipes contractor got some chemical onto his overalls resulting in burns to his back	Minor Incident	Safety	Accidental injury	Programme to improve safety
218	Employee struck by falling metal extension cord reel.	Minor Incident	Safety	Accidental injury	Programme to improve safety
219	Personnel was bruised from falling clamp.	Minor Incident	Safety	Accidental injury	Programme to improve safety
220	Mechanical assistant bumped his right thumb while removing a flexible hose from Tank G.	Minor Incident	Safety	Accidental injury	Programme to improve safety
221	Welder was struck on the back of his head by an earth clamp which had become detached.	Minor Incident	Safety	Accidental injury	Programme to improve safety
222	Employee lost control and injured his upper knee muscle. Employee was working on the suction strainer while loosening, the bolt went too loose and lost control.	Minor Incident	Safety	Accidental injury	Programme to improve safety
223	A contract operator got foreign body particles into his left eye. First aid- foreign body in eye.	Minor Incident	Safety	Accidental injury	Programme to improve safety
224	Injury to small left finger whilst tightening flange	Minor Incident	Safety	Accidental injury	Programme to improve safety
225	Technician whilst removing the measuring cylinder stopper from the glass cylinder slightly cut the left thumb.	Minor Incident	Safety	Accidental injury	Programme to improve safety
226	operator removed valve on a live system and sustained superficial burns on left hand	Minor Incident	Safety	Accidental injury	Programme to improve safety
227	contract employee sustained bruise to the hip whilst disembarking from the truck at gate 3 security check point.	Minor Incident	Safety	Accidental injury	Programme to improve safety
228	2 contractor personnel got into a fight over the use of a drill. One of them got injured and reported to the clinic. Injury was laceration to nose.	Minor Incident	Safety	Accidental injury	Programme to improve safety
229	Driver completed offloading. Disconnected delivery hoses then drove off. He did not disconnect his electrical cable from truck to power point. This resulted in the cable being ripped off from the connected plug. The naked stripped wires touched causing sparks. this blew the fuses in the switch gear in Sub R, stopped driver and breatheralysed him. statements taken. electrical system checked and reset	Minor Incident	Safety	negligence	Investigate and discipline
230	water trap failed under pressure causing the hose to whip about.	Minor Incident	Safety	negligence	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
231	Stopped work at spoke to the scaffolders and their foreman to rectify and discuss falling objects. Asked the to beware of activity in the area and to be more careful	Minor Incident	Safety	negligence	Programme to improve safety
232	operator was standing opening and closing the discharge ball valve, He was not wearing any eye protection. This pump is pumping 50% product. Instructed operator to put on his goggles.	Minor Incident	Safety	negligence	Programme to improve safety
233	contractor worked without a permit. Tank D was also full at that time. Contractor was recalled and given a written warning.	Minor Incident	Safety	negligence	Programme to improve safety
234	whilst off loading, the coupling came adrift in the bunded area and a little amount of caustic fell on the driver's PPE. Operation was stopped. Driver had full ppe and had no spill on him. He was taken to the clinic for a check.	Minor Incident	Safety	negligence	Programme to improve safety
235	water was commissioned to a foam nozzle Appendix that was on the hydrant flew out and landed on the road side	Minor Incident	Safety	negligence	Improve operations /training
236	Using wire to hold deadman's valve open	Near Miss	Safety	poor maintenance	Improve maintenance
237	the driver climbed on top of the tanker, on the opposite side to the loading platform, and stood on the edge of the hatch bund whilst disconnecting. Driver missed to fall. The lighting was also very poor.	Minor Incident	Safety	negligence	Programme to improve safety
238	Asphalt Plant Tank X. They were at the Top platform of the tank on the gratings. Employee nearly fell through the. Grating very rusty and dangerous.	Minor Incident	Safety	negligence	Programme to improve safety
239	exposed live wire. System isolated and made safe. Reported in to OM+S and requested the hole to be covered. Also reported into the clinic but fortunately no injury	Minor Incident	Safety	negligence	Programme to improve safety
240	passenger went to fetch her bag of the rear passenger seat. Without realising that she went to the rear passenger door, I let of the car move forward and rode over her leg. Took her to the clinic and no injury was found.	Minor Incident	Safety	Accidental injury	Programme to improve safety
241	at the bottom of a tank, The plate slipped whilst they were moving it into position to be lowered by rope to the ground. Alarm raised .supervisor assisted to stablise the situation.	Minor Incident	Safety	negligence	Programme to improve safety
242	Road Tanker Vehicle Earthing Cable not Fixed	Minor Incident	Safety	poor maintenance	Programme to improve safety
243	Vehicle overload	Near Miss	Safety	negligence	Programme to improve safety
244	NO FIRE EXTINGUISHER--HOT WORK	Near Miss	Safety	negligence	Programme to improve safety
245	ENTRY WITHOUT PERMIT	Near Miss	Safety	non compliance	Programme to improve safety
246	Grinder safety switch installed incorrectly	Minor Incident	Safety	negligence	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
247	no emergency stop switch for loading arm	Minor Incident	Safety	poor design	Programme to improve safety
248	no gasket for filter	Minor Incident	Safety	poor maintenance	Programme to improve safety
249	Damaged road tanker grounding system	Minor Incident	Safety	poor operations	Transporter to sort
250	VIOLATION OF PERMIT CONDITIONS.	Near Miss	Safety	non compliance	Investigate and discipline
251	Failure of SCADA and DCS Unit	Minor Incident	Safety	poor maintenance	Follow maintenance programme
252	Violation of isolation and lockout procedure.	Near Miss	Safety	non compliance	Investigate and discipline
253	Violation of Isolation and lockout procedure.	Near Miss	Safety	non compliance	Investigate and discipline
254	Violation of regulatory sign	Near Miss	Safety	non compliance	Investigate and discipline
255	Portable Lifting Equipment Falling of Vehicle Ramp	Minor Incident	Safety	poor maintenance	Follow maintenance programme
256	Unsafe road tanker.--	Minor Incident	Safety	non compliance by transporter	Transporter to sort
257	Lab technician burnt by ascetic acid	Minor Incident	Safety	negligence	Programme to improve safety
258	Job being done without adopting correct procedures	Near Miss	Safety	non compliance	Investigate and discipline
259	Operator was climbing over pipe work with a flange in his hand when he slipped on the pipe work and the flange injured his left thumb. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
260	Operator was releasing pressure on tank line 75 whilst standing on the drumming conveyor. When she stepped off she stood on a piece of hose lying around thus spraining her ankle. She was treated at the clinic. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
261	Operator was entering hose exchange no. 6 using the stairway when it suddenly shifted resulting in him falling and bruising his left knee and ankle. He received treatment at clinic and returned immediately to work. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
262	After dipping & sampling the sampling bottle fell from the surveyor's hand and a fine spray of chemical sprayed onto his face & neck. Treated at clinic as minor. NO LOST TIME	Minor Incident	Safety	Accidental injury	Programme to improve safety
263	Whilst being called out of a training class in the training room by a colleague, he focused on his colleague and tripped over a chair and fell hitting a table, thus cutting his right ear. It was treated at the clinic as a minor injury. NO LOST TIME.	Minor Incident	Safety	Accidental injury	Programme to improve safety
264	Operator was working on a scaffold inside a tank doing a grinding operation. A strong wind blew dust/metal filing into his eye. Treated as a minor injury at clinic. NO LOST TIME	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
265	Maintenance assistant fell over a barrier and sustained soft tissue injury to his right hip / leg area. Treated at clinic and taken to Hospital for x – rays. Minor injury. NO LOST TIME.	Minor Incident	Safety	Accidental injury	Programme to improve safety
266	Operator was busy carrying out house keeping duties when he leaned over a pipe while resting his right hand on a pipe, when his hand accidentally slipped out & caused him to fall forward & hit his head on a pipe flange resulting in a minor injury to his forehead. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
267	A security guard was sprayed with ULP 95 in his eyes whilst attending to a driver's documentation in the loading bay. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
268	Maintenance assistant injured his right index finger (abrasion) when a gas cylinder fell whilst he was trying to off – load it from a vehicle. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
269	Minor injury to operators eyes occurred from vapours / fumes during the dye penetration process in the tank. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
270	Operator received minor burns to his buttocks when he sat on an empty 25 Lt container that previously contained a phenol mix. Treated at clinic. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
271	Operator was sprayed with caustic from a bucket whilst carrying it during a floor cleaning operation. He received minor burns to his left calf. He was treated at the clinic.	Minor Incident	Safety	Accidental injury	Programme to improve safety
272	Operator twisted his right ankle when climbing down off a road tanker.	Minor Incident	Safety	Accidental injury	Programme to improve safety
273	Operator was climbing over pipe work with a flange in his hand when he slipped on the pipe work and the flange injured his left thumb. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
274	Clerk was leaning over a desk leaving a message, when she turned around her leg got caught in a loose cable which resulted in her falling on her knees & left side of her body. She received minor grazes to her knees. Treated at clinic as a minor injury. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
275	Operator sustained minor product burns whilst pulling an air hose across the line, thus causing the coupling to loosen on the N2 hose, displacing it & spraying product into the atmosphere, causing minor burns to his face, neck & hands. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
276	Operator sustained minor burns to his right forearm when touching a dip hatch on tank 609, whilst painting handrails on the tank. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
277	Operator tripped over a 6 inch valve at a hose exchange which resulted in him falling and injuring his right ankle. He was treated at the clinic and taken at a later stage to hospital for an X – ray. He returned to work. RESTRICTED WORKDAY	Minor Incident	Safety	Accidental injury	Programme to improve safety
278	Operator was busy lowering a 4 inch hose using the ship's crane. While he was guiding the hose down he was walking backwards when he tripped over a 6 inch hard black hose, causing the 4 inch hose that he was guiding down to fall onto his right ankle. He was treated on site by the sister and booked off the remainder of the shift. He did not return to duty. LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
279	Operator was busy packing drums into a container onto the second row, when he accidently slipped between two drums resulting in a minor bruising to his right thigh. He went immediately to the clinic for medical treatment. He returned to duty after his treatment. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
280	Operator cut his lower lip when an air hose come loose from the clamp and hit him in the mouth area. This resulted in a minor cut being received which was treated at the clinic. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
281	Operator had completed spading off a product line when he decided to remove his gloves in an unsafe manner. The fine spray that was generated caused minor superficial burns to his face. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
282	Operator was sprayed with ULP on her back area when a gasket burst as a result of pressure from the line S 1. She spent approximately 30 minutes under a shower then received treatment at the clinic for minor burns. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
283	Operator was busy loading a container with drums, whilst pushing a drum on the top layer of drums he slipped between the drums injuring his left knee. This was a minor injury and he was treated at the clinic. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
284	Operator was injured when he was entering the site office. His left ring finger got caught in the door handle causing a slight sprain. He was treated at the clinic and sent to hospital for x rays. He returned immediately to work and completed his shift. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
285	Operator was sprayed with product whilst decanting a railcar. He was treated at the clinic for minor burns to the chest area. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
286	Operator received minor product burns when he was rolling up danger tape at plant. He was busy with x rays on lines at the time. He was treated at the clinic for minor burns to both hands, he returned immediately to work after treatment. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
287	Operator injured his back slightly when the driver of the vehicle started up and pulled forward without knowing that the loader was still on top of the vehicle. Slight sprain to back. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
288	Operator injured his right finger on a scraper which was in his pocket, whilst trying to climb off the forklift. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
289	Operator injured his right foot when the swing gate no. 3 at site opened and the arm of the gate crushed his right foot.	Minor Incident	Safety	Accidental injury	Programme to improve safety
290	Operations manager injured his left knee when he was getting up from his desk and accidently walked into an open drawer in his desk. He was treated at the clinic. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
291	Operator was proceeding to open a 6 inch valve when he suddenly collapsed and fell thus causing a minor injury to his nose and head. He was treated at the clinic and returned immediately to work. NO LOST TIME INJURY	Minor Incident	Safety	Accidental injury	Programme to improve safety
292	Operator injured a finger on his left hand whilst descending a stair case in the admin building. He was treated at the clinic as a minor injury and returned immediately to resume his duties. NO LOST TIME INJURY.	Minor Incident	Safety	Accidental injury	Programme to improve safety
293	Maintenance Assistant was working on the homongenisor. The blender was routinely circulating in kettle x, bypassing the homogenisor, which was locked out electrically. Product sprayed out while the Maintenance Assistant was opening up the flange leading to the machine. A few drops of the product fell on his right wrist and he sustained minor burns which was treated by the First Aider. The assistant went back to work.	Minor Incident	Safety	Accidental injury	Programme to improve safety
294	Plant: Maintenance Assistant sustained minor burns from hot product that leaked while he was opening the flange leading to the Homogeniser. He was tasked to change the homogeniser seals. At the same time, the Blender was circulating in Kettle x. The pipe connecting the Homogeniser& and the Kettle x has no valves to lock out	Minor Incident	Safety	Accidental injury	Programme to improve safety

No	Incidents	MI or NM	Cat	Cause	Interventions
295	Hot product spill at the Plant: Two Plant employees were slightly injured when the filter that they were re-assembling after cleaning, spilled hot grease (>90oC) as a result of the Blender removing the lock-out in place and opening the isolating valve prematurely.	Minor Incident	Safety	Accidental injury	Programme to improve safety
296	Truck collision - despatch area	Minor Incident	Safety	accident	Investigate and discipline
297	Incident in Lab Retention Stores : Rusty light fitting above the retention store roller door fell off its support and caused the electrical to arc.	Minor Incident	Safety	poor maintenance	Follow maintenance programme
298	Plant: The portable pump fell on its side while the Foreman was transferring product from drums into flobins. One of the Plant Assistant who assisted in lifting the pump back into position claims he sprained his ankle when he stepped back after repositioning the pump. He did not report any injuries or incident at the end of shift. He arrived the next day with a swollen ankle.	Minor Incident	Safety	Accidental injury	Programme to improve safety
299	Contract worker connected water pipe to fire hydrant – PSO Site inspection	Minor Incident	Safety	negligence	Investigate and discipline
300	Contractor employees working on the roof with safety harnesses that are not attached to lifelines in the presence- PSO – site inspections.	Minor Incident	Safety	negligence	Investigate and discipline
301	Plant Supervisor's left leg slipped through a drain cover when she stepped on it to locate the pressure gauge on filter. Sustained a slight bruise to her leg- no treatment was required.	Minor Incident	Safety	negligence	Maintenance to fix
302	There was foul odour from the laboratory fume hoods.	Near Miss	Safety	negligence	Investigate and sort
303	While employees were cleaning up a diesel spill at pump shed found the workers with no PPE.	Minor Incident	Safety	negligence	Programme to improve safety
304	Lab. Assistant connected the incorrect gas to the ICP, resulting in the torch not igniting.	Near Miss	Safety	negligence	Programme to improve safety
305	Operators and assistants in the Filling Hall are wearing their overall tops wrapped around their waist.	Minor Incident	Safety	negligence	Programme to improve safety
306	Plant Filling Operator & Plant Assistant Contractor were not wearing their safety glasses during filling.	Minor Incident	Safety	negligence	Programme to improve safety
307	GP Filling Operator's thumbs are getting blisters from opening the 5Kg containers.	Minor Incident	Safety	Accidental injury	Programme to improve safety
308	Hand rails next to B8 was out of the slot and hanging	Minor Incident	Safety	poor maintenance	Maintenance to fix
309	Transport was loading LPG gas bottles onto normal delivery truck, not legally approved for such activity.	Near Miss	Safety	not following procedures	Investigate and discipline
310	Bakkie was being loaded with LPG cylinders to be taken to the gates due to gas delivery driver not carrying his ID book	Minor Incident	Safety	not following procedures	Follow procedures

No	Incidents	MI or NM	Cat	Cause	Interventions
311	The Plant Assistant had some grease splash into his eyes while air-blowing the filling line to clear a blockage. He experienced eye irritation and was taken to on-site Occupational Medical Practitioner. He was referred to Bluff Medicross for medical attention.	Minor Incident	Safety	Accidental injury	Programme to improve safety
312	A truck carrying flobins hit an overhead water pipe between the Production and Plant passage.	Minor Incident	Safety	negligence	Investigate and discipline
313	Blender using cell-phone in the plant.	Near Miss	Safety	not following procedures	Investigate and discipline
314	DB Board in the blend tower and 1st landing is not locked	Minor Incident	Safety	negligence	Lock DB
315	F20 pump cover is rusted, motor exposed	Minor Incident	Safety	poor maintenance	Follow maintenance programme
316	Fire hydrant valve next to F20 was leaking. Evidence of hydrant being used.	Minor Incident	Safety	not following procedures	Maintenance to fix
317	Blend tower - B1 steam line is leaking	Minor Incident	Safety	negligence	Maintenance to fix
318	An employee sustained a bruise on left rib area when entering the office block.	Minor Incident	Safety	Accidental injury	Programme to improve safety
319	Operators are climbing over pipes to access Tanl99 and valves /pumps.	Minor Incident	Safety	Accidental injury	Programme to improve safety
320	Stairs at Tanks are steep. Operators find it difficult to complain.	Minor Incident	Safety	Accidental injury	Programme to improve safety
321	Cables in production office is loose	Minor Incident	Safety	poor maintenance	Install permanent cables
322	Non-slip material on some steps at the Plant is missing	Minor Incident	Safety	poor maintenance	Maintenance to sort
323	The driver was taking a load of packed finished goods to the warehouse at Re-Union. As the driver was approaching the bend and the incline in Bluff road the load shifted from the RHS to the LHS, causing the packed boxes(24) to fall onto the pavement.+- 12 x 1 liters of product spilled onto the side of the road.	Minor Incident	Safety	poor loading	Investigate and discipline
324	Explosion took place at the plant site at +-18h45.Flame arrestor with a piece of pipe fell through the roof and landed in the production warehouse. The asbestos roof had a hole, the angle iron that supports the roof and part of the racking were damaged.	Minor Incident	Safety	fire at Plant	Repair roof
325	Cleaner forced the window open by pushing directly onto the window pane. he cut his hand and arm.	Minor Incident	Safety	Accidental injury	Programme to improve safety
	Total		240		
326	600litres of additive spilled	Minor Incident	Spill	poor operations	Investigate and discipline
327	6000litres lube spilled	Minor Incident	Spill	poor operations	Investigate and discipline

No	Incidents	MI or NM	Cat	Cause	Interventions
328	Transporters Truck Leaked out product	Minor Incident	Spill	poor operations	Investigate and discipline
329	Product spillage when filling the bulk truck	Minor Incident	Spill	poor operations	Investigate and discipline
330	Found paint in separator -Next to fire house, found small blobs of paint in outlet at wharf.	Near Miss	Spill	negligence	Investigate and discipline
331	During the flushing of the bulk additive manifold with Power-oil - the 3/4" flushing hose came off causing a spill.	Minor Incident	Spill	poor operations	Investigate and discipline
332	Truck spilled diesel on the road.	Minor Incident	Spill	negligence	Investigate and discipline
333	Crude overheads line developed leak	Minor Incident	Spill	poor maintenance	Maintenance to fix
334	Leak on solvent line from Solvent chillers @ Tank E.	Minor Incident	Spill	poor maintenance	Maintenance to fix
335	Solvent line developed a leak above Tank D.	Minor Incident	Spill	poor maintenance	Maintenance to fix
336	Found product on the roof of Tank F	Minor Incident	Spill	poor operations	Investigate and discipline
337	Tank G seal unit pressure gauge leak.	Minor Incident	Spill	poor maintenance	Maintenance to fix
338	While Fitter was loosening bolts to remove a blank flange from Pump 200 discharge to reinstate spool piece product sprayed out from the flange and the fitter sustained burns.	Minor Incident	Spill	poor operations	Investigate and discipline
339	During the process of charging the oxidizer D 7 - product started coming out of piping.	Minor Incident	Spill	poor operations	Investigate and discipline
340	Tank B outlet piping popped a leak and was bandage but Liquid started to drip and sour smell was released.	Minor Incident	Spill	poor maintenance	Maintenance to fix
341	MSC container loading asphalt leaked from the bottom	Minor Incident	Spill	poor operations	Investigate and discipline
342	X118 Tank shell sprung a leak.	Minor Incident	Spill	poor maintenance	Maintenance to fix
343	Whilst preparing the tank for transfer, operator drained 21m3 of a mixture of water & product into the oily sewer. This caused the sewer to overflow into the tank farm. Resulting in an environmental & safety hazard.	Minor Incident	Spill	poor operations	Investigate and discipline
344	Whilst a product tank was being pumped across from tank J into X300 the product was seen pouring out the foam lateral junction box of x54	Minor Incident	Spill	poor operations	Investigate and discipline
345	Furfural Sump over-filled as a result of an overflow of the water-side of the CBM.	Minor Incident	Spill	poor operations	Investigate and discipline
346	Hot product leak at Extraction pump 6	Minor Incident	Spill	poor operations	Investigate and discipline
347	2" Wet Solvent line to Tank V developed a pinhole leak.	Minor Incident	Spill	poor maintenance	Maintenance to fix

No	Incidents	MI or NM	Cat	Cause	Interventions
348	Clamp installed on 2" solvent line failed - ~30litres solvent migrated to oily water sewer.	Minor Incident	Spill	poor maintenance	Maintenance to fix
349	3" Flexi hose burst, resulting in a spill of approximately 200 litres of product	Minor Incident	Spill	poor maintenance	Maintenance to fix
350	The MSC truck jerked as it pulled off from the loading bay thus causing the container lid to open and spilled +-10 liters of asphalt all over the container shell to the ground.	Minor Incident	Spill	negligence	Investigate and discipline
351	Pump 28 minimum flow line developed a leak downstream of the restriction orifice plate (4). The minimum flow system could not be isolated. There was about 4000 liters of solvents that went to deck, area is bunded.	Minor Incident	Spill	poor maintenance	Maintenance to fix
352	While off loading product R88 into tank B - tank overflowed & created a spill of about 100 litres of the chemical.	Minor Incident	Spill	poor operations	Investigate and discipline
353	Feed to the feed prep was stopped and the system de-pressured as operations isolated the gauge glass. The gauge glass on Tank K had developed a leak.	Minor Incident	Spill	poor maintenance	Maintenance to fix
354	Product leaked out of vent line on X2. Whilst Flushing unit for start up the purge line on the seal pot was left open and product went to grade. The amount was about 20 litres.	Minor Incident	Spill	poor operations	Investigate and discipline
355	X10 mixer seal is leaking.	Minor Incident	Spill	poor maintenance	Maintenance to fix
356	Pump L outboard seal developed a leak.	Minor Incident	Spill	poor maintenance	Maintenance to fix
357	Truck was overfilled and started to spill via overflow pipe	Minor Incident	Spill	poor operations	Investigate and discipline
358	Spill at Tank M	Minor Incident	Spill	negligence	Investigate and discipline
359	Spilled +-40lts of diesel from the bowser tractor on the road whilst delivering it to plant N.	Minor Incident	Spill	negligence	Investigate and discipline
360	While relocating the blind on the crude preheat line for pressure test, an amount of about 20 liters of oil leaked onto the road. The operator was standing by whist the flange was being spread.	Minor Incident	Spill	negligence	Investigate and discipline
361	While a full strapped pallet load of 25 litre sodium product containers was loaded by a forklift on the low bed truck, a container of product dislodged and fell to the ground.	Minor Incident	Spill	negligence	Investigate and discipline
362	The o-ring gasket on the hammer blind separating Crude transfer lines blew and 3000 liters of MCB spilled in the pipe trench.	Minor Incident	Spill	poor maintenance	Maintenance to fix
363	Sour naphta from Plant N was diverted to crude during start up. While this was going, it blew the gasket and spilled +-200 liters into the bunded area.	Minor Incident	Spill	poor maintenance	Maintenance to fix

No	Incidents	MI or NM	Cat	Cause	Interventions
364	Product overflowed into the KO pot although the tank level was reading zero. Some product spilled from the vent to the ground.	Minor Incident	Spill	poor maintenance	Maintenance to fix
365	Leak detected on the BFO rundown line ex Vacuum unit. Bar plug on low point bleeder on BFO rundown line failed causing product to leak	Minor Incident	Spill	poor maintenance	Maintenance to fix
366	Odds and sods rundown line East of Tank O sprung a leak and +-2500 liters of product was spilled in the pipe trench and culvert.	Minor Incident	Spill	poor maintenance	Maintenance to fix
367	Tank P started dropping immediately after Plant N unit fire and upon investigation found product on the roof and in the bunded area. +-60000 lts of product overflowed and contained in the bunded area.	Minor Incident	Spill	poor operations	Investigate and discipline
368	Whilst air freeing the filter using flushing, the process technician observed oil spraying from the flange below the filter. The oil spilled from the first platform and made a pool of about 50 litres on the floor.	Minor Incident	Spill	poor maintenance	Maintenance to fix
369	Spilled +-30 liters of asphalt onto the ground.	Minor Incident	Spill	poor operations	Investigate and discipline
370	Tank C level went over the top and caused PD Tar spill of about 800L	Minor Incident	Spill	poor operations	Investigate and discipline
371	A transporter truck that had been filled with asphalt product 80/100 spilled over after it had been filled.	Minor Incident	Spill	poor operations	Investigate and discipline
372	Thermal Pressure blows gasket	Minor Incident	Spill	poor maintenance	Maintenance to fix
373	Drum damage on flat deck truck	Minor Incident	Spill	poor operations	Investigate and discipline
374	Tank 2 overflow	Minor Incident	Spill	poor operations	Investigate and discipline
375	Product Spill	Minor Incident	Spill	poor operations	Investigate and discipline
376	N Butyl Acetate Spill	Minor Incident	Spill	poor operations	Investigate and discipline
377	Diesel spillage	Minor Incident	Spill	poor operations	Investigate and discipline
378	M/Solvent loss 1016 lts	Minor Incident	Spill	poor operations	Investigate and discipline
379	Spill at the Storage tank(T 2): product spilled while the Maintenance Assistant opened the stop-nut for the lab to take a sample. This took place in a bunded area.	Minor Incident	Spill	poor operations	Investigate and discipline
380	Spill at the Storage tank (T10): product spilled while the Operator was discharging from a container into Storage Tank.	Minor Incident	Spill	poor operations	Investigate and discipline
381	Oil Spill at Filling Line Hose Exchange: Approximately 1300 litres of oil spilled in the Filling Hall due to the valve being left open at the 1st landing hose exchange.	Minor Incident	Spill	poor opertaions	Investigate and discipline
382	Diesel overflowed from the boiler diesel tank.	Minor Incident	Spill	negligence	Investigate and discipline

No	Incidents	MI or NM	Cat	Cause	Interventions
383	A pallet of product 7400 pails dropped out of the FIFO Racking system due to roller brake failure. Due to the impact of the containers on the concrete floor, 8 containers were damaged and the oil spilled.	Minor Incident	Spill	poor maintenance on brakes	Maintenance to fix
384	Oil Spill in the Filling Hall: Flexi hose burst in the middle of transferring product from Blend vessel, C1 to storage tank2	Minor Incident	Spill	poor maintenance	equipment damage
385	Lube oil spill at bulk filling area in the passage alongside the Blend tower.	Minor Incident	Spill	negligence	Investigate and discipline
386	Less than 5 L of fuel additive, spilled from an ISOTAINER outside the plant when the driver opened the hatch, to take a Laboratory sample.	Near Miss	Spill	negligence	Investigate and discipline
387	Spill in production hall- The tank overflowed.	Minor Incident	Spill	negligence	Investigate and discipline
388	While tanker was discharging diesel into the boiler tanks, some diesel spilled.	Minor Incident	Spill	negligence	Investigate and discipline
389	Product (3x180Kg) spilled out of the homogenizer.	Minor Incident	Spill	negligence	Investigate and discipline
390	About 450 litres of product spilled at the bulk loading due to the camlock connection on flexi-hose breaking.	Minor Incident	Spill	damaged camlock	Investigate and discipline
391	About 100L of product oil spilled over the Flush-oil Flobin onto the floor in the Bulk Delivery filling area.	Minor Incident	Spill	negligence	Investigate and discipline
392	Evidence of diesel spill outside the sub-station	Minor Incident	Spill	negligence	Investigate and discipline
393	Drip tray at plant meter sampling point has no outlet valve to empty drip tray when full	Minor Incident	Spill	poor design	Improve on design
394	Safety Rep noticed Tank BA pipeline leaking at 7:30am.	Minor Incident	Spill	poor maintenance	Maintenance to fix
395	About 25 litres of hydraulic flush oil leaked out from flobin.	Minor Incident	Spill	negligence	Investigate and discipline
396	Spill at IBC line	Minor Incident	Spill	negligence	Investigate and discipline
397	Asphalt (aprox 60L) spilled from leaking thermco	Minor Incident	Spill	negligence	Investigate and discipline
398	Asphalt spilled over container whilst loading for ship.	Minor Incident	Spill	negligence	Investigate and discipline
399	Thermco container "boiled over" & spilled asphalt to deck.	Minor Incident	Spill	negligence	Investigate and discipline
400	Asphalt spilled from leaking Thermco container.	Minor Incident	Spill	negligence	Investigate and discipline
401	Asphalt spill due to Thermco flange leak at plant.	Minor Incident	Spill	negligence	Investigate and discipline
402	Asphalt "boiled over" tanker pub during loading.	Minor Incident	Spill	negligence	Investigate and discipline
403	Asphalt overflowed from top of MSC Thermco container whilst exiting the plant near Weighbridge area.	Minor Incident	Spill	negligence	Investigate and discipline
404	Asphalt "boiled over" from Thermco container at loading bay.	Minor Incident	Spill	negligence	Investigate and discipline
405	Asphalt spilled from Thermco container due to overfilling	Minor Incident	Spill	negligence	Investigate and discipline

No	Incidents	MI or NM	Cat	Cause	Interventions
406	Asphalt spill, Thermco "boiled over" during loading when about 75% full at tank	Minor Incident	Spill	negligence	Investigate and discipline
407	Asphalt leaked from Thermco whilst loading 60/70 asphalt	Minor Incident	Spill	negligence	Investigate and discipline
408	Asphalt spilled from Thermco after loading when truck moved whilst hatch was left open.	Minor Incident	Spill	negligence	Investigate and discipline
409	Asphalt spilled to deck when Termco container overfilled during loading.	Minor Incident	Spill	negligence	Investigate and discipline
410	Asphalt spilled fromThemco when container valve started passing whilst loading product 60/70.	Minor Incident	Spill	negligence	Investigate and discipline
411	Leaking Themco left plant un-noticed & spilled asphalt outside, on road	Minor Incident	Spill	negligence	Investigate and discipline
412	Themco leaked when gasket on the decanting valve failed spilling +/- 200 litres of asphalt to deck.	Minor Incident	Spill	negligence	Investigate and discipline
413	Termco Truck spilled asphalt after it had been loaded.	Minor Incident	Spill	negligence	Investigate and discipline
414	200416 L asphalt leaked from Termco contain417er in the bunded area at export loading bay418.	Minor Incident	Spill	negligence	Investigate and discipline
415	The temco tank419er was 75% full, loading 60/70, then the fron420t side of the container started leaking(spraying). The spill caused is estimated at +/-12000littres.	Minor Incident	Spill	negligence	Investigate and discipline
	Total		90		
	Grand Total		415		

CATEGORISED NM&MI (RED) AND CAUSES (BLACK)

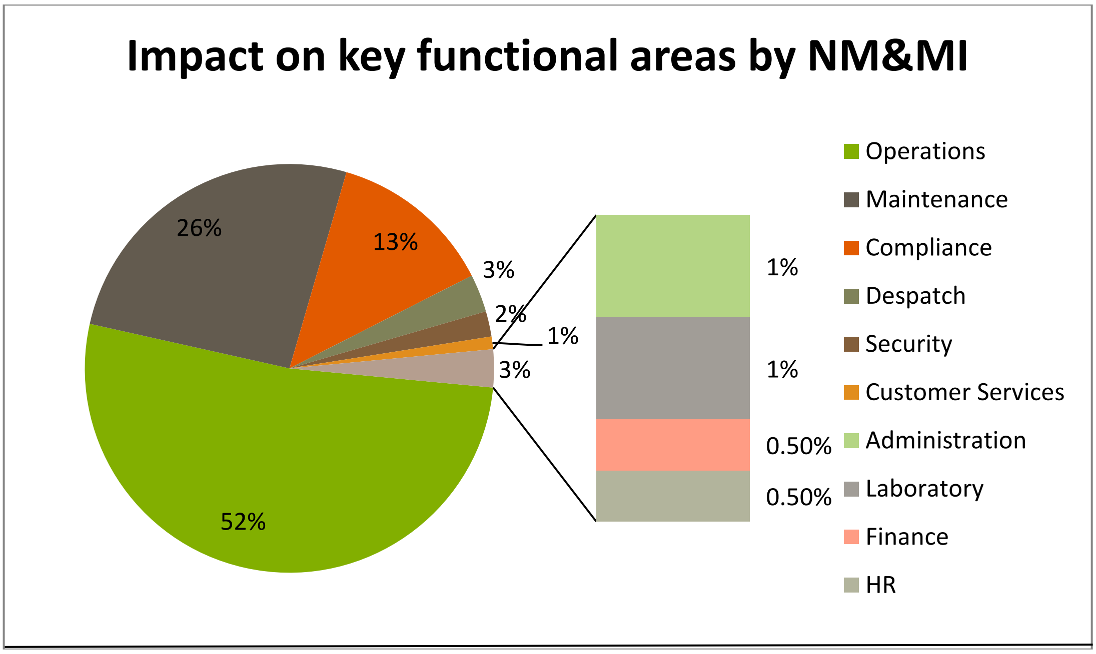
Health-1	Illness	100%			
Environment-1	Negligence	100%			
Fire-32	Negligence	63%	and	Poor Operations	25%
Other-39	Negligence	30%	and	Poor Operations	10%
	Poor Maintenance	10%	and	Theft	13%
Safety-240	Negligence	17%	and	Accidental Injury	70%
Release-12	Negligence	16%	and	Poor Operations	50%
	Poor Maintenance	34%			
Spill-90	Negligence	40%	and	Poor Operations	32%
	Poor Maintenance	25%			

Appendix E: NM&MI DATABASE REVIEW

NM&MI DATABASE - Categorised NM&MI (source -Appendix D)		
CATEGORISED MINOR INCIDENTS (Organisations databases)	CAUSES of MINOR INCIDENTS (only 10% and above used)	
SAFETY - 57%	Accidental injury	70%
	Negligence	17%
SPILLS- 22%	Negligence	40%
	Poor operations	32%
	Poor maintenance	25%
OTHER - 9%	Negligence	30%
	Theft	13%
	Poor maintenance	10%
	Poor operations	10%
FIRE- 7%	Negligence	63%
	Poor Operations	25%
RELEASE- 3%	Poor Operations	50%
	Poor Maintenance	34%
	Negligence	16%
ENVIRONMENT- 1%	Negligence	100%
HEALTH- 1%	Ill health	100%

APPENDIX: F - NEAR MISS AND MINOR INCIDENT IMPACT ON KEY FUNCTIONS

KEY FUNCTIONAL AREAS	IMPACT
OPERATIONS	52%
MAINTENANCE	26%
COMPLIANCE	13%
DISPATCH	3%
SECURITY	2%
CUSTOMER SERVICES	1%
LABORATORY	1%
ADMINISTRATION	1%
FINANCE	.5%
HR	.5%



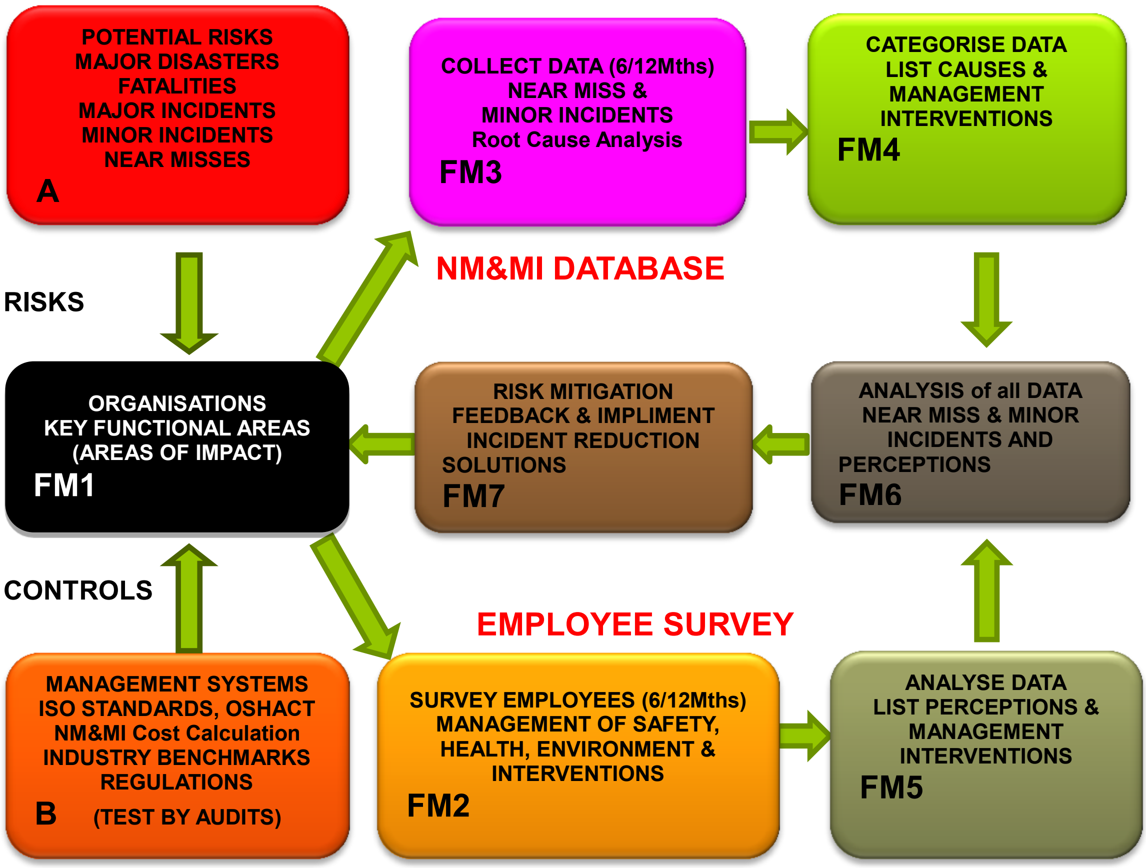
KEY FUNCTIONAL AREAS IMPACTED

IMPACT OF KEY FUNCTIONS BY NM&MI CATEGORIES

IMPACT OF KEY FUNCTIONS BY NM&MI CATEGORIES			
	SAFETY	SPILLS	FIRES
OPERATIONS	50%	32%	11%
MAINTENANCE	86%		6%
COMPLIANCE	36%	27%	

APPENDIX: G- AD HOC INQUIRY AND RESULTS FOR IMPROVEMENT OF THE FM (BASIC)

Methodology for Near Miss & Minor Incident reduction- usefulness and improvement inquiry



The above are the Methodology steps from 1 to 7 showing you how to better manage NM&MI in your workplace.

Please answer the questions on further improvements to the FM:

1) Currently in your organisation is the NM&MI's managed properly? Yes/No

2) Have you used the above Methodology or a similar tool in resolving or reducing NM&MI? Yes/No

Yes/No

3) Would this Methodology assist you in reducing and controlling NM&MI?

4) Would adding an additional step with root cause analysis and a tolerable rate improve this Methodology? (Tolerable rate is a maximum number of NM&MI allowed per organisation) Yes/No

Administered by DRT Nayager- for thesis on near miss and minor incident investigation.

RESULTS OF AD HOC INQUIRY ON FM (BASIC)

QUESTIONS	YES	NO
Q1	4	16
Q2	4	16
Q3	20	0
Q4	20	0

APPENDIX: H -ADDITIONAL INFORMATION ON GLOBAL UNSAFE INCIDENTS AND THREATS AND OPPORTUNITIES

THREATS	OPPORTUNITIES
Negative stakeholder(workers, customers, shareholders, public) trust and confidence in the chemical industries ability to operate their installations safely	Operate with nil safety incidents and improve on the communities trust and confidence a recipe for continued business
Backlash from chemical unions on unsafe plants	Reduce on the NM&MI to improve on safety, health and environment which impacts on labour and their unions
Insurance industry pushing up costs due to the huge number of safety incidents	Operate safely and reduce the add on effect of insurance costs
Pressure from some of the environmental lobby groups eg Greenpeace, Environmental Justice Networking Forum (EJNF) , Groundwork, Living Planet, Friends of the Earth , Waste Watch, Geosphere, Save the Earth Foundation, Environment America, South Durban Community Environmental Alliance (SDCEA)	Pressure groups have formed due to miss management of chemical safety. The chemical organisations must improve urgently on safety, health and environmental management to have continued sustainability of their businesses.
Pressure from public authorities and governments	Reviewing all risk and sustainability programmes for the long term future of the chemical organisations
Residents living around chemical installations	Chemical organisations must grow within the communities that they operate from and develop a win-win relationship by operating safely.
Use of alternative energy sources	Due the enormous destruction of of our planet with chemicals and our reliance, many investors and seeking alternative safe energy. Chemical organisations need to follow the clean energy route.
One major chemical incident / accident can shut down the organisation eg Union Carbide in Bopal India	The adage is ‘ take care of the pennies and the pounds will take of themselves’ it is important the chemical organisations manage and reduce the NM&MI which they

	believe are more of a nuisance value, then the major incidents will reduce in proportion.
Too many chemicals:- 15 million commercially, about 70 thousand substances in regular use.	The opportunity exits for the reduction of chemicals into common groups and formulas, dilute them into safe components and keep them generic.
1970 to 1998- global report on incidents- 13000 deaths; 100000 injuries/ illness; and evacuation of over 3 million people.	This research paves the way in how the chemical organisations need to address the NM&MI in better managing the incidents and accidents.
Litigation from the public on pollution and its side effects	Operate safer plants and reduce the impact of litigation.
The massive costs of all the incidents/ accidents globally and many started as near misses and minor incidents.	The opportunity again calls for the strict management of NM&MI and in doing so keep the major disasters in check.
The World Health Organisation, The Occupational safety, health act; International Labour Organisation; National Environmental management act; South African department of labour.	Follow all the rules and regulations before the incidents and accidents and not after. Be a leader in operating a safe organisation. Set up a safety culture that upholds good safety behaviour and attitude. Lead by example.
Competition from other chemical organisations	Manage safety, health and environmental approaches and keep the competition out and become the chemical organisation of choice for the chemical market, expand global trade, maximise profits

Source: Guidance on Developing *Safety* Performance Indicators for Industry; Manual - World *Health Organisation; Health*, *Safety* and *Environment; Safety* and *Health* Management System

In March 2010, the magazine SHEQAFRICA reported that process safety managers agree that minor incidents offer opportunities to measure and manage health and safety, and prevent major disasters. Industrial history worldwide between 1911 and 1995, records 525 major hazardous chemicals incidents. Despite adopting modern technology and methods to manage process safety, some areas still require improvement, as the number and size of process operations increase worldwide. BP Texas City refinery explosion in 2005 caused 15 deaths and 170 injuries. Buncefield fire and explosion in England in 2005 caused losses counted in the billions. Countless minor incidents occur all the time, each with the potential to cause disasters, depending on multiple manageable factors.

BP Texas City refinery explosion in 2005 caused 15 deaths and 170 injuries. Buncefield fire and explosion in England in 2005 caused losses counted in the billions.

Vice President of the Texas City Refinery cited after an explosion on 24 April 2006, at the Center for Chemical Process Safety, 2nd Global Congress on Process Safety, in Orlando, Florida: "This was a preventable incident. It should be seen as a process failure, a cultural failure and a management failure."

Mannan, West, and Berwanger (2007:16-21) in their article Lessons learned from recent incidents: Facility sitting, atmospheric venting, and operator information systems state that following incidents occurred due to operator information deficiency :

1. Texaco Refinery, Milford Haven Wales, July 1994

The explosion was caused by flammable hydrocarbon liquid being continuously pumped into a process vessel that, due to a valve malfunction, had its outlet closed. The investigation into the incident also identified excessive alarms — two operators were confronted with 275 alarms during the 11 min before the explosion.

2. Bellingham pipeline rupture, June 1999

A 16-in-diameter steel pipeline owned by Olympic Pipe Line Company ruptured and released about 237,000 gal of gasoline into a creek in Bellingham, Washington. The escaping gasoline ignited and burned along

1.5 miles of the creek. Several people died as a result of the accident. The incident report noted that the computer system may have been overloaded with extraneous tasks, thereby providing sluggish response to pipeline conditions and operator actions.

3. BP Texas City Refinery, March 2005

A catastrophic release of hydrocarbons resulted in fires and explosions that caused the deaths of 15 workers and injured more than 170 others. The BP final report clearly states that the incident would not have occurred if the process control system was placed on automatic control during the start up when the raffinnate tower level passed 50%, a manual requirement in the written start up procedure.

4. Terra Industries, Port Neal, IA, December 1994

A probe used to monitor pH in an ammonium nitrate unit neutralization tank was out of commission for 2 weeks prior to the accident, but operations continued. Operators were unable to determine when unsafe acidic conditions developed in the tank, contributing to the accident.

5. Tosco Martinez, California Refinery, February 1999

Control room indications of hydrocracker temperature were unreliable, and operators were forced to obtain temperature readings from a distant field instrument panel. This prevented operators from taking timely action to mitigate a dangerous temperature excursion. A pipe rupture occurred, killing one worker (ironically, the same worker who was monitoring the field temperature reading).

6. Shell Chemical, Deer Park, TX, June 1997

A check valve used to control process gas flow was not properly designed for heavy duty hydrocarbon gas service. The design of the valve placed extremely high stresses on a relatively thin drive shaft dowel pin. The pin fractured and the drive shaft was expelled from the valve, resulting in a large flammable gas leak and vapour cloud explosion.

7. Surpass Chemical, Albany, NY, April 1997

The company had recently installed a scrubber at the end of the vent pipe connected to a large hydrochloric acid storage tank to neutralize acid vapour emissions from the storage tank. However, the scrubber also caused back pressure to build up in the tank when it was being filled, and the tank ruptured.

Observations

Each of the incidents discussed above occurred or was made more severe because the instrumentation necessary to safely control the process was not available or the alarm systems did not give the operators the most important information or, even worse, inundated the operators with vast quantities of redundant or irrelevant data. Operators were essentially forced to “fly blind”.

PROCESS HAZARD ANALYSIS

April 11, 2003, explosion and resulting ammonia release at the D.D. Williamson and Co. plant in Louisville were caused by over-pressurization of an eight-foot-tall food additive processing tank.

April 12, 2004 chemical accident at the MFG Chemical Inc. facility in Dalton, Georgia, which triggered a release of allyl alcohol and hydrochloric acid into the surrounding community.

The U.S. Chemical Safety and Hazard Investigation Board (CSB) is investigating a spill of approximately 12,500 tons of molten sulfur from a storage tank located at the Port of Tampa, Florida.

Washington, DC, March 30, 2004 - U.S. Chemical Safety and Hazard Investigation Board (CSB) Chairman Carolyn W. Merritt praised the U.S. Occupational Safety and Health Administration (OSHA) (US Department of Labour, 2009) for its initiative in forming a new alliance to address reactive chemical hazards, saying the effort "can help save lives, protect businesses, and spare communities from the devastating impact of reactive chemical accidents."

Baton Rouge, LA, March 30, 2004 - Investigators from the U.S. Chemical Safety and Hazard Investigation Board (CSB) provided a community update on the ongoing investigations into three accidents that occurred at Honeywell International in East Baton Rouge Parish over a 24-day period in 2003.

INCIDENT 1: CHLORINE RELEASE - July 20, 2003

A chlorine release on July 20, 2003, injured eight Honeywell employees with four of them hospitalized. It was caused by a failure of a chlorine cooler, which allowed liquid chlorine to enter the refrigerant system.

INCIDENT 2: ANTIMONY PENTACHLORIDE RELEASE - July 29, 2003

Investigator Mike Morris reported that a worker, Delvin S. Henry, was fatally injured after he was sprayed with spent, or used, antimony pentachloride, a highly corrosive chemical that can cause serious chemical burns and lung damage.

INCIDENT 3: HYDROFLUORIC ACID SPRAY INCIDENT - Aug. 13, 2003

CSB Investigator Johnnie Banks reported that the Honeywell plant had been rapidly shut down following the July 20, 2003, chlorine accident. After the July 29 incident the company ordered the facility to remain shut down until

procedures and equipment could be checked to ensure the facility could be operated safely. On Aug. 13, liquid hydrofluoric acid splashed onto a worker.

Investigators from the U.S. Chemical Safety and Hazard Investigation Board (CSB) have determined that the October 2003 fatal accident at the Hayes Lemmerz automotive parts plant at Huntington, Indiana likely involved an explosion of aluminium dust that originated near an aluminium chip melting furnace.

Combustible dust, ignited by a malfunctioning oven, caused an explosion and fire that took seven lives and caused over thirty injuries. The incident occurred at the CTA Acoustics plant in Corbin, KY, in Feb. 2003

In New York City the U.S. Chemical Safety and Hazard Investigation Board (CSB) has presented preliminary findings from an investigation into the April 2002, explosion at Kaltech Industries, which injured 31 people seriously enough to seek hospital treatment, including 14 members of the public.

(Washington, DC - November 22, 2002) The U.S. Chemical Safety Board approved the final staff report into the root causes of the January 16, 2002, hydrogen sulfide gas leak at the Georgia-Pacific Naheola pulp and paper mill

in Pennington, Alabama, which took the lives of two workers and injured another eight.

(Sept. 20, 2002 - Washington, DC) Meeting before a public audience in Houston on September 17th, the U.S. Chemical Safety and Hazard Investigation Board (CSB) unanimously approved a total of 18 new recommendations to reduce the number of serious industrial accidents caused by uncontrolled chemical reactions and called on the Occupational Safety and Health Administration (OSHA) (US Department of Labour, 2009) and the U.S. Environmental Protection Agency (EPA) to issue new mandatory safety standards.

CSB investigators told the Board members and the public that inadequate controls of chemical reaction hazards are responsible for continuing deaths, injuries, and environmental and property damage around the country. Three workers who were severely burned on March 27, 2000, in a reactive accident at Phillips Chemical Co. in Pasadena, Texas, spoke at the public meeting prior to the Board vote.

New York City Scaffolding Disaster Kills 5 and Injures Many Others
October 15th, 2001

A 14-story combination frame and tube and clamp scaffolding erection collapsed and crushed five workers to death in New York City's Gramercy Park neighbourhood on October the 15th. NYC Licenses and Inspection Authorities were quoted as saying that the scaffolding was erected without a permit and was never inspected by the city. Also injured in the incident were 13 workers, a pregnant woman who was a bystander and several FDNY and NYPD rescue workers.

Workers erected the scaffolding, which was set up to repair the facade in a courtyard behind 215 Park Avenue South. It was reported that both the construction firm and the scaffold erectors had had run-ins with both regulatory and legal authorities in the recent past.

Another Ammonium Nitrate Disaster, 29 people killed, 34 'gravely injured', and 650 others hospitalized.
September 21st, 2001

The most damaging non-nuclear explosions worldwide have been caused by ammonium nitrate. The most disastrous was the 1947 explosion of an ammonium nitrate loaded ship in the Texas City, Texas Harbour.

Ammonium nitrate is an amazing fertilizer. You can write your name in your lawn by carefully sprinkling it. However, its great hazard is that it is also both an explosive and a monopropellant. That is, the molecule contains both oxidizing (nitrate) and reducing (ammonium) components.

SERIOUS INCIDENTS UNDER INVESTIGATION

SULFURIC ACID TANK FAILURE AND FIRE DELAWARE CITY, DELAWARE - JULY 17, 2001

The catastrophic failure of a storage tank containing spent sulfuric acid that followed with a fire killed one contract employee and injured eight people. The incident occurred at the Motiva Enterprise's Delaware City, Delaware refinery.

Maintenance operations were on-going near the tank, which was close to other tanks. Five contract employees were welding on metal catwalks above the tanks. Over 600,000 gallons of acid emptied into the Delaware River. As of the first week of August, the dead contractor had not been found.

Employees reported that the tank had holes in it before the incident "that you could put your arm through". Possibly the practice was to not fill the tank to those levels that would cause an immediate leak. Whatever berm there was around the tank to contain any spills apparently failed rapidly and allowed most of the stored acid into the river.

RUNAWAY CHEMICAL REACTION INCIDENT PATERSON, NEW JERSEY - July 18, 2000

Investigators from the U.S. Chemical Safety and Hazard Investigation Board (CSB) have concluded that the April 1998 explosion at Morton Specialty Chemical's (now Rohm and Haas) Paterson, New Jersey facility likely could have been prevented had the company's safety program for reactive chemicals followed recommended industry safety practices. The blast injured nine workers and released chemicals into the neighbouring community.

REFINERY EXPLOSION CHARGES AND COUNTER CHARGES

Employee Lawsuit Against Tosco

On January 19, 2000 the surviving victim of a February 23, 1999 explosion at Tosco Corp.'s refinery in Avon, CA near San Francisco and the family of an operator killed in the blast filed a wrongful death lawsuit against the TOSCO. The explosion, occurred when repairs were made to a leaking naphtha 'drawline' in a crude fractionator unit. Four contract workers were killed. Tosco staff operator Steven Duncan, the lead plaintiff in the case was severely burned. Duncan reportedly saved his life by jumping 58 feet down from the scaffolding that supported the repair crew.

DELAY REFINERY MAINTENANCE TO BOOST PRODUCTION?

Union Executive Reacts to Energy Secretary's Comments

As reported in PRNewswire from Nashville, Tennessee, on February 17th, Executive Vice President Robert E. Wages of PACE International Union (Paper, Allied-Industrial, Chemical and Energy Workers) reacted angrily to February 16th statements by U.S. Energy Secretary Bill Richardson. Richardson had urged U.S. oil refiners to delay scheduled maintenance work in order to boost production.

Mr. Wages said ``delays in scheduled maintenance in an industry that already stretches its maintenance schedule to the outer limit poses an imminent danger to all involved.'' Robert Wages heads the PACE national oil bargaining program and handles the union's day-to-day relations with oil industry employers.

Maintenance Delays Blamed for Other Refinery Incidents

Richardson's request, made in a statement on February 16th, was announced as a move to help keep oil prices down by boosting production. ``This is indefensible,'' said Wages. ``The increased risk to the health, safety and environment of our members, other refinery workers and PACE communities is unacceptable to us.'' Wages cited two other serious refinery accidents in recent years, one at a Unocal facility in Lemont, Ill., and another at a Shell refinery in Norco, La., both of which involved the employer's failure to perform scheduled maintenance. The February 1999 accident at a Tosco Corp. refinery in Avon, Calif., involved maintenance performed on high temperature and pressure units while they were operating to minimize production losses.

FERTILIZER PLANT EXPLOSION KILLS ONE, INJURES TEN OTHERS

An explosion and fire at CF Industries' Donaldsonville, La., fertilizer plant killed one worker and injured 10 others. Five of the injured workers and the one killed were contractors employed by Catalyst Process Specialists Inc.; another injured worker was with Turner Industries Services. Both companies had employees at the site conducting routine maintenance. The other four injured were CF Industries employees.

HYDROXYLAMINE EXPLOSION KILLS FOUR

An explosion at a hydroxylamine plant in Gunma Prefecture in Japan destroyed the facility on June 10, 2000. The blast killed four people and injured 28.

The plant was operated by Nisshin Chemical, a small producer of purified hydroxylamine. The company's president is reported to have said that purified hydroxylamine, which has an explosive power similar to TNT, had exploded. The material, which is used as a cleaning agent in the manufacturing of semiconductors, becomes unstable when heated.

OSHA CITES CONCEPT SCIENCES, INC. FOR SAFETY AND HEALTH VIOLATIONS; PROPOSES PENALTIES OF $641,200.

The federal Occupational Safety and Health Administration (US Department of Labour, 2009) has cited Concept Sciences, a chemical manufacturing company near Allentown, Pa., for safety violations that allegedly led to a catastrophic explosion in February, 1999. OSHA proposed penalties of $641,200. The explosion killed five workers, including a father and son, and injured two others.

The 11 alleged, wilful violations, with a total proposed penalty of $616,000, are composed of various groupings of individual requirements of both standards. They include: *failure to compile process safety information; *inadequate process hazard analysis and operating procedures; *failure to train employees on operating procedures and the physical hazards of chemicals; *lack of a pre-startup safety review; *process equipment deficiencies; and *failure to develop mechanical integrity procedures.

Herbicide Exposure Contributes to Fatalities

On October 12, 1998 there was a fatal exposure to herbicide components in a Michigan factory. The incident occurred at the Dow Chemical AgroSciences plant in Midland, Mich. The worker's hands and feet were exposed to 2,4-dichlorophenol and were undergoing decontamination when he suffered a fatal cardiac arrest.

Six Die in Explosion During Recovery from Power Outage

An explosion occurred at about 1:30 p.m. Pacific Standard Time Wednesday (11/25/98) at the Equilon Puget Sound Refining Co. in Anacortes, Wash.

Company officials report that at the time of the explosion the plant was recovering from a total electrical power failure which began Monday evening as a result of recent wind storms. They say the explosion and fire occurred in the delayed coker unit, which is part of the refining process.

Seven Die in Natural Gas Well Explosion

The CSHIB is investigating ***the Bryceland, La. site of a natural gas well explosion*** which claimed the lives of seven workers. Bryceland is about 45 miles east of Shreveport.

The explosion occurred at about 2 p.m. Saturday October 24, 1998 at a well owned by Sonat Exploration Company. The CSHIB already has an investigation underway of a March 4, 1998 explosion at a Sonat oil separation facility, in Pitkin, La., which killed four men working for the company.

35 Injured in Processing Tank Incident

An explosion and fire ripped through a Point Comfort, Texas chemical plant on October 12, 1998. The incident at the Formosa Plastics Corporation injured at least 35 employees and contract workers and at least two members of the public.

Reports from the company indicate that the incident occurred when a processing tank exploded for unknown reasons. The force of the blast sent a shock wave that blew out the windows of a maintenance building 300 yards away. Most of the injuries were reportedly to workers who were struck by flying debris, and none were considered life-threatening.

ADD AN ODORANT TO NITROGEN?

Nitrogen is odourless. Natural gas is almost odourless. Most people are familiar with the odour of the mercaptans added universally to consumer natural gas so that concentrations of natural gas can be detected by the disagreeable mercaptanodor. That odour has proven very effective in warning of natural gas leaks.

OSHA (US Department of Labour, 2009) reports that in the 1990s there have been three to four deaths per year caused by asphyxiation due to nitrogen. Individuals have tried briefly entering nitrogen atmospheres while holding their breath. One slip-up, and a breath or two in that atmosphere can mean death. *Just don't try it!*

A March 1998 asphyxiation due to a worker entering a pipeline blanketed with nitrogen has prompted the CSHIB to request that NIOSH investigate the feasibility of adding an odorant to nitrogen. NIOSH has commented that such a study will be involved and will take awhile.

Meanwhile, all workers must be properly trained about the hazards of entering confined spaces, and must be trained in the importance of sampling for a safe breathing oxygen level, and must know the use of PPE.

For a fee-based consultation call with a Licensed Professional Engineer between 3:00pm and 5:00pm Eastern Daylight Time, call (302) 239-2700.For information at any time on our Hazardous Waste Operations and Emergency Response (HAZWOPER) and other safety training.

APPENDIX I: Statistical analysis for employee survey

Demographics

Please find graphs of demographics attached in Excel file.

Cronbach's alpha

Cronbach's alpha is calculated to find out whether specific groups of questions are consistent and therefore could be joined together to measure one 'theme'. Before applying Cronbach's, some questions which were worded in a 'negative direction' were recoded so that all questions had the same positive direction. These included Q4, Q12 – 13, Q16 – 18, Q19 and Q23. The new wording is: 4.In my workplace superiors never turn a blind eye to safety incidents

12. All health and safety rules and procedures are practical
13. All safety rules and procedures need to be followed to get the job done safely
16. Operational targets never conflict with safety measures
17. Conditions here never hinder my ability to work safely
18. I am always given enough time to get the job done safely
19. No employees display a poor attitude towards their job
23. There are not many inexperienced staff in our workplace

Group	Questions	Cronbach's alpha
Management Commitment	Q1 – Q6	0.757
Priority of Safety and Health	Q8 – Q11	0.764
Safety Rules and Procedures	Q12 – Q13	0.604
Work Environment	Q16 – Q18	0.450
Communication	Q25 – Q27	0.656

Generally, an alpha value of 0.7 or more is considered good and the questions can be grouped to measure one 'idea'. Thus, Management commitment and Priority of Safety and Health can become two groups. The value of 0.65 is not too low and I would join these if necessary. However, the work environment questions and the safety rules and procedures questions need to be kept separate as they are not consistent with each other and cannot be thought of as measuring one 'idea'.

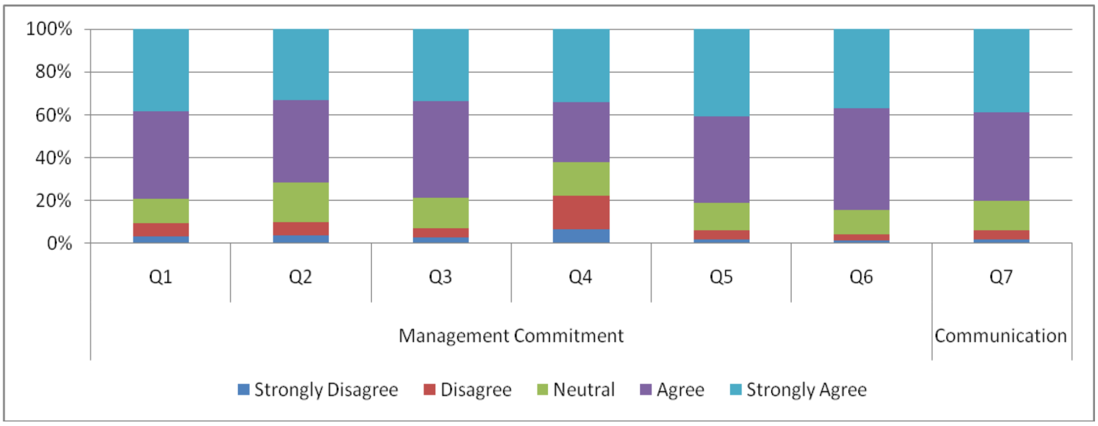
Chi-square goodness-of-fit

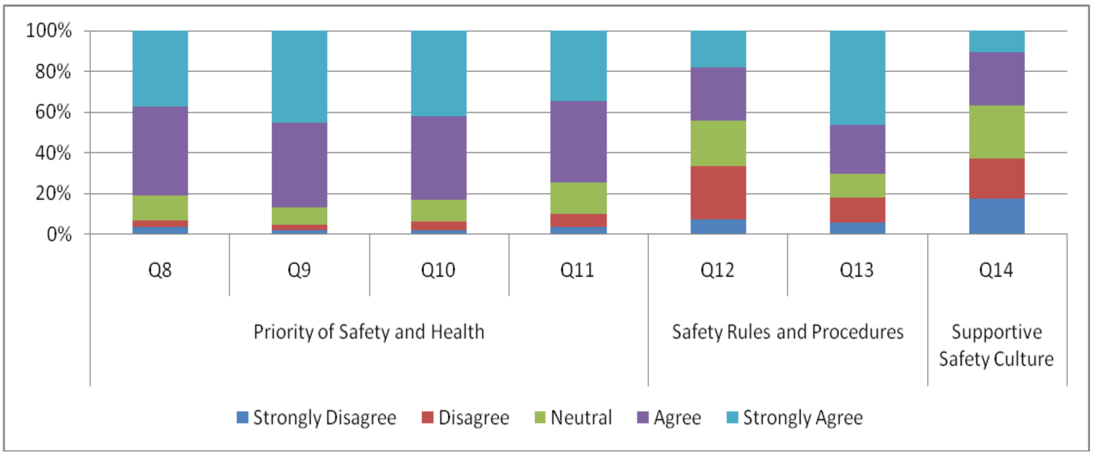
This test was applied to all questions to ascertain whether any one option was selected significantly more/less often than expected. (Under the null hypothesis, it is assumed that all options are equally likely to be chosen.) All questions (1 – 30) showed that response options were not equally chosen. Results are summarized below.

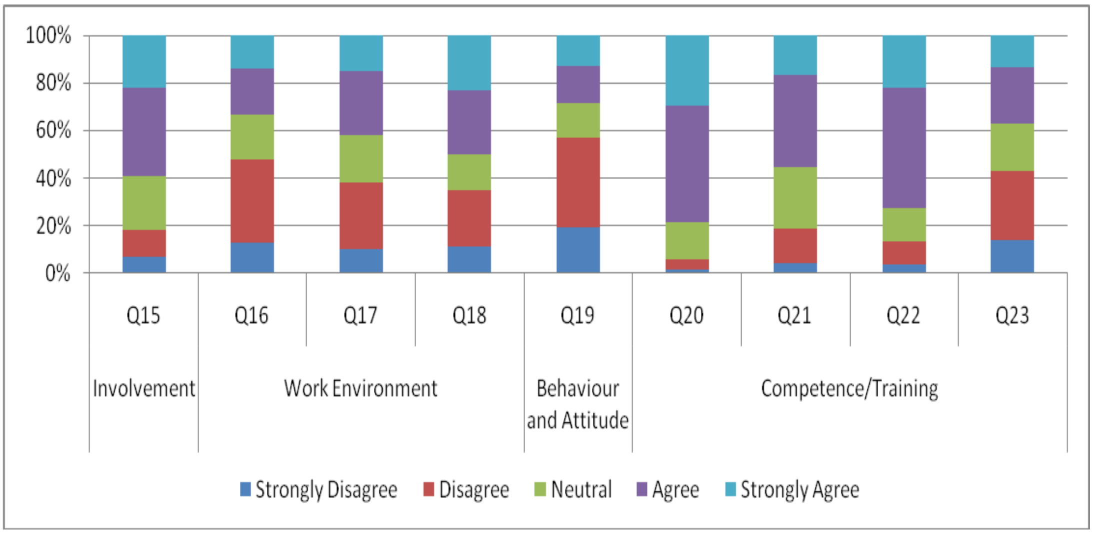
			SD	D	N	A	SA	p-value	Significant...
Management Commitment									
	Q1		13	23	43	154	146	<.0005	agreement
	Q2		14	24	69	147	125	<.0005	agreement
	Q3		10	17	54	171	127	<.0005	agreement
	Q4		26	58	60	106	129	<.0005	agreement
	Q5		8	16	48	153	154	<.0005	agreement
	Q6		6	11	43	179	140	<.0005	agreement
Communication									
	Q7		8	16	52	155	148	<.0005	agreement
Priority of Safety and Health									
	Q8		12	13	46	166	142	<.0005	agreement
	Q9		6	11	32	158	172	<.0005	agreement
	Q10		6	17	39	156	161	<.0005	agreement
	Q11		12	24	59	152	132	<.0005	agreement
Safety Rules and Procedures									
	Q12		27	99	85	99	69	<.0005	agree and disagree(not strongly)
	Q13		20	47	44	92	176	<.0005	agreement
Supportive Safety Culture									
	Q14		64	75	100	99	41	<.0005	neutral and agree(not strongly)
Involvement									
	Q15		26	44	85	141	83	<.0005	agree

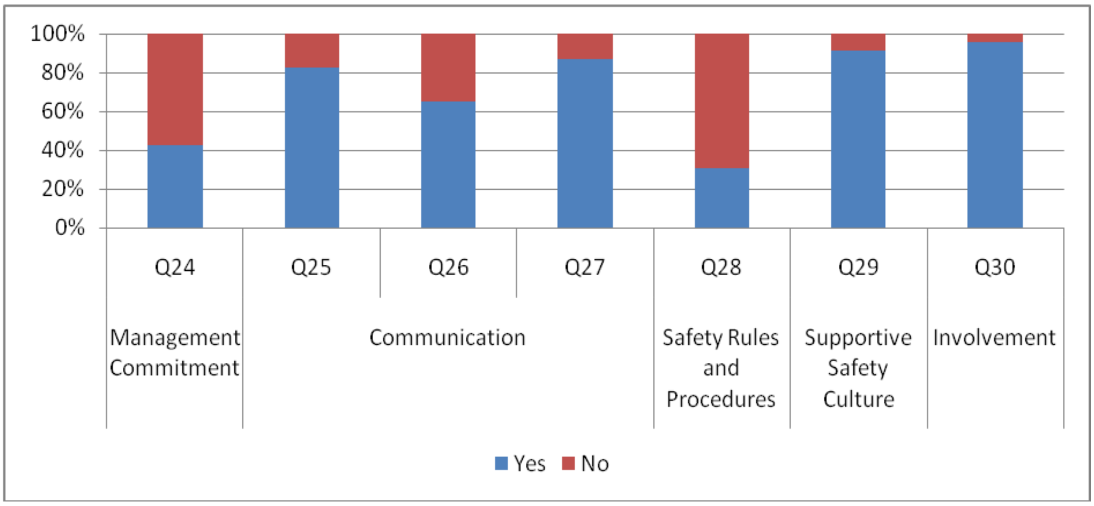
Work Environment									
	Q16		49	133	71	74	52	<.0005	disagree(not strongly)
	Q17		39	106	75	102	57	<.0005	Agree and disagree(not strongly)
	Q18		42	90	58	101	88	<.0005	Agree and not strongly disagree
Behaviour and Attitude									
	Q19		74	143	53	61	48	<.0005	disagree
Competence/Training									
	Q20		6	17	58	185	113	<.0005	agreement
	Q21		17	53	97	147	62	<.0005	agree(not strongly)
	Q22		14	37	53	192	83	<.0005	agree
	Q23		53	110	76	89	51	<.0005	disagree

			Yes	No	p-value	Significant...
Management Commitment						
	Q24		160	219	0.002	no
Communication						
	Q25		312	67	<.0005	yes
	Q26		245	133	<.0005	yes
	Q27		330	49	<.0005	yes
Safety Rules and Procedures						
	Q28		115	264	<.0005	no
Supportive Safety Culture						
	Q29		345	34	<.0005	yes
Involvement						
	Q30		362	17	<.0005	yes


100%
80%
60%
40%
20%
0%
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Management Commitment
Communication
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


100%
80%
60%
40%
20%
0%
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Priority of Safety and Health
Safety Rules and Procedures
Supportive Safety Culture
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


100%
80%
60%
40%
20%
0%
Q15
Q16
Q17
Q18
Q19
Q20
Q21
Q22
Q23
Involvement
Work Environment
Behaviour and Attitude
Competence/Training
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree



T-test and averages

For Q1 – Q23, the average score was calculated. This score was then analysed (t-test) against an average value of 3 to test whether the average is significantly different from the neutral value of 3. The null hypothesis states that the average value = 3. Significant results would indicate that there is significant agreement or disagreement.

Significant results are shown in red.

Question	Average score	p-value	Interpretation
1. In my workplace management usually acts immediately to correct safety incidents	4.05	<.0005	agreement
2. Management usually acts decisively when a safety concern is raised	3.91	<.0005	agreement
3. Corrective action is taken when management is told about unsafe incidents	4.02	<.0005	agreement
4. In my workplace superiors never turn a blind eye to safety incidents	3.67	<.0005	agreement
5. In my workplace managers/supervisors show interest in my safety	4.13	<.0005	agreement
6. Managers and supervisors express concern if safety procedures are not adhered to	4.15	<.0005	agreement
7. My superior always informs me of current concerns and incidents	4.11	<.0005	agreement
8. Safety rules and procedures are carefully followed	4.09	<.0005	agreement
9. I believe that safety issues are assigned a high priority	4.26	<.0005	agreement

10. I believe management clearly considers the safety of employees of great importance	4.18	<.0005	agreement
11. I Believe management considers safety to be equally as important as production	3.97	<.0005	agreement
12. All health and safety rules and procedures are practical	3.22	<.0005	agreement
13. All safety rules and procedures need to be followed to get the job done safely.	3.94	<.0005	agreement
14. A "no-blame" approach is used to persuade people acting unsafely that their behaviour is inappropriate.	2.94	.367	
15. I am sometimes involved in the ongoing review of safety	3.56	<.0005	agreement
16. Operational targets never conflict with safety measures	2.86	.032	disagreement
17. Conditions here never hinder my ability to work safely	3.08	.189	
18. I am always given enough time to get the job done safely	3.27	<.0005	agreement
19. No employees display a poor attitude towards their job	2.65	<.0005	disagreement
20. Safety reports are generally well written	4.01	<.0005	agreement
21. Contract labour are generally competent	3.49	<.0005	agreement
22. My safety training is adequate	3.77	<.0005	agreement
23. There are not many inexperienced staff in our workplace	2.93	.314	

Below is a list of the questions in order from most agreed to most disagreed. Red values are those showing significant agreement/disagreement.

Question	Average score
9. I believe that safety issues are assigned a high priority	4.26
10. I believe management clearly considers the safety of employees of great importance	4.18
6. Managers and supervisors express concern if safety procedures are not adhered to	4.15
5. In my workplace managers/supervisors show interest in my safety	4.13
7. My superior always informs me of current concerns and incidents	4.11
8. Safety rules and procedures are carefully followed	4.09
1. In my workplace management usually acts immediately to correct safety incidents	4.05
3. Corrective action is taken when management is told about unsafe incidents	4.02

20. Safety reports are generally well written	4.01
11. I Believe management considers safety to be equally as important as production	3.97
13. All safety rules and procedures need to be followed to get the job done safely.	3.94
2. Management usually acts decisively when a safety concern is raised	3.91
22. My safety training is adequate	3.77
4. In my workplace superiors never turn a blind eye to safety incidents	3.67
15. I am sometimes involved in the ongoing review of safety	3.56
21. Contract labour are generally competent	3.49
18. I am always given enough time to get the job done safely	3.27
12. All health and safety rules and procedures are practical	3.22
17. Conditions here never hinder my ability to work safely	3.08
14. A “no-blame” approach is used to persuade people acting unsafely that their behaviour is inappropriate.	2.94
23. There are not many inexperienced staff in our workplace	2.93
16. Operational targets never conflict with safety measures	2.86
19. No employees display a poor attitude towards their job	2.65

Chi-square test of Independence

Questions 1 – 30 have been cross-tabulated with the demographic variables Department, Position and Years of service. Chi-square test of independence has then been applied to ascertain whether a significant relationship exists between the responses to the questions and the categories of the given demographic variable. To ensure validity of results, categories have been combined as follows:

Strongly disagree and disagree = Disagreement

Strongly agree and agree = Agreement

Those respondents that selected ‘Neutral’ were excluded from the analysis as it is deemed that they are fence sitters and don’t add to the analysis. Thus this test is examining whether significantly more than expected of the respondents from different position categories/department categories/service categories show agreement or disagreement with the statements of Q1 – Q30.

Significant results are summarized below.

	Question	Chi-square p-value	Fisher's Exact p-value	Relationship Significantly more than expected.... Responded ....
Department	8. Safety rules and procedures are carefully followed	0.01	0.024	Custserv/ Admin/ Training = Disagree
	13. All safety rules and procedures need to be followed to get the job done safely	0.029	0.025	IT = disagree
	16. Operational targets never conflict with safety measures	0.006	0.003	Ops = Disagree; Custserv/HR/Admin/Other = Agree
	17. Conditions here never hinder my ability to work safely	0.037	0.025	Ops = Disagree; Finance/Training/Other = Agree
	24. Generally management acts only after accidents have occurred	0.001	<.0005	Ops = Yes; C&S/ Other = No
Position	4. In my workplace superiors never turn a blind eye to safety incidents	0.026		Clerk = Disagree
	5. In my workplace managers/supervisors show interest in my safety	0.013	0.025	Operator = Disagree
	6. Managers and supervisors express concern if safety procedures are not adhered to	0.004	0.008	Operator = Disagree
	16. Operational targets never conflict with safety measures	0.007		Clerk/Other = Agree; Contractor = Disagree

	17. Conditions here never hinder my ability to work safely	0.008		Manager/Clerk = Agree; Operator = Disagree
	18. I am always given enough time to get the job done safely	0.003		Other/Clerk = Agree; Contractor = Disagree
	22. My safety training is adequate	0.05		Operator = Disagree
	24. Generally management acts only after accidents have occurred	<.0005		Contractor = Yes; Manager/Other = No
	25. Management operates an open door policy on safety	0.001		Manager = Yes; Operator = No
	26. I receive praise for working safely	<.0005		Supervisor/Clerk/Other = Yes; Operator = No
	27. Generally there is good communication on safety in our organisation	0.003	0.005	Contractor = No
	28. Sometimes it is necessary to depart from safety requirements for production's sake	<.0005		Operator/Contractor = Yes; Manager/Clerk/Other = No
	29. I am strongly encouraged to report unsafe conditions	<.0005	<.0005	Contractor = No
	30. I understand my role and responsibilities for health and safety	0.006	0.02	Contractor = No

	Question	Chi-square p-value	Fisher's Exact p-value	Relationship Significantly more than expected.... Responded ....
Service	20. Safety reports are generally well written	0.013	0.036	21 - 25/36+ = Disagree
	21. Contract labour are generally competent	0.036	0.036	21 - 25/31 - 35/36+ = Disagree
	24. Generally management acts only after accidents have occurred	0.048	0.031	1 - 5 = Yes; 16 = 20 = No
	26. I receive praise for working safely	0.025	0.011	16 - 20 = Yes; 6 - 10 = No

[Please note that in some cases it was necessary to use Fisher's exact test to find the p-value. This was in order to satisfy conditions and validate results.]

APPENDIX J: Statistical analysis for NM&MI database

Frequency Tables and analysis of counts

Category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Safety	227	54.2	54.2	54.2
	Environment(Spillage, Release, Fire)	138	32.9	32.9	87.1
	Other	54	12.9	12.9	100.0
	Total	419	100.0	100.0	

a. Sector = Chemical

Cause

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Accidental Human error	191	45.6	45.6	45.6
	Poor work by Humans	181	43.2	43.2	88.8
	Negative human behaviour	5	1.2	1.2	90.0
	Mechanical failure/accidents	41	9.8	9.8	99.8
	Other	1	.2	.2	100.0
	Total	419	100.0	100.0	

a. Sector = Chemical

Impact

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Personal injury	172	41.1	41.1	41.1
	Damage to property	21	5.0	5.0	46.1
	Interruption/'damage' to business	171	40.8	40.8	86.9
	Near miss	55	13.1	13.1	100.0
	Total	419	100.0	100.0	

a. Sector = Chemical

Seriousness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	1.4	1.4	1.4
	2	25	6.0	6.0	7.4
	3	140	33.4	33.4	40.8
	4	248	59.2	59.2	100.0
	Total	419	100.0	100.0	

a. Sector = Chemical

For each of these 'measures' analysis is done to ascertain whether any category occurs more/less often than would be expected. We expect each category to be equally likely to occur. The Chi-square goodness-of-fit test is applied.

Category: Significantly more incidents than expected ($p<.0005$) fall under the 'safety' category.

Cause: Significantly more incidents than expected ($p<.0005$) are caused by Human error – both accidental and poor standard of work.

Impact: Significantly more incidents than expected ($p<.0005$) resulted in personal injury or an interruption to production/'damage to the business'.

Seriousness: More than expected of the incidents ($p<.0005$) have a seriousness rating of '4' – the least serious rating.

Cross-tabulations and analysis of relationships

For each of the following cross-tabulations, chi-square test of independence is applied to investigate whether a significant relationship exists between the two variables.

Category X Cause

Category * Cause Cross tabulation

Count

		Cause					Total
		Accidental Human error	Poor work by Humans	Negative human behaviour	Mechanical failure/accidents	Other	
Category	Safety	167	54	0	6	0	227
	Environment(Spillage, Release, Fire)	18	89	0	31	0	138
	Other	6	38	5	4	1	54
Total		191	181	5	41	1	419

a. Sector = Chemical

Significantly more than expected ($p<.0005$) of the incidents in the 'safety' category were caused by accidental human error; those in the Environmental category were caused by Mechanical failure or 'poor quality work by humans'; and those in the 'other' category were caused by 'negative behaviour' or 'poor work quality'.

Category X Impact

Category * Impact Cross tabulation

Count

		Impact				Total
		Personal injury	Damage to property	Interruption/'damage' to business	Near miss	
Category	Safety	170	3	20	34	227
	Environment(Spillage, Release, Fire)	0	6	112	20	138
	Other	2	12	39	1	54
Total		172	21	171	55	419

a. Sector = Chemical

Significantly more than expected (p<.0005) of the incidents in the 'safety' category resulted in personal injury; those in the Environmental category resulted in an interruption to production/damage to the business; and those in the 'other' category resulted in damage to property and an interruption to production/damage to the business.

Category X Seriousness

Category * Seriousness Cross tabulation

Count

		Seriousness				Total
		1	2	3	4	
Category	Safety	1	10	88	128	227
	Environment(Spillage, Release, Fire)	4	11	38	85	138
	Other	1	4	14	35	54
Total		6	25	140	248	419

a. Sector = Chemical

No significant relationship exists between these two variables.

Cause X Impact

Cause * Impact Cross tabulation

Count

		Impact				Total
		Personal injury	Damage to property	Interruption/'damage' to business	Near miss	
Cause	Accidental Human error	165	7	18	1	191
	Poor work by Humans	4	7	121	49	181
	Negative human behaviour	1	1	3	0	5
	Mechanical failure/accidents	1	6	29	5	41
	Other	1	0	0	0	1
Total		172	21	171	55	419

Cause * Impact Cross tabulation

Count

		Impact				Total
		Personal injury	Damage to property	Interruption/'damage' to business	Near miss	
Cause	Accidental Human error	165	7	18	1	191
	Poor work by Humans	4	7	121	49	181
	Negative human behaviour	1	1	3	0	5
	Mechanical failure/accidents	1	6	29	5	41
	Other	1	0	0	0	1
Total		172	21	171	55	419

a. Sector = Chemical

Significantly more than expected ($p < 0.0005$) of the incidents caused by accidental human error, result in personal injury; those caused by poor quality work result in an interruption to production/damage to the business or ‘near miss’; those caused by negative behaviour result in damage to property; and those caused by mechanical failure result in damage to property or an interruption to production/damage to the business.

Cause X Seriousness

Cause * Seriousness Cross tabulation

Count

		Seriousness				Total
		1	2	3	4	
Cause	Accidental Human error	1	7	60	123	191
	Poor work by Humans	1	14	64	102	181
	Negative human behaviour	0	0	0	5	5
	Mechanical failure/accidents	4	4	15	18	41
	Other	0	0	1	0	1
Total		6	25	140	248	419

Significantly more than expected (p=0.004) of the incidents caused by mechanical failure/accidents result in a seriousness level of ‘1’ – the worst level.

Impact X Seriousness

Impact * Seriousness Cross tabulation

Count

		Seriousness				Total
		1	2	3	4	
Impact	Personal injury	1	7	60	104	172
	Damage to property	3	1	7	10	21
	Interruption/'damage' to business	2	14	39	116	171
	Near miss	0	3	34	18	55
Total		6	25	140	248	419

a. Sector = Chemical

Significantly more incidents than expected (p<0.0005) which damaged property, had a level of seriousness of 1 (very serious); those than impacted by interrupting business/damaging the business had a seriousness level of 4; and the near misses had a seriousness of 3.

APPENDIX K: NM&MI COST CALCULATION (AVERAGE)

The average of ten NM&MI (5x low value near misses and 5 x high value Minor incidents) from Appendix D is calculated for average costs. The average cost is extended to all 415 NM&MI and a total cost is calculated.

The selected 10 NM&MI are:
High value minor incidents

The temco tanker was 75% full, loading 60/70, then the front side of the container started leaking(spraying). The spill caused is estimated at +/- 12000littres.	Spill	negligence	Investigate and discipline
Tank P started dropping immediately after Plant N unit fire and upon investigation found product on the roof and in the bunded area. +-60000 lts of product overflowed and contained in the bunded area.	Spill	poor operations	Investigate and discipline
The unit operator observed smoke emanating from the diesel compressor and the compressor was taken down. The cover was lifted by and there was a fire at the rear end of the compressor.	Fire	negligence	Investigate and discipline
A contractor working in laydown area noticed a fire at the disel pump and immediately informed the Plant. Fire put off. Diesel engine pin came through block and caused a fire.	Fire	accident breakdown	Review maintenance preparation
6000litres lube spilled	Spill	poor operations	Investigate and discipline

Low value near miss incidents

Struck hand against the emblem on floor mat whilst cleaning	Safety	Accidental injury	Programme to improve safety
First aid muscular strain	Safety	Accidental injury	Programme to improve safety
contractor worked without a permit. Tank D was also full at that time. Contractor was recalled and given a written warning.	Safety	negligence	Programme to improve safety
Vehicle overload	Safety	negligence	Programme to improve safety
Job being done without adopting correct procedures	Safety	non compliance	Investigate and discipline

THE INCIDENT COST CALCULATOR **(NM&MI) Only critical cost elements shown for exercise**		
Description of incident 1. Themco tanker leaked about 12000litres of product		
Dealing with the incident	**Time Spent**	**Costs**
Making the area safe.- 4 x R4800	24hrs	R 19200
Immediate staff downtime (work stopped)	24hrs	4800
Investigation of incident		
Staff time to report and investigate	50	7500
Meeting to discuss incident	50	5000
Getting back to business		
Assessing / rescheduling works	3	600
Recovering work / production (inc staff cost)	10	2000
Cleaning up site, disposal of waste /equipment / production		5000
Business costs		
Overtime costs	20	3000
Potential near miss	10	2000
Sanctions and penalties		
Compensation claim payments		156000
Other costs		
Total		R 205100

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR **(NM&MI) Only critical cost elements shown for exercise**		
Description of incident 2.Tank P –product spilled on to roof during plant fire. 60000 litres spilled into the bund.		
Dealing with the incident	**Time Spent**	**Costs**
Making the area safe -12 x R9600	48hrs	115200
Putting out fires.	6hrs	15000
Immediate staff downtime (work stopped)	6hrs	18000
Investigation of incident		
Staff time to report and investigate	24	6500
Meeting to discuss incident	3	15000
Time spent with SHE / inspector	5	1000
Getting back to business		
Assessing / rescheduling works	5	2000
Recovering work / production (inc staff cost)		50000
Cleaning up site, disposal of waste /equipment / production		65000

Repairing any damage / faults		30000

Hiring or purchasing tools, equipment / plant / services		10000
Business costs		
Lost work time, Persons waiting to resume work. Delays/ reduced production		50000
Overtime costs		30000
Contract penalties		120000
Action to safe guard future business		
Reassuring clients		5500
Providing alternative sources of supply		250000
Total		R783200

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR **(NM&MI) Only critical cost elements shown for exercise**		
Description of incident 3. Diesel compressor on fire		
Dealing with the incident	**Time Spent**	**Costs**
Making the area safe - Putting out fires- 3 x R1773	5hrs	5320
Immediate staff downtime (work stopped)	24hrs	28800
Investigation of incident		
Staff time to report and investigate	4	3000
Meeting to discuss incident	2	4000
Getting back to business		
Assessing / rescheduling works		15000
Cleaning up site, disposal of waste /equipment / production		20000
Repairing any damage / faults		265000
Hiring or purchasing tools, equipment / plant / services		55000
Business costs		
Lost work time, Persons waiting to resume work. Delays/ reduced production		45000
Overtime costs		20000
Cancelled and / or lost instructions		21000
Total		R482120

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR (NM&MI) Only critical cost elements shown for exercise		
Description of incident 4. Diesel pump damaged and resultant fire		
Dealing with the incident	**Time Spent**	**Costs**
Making the area safe	3	1800
Putting out fires.		2500
Immediate staff downtime (work stopped)	5	5000
Investigation of incident		
Staff time to report and investigate	5	3500
Meeting to discuss incident	2	4000
Getting back to business		
Recovering work / production (inc staff cost)		33000
Cleaning up site, disposal of waste /equipment / production		23500
Repairing any damage / faults		285000
Hiring or purchasing tools, equipment / plant / services		24000
Business costs		
Overtime costs		15000
Total		R397300

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR (NM&MI) Only critical cost elements shown for exercise		
Description of incident 5. 6000l of product spilled		
Dealing with the incident	**Time Spent**	**Costs**
Making the area safe - 5 x R1200	12hrs	6000
Immediate staff downtime (work stopped)	4	4000
Investigation of incident		
Staff time to report and investigate	3	2100
Meeting to discuss incident	1	2000
Getting back to business		
Recovering work / production (inc staff cost)		29000
Cleaning up site, disposal of waste /equipment / production		39000
Bringing up work to standard, Product re-working / time costs.		70000
Business costs		
Overtime costs		3200
Action to safe guard future business		
Sanctions and penalties		
Total		R155300

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR (NM&MI) Only critical cost elements shown for exercise		
Description of incident 6. Struck hand on emblem on floor mat when cleaning		
Dealing with the incident	**Time Spent**	**Costs**
First aid treatment	1	350
Investigation of incident		
Staff time to report and investigate	1	200
Meeting to discuss incident	1	600
Total		R1150

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR (NM&MI) Only critical cost elements shown for exercise		
Description of incident 7. Muscular strain sorted with first aid		
Dealing with the incident	**Time Spent**	**Costs**
First aid treatment	2	500
Investigation of incident		
Staff time to report and investigate	1	200
Meeting to discuss incident	1	500
Salary costs of replacement staff	8	1600
Total		R2800

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR (NM&MI) Only critical cost elements shown for exercise		
Description of incident 8. Contractor worked without a permit at tank D		
Dealing with the incident	**Time Spent**	**Costs**
Stopped work	2	650
Investigation of incident		
Staff time to report and investigate	1	200
Meeting to discuss incident	1	750
Getting back to business		
Lost work time, Persons waiting to resume work. Delays/ reduced production	6	2500
Overtime costs	3	1800
Total		R5900

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR **(NM&MI) Only critical cost elements shown for exercise**		
Description of incident 9. Vehicle overloaded		
Dealing with the incident	**Time Spent**	**Costs**
Making the vehicle safe-decant	4hrs	800
Investigation of incident		
Staff time to report and investigate	1	200
Meeting to discuss incident	1	500
Business costs		
Lost work time, Persons waiting to resume work. Delays/ reduced production	5	1000
Total		R2200

Source: Health and Safety Executive UK (2010)

THE INCIDENT COST CALCULATOR **(NM&MI) Only critical cost elements shown for exercise**		
Description of incident 10. Job being done without the correct procedures		
Dealing with the incident	**Time Spent**	**Costs**
Stop work. Making the area safe	1	250
Potential near miss		5000
Investigation of incident		
Staff time to report and investigate	1	200
Meeting to discuss incident	1	800
Getting back to business		
Assessing / rescheduling works	2	500
Total		R6750

Source: Health and Safety Executive UK (2010)

The total costs for the ten NM&MI are:

Incident 1	205100	
Incident 2	783200	
Incident 3	482120	
Incident 4	379300	
Incident 5	155300	
Incident 6	1150	
Incident 7	2800	
Incident 8	5900	
Incident 9	2200	
Incident 10	6750	R2 041 820

Average incident cost is 2041820 ÷ 10 + **R204 182**

Total cost for 415 NM&MI is R204 182 X 415 =R84 735 530

APPENDIX L: Characterisation of the operation and management of key functional areas

Operations Department

The operations department will be responsible in converting the orders into production and services and the responsibilities include:

- Delegation of responsibilities to and monitoring the effectiveness of all supervisors while managing the plant in the safest, most efficient manner to maximize earnings.
- Directing the activities of each department through supervisors, who are responsible to produce effective results within their areas of responsibilities, to ensure optimum product availability and line efficiency.
- Reviewing and checking operation of the plants to meet OSHA (US Department of Labour, 2009) and environmental regulations.
- Running the plants on a cost-effective basis and keeping subordinates informed of the financial health of the plants.
- Conducting staff meetings to learn and solve problems, to listen to suggestions for improvement and to establish goals.
- Conducting HS&E meetings execute plant safety to all levels of employees.
- Participation in local Plant Managers' meetings and attends to community activities to enhance Company image in area.
- Approving daily, monthly, and annual reports and reviews comparisons, status changes of employees, and process change in technical improvements.
- Preparing, reviewing and controlling plant budgets, and executes AFE's.
- Makes recommendations on improvements that will increase earnings and reduce costs.
- Proposes Company policy that will lead the plant administration in a good manner.

- Recommends proper approaches to keep contractors performing well in maintenance and engineering.
- Recommends proper work force for special projects which were assigned to plant people to handle.
- Ensures quality goals are met.
- Maintains accurate production records and goals.
- Maintains labour, equipment cost and materials to ensure continued production to remain within projected budgets.
- Performs special projects as assigned and other coordinating activities as required to operate the plant on a cost-effective basis.

Finance Department

Directs annual budgeting and planning process for the organisation's annual budget.

- Develops and manages annual budget
- Oversees monthly and quarterly assessments and forecasts of organisation's financial performance against budget, financial and operational goals. Oversees short and long-term financial and managerial reporting.
- Managing day to day processing of accounts receivable and payable, producing reports as requested.
- Reconciling monthly activity, generating year-end reports, and fulfilling tax related requirements.
- Assisting Executive Director and Board in creating annual organisational budget and monitoring cash flow.
- Managing contracts and reimbursement requests.
- Maintaining Interdepartmental archival and administrative files.
- Administering payroll and employee benefits and organisational insurance.

- Ensures that Accounting Department requests are resolved and communicated in a timely manner to internal and external parties.
- Develops long-range forecasts and maintain long-range financial plans.
- Prepares annual audit and be a liaison with all outside vendor.

Maintenance Department

Responsible for the safe maintenance, repair or replacement of plant equipment and systems, to ensure maximum production quantity and quality, while supporting the policies, goals and objectives of the company.

• Participates in objective setting, plan development and performance review of plant performance.

• Initiates, implements, and manages the plant maintenance program based on best practices in the chemical industry, with an emphasis on planning/scheduling and preventive/predictive maintenance.

• Monitors the use and inventories of spare parts, maintenance supplies, and equipment and initiates reordering when necessary.

• Maintains and repairs maintenance shop equipment.

• Establishes and maintains a computerized maintenance management system (CMMS) for tracking work orders, spare parts, and maintenance history of plant equipment.

• Prepares reports, analyzes data, and makes recommendations for improving plant operations and solving maintenance-related problems.

• Supervises plant maintenance personnel.

• Ensures that maintenance technicians are adequately trained, equipped, and motivated so that the maintenance program can be accomplished in a safe, timely, and cost-effective manner.

• Communicates regularly with all maintenance technicians, both individually and as a group, to ensure good two-way communication concerning maintenance issues.

• Assists with hiring of maintenance personnel.

• Conducts employee performance reviews based on job descriptions to determine competency, knowledge, and contribution of the maintenance technicians.

• Maintains and updates operating and training manuals for the maintenance department.

• Ensures that all maintenance technicians are trained on the most updated version of the operating procedures.

• Monitors operation of plant equipment and systems.

• Reviews the operation of plant equipment and systems constantly, to minimize unplanned downtime, anticipate solve problems in a timely manner, and to identify opportunities for improvement.

• Initiates and carries out projects that improve efficiency and/or reduce operating costs.

• Tracks, analyzes and improves key maintenance parameters such as asset utilization, maintenance cost, Project Management compliance, schedule compliance, etc.

• Maintains safety, health, and environmental policies and procedures.

• Ensures city, county, state, and federal regulations relating to the maintenance department are met at all times.

• Directs, maintains, and enforces the safety program for the maintenance department; reviews safety records to uphold standards of maximum safety for all maintenance technicians.

• Communicates directly with the operations department to coordinate maintenance and repair work in process areas.

Compliance Department (SHE)

- Plant environmental permit support, assisting with and developing an evolving comprehensive audit program, environmental compliance auditing
- At plants, audit follow up, tracking corrective actions for deficiency findings at all plants.

- Liaises with corporate legal, operations, SHE departments and regulatory agencies as necessary.
- Regulatory elements include: Solid and Hazardous Waste, Storm Water, Municipal Wastewater Pre-treatment, Tier II Right to Know. Knowledge of OSHA regulations and ISO 9001, 14001and 18001. NEMA.
- Auditing/tracking software; familiarity with computer programmes. The ability to prioritize and drive corrective action, in a fast-paced environment. The ensuring a safety-first environment at all times while being in compliance with safety standards.

Human Resources Department

The Human Resources guides and manages the overall provision of Human Resources services, policies, and programs for organisations which include:

- recruiting and staffing;
- organisational departmental planning;
- performance management and improvement systems;
- organisation development;
- employment and compliance to regulatory concerns regarding employees;
- employee onboarding, development, needs assessment, and training;
- policy development and documentation;
- employee relations;
- company-wide committee facilitation;
- company employee and community communication;
- compensation and benefits administration;
- employee safety, welfare, wellness and health;
- charitable giving; and
- employee services and counselling.

Customer Service Department

The purpose of the customer services department is to maintain customer satisfaction by providing problem-solving resources to the customers.

- Achieves customer service objectives by contributing customer service information and recommendations to strategic plans and reviews; preparing and completing action plans; implementing production, productivity, quality, and customer-service standards; resolving problems; completing audits; identifying customer service trends; determining system improvements; implementing change.
- Meets customer service financial objectives by forecasting requirements; preparing an annual budget; scheduling expenditures; analyzing variances; initiating corrective actions.
- Determines customer service requirements by maintaining contact with customers; visiting operational environments; conducting surveys; forming focus groups; benchmarking best practices; analyzing information and applications.
- Improves customer service quality results by studying, evaluating, and re-designing processes; establishing and communicating service metrics; monitoring and analyzing results; implementing changes.
- Maximizes customer operational performance by providing help desk resources and technical advice; resolving problems; disseminating advisories, warnings, and new techniques; detecting and diagnosing network problems.
- Updates job knowledge by participating in educational opportunities; reading professional publications; maintaining personal networks; participating in professional organisations.

Despatch Department

- Ascertain industry/logistics best practices to identify new and/or unique programs to differentiate Customer from the marketplace and drive customer satisfaction.
- Responsible for internal communications and presentations related to key performance metrics, program updates and on-going program information.
- Manages the supply of logistics-related data to support customers in the day-to-day general areas of engineering, supply, configuration management, technical requirements identification, installation and maintenance of equipment, safety and documentation development and maintenance. Investigates potential risk and other matters of significance, and provides and implements solutions.
- Consults with assigned clients to understand their distribution networks and determines the logistics resources required to support equipment, safety, personnel and maintenance. Negotiates with supply sources to meet technical requirements.
- Works in conjunction with various parties such as business development, field support and customer service to handle complaints and ensure support plans are in place to maintain long-term customer relationships.
- Analyzes and evaluates design concepts and integration support requirements to determine if concepts satisfy support requirements. Implements, monitors and adjusts solutions to ensure the integration of support considerations as needed.
- Analyzes technology and distribution network trends and implements changes in department as appropriate.
- Prepares and recommends operating and personnel budgets for approval. Monitors spending for adherence to budget, recommends variances as necessary.

- Responsible for the strategic and operational planning of Customer logistics operations.
- Ensure that partners understand and accept Customer guidelines and requirements for all logistics operations, including service and repair.
- Manage on-going partner relationships
- Root cause analysis and problem resolution for all logistics operations
- Serve as liaison with all internal and external partners for daily operational activities
- Track, analyze and communicate key performance metrics
- Responsible for all logistics operations and support across all distribution channels.
- Drives the design, development, implementation and management of logistics solutions for Customer.

Laboratory Department

- Organise and manage the workflow in the laboratory
- Co-ordinate activities throughout the laboratory
- Delegate work amongst the various technicians
- Monitor outputs and keep records of workflow and usage of supplies
- Supervise the ordering and delivery new supplies
- Test and calibrate equipment to ensure optimum results, monitor chemistry in equipment
- Perform quality tests and ensure the company meets it quality assurance standards
- Oversee customer services to maximise sales
- Promote the continuing professional development of staff and oversee the training of trainees
- Make risk assessments for the laboratory and ensure that the company's Health & Safety policy is observed

- Evaluate and assess new equipment

Security Department

- Monitors and evaluates unit performance on key security issues and programs, recommends corrective action programs here appropriate.
- Maintains knowledge of complex industry trends, current security issues and security technology and update management on risk and threat that could impact company business.
- Responsible to perform annual risk analysis for the country, particularly with respect to level of crime, terrorism, workplace violence, threats from natural and manmade disasters.
- Responsible for providing leadership, advice and counsel to line management on security policy and practices. Identifies exposures and to recommend and develop corrective plans as appropriate.
- Provides advice and counsel to management on the expenditures of resources for protection of company assets where compromise or loss of these assets could seriously effect company business.
- Provides leadership, advice and counsel to all security staff in achieving current and long rage strategic program objectives.
- Serves as staff support to security management and assists in conducting investigations of significant threats and/or the loss or misappropriation of assets.
- Develops and implements security coordinator program which includes developing a training program for all security coordinators for each organisation.

APPENDIX -M: Costs of major chemical disasters globally

IchemE Loss Prevention Bulletin April 1998 no 140- Costs of Major Chemical disasters			
Date	**Location**	**Company**	**Cost**
23/10/89	Pasadena, Texas	-	$ 1,456 m
11/09/92	La Mede, France	-	458m
14/11/87	Pampa, Texas	-	396m
07/03/89	Antwerp, Belguim	-	356m
24/02/86	Thessaloniki, Greece	-	300m
05/05/88	Norco, Louisiana	-	293m
04/13/91	Sweeny, Texas	-	264m
23/07/84	Romeoville, Illinois	-	241m
13/12/84	Port Neal, Iowa	-	182m
16/10/92	Sodegaura, Japan	-	172m
02/12/91	Seadrift, Texas	-	172m
24/07/94	Penbroke, Dyfed	Texaco/ Gulf	158m
22/03/87	Grangemough, Edinburgh	BP	158m
03/04/77	Umm Said, Qatar	-	156m
20/08/81	Shuaoba, Kuwait	-	148m
05/01/91	Sterlington, Louisiana	-	148m
15/09/84	Warrington, Cheshire	Laporte Chemicals	68m
14/12/84	Brightside Lane, Sheffield	National Freight Consortium	58m
09/10/85	Wilton, Teeside	BASF	32m
04/01/77	Braehead, Renfrew	L Kelman Transport	32m
30/08/83	Milford Haven	Amoco	28m
27/07/83	Dursley, Gloucestershire	RA Lister	25m
13/10/84	Bromborough, Merseyside	Morganite Ceremic Fibres	16m
20/03/90	Ellesmere Port, Cheshire	Shell	16m
04/06/85	Warrington, Cheshire	Laporte Chemicals	14m
12/10/90	Baglan Bay, Swansea	BP	14m
26/11/81	Lough, Lincolnshire	CK Addison	11m
01/02/94	Ellesmere Port, Cheshire	Associated Octel	10m
17/01/81	Llandarcy, West Glamorgan	BP	10m
13/02/82	Woodkirk, Yorkshire	Universal Freight	9m
21/07/92	Bradford, Yorkshire	Allied Colloids	8m
18/01/91	Bromborough, Merseyside	Unichema	7m
21/06/88	Poole, Dorset	British Drug House	6.5m
21/09/92	Castleford, Yorkshire	Hickson & Welch	2.5-5.2m

Source: Fewtrell, (1998:6)

APPENDIX –N: STRATEGIC METHODOLOGY

Strategic methodology

The Strategic Methodology is at the highest level of the OM and promotes the basis of managing all types of organisational risks. The elements in this SM will also cover the near miss and minor incident risks at the respective organisations.

Management elements in this strategy are:

Policy: this is a set of guiding principles drawn up by the organisations that dictates how the organisations have to deal with control and minimization of potential risks to the respective organisation. Roles and responsibilities should also be clear and all role players should be accountable, while the policy should also assist in developing a committed safety culture. Top management should furthermore aggressively be driving for better management of NM&MI.

Legal: the legal aspects will cover all the rules and regulations for the specific organisations, as well as guidelines on how to deal with the respective legislation, standards, rules and regulations.

Plan: the plan will outline the steps to be taken to make the strategy for risk management work at the organisations. This should include the capacity to manage the process.

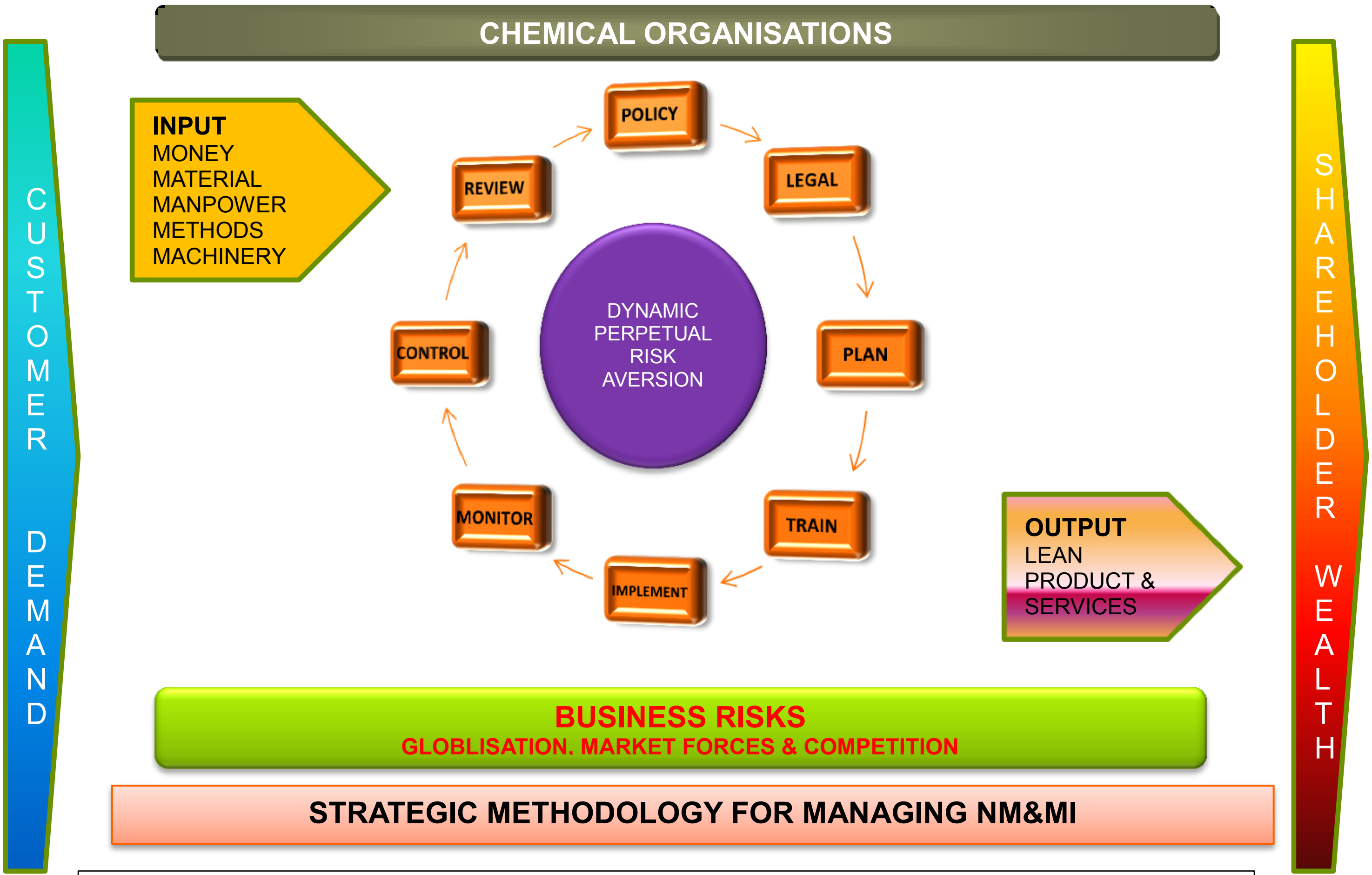
Train: the strategy and the elements will have to be discussed and relevant role players trained in order to make the strategy work. Training should be reviewed at all levels of the organisations and should include external service providers and other stakeholders.

Implement: once the role players have been trained and briefed on the plan, the next step on making the strategy work will be implementation. This will be the action step of the process. All bottlenecks should be removed and regular review and feed back done.

Monitor: the strategy has to be monitored carefully to ensure that each role player acts on his or her action plan in order to make the strategy a reality and a success. This step should also be used in all tiers of the OM.

Control: the whole SM has to be rigorously controlled in order to ensure that it is on track and that it keeps to the plan. If any action step is not aligned it will have to be brought back in line. The control should include all other tiers of the OM.

Review: a management review should be done on a planned basis to consider the pros and cons of the strategy so as to review the value adding aspects to the SM for managing risk (NM&MI). If policy changes have to be made or changed it will be done at this stage and reports made on the success of the strategy. The review must, again, be extended to the other tiers of OM.



Source: Adapted and developed by author from various sources e.g.: Slovic, (2010); Fiagle, (2012); Chen and Yang, (2004:233).

APPENDIX O : TACTICAL METHODOLOGY

The TM is the second tier of the OM on managing risk. The elements of the TM are pivotal elements for management, supervisors and workers to use in maintaining safe, healthy and environmentally friendly chemical organisations.

The following are key elements:

Management commitment: the reference is on how committed the management team is in making safety work at the organisations. The SHE policy can be very well constituted, but unless there is sufficient management commitment to action the strategic policy, the policy is worthless.

Supportive culture: the question is, whether top management just pays lip service to SHE approaches or if they are truly supportive. Is the safety culture fully entrenched to support and make safety approaches work?

Communications: safety communications is crucial in maintaining SHE approaches on the chemical plants. All employees working in the operations must be kept informed on safety, health and environmental issues all the time.

Safety priority: the important question is whether all levels of the chemical organisations give the highest priority to safety approaches in ensuring that safety comes first.

Safety rules and regulations: are safety rules and regulations updated regularly; are they reflective of the operations? Do the rules and regulations make the operations more cumbersome and risky or are they just there for the auditors?

Involvement: it is crucial that all workers, supervisors and management are fully involved to make a success of all safety approaches. The safety representative and supervisors must check whether all workers understand all aspects of safety approaches taking place at the organisations. Are the workers full participants or are they just standing on the sidelines?

Supportive environment: do workers receive the necessary support from their supervisors and managers on all safety approaches or are they blamed for all the safety issues at their plants?

Behaviour and attitude: are behaviour and attitude counter productive to the safety approaches at the organisations? Are the workers, supervisors and managers behaving poorly?

Competency and training: do all the organisations have good training programmes to cover all approaches for safety training? Are the workers, supervisors and managers competent?

The elements of TM form the basis of the questionnaire for gathering of the employee survey (Appendix C).

TACTICAL METHODOLOGY FOR MANAGING NM&MI

Source: Tactical Methodology developed from Employee survey (Appendix C)

APPENDIX P : FUNCTIONAL METHODOLOGY (advanced)

The FM (advanced) was developed with information from employee surveys, (Employee survey - Appendix C), categorized NM&MI from the seven organisations, (NM&MI database - Appendix E) and the comparison with international benchmarks on the FM (basic).

POTENTIAL RISKS
MAJOR DISASTERS
FATALITIES
MAJOR INCIDENTS
MINOR INCIDENTS
NEAR MISSES
A

Step A - shows all the risks and incidents that organisations are exposed to including NM&MI. The NM&MI could lead to major incidents and disasters resulting in fatalities.

MANAGEMENT SYSTEMS
ISO STANDARDS,
OSHACT
NM&MI COST
CALCULATIONS
INDUSTRY BENCHMARKS
REGULATIONS
B (TEST BY AUDITS)

Step B - indicates the management systems in place to mitigate the risks and incidents. Some incidents are controlled yet many NM&MI still occur. NM&MI costs should be calculated to give a true reflection of the actual value of the NM&MI.

ORGANISATIONS
KEY FUNCTIONAL AREAS
FM1 (AREAS OF IMPACT)

FM 1 – The process flow starts at this point where all the key functions are at the organisations which bears the impact of the NM&MI.

SURVEY EMPLOYEES
(6/12Mths)
MANAGEMENT OF SAFETY,
HEALTH, ENVIRONMENT &
INTERVENTIONS
FM2 Primary Data
(Appendix C)

FM 2 - an employee survey should be done on an annual basis or sooner depending on the level of severity of NM&MI. The employee survey will show inside safety occurrences not readily apparent to management

COLLECT DATA (6/12Mths)
NEAR MISSES &
MINOR INCIDENTS
Root Cause Analysis
FM3 (Appendix D)

FM 3 - near miss and minor incident data should be collected from the organisations' databases. Root cause analysis should be done of data that show problematic trends. Best solutions can only be found when the true cause of incidents is identified.

CATEGORISE DATA
LIST CAUSES & MANAGEMENT INTERVENTION
NM&MI database (Appendix E)
FM 4

FM 4 - NM&MI should be categorized and the causes and management interventions listed. This step will assist in identifying specific trends for immediate action.

ANALYSE DATA
LIST PERCEPTIONS & MANAGEMENT INTERVENTIONS
FM5

FM 5 - data from employee surveys (FM2) should be analysed and management interventions listed for review and action.

TOLERABLE LEVEL (1)
(SET FOR EACH ORGANISATION)

NM&MIR Formula

$$\frac{\text{NM\&MI X 200000}}{\text{Employee \& Contractor hours worked}}$$

-Calculate NM&MIR-check Tol. Rate
-Check variables with:
Root Cause Analysis Results
Management Interventions
Employee perceptions
FM6

FM 6 – calculate the NM&MIR and check against the tolerable rate of 1. Also check root cause analysis. Management interventions and employee surveys. The best solutions should be developed and used for management of the NM&MI

ANALYSE DATA

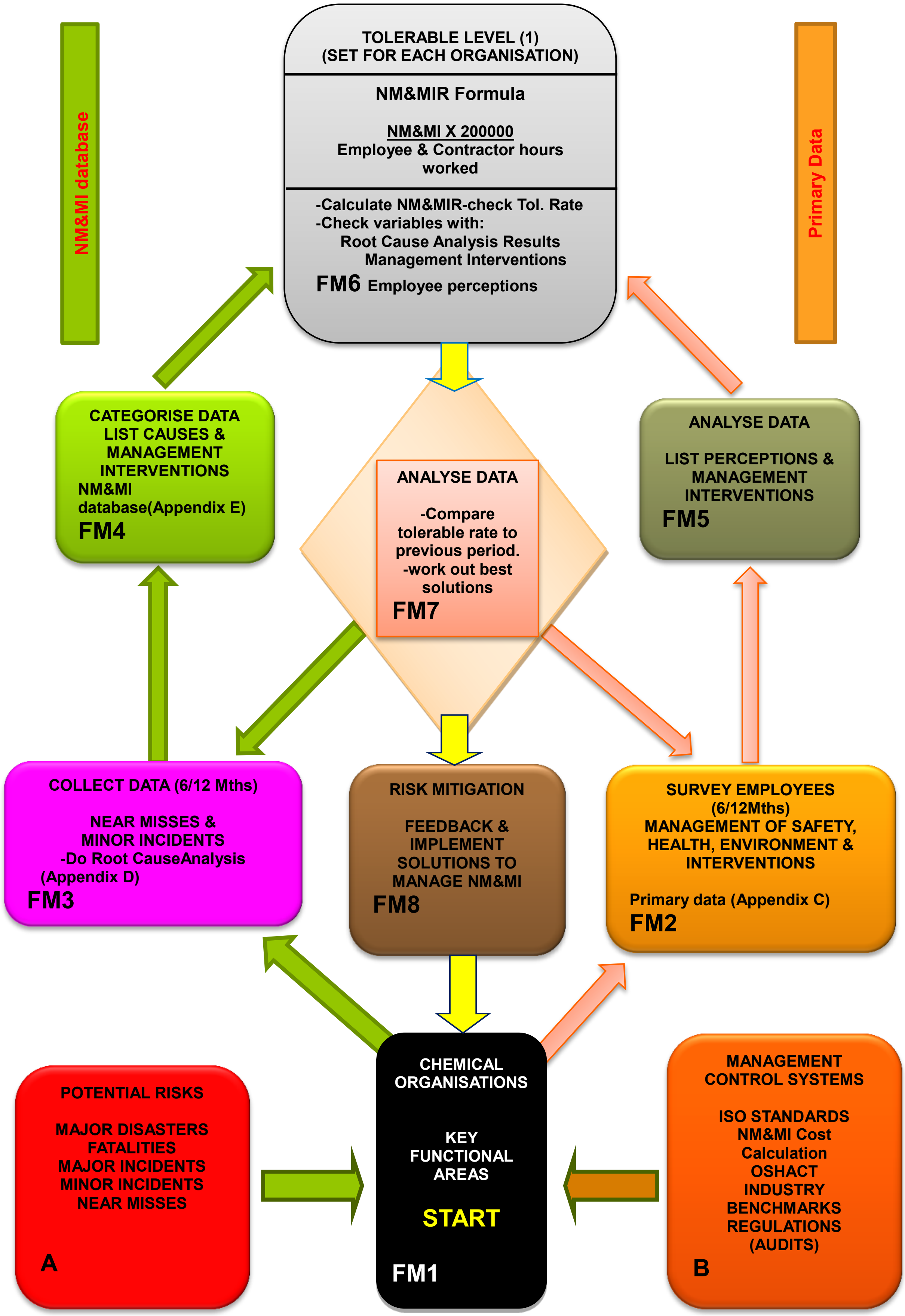
-Compare tolerable rate to previous period.
-work out best solutions
FM7

FM 7 – compare the current tolerable rate to previous period. Work out best fit long lasting solutions.

RISK MITIGATION

FEEDBACK & IMPLEMENT SOLUTIONS TO MANAGE NM&MI
FM8

FM 8 - all the best solutions developed/ selected would be used to mitigate the risks and manage the NM&MI. This step leads back to the key functional areas of the organisations (step 1). All stakeholders must be trained and made aware of the NM&MI, their solutions and the resultant corrective actions implemented.



Functional Methodology for NM&MI (advanced)