OPERATIONAL RISK ANALYSIS FOR THE MANAGEMENT OF RAILWAY INFRASTRUCTURE MAINTENANCE

BY

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ABSTRACT

This dissertation proposes a methodology for the analysis of the operational risks that are caused by railway infrastructure component failure. The objective of this methodology is to assist the engineers that manage railway infrastructure maintenance to forecast the following:

- the frequency of operational risk events that are caused by railway infrastructure failure;
- the cost of rehabilitating railway infrastructure after an operational risk event that was caused by railway infrastructure failure; and
- the impact that railway infrastructure maintenance strategies have on the frequency and cost of operational risk events that are caused by railway infrastructure failure.

A brief literature study of operational risk analysis is presented.

The proposed operational risk analysis methodology involves the identification of the operational risks that are caused by railway infrastructure failure and causal modelling using Bayesian network causal models.

The proposed operational risk methodology is applied in a case study concerning a railway company (called African Railways Ltd as a pseudonym for the sake of confidentiality). The train derailments that are caused by infrastructure component failure in a particular region are analysed in the case study. The case study presents historical data and the results of a questionnaire that was used during face-to-face individual interviews with three track maintenance experts. The frequency of train derailments, the cost of rehabilitating railway infrastructure after train derailments and the impact of railway infrastructure maintenance on these two issues are forecasted. The case study concludes with a comparison of the forecasted and actual frequency of train derailments and cost of rehabilitating the railway infrastructure after a train derailment.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ARL	:	African Railways Ltd
OHTE	:	Overhead track equipment
ISO	:	International Organization for Standardization
TCO	:	Train Control Officer
FMECA	:	Failure Mode, Effect and Criticality Analysis
EVT	:	Extreme Value Theory
VAR	:	Value at Risk

CHAPTER 1 : INTRODUCTION

1.1 BACKGROUND

An efficient railway system plays a major role in optimising the economy of a country. Such a system enables production factors to be assembled at a low cost and markets to be reached at a cost advantage [26, 27]. Railway infrastructure maintenance involves the activities that ensure the components of the railway infrastructure system are reliable and safe for the movement of trains.

1.1.1 RAILWAY INFRASTRUCTURE

The infrastructure of a railway system consists of fixed facilities that support the movement of rolling stock (i.e. locomotives and wagons) from one point to another. A typical railway infrastructure system consists of the following major subsystems:

(1) track;
(2) bridges;
(3) electrical;
(4) train authorisation; and
(5) telecommunication.

1.1.1.1 TRACK

The track is composed of a super structure and a sub-structure. The super structure consists of rails, sleepers and the fastening system. The sub-structure comprises of the ballast and the sub-grade. A diagram of the track is given in Figure 1.1. The function of rails is to guide the train wheels evenly, transfer the concentrated wheel loads to the sleepers and to support the loads. Sleepers enable the wheel stresses that go through the sub-structure to spread and they reduce the dynamic impact caused by the wheel loads. The ballasts provide drainage, elastic and resilience support.

1.1.1.2 BRIDGES

Typical railway infrastructure systems contain the following types of bridges:

(1) rail carrying; and

(2) foot and road bridges that cross the railway. These bridges are often made of steel or concrete.

1.1.1.3 ELECTRICAL INFRASTRUCTURE

A typical railway electrical infrastructure system comprises of traction sub-stations, overhead track equipment (OHTE), locomotives and rail. The traction sub-stations receive electrical power from utility companies and supply AC or DC electrical power to the OHTE.

The function of OHTE is to supply electrical power from the sub-stations to the locomotives. Each locomotive has a pantograph that draws current from the overhead track wires. The overhead track wire configuration varies depending on the electrical requirements and the physical design.

Each electrification support structure is connected to one of the rails referred to as the traction rail. This is done in order to ensure that the voltage between the structures and ground are kept within safe limits, in the event of failure of overhead insulation.

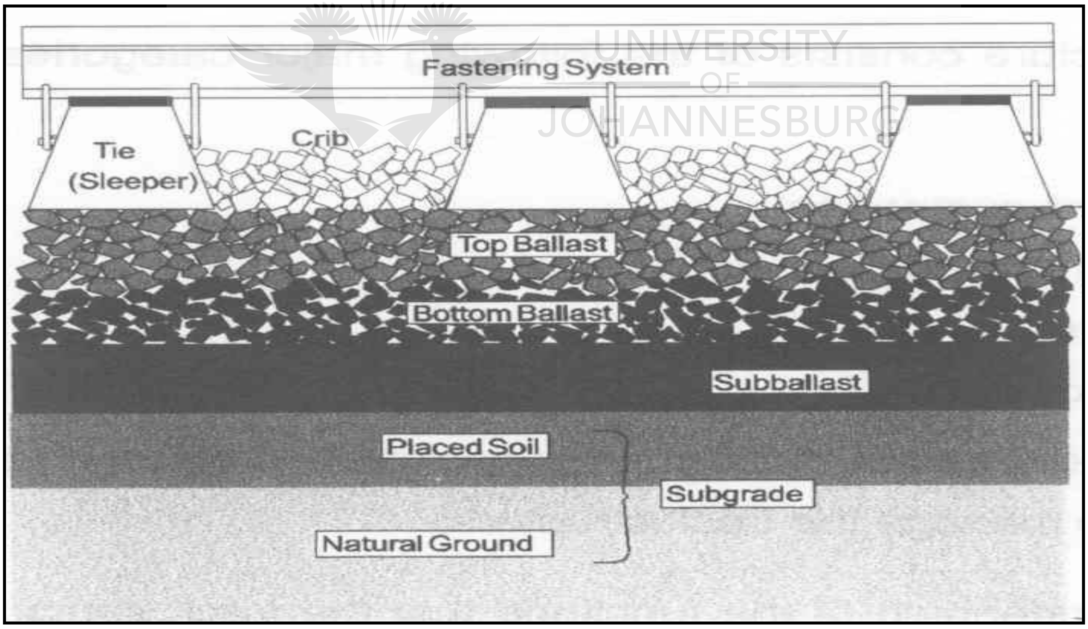

Figure 1.1 A schematic diagram of the track [1]

1.1.1.4 TRAIN AUTHORISATION

Train authorisation is a process of safely generating and conveying authorisation from the train control officer (TCO) to the train driver to enable trains to move from one point to another. The purpose of this process is to regulate the movement of trains, increase the capacity of the line and ensure a safe distance between trains on the same line. The most common method of train authorisation is signalling. The basic elements that are found in signalling systems are:

- Points machines
- Signals
- Train detection
- Interlocking
- Condition monitoring track side equipment.

Points machines are track equipment that enable trains to move from one track to another. The functions of signals are to provide visual information to the train driver of the availability, route and safety of the way ahead. Train detection equipment is used to detect the occupation of a track by a train in a safe and reliable manner. Interlocking is equipment used to prevent conflicting train movements. Points, signals and train detection equipment are combined by interlocking to ensure that conflicting signalled movements do not occur. Condition monitoring track side equipment is installed next to the track in order to detect any irregular and potentially dangerous conditions of the train. Two examples of condition monitoring track side equipment are weigh bridges and hotbox bearing detectors. Weigh bridges are axle and vehicle mass measurement equipment that are installed along the track. If a wagon has been loaded in excess of its tare mass, damage of the vehicle and track can occur. In such instances, the wagon is taken out of service and the customer is requested to offload the wagon to the correct mass. Hotbox bearing detectors are used to monitor the temperature of rolling stock wheel bearings. If a bearing is detected, an alarm is activated in the control centre where the TCO is situated and the train is stopped.

1.1.1.5 TELECOMMUNICATION

Communication occurs via copper, optic fibre and radio links to ensure the smooth operation of trains. The examples of uses of railway communication systems are for train authorisation, shunting and telecontrol.

In train authorisation, the signalling system is the primary means of communication between the TCO and the train driver. In the event that signals fail, the train radio is used as back up communication. A copper or fibre optic communication link is used between track side equipment (train detection condition monitoring) and the TCO's computers.

Shunting is the movement of rolling stock within a shunting yard i.e. a yard where wagons and locomotives connect and disconnect. Hand-held radios are used by a shunt locomotive driver, one or more yard officials, number takers and data-logging clerks to communicate. Examples of issues that are commonly addressed during communication in shunting yards are:

- commands to the train driver to move or stop the locomotive from the yard official;
- the number of locomotives and wagons that make up one train that are physically counted by the number taker as he/she walks along the train must be conveyed to the data-logging clerks that are situated in the yard administration office.

The switchgear in sub-stations is remotely controlled by operators in the electrical control areas. The command that is sent by an operator to either open or close the switchgear in a particular station is sent to a telecontrol master station. The command is then sent from the telecontrol masterstation to a specific telecontrol outstation in a particular station via a copper, optical fibre or radio link. Upon receiving the command, the telecontrol outstation either opens or closes the switchgear.

1.1.2 RAILWAY INFRASTRUCTURE MAINTENANCE

1.1.2.1 RAILWAY INFRASTRUCTURE LIFE CYCLE

The life cycle of railway infrastructure components consists of the following phases:

(1) planning and specification;
(2) design;
(3) construction;
(4) operation;
(5) research; and
(6) maintenance and retirement phases.

The planning and specification phase starts with the compilation of a mission statement. The mission statement contains the business goals, key assumptions, the target market and constraints. This phase ends with the development of specifications in which the form, function and features of the infrastructure components are described. The design phase begins with high level design and is followed by detailed design. The construction phase consists of testing, refinement and production ramp-up. The research phase involves discovery of ways in which the maintenance of railway infrastructure can be optimised. The railway infrastructure components are used during the operation phase and the maintenance of these components is performed during the maintenance phase. During the retirement phase, the infrastructure components are disposed or recycled.

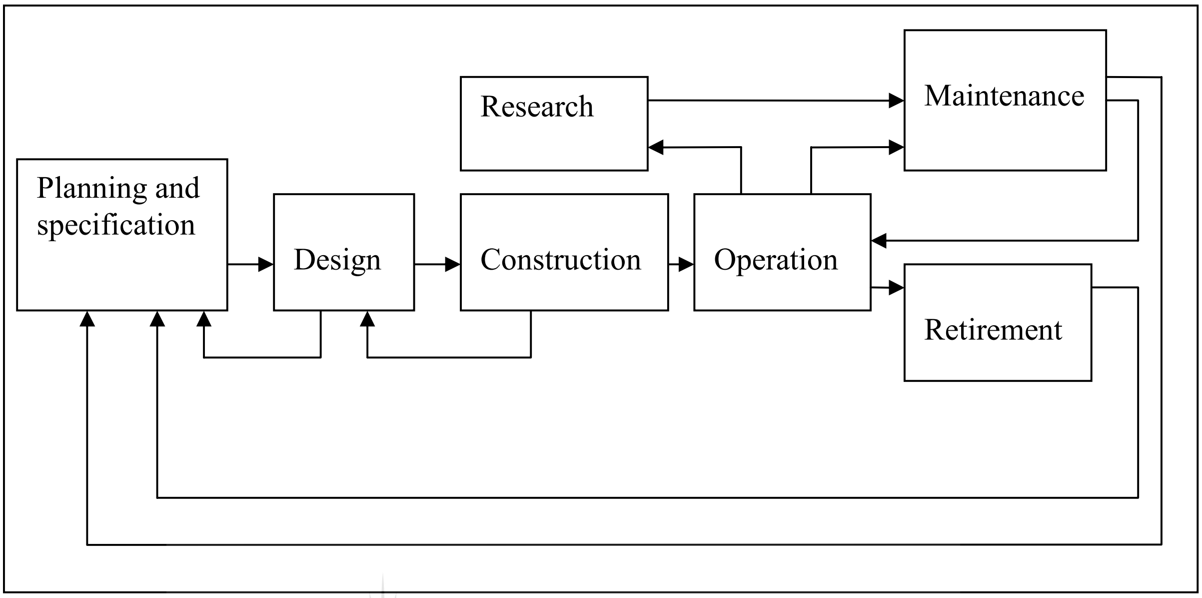

Figure 1.2 Railway infrastructure life-cycle.

1.1.2.2 RAILWAY INFRASTRUCTURE MAINTENANCE CYCLE

Maintenance includes all actions necessary for retaining a system or product in, or restoring to a serviceable condition [2]. The maintenance of railway infrastructure can be effectively performed by executing the following steps of the maintenance cycle:

1. Identification of the need for maintenance
2. Maintenance cost justification
3. Resource allocation planning
4. Scheduling
5. Assignment of tasks
6. Execution of maintenance activities
7. Feedback.

1.1.2.2.1 IDENTIFICATION OF THE NEED FOR MAINTENANCE

The need for the maintenance of infrastructure can be identified by having a clear understanding of the infrastructure components. This understanding can be achieved by using a tool such as failure mode, effects and criticality analysis (FMECA). The principle of FMECA is used to consider each mode of failure of every component in a system and to further ascertain the effects on system operation of each failure mode in turn [3]. A typical FMECA document is a table with columns consisting of the following information:

(1) the component identification number;

(2) function;

(3) operational mode;

(4) failure modes and causes;

(5) failure effects:

(6) failure detection method;

(7) compensating provisions and severity class.

The failure of a facility occurs when it is in an unsatisfactory condition. Functional and potential failures are the types of failures that occur. A functional failure occurs when a facility or component cannot meet its specified performance standard and potential failure occurs when a physical condition indicates that a failure is imminent [1].

The core categories of maintenance activities are preventative and corrective maintenance. The former and latter are performed respectively for the prevention and correction of infrastructure system component failures. There are two main types of preventative maintenance; namely routine and predictive-based maintenance. Routine maintenance is based on timely, planned prevention breakdown [1]. The two kinds of routine maintenance are scheduled rehabilitation and scheduled component replacement. Scheduled rehabilitation involves the periodic repair of an item to its original condition in order to restore the item's original resistance to failure. Scheduled component replacement involves the replacement of an item at or before a specified age limit. Predictive-based maintenance is the maintenance of facilities and equipment based on their measured conditions [1]. The two types of predictive-based maintenance are on-condition rehabilitation and on-condition replacement. On-condition rehabilitation entails the inspection for potential failures and consequent reparation of a facility, if it is necessary and possible, to prevent the failure of that item. On-condition replacement involves the inspection for potential failures and consequent replacement of a facility, if it is necessary and not possible, to prevent the failure of that item. Corrective maintenance involves the performance of unscheduled maintenance activities on a facility that has failed. These activities involve either the rehabilitation or replacement of the facility.

1.1.2.2.2 MAINTENANCE COST JUSTIFICATION

The total cost of maintenance comprises of preventative and corrective maintenance costs. Preventative maintenance costs are comprised of the costs for preventative maintenance activities (e.g. labour, material and equipment) and downtime costs (the amount of money that the company could have earned during the downtime). Corrective maintenance costs consist of costs for corrective maintenance activities and downtime costs. An increase in the quantity and effectiveness of preventative maintenance activities often results in an increase in total preventative maintenance costs and a decrease in corrective maintenance costs. Thus, preventative maintenance should only be performed on an item if the failure of that item is preventable, and the financial losses that can occur due to the failure of this item exceed the preventative maintenance costs.

1.1.2.2.3 RESOURCE ALLOCATION PLANNING

Resource allocation planning must be done by an individual with the necessary technical aptitude and expertise regarding the particular system. The process ensures that resources are available during the maintenance activities. These resources include equipment, material, engineering drawings, etc.

1.1.2.2.4 SCHEDULING

Scheduling determines the timing and resources in the form of equipment and people with the necessary technical skills are used for the completion of maintenance tasks. In the railway environment, occupation is an important factor to consider. This is the permission to ensure that no trains may move in a particular area so that maintenance activities can be carried out. It is imperative that the planner requests, and is granted this permission, to ensure the prevention of rolling stock and infrastructure damage and the safety of maintenance personnel and train crew, respectively.

1.1.2.2.5 ASSIGNMENT OF TASKS

During this phase, maintenance tasks are assigned to personnel with the necessary skills. Personnel may perform their tasks individually or work in teams.

1.1.2.2.6 EXECUTE WORK

Maintenance activities are executed during this phase.

1.1.2.2.7 FEEDBACK

The information concerning the executed maintenance activities should be recorded in a maintenance history database. It is prudent to record the following data in this database:

1. Name of personnel that executed the maintenance activities
2. Date of maintenance activities
3. Time of maintenance activities
4. Geographic location of maintenance activities
5. Operating conditions
6. Maintenance activities that were executed

The following data can be further recorded in the maintenance history database after the execution of corrective maintenance:

1. Date of failure
2. Time of failure
3. Equipment operating time during failure
4. Failure symptom description
5. Effect of failure mode
6. Failure classification (e.g. manufacturing, design, etc)
7. Recommendations for the correction of failure mode

The maintenance history database records can be used for planning, analysing, costing, resource allocation and scheduling.

1.1.3 OPERATIONAL RISK ASSESSMENT IN RAILWAY INFRASTRUCTURE MAINTENANCE

Risk can be defined as the probability of loss, injury, and disadvantage or destruction [5].Operational risk is the risk of loss resulting from inadequate or failed internal processes, people and systems or external events [6]. In order to forecast the frequency of operational risk events and their related costs for infrastructure rehabilitation, it is imperative that the operational risk of infrastructure maintenance is extensively analysed. The term 'risk analysis' is used to denote methods which aim to provide a comprehensive understanding and awareness of the risk associated with a particular variable of interest [8]. Operational risk analysis is an important tool for railway infrastructure maintenance planning because it allows the impact of any maintenance strategic decisions on operational risks to be forecasted.

1.2 PROBLEM STATEMENT

The events that require the rehabilitation of railway infrastructure e.g. train accidents, floods and theft cause huge losses each year to a railway company, which is called African Railways Ltd (ARL) for the sake of confidentiality. These losses are due to factors such as railway infrastructure rehabilitation, employee injury claims and train cancellations. Currently, the ARL risk management department analyses the operational risk that the entire ARL is exposed to using qualitative risk analysis. Depot engineers are responsible for the management of railway infrastructure maintenance in particular regions. They lack operational risk analysis tools that will assist them to predict the effect of the railway infrastructure maintenance strategies on operational risk events that are caused by railway infrastructure component failure.

1.3 RESEARCH OBJECTIVES

In this dissertation, the author aims to introduce an operational risk analysis methodology that will enable the engineers who manage railway infrastructure maintenance activities to forecast the following:

- the frequency of operational risk events that are caused by railway infrastructure failure;
- the cost of rehabilitating railway infrastructure after an operational risk event that was caused by railway infrastructure failure; and
- the impact that railway infrastructure maintenance strategies have on the frequency and cost of operational risk events that are caused by railway infrastructure failure.

1.4 RESEARCH METHODOLOGY

A case study was made of the operational risk analysis of the train derailments that are caused by railway infrastructure component failures that occur in ARL in a particular region. This case study involved the application of the proposed operational risk analysis methodology using historical data and the results of face-to-face interviews. The frequency of train derailments, the cost of rehabilitating railway infrastructure after train derailments and the impact of railway infrastructure maintenance on these two issues are forecasted using Bayesian network causal models. Lastly, a comparison is made of the forecasted and actual frequency of train derailments and cost of rehabilitating the railway infrastructure after a train derailment.

1.5 CONCLUSION

The prevention of operational risks that are caused by railway infrastructure component failure is crucial for the sustainability and profit maximisation of railway companies. This can be achieved by planning and implementing effective railway infrastructure maintenance strategies. This dissertation proposes an operational risk analysis methodology for the engineers that manage railway infrastructure maintenance. The proposed operational risk analysis methodology enables them to forecast the impact of their infrastructure maintenance strategies on the frequency and cost of operational risk events that are caused by railway infrastructure component failure.

Firstly, the author provides a brief literature study of operational risk analysis. Secondly, the author proposes an operational risk analysis methodology. Thirdly, the author provides a case study of the analysis of an operational risk that is caused by infrastructure component failure in a railway company (called African Railways Ltd for the sake of confidentiality). Lastly, the author presents the conclusions made from the study, the lessons learnt and in addition, makes certain recommendations for further study and consideration.

CHAPTER 2 : OVERVIEW OF OPERATIONAL RISK ANALYSIS

2.1 INTRODUCTION

The effective analysis of an organisation's operational risk involves identifying and analysing its operational risk. Section 2.2 provides a brief overview of operational risk identification. Section 2.3 discusses, in more detail, operational risk analysis.

2.1.1 TOP-DOWN AND BOTTOM-UP APPROACHES

Operational risk analysis can be performed using one of two approaches; namely the top-down or the bottom-up approach.

The top-down approach involves a high level analysis of operational risk. Thus individual operational loss events are not analysed using this approach. The foremost advantage of the top-down approach is that it assists senior and executive managers in managing the operational risk of an entire business unit or organisation. However, this approach is less effective for the daily management of operational risks by line managers.

The bottom-up approach involves a low level assessment of an operational risk. In this approach, each business unit assesses the operational risk to which it is exposed [7]. The individual risk events that are associated with each business unit are assessed using this approach. The main advantage of the bottom-up approach is that it assists line managers to gain sufficient knowledge to effectively manage the daily operational risk of their departments. However, the performance of this approach can become too time-intensive.

2.2 OPERATIONAL RISK IDENTIFICATION

Operational risks can only be analysed once they have been identified. Operational risk identification should be done whenever any significant changes occur in the organisation and its environment. It is imperative that before operational risk identification commences, the following activities have been performed:

- sufficient information for the effective identification of operational risk has been gathered;
- an operational risk identification tool has been selected;
- all the individuals who will be participating in operational risk identification have gained a clear understanding of the organisation's business activities, strategic and operational objectives.

It is critical that risk identification is performed in an environment that allows all the participants to identify risks without inhibition and fear. The knowledge that the risk identification participants have gained from their work experience in a particular industry or organisation is essential for the effective identification of operational risks. When operational risk identification is completed, all the identified risks are stored in a risk database called a risk register.

2.2.1 OPERATIONAL RISK IDENTIFICATION STRUCTURES AND TECHNIQUES

There are various ways in which operational risk identification can be structured e.g. workshops, questionnaires and discussions. Factors, such as the availability of role players, determine the way in which operational risk identification is structured. The identified operational risks can be categorised utilising numerous techniques such as the following:

- checklists;
- organisational charts; and
- organisational flow charts.

2.2.1.1 CHECKLISTS

Checklists allow the identification of risks according to various categories. Table i. represents a typical checklist that is commonly used by insurance companies.

Operational risk category	Examples
Fire; explosion	
Natural perils	Earthquake, storms, flood, hail, snow and others
Crime	Theft, burglary, fraud, fidelity, arson, sabotage, terrorism and others
Engineering	Breakdown, loss or damage to machinery or utilities
Transit	Breakdown, loss or damage to goods in transit
Legal liability	Environmental impairment, products liability and employers liability

Table i: A typical insurance review checklist [10]

2.2.1.2 ORGANISATIONAL CHARTS

Risks are identified using organisational charts in order to identify risks according to an organisation's structure and activities such as marketing, train authorisation and human resource departments.

2.2.1.3 ORGANISATIONAL FLOW CHARTS

Organisational flow charts are used to identify the risks that are associated with all the flows of an organisation. The use of organisational flow charts allows more flexibility than organisational charts because the latter is limited to identifying risks in each structure. However the former enables risks to be identified per flow which may involve various structures. An example of a flow is the electrical control flow involving the remote control of electrical power supply to the trains by operators from the operations department. Thus, the structures that are involved in the electrical control flow are the electrical, telecommunications and operations departments, respectively.

2.2.2 OPERATIONAL RISK IDENTIFICATION RISK INFORMATION SOURCES

Conventionally, risk assessment processes rely upon the following sources of information:

- environmental scans;

- financial documentation;
- legal documentation;
- onsite inspections;
- interviews;
- statistical analysis;
- benchmarking/best practices; and
- consultancy services [10].

2.3 OPERATIONAL RISK ANALYSIS

Operational risk analysis allows engineers to forecast the frequency and severity of operational losses in order to evaluate the effect of a railway infrastructure maintenance management strategy. The analysis of operational risk can either be performed using methods that are qualitative, quantitative or a combination of both methods.

2.3.1 QUALITATIVE OPERATIONAL RISK ANALYSIS

The qualitative analysis of operational risk is often performed by managers and experts. An expert is a person who has background in the subject area and is recognised by his or her peers for having such acumen, or those conducting the study as qualified to answer the question [16]. Qualitative operational risk analysis often involves estimating operational risk that is difficult or impossible to calculate numerically. Some operational risks are difficult to calculate numerically due to a lack or unreliability of quantitative data that is required for quantitatively analysing operational risk. Some operational risks, such as an organisation's reputation risks are impossible to be calculated numerically. Qualitatively analysed risks are often expressed in terms of risk-map-rating scales. The most common qualitative operational risk analysis methods are risk self assessments, risk process flow analysis and scenario analysis.

2.3.1.1 RISK MAPS

Risk maps (or risk matrices) are matrices with rows and columns that often represent the severity (i.e. the financial loss impact) and frequencies (i.e. the number of loss events per period) of operational risk events. Thus, the risk estimations of events are expressed as products of the frequencies and severities of those risks. Risk maps are commonly used to express operational risk during qualitative risk analysis. Qualitative and semi-qualitative risks maps can be used.

2.3.1.1.1 QUALITATIVE RISK MAPS

In qualitative risk maps, the estimated consequence and frequency of the identified risks are expressed in words as relative scales e.g. low, medium and high. Since the estimated risk is expressed as a product of the consequence and frequency, an example of an estimated risk where the frequency is low and the severity is medium, is low*medium.

2.3.1.1.2 SEMI-QUALITATIVE RISK MAPS

In semi-qualitative risk maps, the identified risk's estimated consequence and frequency are respectively expressed qualitatively and quantitatively or vice versa. For instance, an identified risk with an estimated frequency of 0.5 and a severity that is low has an estimated risk of 0.5*low.

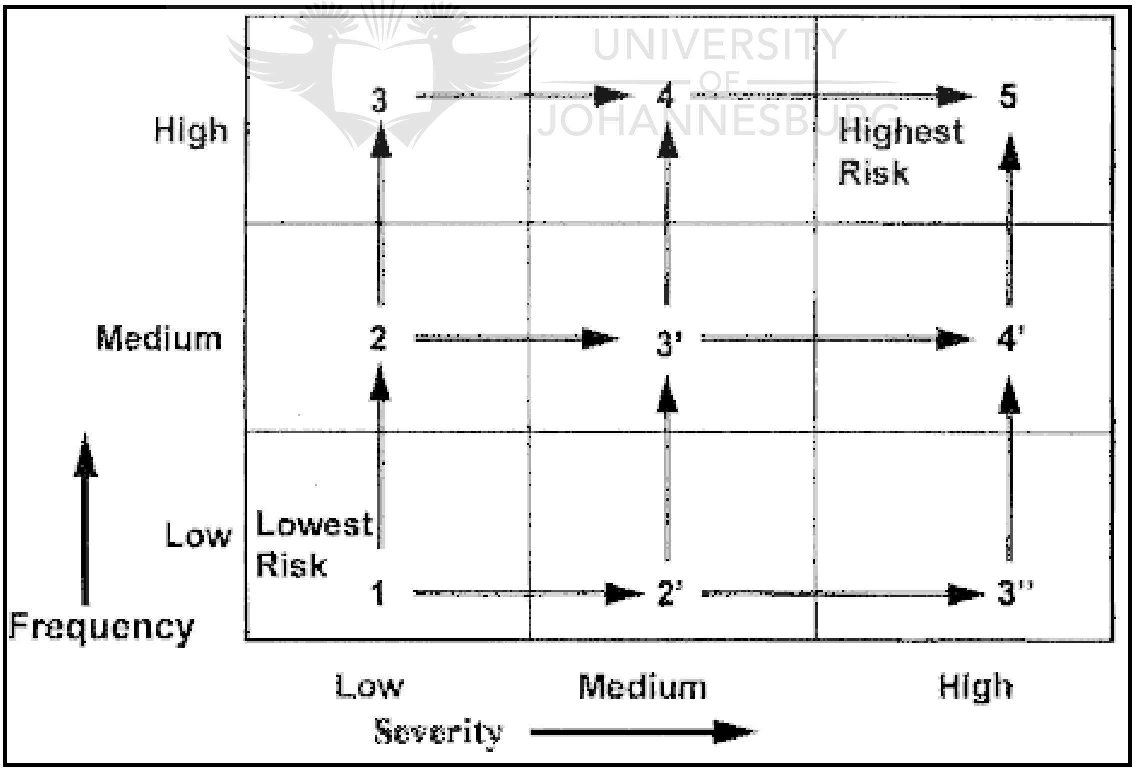

Figure 2.1. A qualitative risk map indicating the relative magnitude of risk levels [9]

A 3x3 matrix is illustrated in Figure 2.1 with 9 risk regions and six groups of chains of comparable risk regions e.g. group one consists of the regions low*low, medium*low, high*low, high*medium, high*high. The risks of these risk regions in each chain is presented in ascending order therefore

Risk (low*low) <Risk (medium*low) <Risk (high*low) <Risk (high*medium) <Risk (high*high)

However risk regions that are not in the same chain cannot be compared e.g. since high*low is not in the same group as medium*high, it cannot be assumed that medium*high has more risk than high*low. Thus the risks of the risk regions that are not in the same chains cannot be compared logically and objectively. The two disadvantages that are common in qualitative risk analysis are highlighted in this illustration, i.e. qualitative risk analysis tends to be subjective and vague at times.

2.3.1.2 QUALITATIVE RISK ANALYSIS METHODS

2.3.1.2.1 RISK SELF-ASSESSMENTS

Risk self-assessments are internally driven analysis of risk, controls and its implementation. The objective is to determine a common understanding of the strengths and weakness of the operational risk environment [7]. They are often performed with a bottom-up approach by an organisation's risk management department and each department. The following types of risk self assessments exist:

- facilitated workshops ;
- independent assessments;
- questionnaire ; and
- issue-oriented forms

A facilitator from the risk management department and members of different departments comprise the delegates that attend facilitated workshops. Operational risks are estimated and the management of these risks are suggested during these workshops. During independent assessments, the business activities, operational risks and operational risk management of an organisation are reviewed by an independent department i.e. the risk management or internal audit department. The existence, extent and effectiveness of the operational risk controls that are performed by an organisation's employees are analysed in questionnaires. Issue-oriented forms usually consist of questions regarding the existence, extent and effectiveness of the operational risk controls and monitoring and ways in which the organisation's risk management are capable of being improved.

2.3.1.2.2 RISK PROCESS FLOW ANALYSIS

During risk process flow analysis, the flows (e.g. production flow) that occur within the organisation are initially defined. Hereafter, the inherent and residual operational risks are identified. The risks that are analysed without considering the means to manage these risks are referred to as the inherent risks. Residual risks are the risks that are analysed when the management of these risks is considered. Risk process flow analysis usually takes the form of a bottom-up approach. The activities of this analysis method can be performed in events such as workshops, interviews, etc.

2.3.1.2.3 SCENARIO FORMULATION AND ANALYSIS

Scenario formulation and analysis involves the generation and assessment of the scenarios that have the potential to cause an organisation to become exposed to operational risk by a panel of experts. Either a top-down or bottom-up approach can be used to perform scenario formulation and analysis. In the top-down and bottom-up approaches, high level and meticulous applications of scenario formulation and analysis are applied respectively. The organisation's loss data, environment and expert opinions with knowledge from work-based experience in a particular industry or organisation are essential for this method of qualitative risk analysis.

2.3.2 QUANTITATIVE OPERATIONAL RISK ANALYSIS

Quantitative operational risk analysis involves the numerical estimation of operational risk. The actuarial approach and stress testing are examples of quantitative operational risk analysis methods.

2.3.2.1 ACTUARIAL APPROACH

The actuarial approach combines the estimation of loss severity and frequency distributions in order to construct operational loss distributions [14]. There are three methods that are used in the actuarial approach i.e. parametric loss distribution modelling, empirical loss distribution modelling and extreme value theory.

In parametric loss distribution modelling, the loss severity and frequency distributions are fitted to parametric models e.g. Weibull and Poisson. The loss severity and frequency distributions are combined with methods such as Monte Carlo simulation. Thereafter the two distributions are combined to form an operational loss distribution.

In empirical loss distribution modelling, the loss severity and frequency distributions are developed using the external and internal data on operational losses. Empirical loss distribution models are more accurate than parametric loss distribution models as the latter is based more on assumptions than the former. The disadvantage of this type of modelling is that it requires a lot of historical data.

The extreme value theory (EVT) is used to deal with the tails of the loss distributions and to set the minimum loss threshold that defines a minimum large loss [15]. The tails of the loss distributions are developed by using low frequency high severity loss data. There is usually a shortage of this data in most organisations; the application of EVT can address this shortcoming by coupling large loss scenarios and historical losses. A parametric method is used to calculate the extreme values.

The value at risk (VaR) of an organisation is a common measure of operational risk and can be used to calculate the operational risk capital. VaR is defined as the cumulative value of the operating losses at a specific confidence level (e.g. 95%) for a specific period [11]. The confidence value is the probability at which a value lies within a particular interval. Therefore when the confidence level is 99%, there is a 99% probability that the VaR is within a particular confidence interval. In most calculations of VaR, the confidence level is usually chosen to be 95% or 99%. The operational risk capital is calculated by obtaining the difference between the VaR and the expected loss. Figure 2.2 shows the schematic diagram of the actuarial approach.

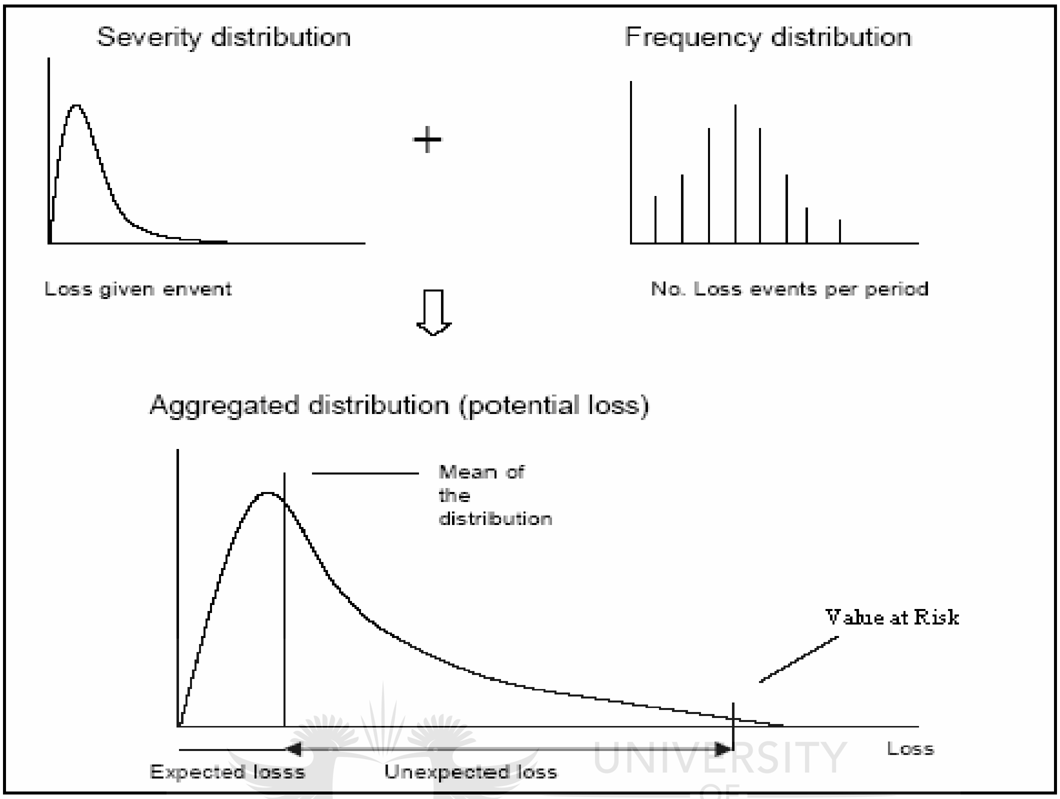

Figure 2.2 A schematic diagram of the actuarial approach [16]

2.3.2.2 STRESS TESTING

Stress testing is a process whereby operational risk events that can cause extraordinary large losses are identified and analysed. This process is performed for the following reasons:

- to determine the extent to which an organisation is vulnerable to possible risk events that can cause extraordinary large losses; and
- to calculate the required operational risk capital that will ensure that an organisation remains solvent when such losses occur.

Operational risk events that can cause extraordinary large losses are identified using scenarios that are generated from statistical research data, internal & external historical data and expert opinion. Thereafter, the potential loss severities and probabilities of these events are estimated. Stress testing can be performed using numerous different methods. The under mentioned are examples of such methods where the operational risk event losses are varied (e.g. by a percentage of the estimated losses or by a multiple of the standard deviation), in order to determine the potential operational risk capital:

- varying the losses of each operational risk event at a time;
- varying the losses of one or more operational risk events that are related (e.g. when one risk event is correlated or dependent on the other risk event) to each other. Historical data can be used to determine the operational risk events that are related to each other, how and to what extent they are related; and
- selecting the maximum estimated losses of the operational risk events simultaneously.

2.3.3 COMBINED QUALITATIVE AND QUANTITATIVE OPERATIONAL RISK ANALYSIS

Operational risk can be analysed by employing methods that can use a combination of qualitative and quantitative data. Qualitative operational risk analysis involves estimating operational risk in words. Quantitative operational risk analysis involves the numerical estimation of operational risk.

2.3.3.1 CAUSAL MODELLING

During causal modelling, scenarios and simulations are used to predict the potential behaviour of processes and to estimate potential losses [7]. Causal modelling involves the development of graphical representations of events, their causes and a simulation that derives their cumulative probability distributions. Historical loss data and scenarios can be used to create these distributions. Causal modelling is beneficial in operational risk management for the following reasons:

- the determination of the causes of operational loss event provides management with clues regarding how best to develop effective strategies that can address the identified causes;
- the operational risk capital can be determined by calculating the forecasted operational losses; and

- considering that causal models are represented graphically, the determination of operational losses and probabilities are less abstract than other only mathematical risk analysis methods.

Causal modelling can be performed by using linear and non-linear methods. Linear methods (e.g. multifactor modelling and multivariate factor analysis) require more data than non-linear methods (e.g. neural networks and Bayesian networks). Thus, the latter methods are more favourable than the former.

2.3.3.1.1 NEURAL NETWORKS

Neural networks are simple computational tools for examining data and developing models that help to identify interesting patterns or structures in the data [24]. They consist of interconnected elements that are referred to as neurons. Neural networks operate similarly to the human and animal brains, as they are able to respond to external input by learning and to encode the information using the strengths of the connections between the neurons. Neural networks are distinguished according to their topology and algorithm. A neural network can be made to perform a particular task by the adaptation of its topology. The main topology types are the feed-forward, limited recurrent and fully recurrent topologies. The main types of neural network algorithms are the supervised, unsupervised and the re-enforced learning algorithms. The forecasting of data can be achieved using the following steps:

1. preparing and training the network using historical data; and
2. forecasting the data using the trained network.

Data preparation entails activities such as data cleansing, selection, pre-processing, scaling, normalisation and symbolism to numeric translation. Neural network training entails data analysis and the adaptation of the inter neuron connection weights in a manner in which the dependencies in the data are reflected. The trained network is used to forecast the data that is required to be forecasted.

Neural networks have the following advantages:

- they can detect hidden patterns from data;
- they can develop a representation of the data; and
- they require minimal apriori assumptions about the data patterns thereby allowing the historical data to become the main factors that determine the forecasted values.

The following are the disadvantages of using neural networks:

- the amount of data is proportional to the accuracy of the forecast, thus a lot of data is required for the optimum accuracy of a neural network's forecast; and
- neural networks are treated like "black boxes" thus the user is oblivious to how the forecasts are made.

2.3.3.1.2 BAYESIAN NETWORKS

Bayesian network causal models consist of random variables that are, based on its dependence, linked together. A variable "A" is dependent on another variable "B" if a change in the state of "B" causes a change in the probability distribution for the states in "A" [15]. Bayesian networks are the most commonly used compared to other non-linear methods for the following reasons:

- the arrows in Bayesian networks represent the link between events and their causes whereas in fuzzy logic and neural networks, arrows represent the flow of information during reasoning;
- Bayesian networks allow more modelling flexibility than system dynamic simulation models;
- objective and subjective data can be combined to obtain an estimated operation loss; and
- operational losses that have little or no operational losses such as those with low frequency and high severity are effectively modelled with causal modelling.

The main disadvantage of using causal modelling is that it often requires a lot of apriori assumptions about the conditional probabilities.

2.4 CONCLUSION

Operational risk can be identified using one or more structures, techniques and information sources. The proposed operational risk identification methodology is structured as a discussion using the organisational chart technique with historical data as the main source of information.

Operational risk analysis allows managers to predict possible future operational losses in order to evaluate a risk management strategy that can minimize these losses. An organisation's operational risk analysis can be done with either a top-down or a bottom-up approach. The proposed operational risk analysis methodology for the management of railway infrastructure corrective maintenance adopts a bottom-up approach. This approach was selected as it assists managers to gain sufficient knowledge to effectively manage the operational risk of their departments.

There are three main types of operational risk analysis, namely qualitative, quantitative and a combination of both. Qualitative operational risk analysis often involves estimating operational risk that difficult or impossible to calculate numerically. Qualitative operational risk analysis results are often expressed using risk maps. Examples of qualitative operational risk analysis methods are risk self-assessment, risk process flow analysis and scenario formulation and analysis. Quantitative operational risk analysis involves the numerical estimation of operational risk. Examples of quantitative risk analysis methods are the actuarial approach and stress testing. Combinations of qualitative and quantitative risk analysis allow the advantages of both methods to be used. Examples of combinations of qualitative and quantitative operational risk analysis are causal models using neural networks or Bayesian networks. The credibility of Bayesian network causal models that use historical data is higher than that of qualitative operational risk assessment because this form of assessment is highly subjective. Assuming that past events are good predictors of the future, Bayesian network causal models that use historical data are provide more accurate predictions than parametric loss distribution actuarial models. The use of Bayesian network causal models that use historical data is more effective than actuarial models for the management of operational risk as the causes of losses are specified in causal modelling. The frequency and severity of operational losses due to worst case scenarios can be predicted by stress testing using Bayesian network models that use historical data. Thus the proposed operational risk assessment methodology for the management of railway infrastructure corrective maintenance uses Bayesian network causal models.

CHAPTER 3 : THE PROPOSED OPERATIONAL RISK ANALYSIS METHODOLOGY FOR INFRASTRUCTURE MAINTENANCE

3.1 INTRODUCTION

The proposed operational risk analysis methodology for the management of railway infrastructure maintenance is discussed in this chapter. Section 3.2 discusses operational risk identification which is structured as a discussion using the organisational chart technique with historical data as the source of information. Section 3.3 discusses operational risk analysis using Bayesian network causal models.

3.2 OPERATIONAL RISK IDENTIFICATION

The proposed operational risk identification methodology for the management of infrastructure corrective maintenance occurs in a discussion. The people who participate in this discussion should ideally be the following:

- a senior engineer who maintains the railway infrastructure of a particular region;
- the engineers who maintain the different components of the railway infrastructure system i.e. track, permanent-way, electrical, train authorisation and telecommunication; and
- a member of the risk management department.

Operational risks are identified primarily using historical data, (e.g. the train accident database). Ideally, this historical data should contain the dates, times, descriptions and root causes of events that required corrective maintenance. The author suggests that operational risk identification is performed in a discussion so that any additional operational risks that have not yet occurred but have the potential to occur and their causes are identified. The organisational chart technique is performed in order to categorise the causes of the identified operational risks according to the organisation's structures that must manage these risks.

3.3 OPERATIONAL RISK ANALYSIS

The proposed operational risk analysis methodology for the management of infrastructure maintenance is done by developing Bayesian network causal models. Two causal models are developed for each identified operational risk for forecasting the operational risk frequency and severity. The development of a Bayesian causal model is composed of the following stages:

- causal model building;
- causal model data collection; and
- causal model data processing.

3.3.1 CAUSAL MODEL BUILDING

Causal model building involves the identification of operational risk causes and causal model formation.

3.3.1.1 THE IDENTIFICATION OF OPERATIONAL RISK CAUSES

All the causes of the identified operational risks and the dependencies of these causes are identified. Thereafter, a list of the identified operational risk, causes and contributing factors is compiled.

3.3.1.2 CAUSAL MODEL FORMATION

The elements of the list of the identified operational risks, causes and contributing factors are selected to become the nodes of the causal model. A node is a representation of a random variable which is either continuous or discrete, with a finite number of states. Each node that represents a random variable that is continuous contains a density function. Each node that represents a random variable that is discrete contains a distribution function. This type of node has a probability table that is associated with it which contains the values of the distribution function. Only the nodes that represent discrete random variables are used in the proposed operational risk analysis methodology. The structure of the causal model is formed by linking the nodes with arrows that display the dependencies and causal relationships between the nodes.

Railway infrastructure components are inspected to check for defects on a regular basis, the frequency of the inspections depend on the type of railway infrastructure component. The author has assumed that each operational risk cause has the following three (3) contributing factors:

1. a defect of an infrastructure system component that was not detected during the inspection of that component;
2. a defect of an infrastructure system component that was detected during inspection but caused an operational risk event before it was repaired; and
3. a defect of an infrastructure system component that was detected during inspection, was repaired but caused an operational risk event due to inefficient repair.

3.3.2 CAUSAL MODEL DATA COLLECTION

Causal models can be constructed using a combination of objective and subjective data.

3.3.2.1 CAUSAL MODEL OBJECTIVE DATA

3.3.2.1.1 FREQUENCY CAUSAL MODEL OBJECTIVE DATA

Objective data is used for frequency model data collection to obtain the probability distribution function of the contributing factors of the operational risk causes. This data can be obtained from an organisation's risk register which contains historical operational loss data indicating the number of loss events. Additionally, data from the maintenance activities database can be used to determine the dates in which maintenance activities where scheduled.

3.3.2.1.2 SEVERITY CAUSAL MODEL OBJECTIVE DATA

Objective data is used for severity model data collection to obtain the probability distribution of the contributing factors of operational risk costs. This data can be obtained from an organisation's risk register to obtain historical loss data. Additionally, data from the financial claims database can be used to obtain the records concerning the amount of money that was claimed for rehabilitating railway infrastructure after operational loss events.

3.3.2.2 CAUSAL MODEL SUBJECTIVE DATA

3.3.2.2.1 FREQUENCY CAUSAL MODEL SUBJECTIVE DATA

Subjective data is used for frequency model data collection to obtain the conditional probability distribution functions of operational risks and their causes. This data is estimated by railway infrastructure maintenance experts. In the proposed operational risk assessment methodology, subjective data is collected through face-to-face interviews with experts. The advantages of face-to-face interviews above other methods (e.g. complete questionnaires) and telephonic interviews are the following:

- any issues that the expert is unsure of can be dealt with immediately, thus they are able to make predictions more accurately as a result of having a better understanding of the questions that are posed; and
- the interviewers are able to gain better insight from the experts.

3.3.2.2.1.1 INTERVIEW QUESTIONNAIRE

The interview questionnaire consists of an introduction and main questions section.

3.3.2.2.1.1.1 INTRODUCTION

The questionnaire begins with an introduction consisting of the following:

1 Interview circumstantial information i.e. the date and venue;

2 The expert background information i.e. job position, duration in which the expert has been at their current position, nature of work, previous work experience;

3 A description of the target sample e.g. track maintenance experts;

4 An explanation of the purpose of the research;

5 An estimation of the time required to compete the interview;

6 The assurance that the participant's participation is voluntary;

7 The assurance that it is acceptable for the participant's to not respond to every question;

8 The instructions that must be followed in answering the questions.

3.3.2.2.1.1.2 MAIN QUESTIONS

There are various techniques for the subjective quantitative estimation of probabilities. In the proposed operational risk analysis methodology, the technique for the subjective quantitative estimation of probabilities that was developed by Kwabena [16] is used. The experts are asked to estimate the conditional probabilities of the operational risks and their causes. The order of the questions is set in such a way that probabilities from the same conditional distribution are grouped together in order to allow the experts to estimate these probabilities simultaneously and probabilities of the same and adjacent nodes are grouped together.

3.3.2.2.1.2 THE INTERVIEW

The interview begins with the exchange of the introductory information that is discussed in section 3.3.2.2.1.1.1; this is followed by a review of the following concepts: probability theory basics, the recommended probability estimation technique and the format of the interview questions. Thereafter, the interviewer requests the conditional probability distribution values from the experts and captures the answers in a tabular format.

3.3.2.2.2 SEVERITY CAUSAL MODEL SUBJECTIVE DATA

Subjective data is not used for severity model data collection.

3.3.3 CAUSAL MODEL DATA PROCESSING

The collected objective and subjective data are entered into a computer program that develops Bayesian network causal models. This data must be entered in a form that can be encoded into the frequency and severity causal models. The probability distribution of the operational risk frequency, severity and causes are obtained during this stage.

3.4 CONCLUSION

The proposed operational risk analysis methodology for the management of infrastructure maintenance is performed by identifying operational risk and developing Bayesian network causal models. Two causal models are developed for each identified operational risk for forecasting the operational risk frequency and severity. The identification of operational risk is performed during a discussion with experts by primarily using historical data. Operational risk analysis comprises of the following stages:

- causal model building;
- causal model data collection; and
- causal model data processing.

Causal model building involves the identification of operational risk causes and their contributing factors. It is assumed that each cause of operational risk has the following three (3) contributing factors:

1. a defect of an infrastructure system component that was not detected during the inspection of that component;
2. a defect of an infrastructure system component that was detected during inspection but caused an operational risk event before it was repaired; and
3. a defect of an infrastructure system component that was detected during inspection, was repaired but caused an operational risk event due to inefficient repair.

Causal model data collection entails collecting objective historical data from sources such as the organisation's operational risk database and subjective data from face-to-face interviews with railway infrastructure maintenance experts. During causal model data processing, the probability distribution of the operational risk frequency, severity and its causes are obtained using the collected data and a computer program.

CHAPTER 4 : CASE STUDY – OPERATIONAL RISK ANALYSIS FOR AFRICAN RAILWAYS LTD'S INFRASTRUCTURE MAINTENANCE

4.1 INTRODUCTION

In this chapter, the proposed operational risk analysis methodology is applied for the analysis of an African Railways Ltd (ARL) operational risk that is caused by railway infrastructure component failure.

A brief background of ARL's infrastructure maintenance and operational risk analysis activities is presented in section 4.2. The current ARL operational risk analysis methodology is discussed in section 4.3. The application of the proposed operational risk analysis methodology is presented in section 4.4.

4.2 ARL INFRASTRUCTURE MAINTENANCE BACKGROUND

4.2.1 SYSTEM BACKGROUND

ARL is a South African company that provides railway transportation. The management of ARL's infrastructure maintenance activities occur in seventeen (17) depots that are situated throughout South Africa. A typical depot consists of departments such as human capital, finance, per-way, track, electrical and signals. Each depot is managed by a senior engineer referred to as a depot engineer. The per-way, track, electrical and signals departments are each managed by one maintenance manager and one production manager. Maintenance and production managers are engineers, technologists or senior technicians. The sub-ordinates of maintenance and production managers are technicians, foremen, technical assistants and labourers.

The ARL risk management department is situated in Johannesburg, South Africa and is responsible for ensuring that the following activities are performed:

- operational risk management processes are implemented throughout ARL;
- business continuity management is implemented that will allow ARL to continue to be sustainable during abnormal conditions that may interrupt the business;
- ARL complies with the applicable protocols and codes to which South Africa is a signatory;
- ARL complies with all the applicable safety, health and environmental legislation and regulations; and
- operational loss prevention and control is performed.

4.3 THE CURRENT ARL OPERATIONAL RISK ANALYSIS METHODOLOGY

The rehabilitation of the railway infrastructure after operational risk events such as theft, sabotage, natural disasters, train accidents etc is done by the staff of the depot that maintains the area in which the event occurred. Thereafter, the depot engineer gets reimbursed for the funds expropriated for the rehabilitation of the infrastructure from ARL's risk management department.

Annually, members of the risk department, analyse ARL's operational risk in order to forecast the funds that will be needed during the following financial year for the management of operational risk. ARL analyses operational risk according to the principles of the ISO 31000, a document that contains risk management principles and guidelines that were formed by the International Organisation for Standardization (ISO). According to ISO 31000 guidelines, risk analysis can be qualitative, semi-quantitative and quantitative, or a combination of these depending on the circumstances [7]. ARL uses an operational risk analysis methodology that involves the qualitative rating of the consequences and likelihood of operational risk events. Thereafter, the ratings are plotted onto a risk matrix (see paragraph 2.4). ARL's risk appetite is determined by the African Railways Ltd board. The risk appetite and the quadrant, in which the estimated operational risk falls on the risk matrix and determines the decision of whether the risk will be accepted, controlled, transferred or avoided. Additionally, to ensure that ARL will be sustainable during abnormal conditions, Scenario formulation and analysis, (see paragraph 2.3.1.2.3) is performed using historical data.

The limitation of the current ARL operational risk methodology is that it does not assist the depot engineer to forecast the effect of railway infrastructure maintenance strategies on operational risks.

4.4 PROPOSED OPERATIONAL RISK ANALYSIS METHODOLOGY APPLICATION

The consequences of operational risk events that are caused by railway infrastructure system failures are train delays, cancellations and accidents. The largest operational losses that are caused by railway infrastructure system failure are the latter. In this case study, an assessment of a train accident-related operational risk of the Johannesburg central region is presented by applying the proposed operational risk assessment methodology.

4.4.1 OPERATIONAL RISK IDENTIFICATION

ARL uses a risk register to capture the information about all the train accidents that have occurred. This information is divided into 61 categories e.g. the train accident type, area, date, causes, etc. Data from the risk register of the 2005/2006, 2006/2007 and 2007/2008 financial years were used to identify the train accident related operational risks that the Johannesburg central region infrastructure are exposed to. The identified train accident-related operational risks are the following:

- collision of train running line, i.e. the collisions of ARL trains that occurred along the ARL running line;
- derailment running line, i.e. the derailments of ARL trains that occurred along the ARL running line;
- derailment running line Passenger, i.e. the derailments of trains from companies that transport passengers that occurred along the ARL running line;
- derailment shunt Private, i.e. the derailments of ARL trains during shunting along railway infrastructure owned by private companies;
- derailment shunt African Railways Ltd, i.e. derailments that occurred during the shunting of ARL trains in railway infrastructure that is owned by ARL;
- fatality third party i.e. the deaths of members of the public due to being hit by a ARL train;
- fatality third party (Body found next to line) i.e. the bodies of members of the public that are found on the track which were not hit by a ARL train;
- fatality contractor i.e. the death of contractor employees as a result of being hit by a ARL train;
- fatality employee i.e. the death of a ARL employee as a result of being hit by a ARL train ;
- level crossing accident i.e. the accidents that occurred between ARL trains and vehicles at level crossings;

- signal passed at danger i.e. the accidents that occurred as a result of train drivers passing a signal that has a danger sign (like a red sign of a robot); and
- derailment shunt Transwerk i.e. the derailments that occurred during shunting along African Railways Ltd Rail Engineering railway infrastructure.

Only the operational risks that are related to train derailments that occur along ARL infrastructure are assessed in this case study. These operational risks are derailment running line, derailment running line Passenger and derailment shunt African Railways Ltd. It is mentioned in paragraph 3.2 that operational risk identification should be performed primarily using historical data, additionally a discussion should occur in which the engineers that maintain railway infrastructure identify any operational risks that have not yet happened and are likely to occur. In this case study, one operational risk was identified for further analysis using historical data thus it was found to be unnecessary to identify other operational risks using a discussion with the engineers that maintain railway infrastructure.

4.4.2 OPERATIONAL RISK ANALYSIS

Operational risk analysis was performed using Bayesian causal modelling. This involved causal model building, data collection and data processing.

4.4.2.1 CAUSAL MODEL BUILDING

4.4.2.1.1 THE IDENTIFICATION OF OPERATIONAL RISK CAUSES

Data from the risk register of the 2005/2006, 2006/2007 and 2007/2008 financial years were used to identify the causes of the operational loss events that occurred in the Johannesburg central region. The causes of the operational loss events fall under the following categories:

- Infra T, these are operational loss events that are related to the failure of railway infrastructure that are caused by a variety of reasons;
- InfraH, these are operational loss events that are related to the failure of railway infrastructure as a direct result of negligence or incorrect maintenance by a ARL staff member who is responsible for executing particular maintenance activities;
- Crew, these are operational loss events that are related to the Train crew department consisting of train drivers, train driver assistants etc.
- ROEOps, these are operational loss events that are related to the Operations department staff such as operators that remotely control train authorisation by operating the signals and points (see paragraph 1.1.4);

- Sabot, these are operational loss events that are related to the department that works with security contractors for the prevention of sabotage and theft on ARL assets;
- Wagons, these are operational loss events that are related to the Rolling stock department
- Power, these are operational loss event that were caused by power failures.
- Term, these are operational loss events that are related to the Terminals department
- Trans, these are operational loss events that are related to African Railways LtdRail Engineering
- Obstruct, these are operational loss events were caused by obstructions on the railway line
- Still, these are operational loss events that are still under investigation;
- Notdet, the causes of these operational loss events are unknown

Only the train derailments that are caused by infrastructure system component failure are assessed in this case study. These causes fall under the InfraT and InfraH categories. The data from the risk register for train derailments is presented in Appendix A. Table ii displays the identified operational risk causes that were obtained from the InfraT and InfraH categories of the risk register.

Identified operational risk causes	**Number of operational risk causes**
Points machine defective	68
Wrong rail gauge	32
Retarder/Advancer defective	32
Rail broken	29
Rail slack	18
Rail kick	3
Sleepers rotten	2
Points not set correctly	2
Catcher defective	2
Obstruction on railway line	1
Concurrence	1
Tamping machine apparatus hooked on railway line	1
Pushed over derailer	1
Signal passed at danger	1
Did not ensure that line was safe for movements	1

Table ii: Identified operational risk causes

The Pareto principle of the 'significant few and the insignificant many' was used to select the number of train derailment causes that would be used for further analysis. Thus the following five (5) causes of derailments which caused the most derailments were used to analyse train derailments:

- defective points machine;
- incorrect rail gauge;
- defective retarder/advancer;
- broken rail; and
- slack.

Defective points machines cause the most train derailments that are related to failures of railway infrastructure. Points machines are track equipment that enable trains to move from one track to another. Derailments are also likely to occur when the distance between the rails is not within the prescribed length. A retarder/advancer is a cylindrical apparatus that is used for decelerating or accelerating the wagons and locomotives during shunting. When this apparatus is not well maintained, it can cause a shunting derailment. Broken rail commonly cause derailments to occur. Slack occurs when one of the rails is higher than the other; the resulting movement of a train that passes a rail with slack may result in a derailment.

4.4.2.1.2 CAUSAL MODEL FORMATION

4.4.2.1.2.1 FREQUENCY CAUSAL MODEL FORMATION

The author has assumed that train derailment causes have the following general contributing factors:

1. a train derailment is caused by a defect of an infrastructure system component that was not detected during the inspection of that component;
2. a train derailment is caused by a defect of an infrastructure system component that was detected during inspection but caused a derailment before it was repaired; and

3. a train derailment is caused by a defect of an infrastructure system component that was detected during inspection, was repaired but caused a derailment due to inefficient repair.

The identified operational risk, causes of the operational risk and the factors that contribute to these causes are listed in table iii. Each element of Table iii is represented by a node in the causal model that is displayed in figure 4.1. A demo version of Hugin Lite version 7.1 software was used to construct the causal model.

Identified operational risk	Identified operational risk causes	Factors that contribute to the identified operational risk causes
1. Derailment	1.1 Defective points machine	1.1.1 Undetected defect in points machine.
		1.1.2. Derailment occurs before the repair of detected defect in points machine.
		1.1.3. Derailment occurs after the repair of detected defect in points machine due to the inefficient repair of the detected defect.
	1.2. Incorrect rail gauge	1.2.1. Undetected incorrect rail gauge.
		1.2.2. Derailment occurs before the correction of the rail gauge.
		1.2.3. Derailment occurs after the correction of the rail gauge due to the inefficient correction of the track gauge.
	1.3. Defective retarder/advancer	1.3.1 Undetected defect in the retarder/advancer
		1.3.2 Derailment occurs before the repair of the detected defect in the retarder/advancer
		1.3.3 Derailment occurs after the repair of the detected defect of the retarder/advancer due to inefficient repair.
	1.4. Broken rail	1.4.1 Undetected broken rail.
		1.4.2 Derailment occurs before the repair of the detected broken rail.
		1.4.3 Derailment occurs after the repair of the detected broken rail due the inefficient repair of the broken rail.
	1.5. Slack	1.5.1 Undetected slack
		1.5.2 Derailment occurs before the repair of the detected slack
		1.5.3 Derailment occurs after the repair of slack due to inefficient repair of slack

Table iii: Identified operational risk, causes and dependencies

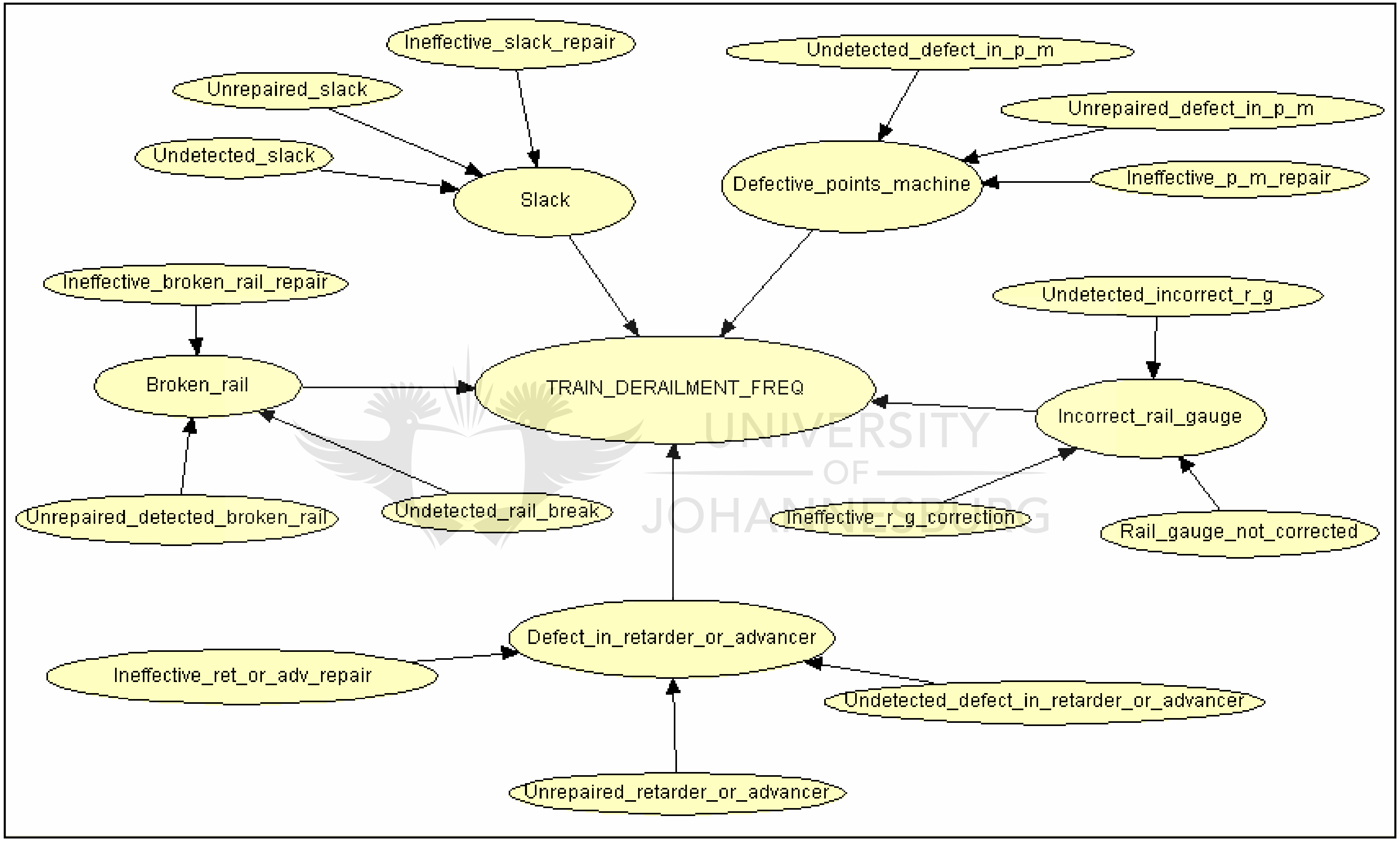

Figure 4.1 Train derailment frequency causal model

4.4.2.1.2.2 SEVERITY CAUSAL MODEL FORMATION

The cost of rehabilitating railway infrastructure after train derailments is largely influenced by the type of train derailments that have occurred. The four main types of train derailments are the following:

- derailment running line-these are derailments of locomotives and wagons that occur along the running line of the track;
- derailment shunt-these are derailments of locomotives and wagons that occur at the shunting yards;
- derailment wagon-these are derailments of wagons that occur in shunting yards and along the running line of a track; and
- derailment-these are derailments of locomotives and wagons that occur at places along the track that are not along the running line and in shunting yards.

The severity of the identified operational risk and the factors that contribute to the severity of the operational risk are listed in table iv. Each element of table iv is represented by a node in the causal model that is displayed in figure 4.2.

Severity of the identified operational risk	**Factors contributing to the severity of the identified operational risk**
1. Train derailment cost	1.1 Derailment running line
	1.2 Derailment shunt
	1.3 Derailment-wagon
	1.4 Derailment

Table iv: Severity of the identified operational risk and contributing factors

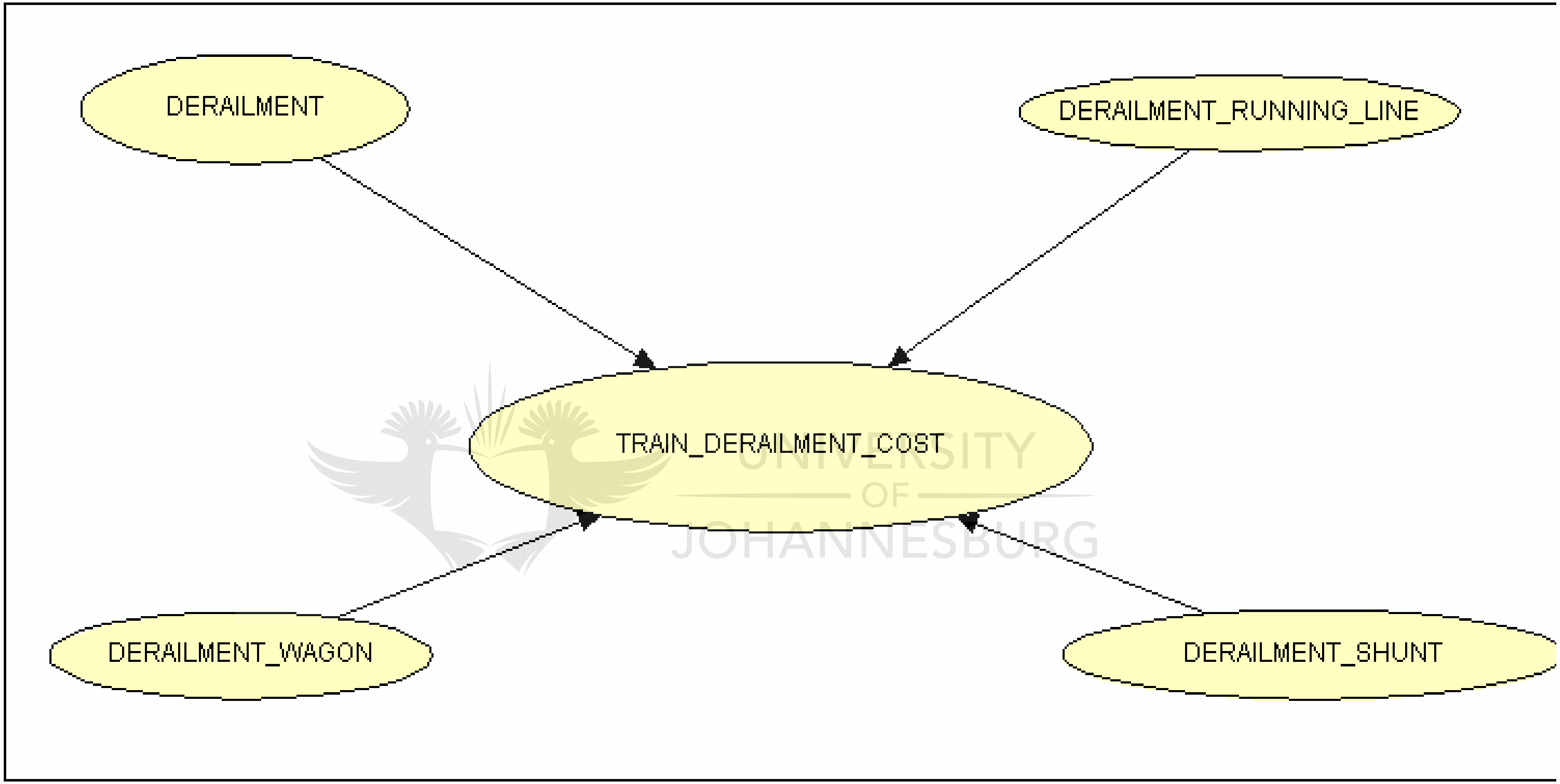

Figure 4.2 Train derailment severity causal model

4.4.2.2 CAUSAL MODEL DATA COLLECTION

This section discusses the collection of data for the processing of the identified operational risk frequency and severity models.

4.4.2.2.1 FREQUENCY CAUSAL MODEL DATA COLLECTION

4.4.2.2.1.2 FREQUENCY CAUSAL MODEL OBJECIVE DATA COLLECTION

Each node that represents the factors that contribute to the causes of operational risk has a discrete probability distribution consisting of two states. One state represents the probability of a defect P and the other state represents the probability of a defect not occurring $P' = 1 - P$.

In every depot, an inspection of the railway infrastructure track components is performed weekly by trackmasters. A list of any defects that are found during the inspection is made. Thereafter, a reference number is assigned to each maintenance work that must be done in order to repair the detected defect. A list of the 2005/2006, 2006/2007 and the 2007/2008 financial years reference numbers, detected defects, planned maintenance dates and areas, were obtained from the Johannesburg central depot finance department database. The information concerning the planned repair of detected points machine defects, incorrect rail gauges, broken rails and slack is presented in Appendix B. Data from the risk register and the Johannesburg central depot finance department, in Appendix A and B respectively, were analysed to find the amount of times in which the following occurred:

1. a defect was not detected during inspection i.e. a particular defect was not discovered in a particular area during inspection yet that defect resulted in a train derailment during the week of its inspection;
2. a defect was detected during inspection, was assigned a reference number but resulted in a train derailment before it was scheduled to be repaired; and
3. a defect was detected during inspection, was assigned a reference number and was repaired however this defect still caused a train derailment on the same week that the defect was detected.

Risk register data was used to obtain the probability distributions of the nodes that represent the factors that contribute to the causes of operational risk. The probability of a factor that contributes to operational risk is estimated to be equal to the number of cases in which derailments occurred due to a particular factor that contribute to operational risk B divided by the number of defects A, thus $P = \frac{B}{A}$ Table v displays the states of these nodes.

Identified operational risk causes	**Total number of defects** *A*	**Factors that contribute to the identified operational risk causes**	**Number of factors that contribute to the identified operational risk causes** *B*	**State 1: Probability of defects** *P*	**State 2: Probability of no defects occurring** *P′*
1.1 Defective points machine	68	1.1.1 Undetected defect in points machine.	57	0.842	0.158
		1.1.2. Derailment occurs before the repair of detected defect in points machine.	7	0.1053	0.947
		1.1.3. Derailment occurs after the repair of detected defect in points machine due to the inefficient repair of the detected defect.	4	0.06	0.895
1.2. Incorrect rail gauge	32	1.2.1. Undetected incorrect track gauge.	28	0.889	0.111
		1.2.2. Derailment occurs before the correction of the track gauge.	0	0	1
		1.2.3. Derailment occurs after the correction of the track gauge due to the inefficient correction of the track gauge.	4	0.111	0.889

Identified operational risk causes	**Total number of defects** A	**Factors that contribute to the identified operational risk causes**	**Number of factors that contribute to the identified operational risk causes** B	**State 1: Probability of defects** P	**State 2: Probability of no defects occurring** P'
1.3. Defective retarder/advancer	32	1.3.1 Undetected defect in the retarder/advancer	32	1	0
		1.3.2 Derailment occurs before the repair of the detected defect in the retarder of advancer	0	0	1
		1.3.3 Derailment occurs after the repair of the detected defect of the retarder/advancer due to inefficient repair.	0	0	1
1.4. Broken rail	29	1.4.1 Undetected broken rail.	25	0.875	0.125
		1.4.2 Derailment occurs before the repair of the detected broken rail.	4	0.125	0.875
		1.4.3 Derailment occurs after the repair of the detected broken rail due to the inefficient repair of the broken rail.	0	0	1
1.5. Slack	18	1.5.1 Undetected slack	18	1	0
		1.5.2 Derailment occurs before the repair of the detected slack	0	0	1
		1.5.3 Derailment occurs after the repair of slack due to inefficient repair of slack	0	0	1

Table v: The states of the operational risk causes contributing factors nodes

4.4.2.2.1.2 FREQUENCY CAUSAL MODEL SUBJECIVE DATA COLLECTION

A face-to-face interview with one engineering technician, one engineer and one senior engineer was done by the author to obtain the conditional probabilities of the following:

- train derailments that are caused by the failure of infrastructure system components; and
- the main causes of these train derailments i.e. defective points, wrong track gauge, defective retarder/advancer, broken rail and slack.

4.4.2.2.1.2.1 INTERVIEW QUESTIONNAIRE

The interview questionnaire consists of a question and an answer sheet. The question sheet and answer sheets of the interview questionnaire are presented in Appendix C.

4.4.2.2.2.1.1 INTERVIEW QUESTIONNAIRE QUESTION SHEET

The interview questionnaire question sheet consists of the following:

1 An explanation of the purpose of the questionnaire.

2 The instructions that must be followed in answering the questions.

3 Interview circumstantial information i.e. the date and venue.

4 The expert's background information i.e. job position, nature of work, duration in which the expert has been at their current position and has worked in a railway infrastructure maintenance environment.

5 The questions that were posed to the experts. The order of these questions were done in such a manner that probabilities from the same conditional distribution were grouped together to allow the experts to estimate these probabilities simultaneously and probabilities of the same and adjacent nodes were grouped together.

4.4.2.2.1.2.1.2 INTERVIEW QUESTIONNAIRE ANSWER SHEET

One engineering track technician, one engineering track chief technician and one senior track engineer from ARL were interviewed. During the interviews, these experts were asked to estimate the conditional probability distributions of train derailments and their causes. The author recorded the estimated conditional probabilities in a matrix format. Thereafter, each state's conditional probabilities were added and divided by three (3) to obtain the average conditional probability distribution for all of the causal model nodes.

The average conditional probability distribution values of a train derailment that were estimated by the experts are displayed in table vi and table vii. This probability distribution consists of two states which represent the occurrence and nonoccurrence of a train derailment when one or more of the following conditions exist in isolation or simultaneously with others in one area along the track:

- defective points machine;
- incorrect rail gauge;
- defective retarder/advancer;
- broken rail; and
- slack.

	Defective points machine															
	Incorrect rail gauge								Correct rail gauge							
	Defective retarder/advancer				Operating retarder/advancer				Defective retarder/advancer				Operating retarder/advancer			
	Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail	
	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack
Train derailment	0.670	0.496	0.360	0.220	0.228	0.208	0.200	0.090	0.300	0.188	0.18	0.16	0.168	0.148	0.140	0.120
No train derailment	0.330	0.504	0.640	0.780	0.772	0.792	0.800	0.910	0.700	0.812	0.82	0.84	0.832	0.852	0.860	0.880

Table vi: The conditional probability distribution values of a train derailment 1

	Operating points machine															
	Incorrect rail gauge								Correct rail gauge							
	Defective advancer/retarder				Operating advancer/retarder				Defective advancer/retarder				Operating advancer/retarder			
	Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail	
	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack
Train derailment	0.296	0.128	0.120	0.120	0.162	0.066	0.080	0.010	0.088	0.068	0.040	0.027	0.008	0.005	0.003	0.000
No train derailment	0.704	0.872	0.880	0.880	0.838	0.934	0.920	0.990	0.912	0.932	0.960	0.973	0.992	0.995	0.997	1.000

Table vii: The conditional probability distribution values of a train derailment 2

The average conditional probability distribution values of a point's machine, rail gauge, retarder/advancer, broken rail and slack are displayed in table's viii-xii. These probability distributions consist of two states which represent the occurrence and nonoccurrence of the above mentioned conditions under one of the following three scenarios:

- An existing defect was not detected during inspection;
- An existing defect was detected during inspection but resulted in a derailment before it was repaired;
- An existing defect was detected during inspection thereafter; it was ineffectively repaired resulting in a derailment.

	Undetected points machine defect				Detected points machine defect			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Defective points machine	0.263	0.463	0.463	0.463	0.033	0.033	0.100	0.067
Operating points machine	0.737	0.537	0.537	0.537	0.967	0.967	0.900	0.933

Table viii: The conditional probability distribution values of a points machine

	Undetected incorrect rail gauge				Detected incorrect rail gauge			
	Uncorrected detected rail gauge		Corrected detected rail gauge		Uncorrected detected rail gauge		Corrected detected rail gauge	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Incorrect rail gauge	0.383	0.383	0.383	0.383	0.067	0.067	0.000	0.000
Correct rail gauge	0.617	0.617	0.617	0.617	0.933	0.933	1.000	1.000

Table ix: The conditional probability distribution values of a rail gauge

	Undetected advancer/retarder defect				Detected advancer/retarder defect			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Defective advancer/retarder	0.630	0.630	0.630	0.630	0.033	0.033	0.067	0.000
Operating advancer/retarder	0.370	0.370	0.370	0.370	0.967	0.967	0.933	1.000

Table x: The conditional probability distribution values of an advancer/retarder

	Undetected broken rail				Detected broken rail			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Broken rail	0.633	0.633	0.633	0.633	0.233	0.233	0.033	0.033
No broken rail	0.367	0.367	0.367	0.367	0.767	0.767	0.967	0.967

Table xi: The conditional probability distribution values of broken rail

	Undetected slack				Detected slack			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Slack	0.100	0.300	0.300	0.300	0.000	0.000	0.000	0.000
No slack	0.900	0.700	0.700	0.700	1.000	1.000	1.000	1.000

Table xii: The conditional probability distribution values of slack

4.4.2.2.2 SEVERITY CAUSAL MODEL DATA COLLECTION

4.4.2.2.2.1 COST CONTRIBUTING FACTOR NODES DATA COLLECTION

Data from the 2005-2008 financial year risk registers, see Appendix A, was used for the forecasting of the cost of rehabilitating railway infrastructure after train derailments caused by infrastructure component failure with the use of the causal model in figure 4.2. The probabilities of the train derailment types (Td) were calculated by dividing the amount of each derailment type with the amount of all the derailments that had occurred (i.e. 179 train derailments). The states of the train derailment cost contributing factors per trip were calculated by multiplying the probability of each train derailment type with the probability of a train derailment per train trip (i.e. 4.02%) which was obtained from the results of the frequency causal model processing; see paragraph 4.5.1.6. The states of the train derailment cost contributing factor nodes are displayed in Table xiii.

Train derailment types	Number of train derailment types	Probability of train derailment types	State 1:Probability of train derailment types per trip	State 2:Complement of train derailment types per trip probability
1.1 Derailment running line	156.000	0.871	0.350	0.650
1.2 Derailment shunt	16.000	0.090	0.036	0.964
1.3 Derailment-wagon	2.000	0.012	0.005	0.995
1.4 Derailment	5.000	0.027	0.011	0.989
Total	179.000	1.000	0.402	0.598

Table xiii: The states of the train derailment cost contributing factor nodes

4.4.2.2.2.2 TRAIN DERAILMENT COST DATA COLLECTION

The ARL depot engineers make claims to the risk management department for the rehabilitation of railway infrastructure after derailments have occurred and keep records of the claims, see Appendix D. The records of the claims that were made during the 2005-2008 financial years were used to determine the conditional probability of the train derailment cost node. Table xiv shows the amount of money that was claimed for the derailments during the 2005 to 2008 financial years.

Financial years	Derailment	Derailment-wagon	Derailment running line	Derailment shunt
2005 - 2006	R 8,500,000.00	R 45,000.00	R 129,518,239.00	R 135,900.00
2006 - 2007	R 6,939,900.00	R 0.00	R 147,509,600.00	R 410,009.00
2007 - 2008	R 1,870,000.00	R 58,991.00	R 121,085,058.80	R 1,220,009.00

Table xiv: Train derailment claimed money

The costs of rehabilitating railway infrastructure in table xiv were calculated for different scenarios concerning the occurrence of particular types of derailments per year. These scenarios are displayed in table xv.

Scenario number	Year	Scenario: The types of derailments that occur per year			
		Derailment shunt	Derailment-wagon	Derailment running line	Derailment
1.1.	2005 to 2006	Yes	Yes	Yes	Yes
1.2.	2005 to 2006	Yes	Yes	Yes	No
1.3.	2005 to 2006	Yes	Yes	No	Yes
1.4.	2005 to 2006	Yes	Yes	No	No
1.5.	2005 to 2006	Yes	No	Yes	Yes
1.6.	2005 to 2006	Yes	No	Yes	No
1.7.	2005 to 2006	Yes	No	No	Yes
1.8.	2005 to 2006	Yes	No	No	No
1.9.	2005 to 2006	No	Yes	Yes	Yes
1.10.	2005 to 2006	No	Yes	Yes	No
1.11.	2005 to 2006	No	Yes	No	Yes
1.12.	2005 to 2006	No	Yes	No	No
1.13.	2005 to 2006	No	No	Yes	Yes
1.14.	2005 to 2006	No	No	Yes	No
1.15.	2005 to 2006	No	No	No	Yes
1.16.	2005 to 2006	No	No	No	No
2.1.	2006 to 2007	Yes	Yes	Yes	Yes
2.2.	2006 to 2007	Yes	Yes	Yes	No
2.3.	2006 to 2007	Yes	Yes	No	Yes
2.4.	2006 to 2007	Yes	Yes	No	No
2.5.	2006 to 2007	Yes	No	Yes	Yes
2.6.	2006 to 2007	Yes	No	Yes	No
2.7.	2006 to 2007	Yes	No	No	Yes
2.8.	2006 to 2007	Yes	No	No	No
2.9.	2006 to 2007	No	Yes	Yes	Yes
2.10.	2006 to 2007	No	Yes	Yes	No
2.11.	2006 to 2007	No	Yes	No	Yes

Scenario number	Year	Scenario: The types of derailments that occur per year			
		Derailment shunt	Derailment-wagon	Derailment running line	Derailment
2.12.	2006 to 2007	No	Yes	No	No
2.13.	2006 to 2007	No	No	Yes	Yes
2.14.	2006 to 2007	No	No	Yes	No
2.15.	2006 to 2007	No	No	No	Yes
2.16.	2006 to 2007	No	No	No	No
3.1.	2007 to 2008	Yes	Yes	Yes	Yes
3.2.	2007 to 2008	Yes	Yes	Yes	No
3.3.	2007 to 2008	Yes	Yes	No	Yes
3.4.	2007 to 2008	Yes	Yes	No	No
3.5.	2007 to 2008	Yes	No	Yes	Yes
3.6.	2007 to 2008	Yes	No	Yes	No
3.7.	2007 to 2008	Yes	No	No	Yes
3.8.	2007 to 2008	Yes	No	No	No
3.9.	2007 to 2008	No	Yes	Yes	Yes
3.10.	2007 to 2008	No	Yes	Yes	No
3.11.	2007 to 2008	No	Yes	No	Yes
3.12.	2007 to 2008	No	Yes	No	No
3.13.	2007 to 2008	No	No	Yes	Yes
3.14.	2007 to 2008	No	No	Yes	No
3.15.	2007 to 2008	No	No	No	Yes
3.16.	2007 to 2008	No	No	No	No

Table xv: Scenarios of the occurrence of types of train derailments

The costs of railway infrastructure rehabilitation after the type of train derailments that are listed in the scenarios in table xiv and table xv were calculated and recorded in table xvi and xvii. The rehabilitation costs were allocated to six (6) cost ranges, the amount of costs that fell under each range were divided by number of financial years i.e. three (3). The resulting probability distribution in table xviii and xvix were used to represent the states of the train derailment cost node.

	Derailment shunt							
	Derailment-wagon				No derailment-wagon			
	Derailment running line		No derailment running line		Derailment running line		No derailment running line	
	Derailment	No derailment	Derailment	No derailment	Derailment	No derailment	Derailment	No derailmen
2005 to 2006	1.1. R138,199,139.00	1.2. R129,699,139.00	1.3. R8,680,900.00	1.4. R180,900.00	1.5. R138,154,139.00	1.6. R129,654,139.00	1.7. R8,635,900	1.8. R135,900.0C
2006 to 2007	2.1 R1548,59,509.00	2.2 R147,919,609.00	2.3. R73,499,09.00	2.4. R410,009.00	2.5. R154,859,509.00	2.6. R147,919,609.00	2.7. R7,349,909.00	2.8. R410,009.0C
2007 to 2008	3.1. R124,234,058.80	3.2. R122,364,058.80	3.3. R3,149,000.00	3.4. R1,279,000.00	3.5. R124,175,067.80	3.6. R122,305,067.80	3.7. R3,090,009.00	3.8. R1,220,009.0

Table xvi: The railway infrastructure rehabilitation costs due to the occurrence of train derailments 1

	No derailment shunt							
	Derailment-wagon				No derailment-wagon			
	Derailment running line		No derailment running line		Derailment running line		No derailment running line	
	Derailment	No derailment	Derailment	No derailment	Derailment	No derailment	Derailment	No derailment
2005 to 2006	1.9. R138,063,239.00	1.10. R129,563,239.00	1.11. R8,545,400.00	1.12. R45,000.00	1.13. R138,018,239.00	1.14 R129,518,239.00	1.15. R8,500,000.00	1.16 0.00
2006 to 2007	2.9. R154,449,500.00	2.10. R147,509,600.00	2.11. R6,939,900.00	2.12. R0.00	2.13. R154,449,500.00	2.14. R147,509,600.00	2.15. R6,939,900.00	2.16. R0.00
2007 to 2008	3.9. R123,014,049.80	3.10. R121,144,049.80	3.11. R1,928,991.00	3.12. R58,991.00	3.13. R122,955,058.80	3.14. R121,085,058.80	3.15. R1,870,000.00	3.16. R0.00

Table xvii: The railway infrastructure rehabilitation costs due to the occurrence of train derailments 2

	Derailment shunt							
	Derailment-wagon				No derailment-wagon			
	Derailment running line		No derailment running line		Derailment running line		No derailment running line	
	Derailment	No derailment	Derailment	No derailment	Derailment	No derailment	Derailment	No derailment
R0-R9	0	0	0	0	0	0	0	0
R10-R99	0	0	0	0	0	0	0	0
R100-R999	0	0	0	0	0	0	0	0
R1k-R999999	0	0	0	0.67	0	0	0	0.67
R1m-R999999999	1	1	1	0.33	1	1	1	0.33
R1b-R1t	0	0	0	0	0	0	0	0

Table xviii: The railway infrastructure rehabilitation costs due to the occurrence of train derailments1

	No derailment shunt							
	Derailment-wagon				No derailment-wagon			
	Derailment running line		No derailment running line		Derailment running line		No derailment running line	
	Derailment	No derailment	Derailment	No derailment	Derailment	No derailment	Derailment	No derailment
R0-R9	0	0	0	0.33	0	0	0	1
R10-R99	0	0	0	0	0	0	0	0
R100-R999	0	0	0	0	0	0	0	0
R1k-R999999	0	0	0	0.67	0	0	0	0
R1m-R999999999	1	1	1	0	1	1	1	0
R1b-R1t	0	0	0	0	0	0	0	0

Table xix: The railway infrastructure rehabilitation costs due to the occurrence of train derailments 2

4.5 CAUSAL MODEL DATA PROCESSING RESULTS

In this section, the results of the processing of the following data are discussed:

- the probability distribution values of the train derailment contributing factors that were obtained from objective historical data; and
- the conditional probability distribution values of train derailment frequencies, causes and track rehabilitation costs that were obtained subjectively from track maintenance experts.

A demo version of the Hugin Lite version 7.1 computer program was used to process the above mentioned data.

4.5.1 FREQUENCY MODEL RESULTS

The same nodes of the train derailment causes and their contributing factors were used in the frequency and severity causal models.

4.5.1.1 POINTS MACHINE PROBABILITY DISTRIBUTION RESULTS

The probability distribution of the defective points machine, undetected defect in points machine and unrepaired defect in points machine nodes of the train derailment causal model is shown in figure 4.3. The probability distributions indicate that there is a 23.19% probability that a points machine is defective and results in a derailment under the following circumstances:

- an 84% probability that the defect was not detected during visual inspection;
- a 5% probability that the defect was detected and was scheduled to be repaired but caused a derailment before the day in which it would be repaired; and
- An 11% probability that the defect was detected and inefficiently repaired resulting in a derailment.

Considering that undetected points machine defects cause the greatest amount of derailments compared to detected defects, it is imperative that track masters are trained to improve their defect detecting skills.

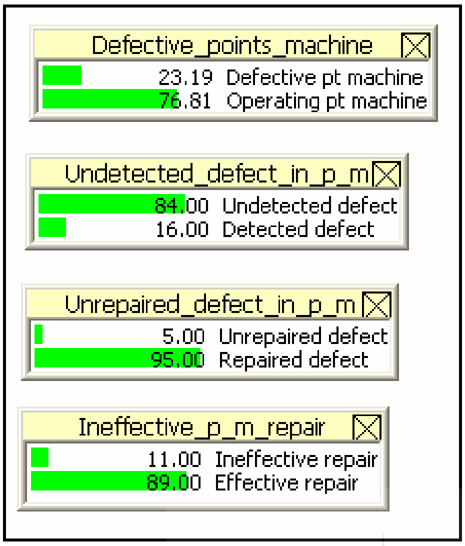

Figure 4.3 Probability distributions of nodes concerning defective points machine.

4.5.1.2 RAIL GAUGE PROBABILITY DISTRIBUTION RESULTS

Figure 4.4 shows the probability distributions of incorrect rail gauges, undetected incorrect rail gauges and unrepaired incorrect rail gauges nodes of the train derailment causal model. The probability distributions indicate that there is a 5.96% probability that an incorrect rail gauge results in a derailment under the following circumstances:

- an 89% probability that the defect was not detected during visual inspection;
- a 0% probability that the defect was detected and was scheduled to be repaired but caused a derailment before the day in which it would be repaired; and
- An 11% probability that the defect was detected and inefficiently repaired resulting in a derailment.

Considering that undetected incorrect rail gauges cause the greatest amount of derailments compared to detected incorrect rail gauges, it is important that correct and well calibrated equipment is used to measure the rail gauges. Additionally, the rail gauge measuring skills of the track masters must be improved by training.

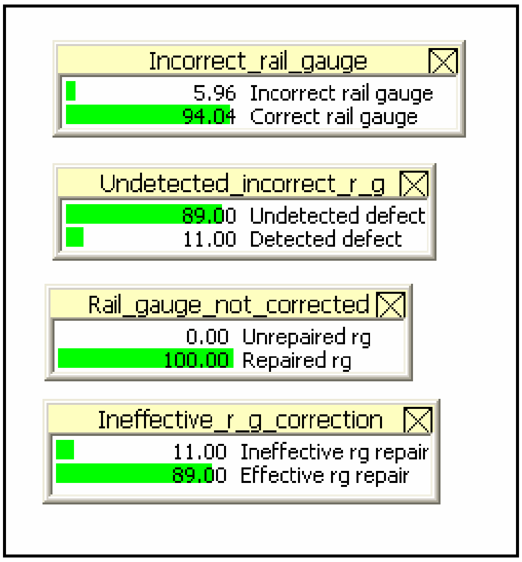

Figure 4.4 Probability distributions of nodes concerning incorrect rail gauge

4.5.1.3 RETARDER/ADVANCER PROBABILITY DISTRIBUTION RESULTS

The probability distributions of retarder/advancer defects, undetected retarder/advancer defects and unrepaired retarder/advancer nodes of the train derailment causal model are presented in figure 4.5. The probability distributions indicate that there is a 30% probability that a retarder/advancer defect may result in a derailment when the defect is undetected during inspection. The probability of retarder/advancer defects can therefore be substantially reduced by improving the defect detection skills of the track masters.

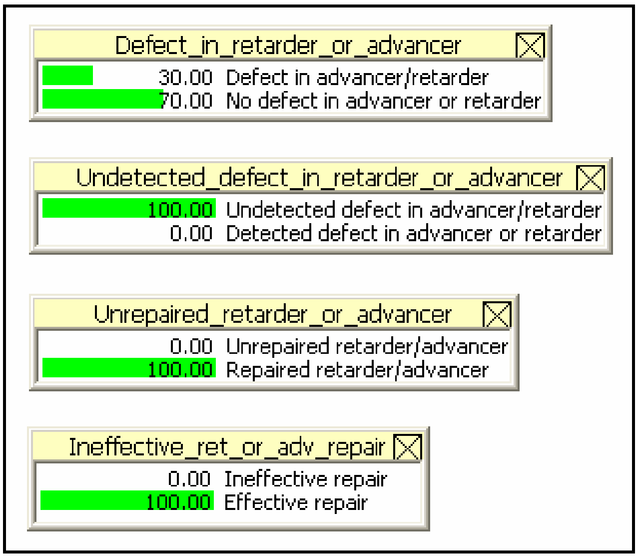

Figure 4.5 Probability distributions of nodes concerning defective retarder/advancers

4.5.1.4 BROKEN RAIL PROBABILITY DISTRIBUTION RESULTS

The probability distributions of broken rail, undetected broken rail and unrepaired broken rail nodes of the train derailment causal model are shown in figure 4.6. The probability distributions indicate that there is a 5.8% probability that an incorrect rail gauge results in a derailment under the following circumstances:

- an 87.5% probability that the defect was not detected during visual inspection; and
- a 12.5% probability that the defect was detected and was scheduled to be repaired but caused a derailment before the day in which it would be repaired.

Considering that undetected broken rail cause the greatest amount of derailments compared to detected incorrect broken rail, it is imperative the broken rail detection skills of track masters are improved. Additionally, the equipment that detects hidden rail defects such as ultra sonic measuring systems should be used at a greater frequency.

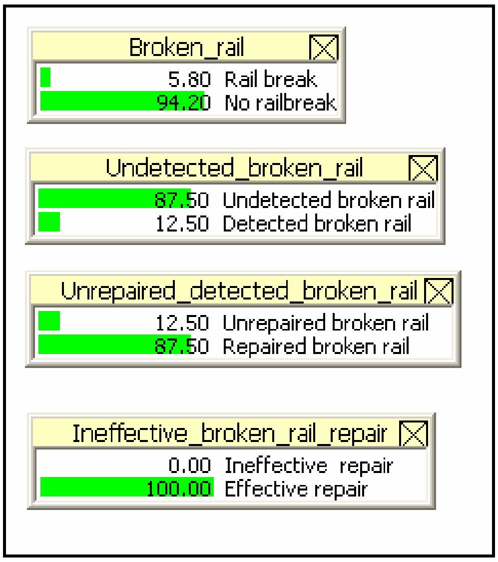

Figure 4.6 Probability distributions of nodes concerning broken rail

4.5.1.5 SLACK PROBABILITY DISTRIBUTION RESULTS

The probability distributions of slack, undetected slack and unrepaired slack nodes of the train derailment causal model are displayed in figure 4.7. The probability distributions indicate that there is a 3% probability that a retarder/advancer defect may result in a derailment when the defect is undetected during inspection. The probability of retarder/advancer defects can therefore be substantially reduced by improving the slack defect detection skills of the track masters.

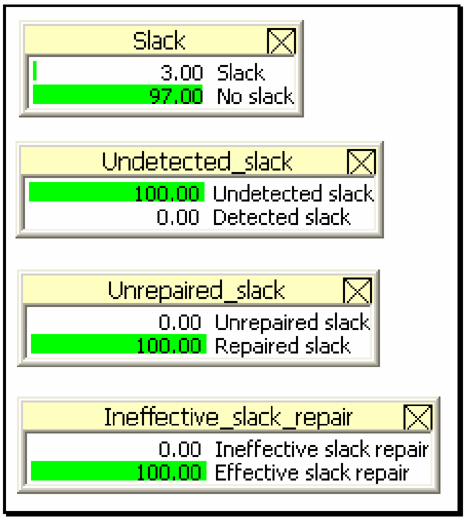

Figure 4.7 Probability distributions of nodes concerning slack.

4.5.1.6 TRAIN DERAILMENT FREQUENCY PROBABILITY DISTRIBUTION RESULTS

The probability distributions of train derailments, defective points machine, incorrect rail gauge, defective retarder/advancer, broken rail and slack nodes of the train derailment causal model are shown in figure 4.8. The probability distributions indicate that there is a 4.02% probability that a train derailment can occur due to the following reasons:

- a 23.19% probability of a defective points machine;
- a 5.96% probability of an incorrect rail gauge;
- a 30% probability of a defective retarder/advancer;
- a 5.8% probability of a broken rail; and
- a 3% probability of slack.

It is estimated that the average amount of trains that move along the Johannesburg region per year is two thousand (2000); the number of train derailments that are likely to occur equals the product of the frequency probability and the number of trips that trains make in a year. Thus, the forecasted frequency is eighty (80) train derailments per year when there is an average of two thousand (2000) trains that pass the Johannesburg region railway infrastructure a year.

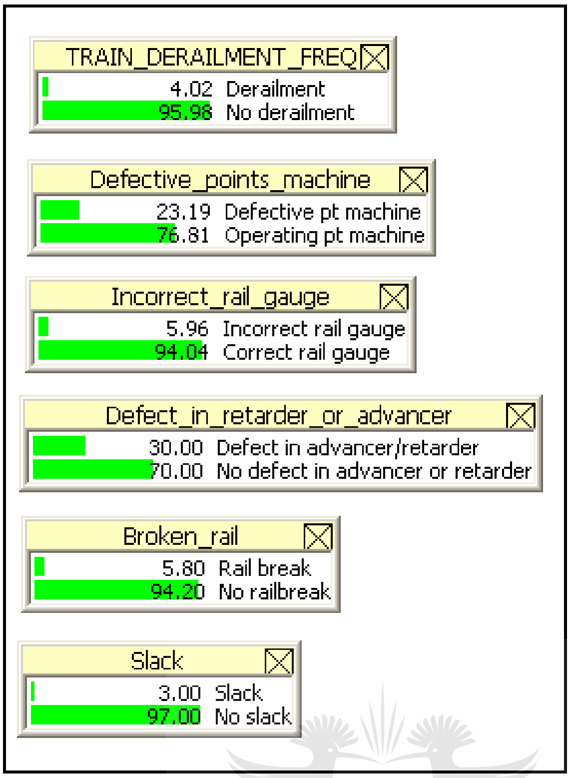

Figure 4.8. Probability distributions of nodes concerning train derailments

4.5.1.7 THE EFFECT OF POINTS MACHINE DEFECT DETECTION ON THE TRAIN DERAILMENT FREQUENCY PROBABILITY DISTRIBUTION

The main contributing factor to all of the above causes of train derailments is the lack of detection of defects during inspection. This problem can be minimised using the following suggested solutions:

- the current defect detection techniques for visual inspection of rail infrastructure should be reviewed and ways should be found that can make defect detection more accurate;
- a program should be implemented in which trackmasters are given practical training by engineers, technicians and more experienced trackmasters that will empower them to improve their defects detecting skills; and

- the rate of use of equipment that detects underlying rail infrastructure defects that cannot be seen visually should be increased.

The use of causal modelling allows managers to predict the effect of any strategies that are made. Thus, the effect of decreasing the probability of any of the contributing factors of operational risks can be forecasted using causal modelling. In table xvii, the initially forecasted probability of undetected points machine defects is decreased by various percentages. This table indicates that a decrease in the probability of undetected points machine defects results in a decrease in the points machine defect and train derailment probability.

Undetected defect in points machine	84%	75.6%	67.2%	58.8%	50.4%	42%	33.6%	25.2 %	16. 8%	8.4%	0%
Points machine defect	23%	21.6%	19.9%	18.3%	16.7%	15%	13.4%	11.8 %	10. 1%	6.%	6.9%
Train derailment frequency	4.02%	3.8%	3.6%	3.4%	3.2%	3%	2.83%	2.6%	2.4 %	2.2%	2%

Table xx: The forecasted effect of decreases in the probability of undetected points machine defects

4.5.2 SEVERITY MODEL RESULTS

The same probability distribution functions were used for the train derailment causes and contributing factors in the severity and frequency models. Therefore only the results of the train derailment cost node are presented in this section

4.5.2.1 TRAIN DERAILMENT SEVERITY PROBABILITY DISTRIBUTION RESULTS

The train derailment severity causal model was simulated to forecast the cost of rehabilitating railway infrastructure, after a train derailment has occurred. The resulting probability distribution of the annual train derailment costs are shown in figure 4.9.

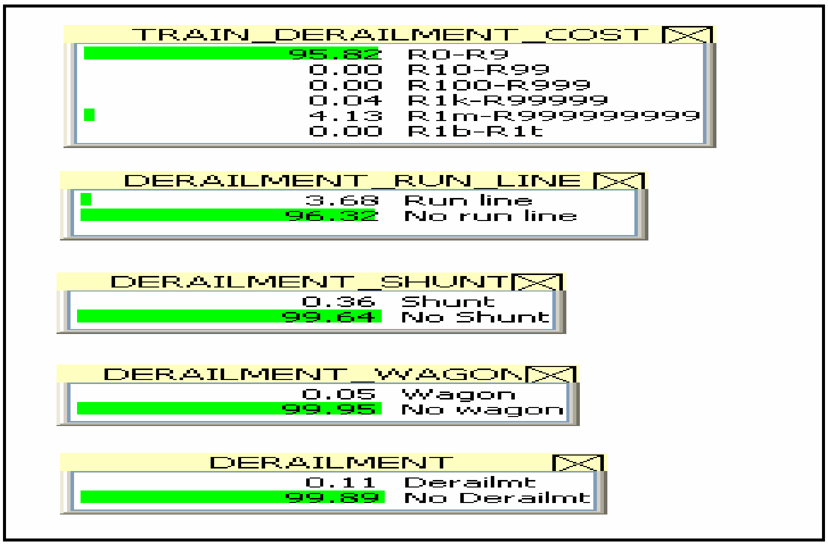

Figure 4.9 Probability distributions of nodes concerning train derailments costs

The forecasted cost of rehabilitating railway infrastructure after the occurrence of a train derailment (C_{td}) was calculated by adding the products of the probabilities (p) and the class marks, i.e. half of the difference of between the upper (x_u) and lower (x_l) limit of each class i (each train derailment cost range).

$$C_{td} = \sum_{i=0}^{i=6} p_i \frac{x_{ui} - x_{li}}{2}$$

Table xvii displays the class numbers, probability, class mark and products of these values. The forecasted cost of rehabilitating railway infrastructure after a train derailment that was caused by railway infrastructure component failure is R20,629,554.09.

Class number *i*	**Probability** (p_i)	**Class mark** $\left(\frac{x_{ui} - x_{li}}{2}\right)$	**Train derailment cost**
1	0.9582	R 4.50	R 4.31
2	0	R 44.50	R 0.00
3	0	R 449.50	R 0.00
4	0.0004	R 499,499.50	R 199.80
5	0.0413	R 499,499,999.50	R 20,629,349.98
6	0	R 499,499,999,999.50	R 0.00

Table xxi: Calculation of the forecasted train derailment cost

Therefore a preventative maintenance strategy, that will be implemented during a particular year, for the prevention of train derailments that costs less than the forecasted annual railway rehabilitation cost R20,629,554.09 is justifiable.

4.5.2.2 TRAIN DERAILMENT SEVERITY PROBABILITY DISTRIBUTION RESULTS

The effect of decreasing the probability of any of the contributing factors of operational risks can be forecasted using causal modelling. The probabilities of the undetected points machine defects were varied using the frequency causal model to obtain the forecasts of the probabilities of train derailments in table xvii. These forecasted probabilities were used in the severity causal model to forecast the effect of varying the probability of undetected points machine on the cost of rehabilitating railway infrastructure after train train derailments. The forecasted train derailment probabilities were multiplied by the probabilities of train derailment types in the second column of table xiii for the calculation of the probabilities of train derailment types per trip. The resulting probabilities and their compliments were used as the states of the contributing nodes in the severity causal model, see Appendix E.

Table xix shows how the values of the train derailment cost change when the probability of the frequency of train derailments is decreased by various percentages. The forecasted probability of undetected points machine defects is 84% resulting in the cost of rehabilitating railway infrastructure after train derailments of R20,629,554.09. Therefore it can be assumed that the implementation of strategies that can halve the forecasted probability to 42% can result in the of the overall probability of train derailments decreasing to 3% and the annual cost of rehabilitating railway infrastructure after train derailments decreasing to R13,527,430.00. Additionally, the implementation of strategies that decrease the probability of undetected points machine defects results in the overall probability of train derailments decreasing to 2% and the cost of rehabilitating railway infrastructure after a derailment to become R10,340,253.00.

Undetected defect in points machine	0.84	0.756	0.672	0.588	0.504
Points machine defect	0.23	0.216	0.199	0.183	0.167
Train derailment frequency	0.0402	0.038	0.036	0.034	0.032
Annual train derailment cost	R 20,629,554.09	R 18,681,504.11	R 17,682,504.12	R 14,785,354.20	R 14,106,521.50

Table xxii: The forecasted effect of decreases in the probability of undetected points machine defects 2

Undetected defect in points machine	0.42	0.336	0.252	0.168	0.084	0
Points machine defect	0.15	0.134	0.118	0.101	0.06	0.069
Train derailment frequency	0.03	0.0283	0.026	0.024	0.022	0.02
Annual train derailment cost	R 13,527,430.00	R 13,185,654.00	R 12,431,494.00	R 12,053,934.00	R 11,439,754.00	R 10,340,253.00

Table xxiii: The forecasted effect of decreases in the probability of undetected points machine defects 2

4.6 TESTING THE PROPOSED METHODOLOGY

The forecasted train derailment frequency and cost of rehabilitating railway infrastructure after train derailments caused by railway infrastructure component failure for the 2008/2009 financial year is compared with the actual train derailment figures in this section.

4.6.1 FREQUENCY MODEL FORECAST AND ACTUAL RESULTS COMPARISON

Eighty (80) train derailments which are caused by railway infrastructure component failure were forecasted to occur in the Johannesburg region during the 2008/2009 financial year. The forecasted probability of a train derailment in the Johannesburg region is 4.02%

Historical data from the operational risk register (see Appendix A) revealed that during the 2008/2009 financial year, sixty five (65) train derailments occurred as a result of railway infrastructure component failure in the Johannesburg region. The actual probability of a train derailment occurring can be estimated to equal the ratio of the number of derailments with the number of train trips. It was estimated that there is an average of 2000 train trips in the Johannesburg region. Therefore the actual probability of a train derailment in the Johannesburg region is 3.25%.

There is a 0.77% difference between the forecasted and actual probability of a train derailment occurring during the 2008/2009 financial year.

4.6.2 SEVERITY MODEL FORECAST AND ACTUAL RESULTS COMPARISON

The rehabilitation cost of railway infrastructure after train derailments caused by railway infrastructure component failure was forecasted to be R20,629,554.09. Historical data from the risk management department (see Appendix D), table xi, figure 4.10 and table xii show that the 2008-2009 financial year's train derailment rehabilitation costs was R29,767,367.80 .

There is a 0.33% difference between the most probable forecasted and actual cost range of rehabilitating railway infrastructure during the 2008/2009 financial year

4.7 CONCLUSION

ARL is a South African company that provides railway services. The management of ARL's infrastructure maintenance activities occur in (seventeen) 17 depots that are situated throughout South Africa. Each depot is managed by a depot engineer. The ARL risk management department analyse all the operational risks that ARL is exposed to. The operational risk analysis methodology that is currently used involves a subjective estimation of the organisation's operational risk qualitatively as well as scenario formulation and analysis using historical data. The limitation of the current ARL operational risk methodology is that it does not assist the depot engineer to predict the effect of railway infrastructure maintenance activities on various operational risks.

The proposed operational risk analysis methodology allows depot engineers to forecast the following:

- the frequency of operational loss events that are caused by the failure of one or more components of their railway infrastructure region;
- the cost of rehabilitating the railway infrastructure after operational loss events such as theft, train accidents, natural disasters and sabotage; and
- the impact that preventative maintenance activities can make on the probability of the frequency and severity of operational loss events.

The ARL operational risk registers of the 2005/2006, 2006/2007 and 2007/2008 financial years were used to identify the occurrence of train derailments as an operational risk. Additionally, these operational risk registers were used to determine the causes of train derailments that are related to the failure of railway infrastructure components. Using the Pareto principle, only the following five factors that caused the most train derailments were considered for further operational risk analysis: defective points machines, incorrect rail gauges, defective retarders/advancers, broken rail and slack.

A train derailment causal model was constructed based on the assumption that the causes of train derailments are influenced by one or more of the following factors:

1. a train derailment is caused by a defect of an infrastructure system component that was not detected during the inspection of that component;

2. a train derailment is caused by a defect of an infrastructure system component that was detected during inspection but caused a derailment before it was repaired; and
3. a train derailment is caused by a defect of an infrastructure system component that was detected during inspection, was repaired but caused a derailment due to inefficient repair.

Objective historical data from the ARL risk registers and the Johannesburg depot finance department database was used to obtain the probability distributions of the contributing factors of train derailment causes. Subjective data from face-to-face individual interviews between the author and a track engineering technician, chief engineering technician and senior engineer was used to obtain the conditional probability distributions of train derailments and their causes.

A demo version of the Hugin Lite version 7.1 computer program was used to process the abovementioned data. This program forecasted that any train that is passing any point on the track in the Johannesburg region has a 4.02% probability that a train derailment can occur due to the failure of railway infrastructure components per trip. Additionally, the annual cost of rehabilitating railway infrastructure after train derailments caused by infrastructure failure is R20,629,554.09 due to the following reasons:

- a 23.19% probability of a defective points machine;
- a 5.96% probability of an incorrect rail gauge;
- a 30% probability of a defective retarder/advancer;
- a 5.8% probability of a broken rail; and
- a 3% probability of slack.

The main contributing factor for train derailment causes was found to be due to undetected defects. The probability of undetected points machine defects was varied to determine the resulting probability distributions of the train derailment frequency and cost. It was found that as the probability of undetected points machine defects decreased the following occurs:

- the probability of a train derailment decreased;
- the forecasted cost for rehabilitating railway infrastructure after train derailments decreased.

The forecasted frequency of train derailments that are likely to occur equal the product of the frequency probability and the number of trips that trains make in a year. The average amount of trains that move along the Johannesburg region per year is estimated to be two thousand (2000). Thus, the forecasted frequency is eighty (80) train derailments per year when there are two thousand (2000) trains that pass the Johannesburg region railway infrastructure per year.

The forecasted cost of rehabilitating railway infrastructure, after train derailments during a particular financial year, begins by allocating the cost of each derailment type to a cost range. The forecasted cost equals the sum of the products of the probability that the costs will fall within the cost ranges and the class marks of the cost ranges. A preventative maintenance strategy, that will be implemented during the 2008/2009 financial year for the prevention of train derailments that costs less than the forecasted annual railway rehabilitation cost of R20,629,554.09 was assumed to be justifiable.

The forecasted frequency and cost of rehabilitating railway infrastructure after train derailments were compared with the actual figures of the 2008/2009 financial year. There were 80 forecasted train derailments and 65 actual train derailments. Therefore the forecasted train derailment frequency exceeded the actual amount by 15 train derailments. The difference between the forecasted and actual probability of a train derailment that is caused by infrastructure component failure is 0.77%. The cost of rehabilitating railway infrastructure after a train derailment was forecasted to be R20,629,554.09 . The actual cost of rehabilitating railway infrastructure after a train derailment during the 2008-2009 financial year was R29,767,367.80. Thus the actual cost of rehabilitation exceeded the forecasted cost by 0.33%.

CHAPTER 5 : SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

Railway infrastructure consists of fixed facilities that support the movement of rolling stock from one point to another. A typical railway infrastructure system comprises of the following subsystems:

(1) Track;
(2) Bridges;
(3) Electrical;
(4) train authorisation; and
(5) telecommunications.

The life cycle of railway infrastructure components consists of the following phases:

(1) planning and specification;
(2) design;
(3) construction;
(4) operation;
(5) research; and
(6) maintenance and retirement phases.

Railway infrastructure that is reliable and safe for the movement of trains can be achieved by the execution of effective maintenance strategies. The maintenance of railway infrastructure can be effectively performed by executing the following steps of the maintenance cycle:

1. Identification of the need for maintenance;
2. Maintenance cost justification;
3. Resource allocation planning;
4. Scheduling;
5. Assignment of tasks;
6. Execution of maintenance activities; and
7. Feedback

Operational risks are identified using various information sources and techniques for identifying operational risk from these information sources such as checklists, organisational charts and organisational flow charts.

The analysis of operational risk can either be performed using methods that are qualitative, quantitative or a combination of both methods. Qualitative operational risk analysis often involves the expression of operational risk in terms of risk map rating scales. The most common qualitative operational risk analysis methods are risk self assessments, risk process flow analysis and scenario analysis. Quantitative operational risk analysis involves the numerical estimation of operational risk. The actuarial approach and stress testing are examples of quantitative operational risk analysis methods. A combination of qualitative and quantitative operational risk analysis methods can be used by developing causal models. Causal modelling involves the development of graphical representations of events, their causes and a simulation that derives their cumulative probability distributions. Methods such as neural networks and Bayesian networks can be used for causal modelling.

The proposed operational risk analysis methodology for the management of infrastructure maintenance is done by developing Bayesian network causal models. Two causal models are developed for each identified operational risk for forecasting the operational risk frequency and severity. The identification of operational risk is performed during a discussion with experts by primarily using historical data. Operational risk analysis is composed of the following stages:

- causal model building;
- causal model data collection; and
- causal model data processing.

Causal model building involves the identification of operational risk causes and causal model formation. Causal model data collection entails the collection of objective historical data from the organisation's operational risk database and subjective data from face-to-face interviews with experts. During causal model data processing, the probability distribution of the operational risk frequency, severity and their causes are obtained using the collected data and a Bayesian causal network computer program.

The research methodology was selected to be a case study of ARL, a South African railway organisation. The management of ARL's infrastructure maintenance activities occur in seventeen (17) depots that are situated nationwide; each depot is managed by a depot engineer. The limitation of the current ARL operational risk methodology is that it does not assist the depot engineer to forecast the effect of railway infrastructure maintenance activities on operational risks that are caused by railway infrastructure failure.

The proposed operational risk analysis methodology allows depot engineers to forecast the following:

- the frequency of operational loss events that are caused by the failure of one or more components of their railway infrastructure region;
- the cost of rehabilitating the railway infrastructure after operational loss events such as theft, train accidents, natural disasters and sabotage; and
- the impact that preventative maintenance activities can make on the probability of the frequency and severity of operational loss events.

The case study was limited to analysing the operational risk of the train derailments that occur in the Johannesburg region caused by railway infrastructure component failure. The operational risk event of train derailments and their causes were identified using the ARL operational risk register for three consecutive financial years. Thereafter, the train derailment frequency and cost causal models were constructed. Objective data was obtained from the ARL risk register and the Johannesburg finance department database. Subjective data was obtained from face-to-face interviews with an engineering technician, chief engineering technician and a senior engineer. The probability of one contributing factor to one cause of train derailments was decreased sequentially; the resulting probability distribution of the train derailment frequency and cost of rehabilitating decreased as well.

The forecasted frequency and cost of rehabilitating railway infrastructure after train derailments were compared with the actual figures of the 2008/2009 financial year. The forecasted train derailment frequency exceeded the actual amount by 15 train derailments. Therefore, the difference between the forecasted and actual probability of a train derailment that is caused by infrastructure component failure is 0.77%. The actual rehabilitation costs exceeded the forecasted by 0.33%.

5.2 CONCLUSION

An engineer who manages the maintenance of railway infrastructure can greatly contribute to society by decreasing the amount of operational risk events that are caused by railway infrastructure component failure as a result of a decrease in the following:

- the amount injuries and fatalities of members of a railway company and the public;
- the amount of spillages of goods ,e.g. chemicals, which have a negative impact on the environment;

- the amount of legal restrictions that are imposed by a country's government or railway safety regulator; and
- the amount of money that the company loses due to train delays, claims and the rehabilitation of railway infrastructure.

This dissertation proposes an operational risk analysis methodology that transfers the approach of operational risk analysis from a macro level to a micro level. The objective of proposing this approach is to provide engineers with the tools to manage railway infrastructure maintenance more effectively and efficiently. The proposed operational risk analysis methodology assists these engineers in forecasting the impact that maintenance activities have on operational risks that are caused by railway infrastructure component failure. This allows engineers, to forecast the probability that their targets for reducing operational risks that are caused by railway infrastructure failure will be met. Additionally, the proposed methodology enables the forecasting of the cost of rehabilitating railway infrastructure after the occurrence of an operational risk event.

The proposed operational risk analysis methodology can be used during various phases of the maintenance cycle. The forecasted cost of rehabilitating the track after the occurrence of an operational loss event can be used to justify the funds that the organisation should use on the maintenance activities that can prevent these events.

The proposed operational risk analysis methodology was made for the engineers that maintain railway infrastructure. However, other technical employees of railway companies can use it. Additionally, engineering consulting companies can use this methodology to assist companies in decreasing the amount of operational risks that are caused by railway infrastructure.

A more detailed causal model is likely to produce more accurate forecasts; the author suggests that the following contributing factors of operational risk causes may be added for increasing the accuracy of the forecasts:

- the volumes of the trains that are passed,
- the climate of the region,
- the resources that is available for preventative maintenance etc.

An increase in the train volume results in an increase in the probability of wear occurring on the rail. Defects such as broken rail can occur as a result of wear. Extreme temperatures can potentially result in defects such broken rail and slack. The lack of resources for preventative maintenance increases the likelihood of operational risk events occurring.

5.3 RECOMMENDATIONS FOR FURTHER STUDY

Possible studies that could be made include a:

- comparative study of the proposed operational risk analysis methodology and other methodologies that are suited for railway infrastructure maintenance management;
- larger survey of the implementation of the proposed operational risk analysis methodology can be made to identify the depots that have successfully implemented the proposed methodology; and
- study of operational risk management in railway maintenance management.

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APPENDIX A. ARL RISK REGISTER: 2005-2009 JOHANNESBURG REGION TRAIN DERAILMENTS

2005/2006 FINANCIAL YEAR

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraH	Retarder/advancer defective	2005/04/21	Natalspruit	1
			2005/04/19	Vlakfontein	1
			2005/04/18	Welgedag	1
			2005/04/16	Sentrarand	1
			2005/04/16	Brakpan	1
			2005/05/15	Sentrarand	1
			2005/05/14	Roodepoort	1
			2005/06/12	Bijlkor	1
			2005/06/10	Sentrarand	1
			2005/07/10	Sentrarand	1
			2005/09/09	Natalspruit	1
			2005/11/02	Kaserne	1
			2005/012/01	Sentrarand	1
		Points defective	2006/12/27	Pretoria West	1
			2006/02/26	Isando	1
			2006/02/25	Bronkhorstfontein	1
			2006/02/25	Langlaagte	1
			2006/02/22	Kaserne	1
			2006/02/22	Enselspruit-Klipdrift	1

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraH	Points defective	2006/02/12	Dalton-Jaagbaan	1
			2006/02/11	Michaelsraad - Fochville	1
			2006/02/03	Geduld - Welgedag	1
			2006/02/01	Bloekomheuning - Vanderbijl	1
			2006/01/21	Houtheuwel	1
			2006/01/16	Germiston	1
			2006/01/16	Braamfontein	1
			2006/01/08	City Deep	1
			2006/01/06	Sentrarand	1
			2005/12/27	Meyerton Siding	1
			2005/12/10	Jupiter	1
			2005/12/27	Natalspruit	1
			2005/11/29	Welgedag	1
			2005/11/26	Springs	1
			2005/11/19	Springs	1
			2005/11/19	Germiston Transwerk	1
			2005/11/18	Germiston Transwerk	1
			2005/11/12	Meyerton Yard	1
			2005/11/12	Welgedag	1
			2005/11/10	Balfour North	1
			2005/11/10	Dryden	1
			2005/11/10	Alloy - Duncanville	1

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraH	Points defective	2005/11/09	Sentrarand	1
			2005/11/09	Jupiter Ppc Cement	1
			2005/11/01	Sasolburg	1
Derailment shunt	InfraH	Incorrect rail gauge	2005/05/14	Viljoensdrift	1
			2005/06/12	Springfontein	1
			2005/06/10	Johannesburg	1
			2005/07/10	City Deep	1
			2005/09/09	Sentrarand	1
			2005/09/27	Sentrarand	1
Derailment-wagon	InfraT	Broken rail	2005/06/23	Sentrarand	1
Derailment	InfraT	Points defective	2005/11/28	Iscor - v d Bijl	1
			2005/12/19	Sentrarand	1

2006/2007 FINANCIAL YEAR

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraT	Retarder/advancer defective	2006/04/01	Vereeniging - Duncanville	1
			2006/04/05	Sentrarand	1
			2006/04/12	Sentrarand	1
			2006/04/14	Sentrarand	1
			2007/01/15	Sentrarand	1
			2007/02/27	Pretoria-Wes	1
			2007/03/02	Bleskop	1

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraT	Retarder/advancer defective	2007/03/17	Sentrarand	1
			2007/05/05	Johannesburg	1
		Points defective	2006/04/12	Elandsfontein	1
			2006/04/26	Elandsfontein	1
			2006/05/02	Kaserne	1
			2006/05/07	Springs	1
			2006/05/10	Natalspruit	1
			2006/05/27	Vlakfontein	1
			2006/05/28	Welgedag	1
			2006/05/29	Sentrarand	1
			2006/05/29	Brakpan	1
			2006/06/01	Sentrarand	1
			2006/06/02	Sentrarand	1
			2006/06/05	Roodepoort	1
			2006/06/06	Bijlkor	1
			2006/06/06	Sentrarand	1
			2006/06/07	Sentrarand	1
			2006/06/11	Natalspruit	1
			2006/06/12	Kaserne	1
			2006/06/13	Springs	1
			2006/06/15	Springs	1
			2006/06/20	Germiston Transwerk	1

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraT	Points defective	2006/06/21	Germiston Transwerk	1
			2006/06/22	Meyerton Yard	1
			2006/06/25	Welgedag	1
			2006/06/26	Balfour North	1
			2006/06/27	Dryden	1
			2006/06/28	Alloy - Duncanville	1
			2006/06/30	Michaelsraad - Fochville	1
			2006/07/01	Geduld - Welgedag	1
			2006/10/02	Bloekomheuning - Vanderbijl	1
			2006/12/04	Houtheuwel	1
			2006/12/05	Germiston	1
			2007/01/08	City Deep	1
			2007/02/10	Sentrarand	1
			2007/02/10	Meyerton Siding	1
			2007/02/13	Jupiter	1
			2007/03/14	Iscor - v d Bijl	1
			2007/03/20	Welgedag	1
		Incorrect rail gauge	2006/04/20	Sentrarand	1
			2006/07/29	Sentrarand	1
			2006/08/04	Springs	1
			2006/08/07	Springs	1
			2006/09/15	Germiston Transwerk	1

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraT	Incorrect rail gauge	2006/10/15	Germiston Transwerk	1
			2006/08/28	Meyerton Yard	1
			2006/13/29	Welgedag	1
			2007/02/21	Balfour North	1
			2007/03/31	Dryden	1
		Broken rail	2006/09/06	Braamfontein	1
			2006/09/14	City Deep	1
			2006/09/18	Natalspruit	1
			2006/10/12	Sentrarand	1
			2006/10/15	Bijlkor	1
			2006/10/17	Germiston - Transwerk	1
			2006/11/10	Sentrarand	1
			2006/11/18	Vereeniging - Duncanville	1
			2006/12/02	Kaserne	1
			2006/12/26	Springs	1
			2007/01/05	Alloy - Duncanville	1
			2007/01/16	Natalspruit	1
			2007/02/07	Vlakfontein	1
			2007/02/11	Welgedag	1
			2007/03/09	Sentrarand	1
			2007/03/10	Brakpan	1
Derailment	InfraT	Slack	2006/10/22	Springdale	1
Derailment shunt	InfraT	Retarder/advancer defective	2006/04/04	Braamfontein	1

2007/2008 FINANCIAL YEAR

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraT	Points defective	2007/04/03	Michaelsraad - Fochville	1
			2007/04/23	Geduld - Welgedag	1
			2007/05/01	Bloekomheuning - Vanderbijl	1
			2007/05/01	Houtheuwel	1
			2007/05/02	Germiston	1
			2007/05/23	Iscor - v d Bijl	1
			2007/06/18	Welgedag	1
			2007/06/19	Sentrarand	1
			2007/06/22	Sentrarand	1
			2007/06/27	Springs	1
			2007/07/10	Springs	1
			2007/07/11	Brakpan	1
			2007/07/17	Germiston	1
			2007/07/18	Vereeniging	1
			2007/07/19	Blinkpan	1
			2007/07/31	Welgedag	1
			2007/08/01	City Deep	1
			2007/08/04	Sentrarand	1
			2007/08/13	Modderfontein	1
			2007/08/24	Isando	1

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment running line	InfraT	Points defective	2007/11/12	Mpilisweni - Angus	1
			2007/11/17	Leeuhof	1
			2007/11/20	Rooikop - Natalspruit	1
			2007/11/23	Sentrarand	1
			2007/12/14	Germiston - Transwerk	1
			2008/01/18	Argent	1
			2008/02/17	Natalspruit	1
			2008/02/21	Vlakfontein	1
			2008/03/04	Welgedag	1
			2008/03/26	Brakpan	1
		Incorrect rail gauge	2007/04/28	Sentrarand	1
			2007/07/29	Natalspruit	1
			2007/06/29	Kaserne	1
			2007/11/29	Springs	1
			2007/12/30	Springs	1
			2007/10/01	Germiston Transwerk	1
			2008/01/27	Germiston Transwerk	1
			2008/03/14	Meyerton Yard	1
Derailment shunt	InfraT	Retarder/advancer defective	2007/05/11	City Deep	1
			2007/05/14	Natalspruit	1
			2007/08/16	Sentrarand	1
			2007/09/17	Bijlkor	1
			2007/11/17	Germiston - Transwerk	1

Count of DATE					
INCIDENT TYPE	**Disc**	**CAUSE**	**DATE**	**PLACE**	**Total**
Derailment shunt	InfraT	Retarder/advancer defective	2007/10/22	Sentrarand	1
			2008/03/18	Vereeniging -Duncanville	1
			2008/03/25	Kaserne	1
			2008/02/17	Springs	1
Derailment		Slack	2007/10/02	Roode-Roovlei	1
			2008/03/17	Welgedat	1
Derailment-wagon		Retarder/advancer defective	2007/05/05	Sentrarand	1

2008/2009 FINANCIAL YEAR

INCIDENT TYPE	Disc	CAUSE	DATE	PLACE	TOTAL
Derailment running line	InfraT	Slack	2008/10/16	Knoppiesfontein - Kameelsynkraal	1
		Incorrect rail gauge	2009/03/17	Schweizer Reneke - Amalia	1
Derailment shunt Transnet Freight Rail	InfraH	Rail broken	2008/05/16	Sentrarand	1
			2009/02/01	Houtheuwel	1
	InfraT	Rail slack	2008/08/30	Sentrarand	1
		Points defective	2008/10/24	Randwater	1
			2008/05/04	Welgedag	1
			2008/06/12	City Deep	1
			2008/11/01	Sentrarand	1
			2008/11/07	Vereeniging	1
			2008/11/16	Sentrarand	1
			2008/12/07	Sentrarand	1
		Retarder or Advancer defective	2009/02/16	Meyerton	1
			2009/03/25	Johannesburg	1
			2008/07/02	Germiston	1
			2008/11/13	Kaserne	1
			2009/03/09	Redan	1
			2008/04/13	Sentrarand	1
			2008/04/21	Sentrarand	1
			2008/05/08	Sentrarand	1
			2008/05/13	Sentrarand	1
			2008/07/04	Sentrarand	1
			2008/07/11	Sentrarand	1
			2008/08/16	Sentrarand	1
			2008/09/02	Sentrarand	1
			2008/11/15	Sentrarand	1
			2008/12/03	Sentrarand	1
			2008/12/10	Sentrarand	1
		Sleepers rotten	2009/03/29	Langlaagte	1
		Wrong track gauge	2008/07/27	Johannesburg	1
			2008/08/02	Kaserne	1
			2008/08/07	Kaserne	1

APPENDIX B. ARL JOHANNESBURG REGION 2006-2009 SCHEDULED MAINTENANCE ACTIVITIES DATABASE

1. DEFECTIVE POINTS MACHINE

Order	Date	Description	Description
201111710	2006/03/03	2/20 YVJ 3 Y/POINTS (BREYTENBACH)	VILJOENSDRIF
201114826	2006/03/08	2/048 ELS_CABLE STUCK/POINTS Tshisevhe	ELSBURG
201116464	2006/03/14	2/85 YLL Y/POINTS (SIDEMELA)	LANGLAAGTE DOWN
201116455	2006/03/15	2/93 YNT Y/POINTS (DE BRUIN)	NATALSPRUIT
201116433	2006/03/16	2/108 CTD repair overlap (SECD SIDING)	CITY DEEP
201119197	2006/03/24	2/158 MTN_1505W OVERLAP J.BRITS	MEYERTON
201122189	2006/03/27	2/178 RPR Y/POINTS 3 & 6 (DE BRUIN)	ROODEPOORT
201127608	2006/03/27	2/184 YSBG Y/POINTS(98) (RAKOTO)	SASOLBURG
201127576	2005/04/06	2/53 YISO Y/POINTS (POHOTONA)	JOHANNESBURG
201128968	2005/04/10	2/82 CTD POINTS FAULTY - TERMINAL SIDEME	CITY DEEP
201130360	2005/04/20	2/158 GRMG_POINT BLADE 11 ROAD J.STOLTZ	GERMISTON GOODS CABIN
201130311	2005/04/22	2/176 GMR YARD "W 11 " H-COCK(DEON	GERMISTON TECHNICAL LOCOMOTIVE DEPOT
201133014	2005/04/24	2/183 LLA YARD TUMBLER HEAD(DE BRUI	LANGLAAGTE DOWN
201132944	2005/04/26	2/203 replace BROKEN turnout crossing	HOUTHEUWEL
201133032	2005/04/28	2/219 LFN 12W NOT CLOSING UEGENE	LEEUHOF CTC
201135376	2005/05/02	2/10 LEF "W24" FAILS OPP(RAMADULA)	LEEUHOF CTC
201137680	2005/05/09	2/075 NT_5W + 8W FAULTY J. BRITS	NATALSPRUIT
201137653	2005/05/12	2/96 YLEF Y/POINTS (EUGENE)	LEEUHOF CTC
201147852	2005/05/15	2/123 KZ YARD "W" H-COCK (SIDIMELA	KASERNE
201142682	2005/05/21	2/169 KZM_No1 +No.2 POINTS P.de BRUIN	KASERNE WEST
201140698	2005/05/21	2/170 GMR_ROAD 2 +1 POINTS B.S. ZONDI	GERMISTON
201142754	2005/05/22	2/175 VER H/POINTS FAULTY - YARD KHOKORE	VEREENIGING
201142769	2005/05/23	2/192 KZY YARD "W1" H- COCK(MOENG)	KASERNE
201142774	2005/05/23	2/193 LF "W3" H-COCK (RAKOTU)	LEEUHOF CTC
201142788	2005/05/26	2/222 LEF Y/POINTS (KEKANA)	LEEUHOF CTC
201142738	2005/05/28	2/236 YKZ Y/POINTS (MOENG)	KASERNE
	2005/05/30	2/264 GMRG_POINT TUMBLER MISS BARKLEY	GERMISTON GOODS CABIN
201145531	2005/05/30	2/254 SBG W96 H- COCK (EUGENE)	SASOLBURG
201145441	2005/05/30	2/268 GMRG_33W BLADE WORN DEON/SIDIMELA	GERMISTON GOODS CABIN
201145583	2005/06/01	2/007 VERVANG HOUT D/C BY WISSEL NO 65	SASOLBURG

201145603	2005/06/02	2/21 LL W86 BLADE BROKEN (DE BRUIN)	LANGLAAGTE OTHER
201147907	2005/06/07	2/77 YGMR Y/POINTS (TSHISEVHE)	GERMISTON
201147901	2005/06/08	2/82 YGMR Y/POINTS (LOCK MISSING)	GERMISTON
	2005/06/09	2/100 LEF_5W HALF COCK HERMAN	
201149966	2005/06/16	2/147 YMTN Y/POINTS (NAIDOO)	MEYERTON
201149942	2005/06/18	2/160 VER 4871W RUNTHROUGH (KEKANE)	VEREENIGING
201157777	2005/06/20	2/185 MTN SPIKE POINTS - YARD FAUGHT	MEYERTON
201157766	2005/06/20	2/187 MTN POINTS DRY - YARD FAUGHT	MEYERTON
201155445	2005/06/26	2/240 HUP Km59/16 B/BLADE (BREYTENBACHT)	HOUTHEUWEL
	2005/06/28	2/262 TEL W/BOARDS BROKEN (MYLA)	TARENTAAL - CACHET
201156354	2005/06/29	2/276 BRR YARD W. BROKEN (KLEINSMITH)	BRAAMFONTEIN
201156348	2005/06/29	2/277 MTN YARD W. FAILS (NAIDOO)	MEYERTON
201158123	2005/07/04	2/27 LF H/COCK 4W (EUGENE)	LEEUHOF CTC
201158114	2005/07/05	2/36 ISO "W"s NOT CLOSING (SIDIMELA)	JOHANNESBURG
201158120	2005/07/08	2/54 YKZ Y/POINTS (SIDEMELA)	KASERNE
201160363	2005/07/12	2/93 NT 153W BLADE KM14/12-13 TSHISEVHE	NATALSPRUIT
201162901	2005/07/13	2/105 LEF 18W FAULTY - YARD KHECHANE	LEEUHOF CTC
201160350	2005/07/14	2/122 NT Km13/15-14 "W"s BLADE (FAUGHT)	NATALSPRUIT
	2005/07/14	2/112 HUP Km1/13 B/BLADE (RAKOTO)	HOUTHEUWEL
201160347	2005/07/14	2/116 YKZW "W"s HEAD OFF (SIDEMELA)	KASERNE WEST
201162623	2005/07/16	2/128 HUP 2431W BALDE BROKEN KM1/13 KHEC	HOUTHEUWEL
201162938	2005/07/17	2/136 GMR "W"s NOT CLOSING (STOLTZ)	GERMISTON
	2005/07/17	2/138 GMR "W"s FAULY (POHOTONA)	GERMISTON WEST CABIN
201162923	2005/07/19	2/154 YSBG Y/POINTS (RAKOTO)	SASOLBURG
201160455	2005/07/19	2/152 HUP 3079W (RAKOTO)	HOUTHEUWEL
201167389	2005/07/26	2/219 RN Km54/10 1451W (STOLTZ)	REDAN
201167435	2005/07/26	2/220 RN Km54/6A 1431W (STOLTZ)	REDAN
201170709	2005/08/02	2/10 BKG 311W BROKEN KM12.575 RAKOTU	BLOEKOMHEUNING
201193915	2005/08/07	2/56 NT "W"s H/COCK (STOLTZ)	NATALSPRUIT
201172509	2005/08/08	2/58 GMRW 81BW (STOLTZ)	GERMISTON WEST CABIN
201175407	2005/08/14	2/87 NT POINTS DAMAGED - YARD BRITS	NATALSPRUIT
201175409	2005/08/14	2/88 BRR 6173W PACK & LIFT - YARD DE BRU	BRAAMFONTEIN NORTH
201174222	2005/08/15	2/94 LF "W"s NO TURNING (KEKANA)	LEEUHOF CTC
201175520	2005/08/16	2/100 BRR 1W NOT CLOSING (SEDIMELA)	BRAAMFONTEIN
201175553	2005/08/18	2/120 YKZ Y/POINTS (SIDEMELA)	KASERNE
201178814	2005/08/29	2/181 YNT Y/POINTS (TSHISEVHE)	NATALSPRUIT
201180189	2005/08/29	2/187 GMR LOCO "W"s H/COCK (TSHISEVHE)	GERMISTON
201180236	2005/08/30	2/189 YLF 30 Y/POINTS (MAILA)	LEEUHOF CTC
201180244	2005/08/30	2/199 YGMR Y/POINTS (TSHISEVHE)	GERMISTON
201180261	2005/08/31	2/219 YSBG 87W (MAILA)	SASOLBURG

201180296	2005/09/01	2/06 SBG POINTS FAULTY - YARD RAKOTU	SASOLBURG
201179558	2005/09/01	2/01 ID 21W CROSSING BROKE KM2/5 TSHISEV	INDIA
201183011	2005/09/06	2/40 ISO H/COCK "W"s CONT.210 (ZONDI)	JOHANNESBURG
201185564	2005/09/11	2/75 YLF 30 Y/POINTS (KHEKORE)	LEEUHOF CTC
201185444	2005/09/12	2/83 VER POINTS BLADE - YARD RAKOTU	VEREENIGING-SUID
201185389	2005/09/12	2/79 RN 1547W LIFT & PACK ZONDI	REDAN
201185409	2005/09/12	2/82 LHF 33W FAULTY - CNTRL 1 RAKOTU	LEEUHOF CTC
201185006	2005/09/13	2/92 RN 1441W & 1503W BROKEN KM54/8 & 9	REDAN
201188715	200509/14	2/101 SBG POINTS BOX BROKEN - YARD RAKOT	SASOLBURG
201185547	2005/09/14	2/105 LEF POINTS NOT CLOSING - LOKO RAKO	LEEUHOF CTC
201188629	2005/09/18	2/123 KZM 4W NOT CLOSING (MOENG)	KASERNE MARK
201188314	2005/09/18	2/119 VER Km0,458 B/BLADE (BREYTENBACH)	VEREENIGING
201188731	2005/09/20	2/146 YLL Y/POINTS (MOENG)	LANGLAAGTE OTHER
201188256	2005/09/20	2/140 HUP 2441W crossing broken	HOUTHEUWEL
201188789	2005/09/22	2/158 KZW POINTS BROKEN MOENG	KASERNE WEST
201190531	2005/09/28	2/186 KZM "W"s NOT CLOSING (MOENG)	KASERNE MARK
201190475	2005/09/28	2/187 LF H/COCK "W"s CONT.2 (KEKANA)	LEEUHOF CTC
201190487	2005/09/29	2/202 YLF 5 Y/POINTS (KHECHANE)	LEEUHOF CTC
201198846	2005/10/04	2/22 BRR 40W FAULTY - YARD DE BRUIN	BRAAMFONTEIN
201194067	2005/10/07	2/46 VER H/COCK "W" (RAKOTO)	VEREENIGING
201198839	2005/10/09	2/57 LHF 28W FAULTY - YARD MAILA	LEEUHOF CTC
201199259	2005/10/12	2/80 YKZ Y/POINTS (SIDEMELA)	KASERNE
201198891	2005/10/12	2/84 SBG 4051W (MAILA)	SASOLBURG
201202069	2005/10/17	2/115 VER Km61/19 W/BLADE (RAKOTO)	VEREENIGING
201202986	2005/10/22	02/140 GMR W, BLADES OPEN J STOLTS	GERMISTON EAST CABIN - ELSBURG
201207827	2005/10/24	2/165 LHF 33W NOT TURNING A. MAILA	LEEUHOF CTC
201211876	2005/10/30	2/225 KZW H/COCK POINTS (SIDEMELA)	KASERNE WEST
201212056	2005/10/30	2/223 KZW "W"s H/COCK (TSHISEVHE)	KASERNE WEST
201211891	2005/11/03	2/18 RPR W'S BLADE FAULTY P. DE BRUIN	ROODEPOORT
201221626	2005/11/14	2/104 PHP-CRN XSING NOSE J. SEDIMELA	CROWN - PAARLSHOOP
201221555	2005/11/16	2/128 GMR W'S FAULTY J. STOLTZ	GERMISTON
201221278	2005/11/19	2/152 KZW "W"s NOT CLOSING (MOENG)	KASERNE WEST
201224326	2005/11/20	2/171 LEF 3W FAULTY A. RAKOTO	LEEUHOF CTC
201227092	2005/11/22	2/187 NT W. DON'T LOCK AND CLOSE DE LAN	NATALSPRUIT
201227086	2005/11/22	2/196 ISO "W"s H/COCK (BRITS)	JOHANNESBURG
201227080	2005/11/23	2/203 ISO W. BLADE FAULTY ROSSOUW	JOHANNESBURG
201227326	2005/11/29	2/248 EFT POINTS BLADE STUCK (SEDIMELA)	ELANDSFONTEIN
201227341	2005/11/30	2/258 GMR "W"s NOT TURNING (De LANGE)	GERMISTON GOODS CABIN
201231125	2005/12/05	2/20 WTI H/TUMBLER STOLEN (SIDEMELA)	WESTONARIA

201231193	2005/12/08	2/52 YKZ SPLIT W'S FAULTY J. SIDEMELA	KASERNE
201233239	2005/12/13	2/98 YLL "W"s NOT CLOSING (MOENG)	LANGLAAGTE OTHER
201238030	2005/12/19	2/132 ISO "X"ing POINT CRACKED (NAIDOO)	JOHANNESBURG
201236733	2006/12/19	2/133 LEF "W"s H/COCK (MAILA)	LEEUHOF CTC
201238017	2005/12/21	2/151 LL "W"s NOT CLOSING (SIDEMELA)	LANGLAAGTE DOWN
201238016	2005/12/24	2/167 YISO Y/POINTS (SIDEMELA)	JOHANNESBURG
201238061	2006/01/03	2/16 YKZ Y/POINTS (SIDEMELA)	KASERNE
201238060	2006/01/03	2/17 YBRR Y/POINTS (SIDEMELA)	BRAAMFONTEIN NORTH
201239121	2006/01/10	2/80 RN OVERLAP ON 1733W J. BRITS	REDAN
201239084	2006/01/12	2/97 YEFT Y/POINTS (BRITS)	ELANDSFONTEIN
201239087	2006/01/12	2/96 VER 4713W (KHECHANE)	VEREENIGING
201241554	2006/01/17	2/143 MSD 301W BLADE H. BREYTENBACH	MICHAELSRAAD
201244990	2006/01/24	2/191 YWTI Y/POINTS (MOENG)	WESTONARIA
201249580	2006/01/31	2/250 LF "W"s NOT CLOSING Rd.3 (RAKOTO)	LEEUHOF CTC
201249569	2006/02/02	2/16 YKZ replace blade noord werf	KASERNE
201252874	2006/02/05	2/34 VER 4441,4451W (RAKOTO)	VEREENIGING
201251065	2006/02/07	2/62 VJD BROKEN BLADE W7 H. BREYTENBACH	VILJOENSDRIF
201252850	2006/02/07	2/67 CTD W'S BROKEN M. MOENG	CITY DEEP
201251097	2006/02/08	2/70 LEF W40 C/RAIL H. BREYTENBACH	LEEUHOF CTC
	2006/02/14	2/117 YDUN Y/POINTS (VUSI)	DUNSWART (741604)
201255427	2006/02/16	2/142 LEF 20W -CCNTRL3 KHECHANE	LEEUHOF CTC
201255326	2006/02/17	2/152 VER 4641W BROKEN KM69/14 KHECHANE	VEREENIGING
201257603	2006/02/19	2/164 LEF 12W NOT CLOSING E. KHECHANE	LEEUHOF CTC
201261798	2006/02/23	2/212 YKZ NO 1 WEST POINTS (POHOTONA)	KASERNE
201261821	2006/02/26	01/224 LL WESSELS FAULTY J.SIDEMELA	LANGLAAGTE OTHER
201261979	2006/02/27	2/234 BRR TUMBLER LOOSE P. DE BRUIN	BRAAMFONTEIN NORTH
201261833	2006/02/28	2/248 CTD POINTS BOLTS LOOSE	CITY DEEP
201261855	2006/03/01	2/2 JU OVERLAP ON 55W J. SIDEMELA	JUPITER
201264721	2006/03/06	2/43 YSBG Y/POINTS 112 (KHECHANE)	SASOLBURG
201267452	2006/03/15	2/137 KZ OVERLAP ON TRACK (MOENG)	KASERNE MARK - KASERNE WEST
201267391	2006/03/16	2/144 YISO Y/POINTS (TSHISEVHE)	JOHANNESBURG
201267407	2006/03/16	2/149 YKZ Y/POINTS (TSHISEVHE)	KASERNE
201267414	2006/03/17	2/162 YKZ Y/POINTS (MOENG)	KASERNE
201272812	2006/03/19	2/170 YVD W8 (H BREYTENBACH)	VILJOENSDRIF
201275362	2006/03/26	2/223 LEF "W"s FAULTY Rd.3 (KHECHANE)	LEEUHOF CTC
201275374	2006/03/27	2/226 YVJ Y/POINTS/8 (BREYTENBACH)	VILJOENSDRIF
201275368	2006/03/27	2/225 HUP 3061W (BREYTENBACH)	HOUTHEUWEL
201275390	2006/04/01	2/2 DES 1729 & 1631W CHECK M. POHOTONA	DALESIDE
201279885	2006/04/02	2/6 BRR 38W BLADE BROKEN J.	BRAAMFONTEIN NORTH

		SIDEMELA	
201279481	2006/04/05	2/29 LFN 5W & 6W STUCK (KHECHANE)	LEEUHOF CTC
201279844	2006/04/10	2/52 RD "W" FAULTY J. SEDIMELA	ROOIKOP
201279859	2006/04/13	2/73 GMR "W"s NOT TURNING (TSHISEVHE)	GERMISTON
201279853	2006/04/14	2/85 ISO CLAMP POINTS SIDING (MOENG)	JOHANNESBURG
201283106	2006/04/16	2/99 LEF 30W STUCKED MAILA	LEEUHOF CTC
201286948	2006/04/24	2/141 LEF 2W & 3W H/COCK (BREYTENBACH)	LEEUHOF CTC
201287084	2006/04/25	2/150 NT "W"s DAMAGED (TSHISEVHE)	NATALSPRUIT
201287135	2006/04/26	2/161 YBRR W DONT CLOSE (J SEDIMELA)	BRAAMFONTEIN NORTH
201286987	2006/04/29	2/175 KPF 611W (KHECHANE)	KLIPDRIF
201287035	2006/04/30	2/186 RN POINTS TO BE PACKED (STOLTZ)	REDAN
201287039	2006/04/30	2/187 HUP 3079W (OVERLAP) (MAILA)	HOUTHEUWEL
201287052	2006/05/04	2/47 LF "W"s HALF COCK (RAKOTO)	LEEUHOF CTC
201289531	2006/05/10	2/86 YISO Y/POINTS (STOLTZ)	JOHANNESBURG
201289519	2006/05/11	2/92 HUP 3061W FAULTY E. KHECHANE	HOUTHEUWEL
201289510	2006/05/11	2/97 LEF POINT BLADE E. KHECHANE	LEEUHOF NOORD
201289508	2006/05/12	2/98 HUP 3061, 3033W (KHECHANE)	HOUTHEUWEL
201289482	2006/05/12	2/99 ISO POINT BLADE T. TSHIVEVHE	JOHANNESBURG
201289477	2006/05/13	2/109 YBOY Y/POINTS (KLYNSMITH)	BOOYSENS
201291877	2006/05/17	2/139 ISO "W"s NOT CLOSING (MOENG)	JOHANNESBURG
201291868	2006/05/18	2/144 YCTD Y/POINTS (SIDEMELA)	CITY DEEP
201296306	2006/05/22	2/178 YBR W'S NOT CLOSING P. DE BRUIN	BRAAMFONTEIN
201296300	2006/05/22	2/181 SBG W'S JOINT PLATE E. KHECHANE	SASOLBURG
201296291	2006/05/25	2/205 GMR "W"s NOT CLOSING (SIDEMELA)	GERMISTON WEST CABIN
201296285	2006/05/26	2/218 KR 1529W RUNTHROUGH (POHOTONA)	KLIPRIVIER
201301347	2006/06/07	2/55 KAF W355 LOOSE BLADE (MOENG)	KAALFONTEIN
201301397	2006/06/10	2/79 YBRR 17W (SIDEMELA)	BRAAMFONTEIN NORTH
201310053	2006/06/14	2/116 KR OVERLAP ON W'S M. POHOTONA	KLIPRIVIER
201310045	2006/06/19	2/155 ISO W'S NOT CLOSING M. POHOTONA	ELANDSFONTEIN - Marsh Y
201305220	2006/06/19	2/163 ID 21W (POHOTONA)	INDIA
201305116	2006/06/20	2/170 LEF 32W A.MAILA	LEEUHOF NOORD
201305121	2006/06/21	2/176 ISO points block blade POHOTONA	JOHANNESBURG
201305129	2006/06/22	2/190 LLA W'S TUMBLER P. DE BRUIN	LANGLAAGTE OTHER
	2006/06/23	2/198 CAT 17W BROKEN MAILA	CACHET
	2006/06/26	2/668 FCR 633W NO- BEN BEUKES	CAMELFORD
201305634	2006/06/26	2/226 UN CRACKS TURNOUT BRITS	UNION
201310954	2006/06/30	2/252 YLEF Y/POINTS (KHECHANE)	LEEUHOF CTC
201311622	2006/07/04	2/31 BRR 673W LIFTED P.DE BRUIN	BRAAMFONTEIN NORTH
201315281	2006/07/05	2/40 O F/BLADE STOLEN J. SIDEMEL	OLIFANTSFONTEIN
201311572	2006/07/06	2/49 LLA_CRACK ON CROSSING. P. de	LANGLAAGTE OTHER

		BRUIN	
201315288	2006/07/16	2/136 LLA W'S NOT CLOSING P. DE BRUIN	LANGLAAGTE OTHER
201315290	2006/07/16	2/137 LLA W'S NOT CLOSING P. DE BRUIN	LANGLAAGTE OTHER
201314474	2006/07/21	2/187 NT 313W (OVERLAP) (POHOTONA)	NATALSPRUIT
	2006/07/30	2/793 MTN 1431W NO - NEETHLING	NEW MACHAVIE - KOEKEMOER
201318053	2006/07/30	2/250 IS W NOT CLOSING SEDEMELA	ISCOR SIDING
201318066	2006/07/31	2/259 YKZ Y/POINTS (DE BRUIN)	KASERNE
201319864	2006/08/11	2/51 VER 4619W BROKEN CROSSING	VEREENIGING
201324141	2006/08/15	2/77 SBG W/BLADE BROKEN _ RAKOTU	SASOLBURG
201322654	2006/08/15	2/81 LLA W-BLADE LOOSE _ de Bruin	LANGLAAGTE OLD
201321697	2006/08/16	2/87 LHF W/TUMBLER FAULTY _ RAKOTU	LEEUHOF CTC
201322659	2006/08/17	2/99 KZW W NOT CLOSING MOENG	KASERNE WEST
201324112	2006/08/22	2/141 YCTD Y/POINTS (MAILULA)	CITY DEEP
201346389	2006/08/23	2/148 YBRR Y/POINTS 32 (MAILULA)	BRAAMFONTEIN NORTH
201333582	2006/08/25	2/169 DLS HAND POINT BEND J. BRITS	DALESIDE
201326021	2006/08/28	2/187 BRR W6 NOT CLOSING DU BRUIN	BRAAMFONTEIN
201326046	2006/08/30	2/199 SBG 34W DRY KECHANE	SASOLBURG
201325948	2006/08/31	2/211 YBRR Y/POINTS 13 (DE BRUIN)	BRAAMFONTEIN NORTH
201329092	2006/09/04	2/022 MTN_8W HALF OPEN S.NAIDOO	MEYERTON
201331308	2006/09/06	2/39 GMR J/ BLADE MISSING MADIHLABA	ELSBURG
201329106	2006/09/06	2/28 KZH CLAMP W' M.J TSHIVULA	KASERNE HUMP
201331317	2006/09/11	2/73 YBRR 21W & 33W (MOENG)	BRAAMFONTEIN NORTH
201334255	2006/09/12	2/77 KZM 43W (STOLTZ)	KASERNE
201333593	2006/09/14	2/103 VJD HALF COCK E. KHECHANE	VILJOENSDRIF
201333597	2006/09/19	2/132POINTS NOT CLOSING NO3 POINTS	KASERNE MARK
201333624	2006/09/21	2/149 YGMR 4 Y/POINTS (BRITS)	GERMISTON
201335642	2006/09/25	2/180 SBG POINTS FAULTY (RAKOTU)	SASOLBURG
201346380	2006/09/26	2/190 GMRG POINTS FAULTY (BRITS)	GERMISTON - DELMORE
201335615	2006/09/28	2/211 GMR HAND TUMBLER BROKEN MADIHLABA	GERMISTON - Loco
201335623	2006/09/28	2/210 W NOT CLOSED MADIHLABA	GERMISTON - Loco
201343374	2006/10/01	2/06 KZ 1+2W FAULTY TSHIVULA	KASERNE
201343400	2006/10/06	2/41 KZN HALF COCK 7W TSHIVULA	KASERNE MARK
201343425	2006/10/08	2/56 LEFN HALF COCK A. RAKOTO	LEEUHOF NOORD
201343455	2006/10/08	2/57 LEFN 18W BROKEN A. RAKOTO	LEEUHOF NOORD
201343367	2006/10/10	2/80 BXE HAND TUMBLER FAULTY MADIHLABA	BOKSBURG-OOS
201359281	2006/10/10	2/81 WTI HAND POINT FAULTY MADIHLABA	WESTONARIA
201343462	2006/10/10	2/85 LEF 23W BROKEN RAKOTO	LEEUHOF NOORD
201346355	2006/10/11	2/94 LEF HALFCOCK 32W RAKOTO	LEEUHOF NOORD
201343373	2006/10/11	2/99 ISO W NOT CLOSE BRITS	JOHANNESBURG
201343682	2006/10/12	2/104 YSBG Y/POINTS 128 (RAKOTO)	SASOLBURG
201343686	2006/10/12	2/116 YCTD Y/POINTS 3 (MOENG)	CITY DEEP

201346194	2006/10/19	2/169 KZ HAND POINTS FAULTY P. MAILULA	KASERNE
201346149	2006/10/20	2/177 LL "W" NOT CLOSING (MAILULA)	LANGLAAGTE OLD
201346142	2006/10/20	2/180 ISO W NOT CLOSING S. NAIDOO	JOHANNESBURG
201349789	2006/10/22	2/195 SBG 96HAND W NOT CLOSING A. RAKOTO	SASOLBURG
201349795	2006/10/22	2/197 BR 41HAND W NOT CLOSING P. DEBRUIN	BRAAMFONTEIN NORTH
201349787	2006/10/24	2/216 SBG 34W CHECK RAIL (T.van TONDER)	SASOLBURG
201359292	2006/10/25	2/227 DUN POINTS NOT CLOSE (J.SEDIMELA)	DUNSWART - APEX
201353168	2006/10/25	2/228 GMR POINTS NOT CLOSE (J.SEDIMELA)	GERMISTON
201353166	2006/10/25	2/229 DUN DORBYL TUMBLER (J.SEDIMELA)	DUNSWART - APEX
	2006/10/29	2/244 GMR W-STUCK@28RD (P. MADIHLABA)	GERMISTON CENTRAL CABIN
201354521	2006/11/02	2/12 MSD BROKEN X/ING 311W (GODFREY)	MICHAELSRAAD
201359294	2006/11/05	2/33 YKZ Y/POINTS (MOENG)	KASERNE
201359089	2006/11/05	2/37 YISO Y/POINTS (MOENG)	JOHANNESBURG
201359093	2006/11/05	2/40 NT 131W (NAIDOO)	NATALSPRUIT
201359267	2006/11/06	2/48 NT W-TUMBLER@TRIANGLE (S. NAIDOO)	NATALSPRUIT
	2006/11/07	2/56 MTN W-NO TURN (P. MADIHLABA)	MEYERTON
201359273	2006/11/08	2/61 W-ML NO CLOSE@CONT.6 (M. MOENG)	LANGLAAGTE OTHER
201359081	2006/11/09	2/71 LA 15W&91W NOT CLOSING P. DEBRUIN	LANGLAAGTE UP
201359023	2006/11/10	2/77 LEF 37W JUMPS E. KHECHANE	LEEUHOF CTC
201370128	2006/11/15	2/109 CD 35W FAULTY P. MAILULA	CITY DEEP
201363050	2006/11/16	2/112 LL 68W NO CLOSE (de BRUIN)	LANGLAAGTE OTHER
201363127	2006/11/16	2/113 KZM HW-ARM BROKEN (P. MAILULA)	KASERNE MARK
201370144	2006/11/20	2/127 KZ BLADE MISSING (J. DEBRUIN	KASERNE MARK
201367730	2006/11/21	2/133 MTN 6W FAULTY J. SEDIMELA	MEYERTON
201370164	2006/11/23	2/152 YLLA Ws FULL MUD (DE BRUIN	LANGLAAGTE OTHER
201369908	2006/11/26	2/176 YLLA 95W 1/2 COCK (DE BRUIN)	LANGLAAGTE OTHER
201369910	2006/11/27	2/184 LEF 19W CONT.2 NO CLOSE (KHECHANE)	LEEUHOF CTC
201369911	2006/11/28	2/191 CYV W#5RD BOLTS OUT (TSHIVULA)	CITY DEEP
201369906	2006/11/29	2/200 NT W-NO TURN#2RD (J. TSHIVULA)	NATALSPRUIT
201369907	2006/11/30	2/202 KZN SPLIT POINTS M.TSHIVULA	KASERNE WEST
201378638	2006/12/10	2/071 KAZ_POINT UNDER SOIL P.MAILULA	KASERNE
201375186	2006/12/12	2/85 RD POINTS FAULTY J. SIDIMELA	ROOIKOP
201378644	2006/12/12	2/89 KZ POINTS WITH SAND P. MAILULA	KASERNE
201374671	2007/12/12	2/93 SBG 34POINTS DRY E. KHECHANE	SASOLBURG

201375188	2006/12/24	2/161 LLA W-HALF-KOK (P. de BRUIN)	LANGLAAGTE DOWN
201375193	2006/12/27	2/171 LAN HAND"W" HALF-COCK S.ZONDI	LANGLAAGTE DOWN
201375216	2006/12/29	2/178 HUP L/PACK@2469W (E. KHECHANE)	HOUTHEUWEL
201378674	2006/01/03	2/19 RW POINTS BLADE FAULTY J.SIDIMELA	ELANDSFONTEIN
201378675	2006/01/03	2/24 UN 373W BLADE FAULTY J.SIDIMELA	UNION
201378733	2006/01/05	2/34 RDR KICKOUT KM 23/3 (SIDEMELA)	RANDWATER
201382867	2007/01/07	2/40 YLL BROKEN POINTS SWITCH (SIDEMELA)	LANGLAAGTE OTHER
201378941	2007/01/09	2/53 SBG 64&30W NO CLOSE (A. RAKOTO)	SASOLBURG
201378731	2007/01/10	2/64 KZ H/W NO-CLOSE (M. MOENG)	KASERNE WEST
201378959	2007/01/11	2/71 ISO POINTS DON'T LOCK P. MADIHLABA	JOHANNESBURG
201378916	2007/01/11	2/74 BJR BROKEN POINT E. KHECHANE	ISCOR SIDING (E) - ISCOR SIDING (I)
201378964	2007/01/12	2/81 GMRG POINTS FAULTY M. MOENG	GERMISTON GOODS CABIN
201382865	2007/01/14	2/88 KZ H/POINTS TIGHT P. MADIHLABA	KASERNE
201382848	2007/01/17	2/104 ELS 51AW (MOENG)	ELSBURG
201382257	2007/01/19	2/121 LF W'S OPENING A. RAKOTO	LEEUHOF CTC
201384828	2007/01/21	2/136 LAA_POINTS MOVING P.de BRUIN	LANGLAAGTE HOLLYWOOD
201384913	2007/01/22	2/143 NT W375 BLADE BROKEN(PAUL)	NATALSPRUIT
201384840	2007/01/22	2/146 SBG W85 LOOSE (BREYTENBACH)	SASOLBURG
201384866	2007/01/25	2/171 MTN CEMENT ON 1505W (MAILULA)	MEYERTON
201384886	2007/01/25	2/173 DES OVERLAP 1631W (MAILULA)	DALESIDE
201387214	2007/01/31	2/213 CTD HALF COCK M. MOENG	CITY DEEP
201387196	2007/02/01	2/02 GMGR YARD SOIL IN POINTS(MAILUL	GERMISTON
201387194	2007/02/01	2/04 ID W24B HIELBLOCK(MAILULA)	INDIA
201387132	2007/02/04	2/17 HUP 2441W FAULTY A. RAKOTO	HOUTHEUWEL
201390387	2007/02/08	2/65 NT W'S HEAD BENT P. MADIHLABA	NATALSPRUIT
201390414	2007/02/08	2/70 BRR W38 BLADE BROKEN P. DE BRUIN	BRAAMFONTEIN
201395808	2007/02/11	2/90 LEF 21W FAULTY H. BREYTENBACH	LEEUHOF CTC
201393322	2007/02/14	2/114 LLA "W95" FASTENINGS(DE BRUI	LANGLAAGTE UP
201393317	2007/02/15	02/121 SBG BENT BLADES A RAKOTO	SASOLBURG
201395798	2007/02/18	02/141 BRR POINTS NOTCLOSING P.DEBRUIN	BRAAMFONTEIN NORTH
201395792	2007/02/19	2/149 BRR XSING W'S BROKEN P. DE BRUIN	BRAAMFONTEIN
201395780	2007/02/20	2/161 LLA W'S NOT CLOSING P. DE BRUIN	LANGLAAGTE OTHER
201395811	2007/02/21	2/169 LEF W'S NOT CLOSING A. RAKOTO	LEEUHOF CTC
201395767	2007/02/22	2/174 GMR W22 H-COCK (BRITZ)	GERMISTON
201395816	2007/02/22	2/181 LEF W19 H-COCK(DALTON)	LEEUHOF CTC
201401347	2007/02/25	2/204 DES CROSSING ON TURNOUT	DALESIDE

201401334	2007/03/02	2/4 BRR 38W BLADE BROKEN MJ. TSHIVULA	BRAAMFONTEIN
201402512	2007/03/03	2/14 GMR W'S NOT TURNING PM. MAILULA	GERMISTON
201402470	2007/03/06	2/39 LLA YARD "W" LUB(MOENG)	LANGLAAGTE DOWN
	2007/03/08	2/52 BXE WS FAULTY (MADIHLABA)	BOKSBURG-OOS
201407878	2007/03/10	2/63 YGMR Y/POINTS (MAILULA)	GERMISTON
201410832	2007/03/10	2/64 FCR CATTLE KM 38/15 (BREYTENBACH)	FOCHVILLE
201410832	2007/03/10	2/64 FCR CATTLE KM 38/15 (BREYTENBACH)	FOCHVILLE
201410832	2007/03/10	2/64 FCR CATTLE KM 38/15 (BREYTENBACH)	FOCHVILLE
201410832	2007/03/10	2/64 FCR CATTLE KM 38/15 (BREYTENBACH)	FOCHVILLE
201410832	2007/03/10	2/64 FCR CATTLE KM 38/15 (BREYTENBACH)	FOCHVILLE
201410832	2007/03/10	2/64 FCR CATTLE KM 38/15 (BREYTENBACH)	FOCHVILLE
201406829	2007/03/13	2/94DES BROKEN POINTS BLADE KM 37/1	DALESIDE
201407918	2007/03/18	2/126 YMTN Y/POINTS (MADIHLABA)	MEYERTON
201407870	2007/03/18	2/131 HUP 3061W (RAKOTO)	HOUTHEUWEL
201407927	2007/03/20	2/140 YSBG 129W (RAKOTO)	SASOLBURG
201407908	2007/03/21	2/144 KZ W'S NOT CLOSING P. DE BRUIN	KASERNE
201413145	2007/03/25	2/167 YKZ YARD W1-W2 FAILS(MOENG)	KASERNE
201413146	2007/03/27	2/182 GMGR "W2" CHUBBLOCK(MAILULA)	GERMISTON
201414507	2007/04/02	2/202 YISO BROKEN W'S SWITCH J. BRITS	JOHANNESBURG
201414508	2007/04/02	2/203 YKZ W'S FAULTY MAILULA	KASERNE
201414511	2007/04/02	2/9 ISO W'S NOT CLOSING P. MADIHLABA	JOHANNESBURG
1001149104	2007/04/02	2/202 YISO BROKEN W'S SWITCH J. BRITS	
1001149106	2007/04/02	2/203 YKZ W'S FAULTY MAILULA	
1001149254	2007/04/02	2/9 ISO W'S NOT CLOSING P. MADIHLABA	
201414515	2007/04/04	2/33 ISC_"W" NO CLOSING. MAILULA	JOHANNESBURG
201414536	2007/04/04	2/37 SSB_26W NOT CLOSING. RAKOTO	SASOLBURG
1001149894	2007/04/04	2/33 ISC_"W" NO CLOSING. MAILULA	
1001149996	2007/04/04	2/37 SSB_26W NOT CLOSING. RAKOTO	
201416382	2007/04/07	2/49 LLA_31W DOES NOT CLOSE. MAILULA	LANGLAAGTE OTHER
1001150488	2007/04/07	2/49 LLA_31W DOES NOT CLOSE. MAILULA	
201417975	2007/04/10	2/81 YVER 21W (BREYTENBACH)	VEREENIGING
1001151281	2007/04/10	2/81 YVER 21W (BREYTENBACH)	
201419961	2007/04/14	2/101 BRR W'S NOT CLOSING P. DE BRUIN	BRAAMFONTEIN NORTH
1001152170	2007/04/14	2/101 BRR W'S NOT CLOSING P. DE BRUIN	
201419948	2007/04/16	2/115 GMRG W11 TUMBLER	GERMISTON

		HEAD(PAUL)	
1001152580	2007/04/16	2/115 GMRG W11 TUMBLER HEAD(PAUL)	
201419985	2007/04/17	2/122 SBG YARD W89 LOOSE(ALBERT)	SASOLBURG
1001152836	2007/04/17	2/122 SBG YARD W89 LOOSE(ALBERT)	
201419992	2007/04/18	2/128 LF W12 H-COCK (ALBERT)	LEEUHOF CTC
1001153173	2007/04/18	2/128 LF W12 H-COCK (ALBERT)	
201419994	2007/04/19	2/132 YSBG Y/POINTS 13, 14 (KOKOME)	SASOLBURG
201419997	2007/04/19	2/133 YSBG Y/POINTS (KOKOME)	SASOLBURG
1001153261	2007/04/19	2/132 YSBG Y/POINTS 13, 14 (KOKOME)	
1001153262	2007/04/19	2/133 YSBG Y/POINTS (KOKOME)	
201426928	2007/04/21	2/145 YLF 11, 14W (RAKOTO)	LEEUHOF CTC
1001153788	2007/04/21	2/145 YLF 11, 14W (RAKOTO)	
201426923	2007/04/22	2/150 RN 1503W OVERLAP P. MAILUL	REDAN
201427469	2007/04/22	2/154 ISO W' DRY P. MAILULA	JOHANNESBURG
1001154084	2007/04/22	2/154 ISO W' DRY P. MAILULA	
1001154076	2007/04/22	2/150 RN 1503W OVERLAP P. MAILUL	
1001155258	2007/04/27	2/201 GRV W1429 INSPECTION(V DYK)	
1001155260	2007/04/27	2/203 BXL YARD "W2" SLACK(MUSA)	
201426969	2007/04/29	2/216 YSBG Y/POINTS/129 (KHECHANE)	SASOLBURG
1001155587	2007/04/29	2/214 YSPR Y/POINTS ROAD/9 (DLAMINI)	LANGLAAGTE OTHER
1001155678	2007/04/29	2/216 YSBG Y/POINTS/129 (KHECHANE)	LANGLAAGTE OTHER
1001155678	2007/04/29	2/216 YSBG Y/POINTS/129 (KHECHANE)	LANGLAAGTE OTHER
1001155899	2007/04/30	2/225 YSPR Y/POINTS/9 (DLAMINI)	NATALSPRUIT
1001155998	2007/05/01	2/03 YVER Y/POINTS (RAKOTO)	NEW MACHAVIE - KOEKEMOER
1001156435	2007/05/03	2/13 HUP 3033W (RAKOTO)	ISCOR SIDING
1001156380	2007/05/03	2/10 MTN LOOSE BLADE J. SIDEMELA	KASERNE
1001156537	2007/05/04	2/19 NT BLADE LOOSE J. SIDEMELA	VEREENIGING
1001156879	2007/05/06	2/27 YWEL Y/POINTS (JIMMY)	SASOLBURG
1001157497	2007/05/08	2/56 JU YARD "W" LOOSE(MAILULA)	LANGLAAGTE OLD
1001158913	2007/05/15	2/100 W H/TUMBLER MISSING P. MAILULA	LEEUHOF CTC
1001158997	2007/05/15	2/112 EFT W' GAUGE OPEN SIDEMELA	KASERNE WEST
1001159041	2007/05/15	2/113 YLL POINTS TUMBLER MISSING	CITY DEEP
1001159235	2007/05/16	2/120 YNT W's NOT CLOSING(S.NDHLELA)	BRAAMFONTEIN NORTH
1001159891	2007/05/20	2/152 YGMR Y/POINTS (SIDEMELA)	DALESIDE
1001160353	2007/05/21	2/161 YWTI Y/POINTS (TSHIVULA)	BRAAMFONTEIN
1001160471	2007/05/21	2/165 LF YARD W11 H-COCK(GODFREY)	SASOLBURG
1001160517	2007/05/22	2/167 CTA W53 RUN THROUGH(BARNARD)	BRAAMFONTEIN NORTH
1001160560	2007/05/22	2/170 WTL 13B/W (SIDIMELA)	MEYERTON
1001162382	2007/05/28	2/212 LES/KRS TUMBLER HEAD(MUSA)	ELSBURG
1001163212	2007/05/30	2/232 YCTD Y/POINTS 8 (MOENG)	KASERNE HUMP
1001163353	2007/05/31	2/241 YNT POINTS TUMBLER FAULTY SIDEMELA	BRAAMFONTEIN NORTH
1001163855	2007/06/02	2/07 KZ 17, 21W (MOENG)	KASERNE

1001163987	2007/06/02	2/10 YKZ POINTS TUMBLER HEAD MISSING	VILJOENSDRIF
1001164431	2007/06/03	2/16 YWEL Y/POINTS (JIMMY)	KASERNE MARK
1001164759	2007/06/04	2/23 CTA B/RAIL ARRIVAL YARD (SYDNEY)	GERMISTON
1001164754	2007/06/04	2/20 SBG 64W FAULTY KHECHANE	SASOLBURG
1001164974	2007/06/05	2/31 LEF HALF COCK E. KHECHANE	GERMISTON - DELMORE
1001166174	2007/06/09	2/71 LES TUMBLER THEFT(ZVF)(KHUMBULANI)	GERMISTON - Loco
1001166656	2007/06/10	2/79 ARG 213W (MATHEBULA)	GERMISTON - Loco
1001166678	2007/06/10	2/80 YLEF Y/POINTS 33 (KHECHANE)	KASERNE
1001167046	2007/06/11	2/94 YWEL Y/POINTS 4 (MATHEBULA)	KASERNE MARK
1001166950	2007/06/11	2/90 YSBG 49 Y/POINTS (KHECHANE)	LEEUHOF NOORD
1001167538	2007/06/12	2/112 LES M/L POINTS (MATHEBULA)	LEEUHOF NOORD
1001167312	2007/06/12	2/105 MTN 1431W (SIDEMELA)	BOKSBURG-OOS
1001168267	2007/06/15	2/126 YSBG 124 Y/POINTS (RAKOTO)	WESTONARIA
1001169282	2007/06/19	2/159 SBG YARD W108 H-COCK(GODFREY)	LEEUHOF NOORD
1001169396	2007/06/19	2/162 RN W1431 RUN THROUGH(SHANDU)	LEEUHOF NOORD
1001169799	2007/06/20	2/170 YBRR Y/POINTS 21, 22 (DE BRUIN)	JOHANNESBURG
1001169923	2007/06/21	2/172 YKZ YARD "W" H-COCK (PAUL)	SASOLBURG
1001171241	2007/06/25	2/200 YSBG W24 FAULTY A. RAKOTO	CITY DEEP
1001172117	2007/06/29	2/214 KZ P/BLADE BROKEN (MOENG)	KASERNE
1001172131	2007/06/29	2/218 SCA "W" H-BLOCK BROKEN(MUSA)	LANGLAAGTE OLD
1001172577	2007/06/30	2/230 DES W1-2 H-COCK (SHANDU)	JOHANNESBURG
1001173228	2007/07/02	2/18 LEFN 2663W (KOKOME)	SASOLBURG
1001174818	2007/07/08	2/58 KZ W'S ROD STOLEN J. SIDEMELA	BRAAMFONTEIN NORTH
1001175162	2007/07/08	2/68 DES_1529W NEEDS TEMPING KM36	SASOLBURG
1001175337	2007/07/09	2/70 STT POINTS CRACKED KHUMBULANI	DUNSWART - APEX
1001175955	2007/07/10	2/93 YKZ WS DONT OPEN (TSHISWAISE)	GERMISTON
1001175955	2007/07/10	2/93 YKZ WS DONT OPEN (TSHISWAISE)	DUNSWART - APEX
1001175771	2007/07/10	2/87 LES TUMBLER LOOSE (K MATHEBULA)	GERMISTON CENTRAL CABIN
1001176273	2007/07/11	2/103 YKZ Y/POINTS (TSHISWAISE)	MICHAELSRAAD
1001176365	2007/07/12	2/105 YMTN Y/POINTS (TUMBLER STOLEN)	KASERNE
1001176435	2007/07/12	2/108 LES Y/POINTS TUMBLER MISSING(BB0)	JOHANNESBURG
1001176589	2007/07/13	2/114 YCTD Y/POINTS (TSHISWAISE)	NATALSPRUIT
1001176509	2007/07/13	2/112 YKZ TUMBLER STOLEN(TSHISWAISE)	NATALSPRUIT
1001176604	2007/07/13	2/115 YWEL Y/POINTS TUMBLER DAMAGED	MEYERTON
1001177593	2007/07/16	2/133 MTN 1633W BROKEN J. BRITZ	LANGLAAGTE OTHER
1001177915	2007/07/17	2/140 SBG 127W NOT CLOSING G. SHIBAMBU	LANGLAAGTE UP
1001178411	2007/07/18	2/158 LEF 12W FAULTY A. RAKOTO	LEEUHOF CTC
1001178129	2007/07/18	2/144 YIS Y/POINTS (56) (RAKOTO)	CITY DEEP
1001179063	2007/07/21	2/174 GMRG TUMBLER MISSING(JAKES)	LANGLAAGTE OTHER
1001178961	2007/07/21	2/170 GMRG YARD TUMBLER	KASERNE MARK

		HEAD(PAUL)	
1001179084	2007/07/21	2/175 ISO W12 UNCLAMP(MOENG)	KASERNE MARK
1001178802	2007/07/21	2/164 KZ W'S HEAD STOLEN MJ. TSHIVULA	MEYERTON
1001180344	2007/07/25	2/207 YNT W'S NOT CLOSING E. KHACHANE	LANGLAAGTE OTHER
1001180530	2007/07/26	2/210 CTD W'S BOLTS LOOSE M. MOENG	LANGLAAGTE OTHER
1001180532	2007/07/26	2/211 CTD W'S BOLTS BROKEN M. MOENG	LEEUHOF CTC
1001181282	2007/07/29	2/226 DRY W719 BOLTS (MUSA)	CITY DEEP
1001181348	2007/07/29	2/227REPLACE ROD ON POINTS ON(MAILULA)	NATALSPRUIT
1001181758	2007/07/30	2/236 DEL "W" H-COCK(MUSA)	KASERNE WEST
1001182029	2007/07/31	2/243 JU W49 B KM 4 FAILS(PAUL)	KASERNE
1001183016	2007/08/04	2/22 YISO BURST WATERPIPE (SIDEMELA)	ROOIKOP
1001183016	2007/08/04	2/22 YISO BURST WATERPIPE (SIDEMELA)	KASERNE
1001183983	2007/08/06	2/43 KZ W'S BLADE BROKEN E. KHECHANE	SASOLBURG
1001183984	2007/08/07	2/44 YCD 2W JUMPING E. KHECHANE	LANGLAAGTE DOWN
1001184231	2007/08/07	2/57 KZ W'S BLADE FAULTY MJ. TSHIVULA	LANGLAAGTE DOWN
1001184431	2007/08/07	2/58 KZ BROKEN BLADE (W161) PM. MAI	HOUTHEUWEL
1001184448	2007/08/07	2/60 NT W131 BLADE FAULTY E. KHECHANE	ELANDSFONTEIN
1001184497	2007/08/07	2/62 MTN W'S ROD/ARM J. SIDEMELA	UNION
1001185583	2007/08/11	2/83 CTA W257 P/BLADE (V DYK)	RANDWATER
1001187031	2007/08/14	2/105 WEL 'W' X LOOSE K.MATHEBULA	LANGLAAGTE OTHER
1001187993	2007/08/17	2/121 CTD W32 HEAD LOOSE MJ. TSHIVULA	SASOLBURG
1001187992	2007/08/17	2/120 KZ W'S HALF KOK MJ. TSHIVULA	KASERNE WEST
1001190277	2007/08/24	2/175 LES HANDTUMELAAR RAYMOND	JOHANNESBURG
1001190762	2007/08/25	02/184 KZ POINTS FAULTY MAILULA	ISCOR SIDING (E) - ISCOR SIDING (I)
1001191183	2007/08/26	2/194 WEL 37W BENT N. BALOYI	GERMISTON GOODS CABIN
1001191419	2007/08/27	2/198 LEF 24W ARM FAULT D. KOKOME	KASERNE
1001191760	2007/08/28	2/207 VJ 3W CRACKED D. KOKOME	ELSBURG
1001193004	2007/09/01	2/8 YKZ BROKEN W BLADE G. TSHIGWAINE	LEEUHOF CTC
1001193451	2007/09/02	02/19 YKZ LOOSE POINTS S TSHISWAISE	LANGLAAGTE HOLLYWOOD
1001195845	2007/09/09	2/84 CTD 2W HALF KOCK M. MOENG	NATALSPRUIT
1001195533	2007/09/09	2/74 NT HEAD OF H/TUMBLER FAULTY KHECHAN	SASOLBURG
1001197005	2007/09/12	2/110 STQ B/XING ON 355W (S MOHLALA)	MEYERTON
1001197006	2007/09/12	2/111 MTN 1731W B/XING (MOENG)	DALESIDE
1001197149	2007/09/13	2/115 NT WS FAULTY (E KHECHANE)	CITY DEEP
1001198505	2007/09/17	2/140 SBG 34W STOCK & SWITCH GODFREY	GERMISTON
1001198952	2007/09/18	2/148 LEF W'S LOOSE... D. KOKOME	INDIA

1001199607	2007/09/20	2/165 CTD HALF COCK M. MOENG	HOUTHEUWEL
1001200131	2007/09/22	2/178 VER 21W HALF COCK G. SHIBAMBO	NATALSPRUIT
1001200114	2007/09/22	2/173 SPR 7W DONT CLOSE NICO BALOYI	BRAAMFONTEIN
1001200525	2007/09/23	2/189 VER 20W DONT CLOSE (SHIBAMBO)	LEEUHOF CTC
1001198697	2007/09/23	2/143 WADEVILLE W'S TUMBLER S. NDHLELA	LANGLAAGTE UP
1001200677	2007/09/24	2/200 YSBG 34W NOT CLOSING (G SHIBAMBO)	SASOLBURG
1001198186	2007/09/25	2/137 GMR W'S NOT CLOSING S. NDHLELA	LANGLAAGTE OTHER
1001201625	2007/09/27	2/221 LES LOOP W'S FAULTY N. BALOYI	LANGLAAGTE OTHER
1001201786	2007/09/28	2/225 YISO NUTS BROKEN ON WS (MAILULA)	LANGLAAGTE OTHER
1001203022	2007/10/02	2/11 WEL W DONT CLOSE JIMMY	NATALSPRUIT
1001203091	2007/10/02	2/13 WEL 2255W STOLEN SPRINGS(ET8)JIMMY	NEW MACHAVIE - KOEKEMOER
1001203411	2007/10/03	2/21 RDE KICKOUT LINDA SIKAMPULA	ISCOR SIDING
1001203564	2007/10/04	2/25 LL POINTS FAULTY TSHIVULA	KASERNE
1001204038	2007/10/06	2/31 RD FAULTY HANDPOINTS MADHLILABA	VEREENIGING
1001204411	2007/10/07	2/36 YWTI W'S TUMBLER S. TSHISWAISE	SASOLBURG
1001204937	2007/10/08	2/51 W BLADE LOOSE L MTSWENI	LANGLAAGTE OLD
1001205318	2007/10/09	2/64 SPR 12W NOT CLOSING K. MATHEBULA	LEEUHOF CTC
1001206530	2007/10/13	2/96 EDC W NOT OPERATE N BALOYI	KASERNE WEST
1001206528	2007/10/13	2/95 VERS W/FAULTY SHIBAMBO	CITY DEEP
1001207300	2007/10/14	2/118 WTI 13W DONT CLOSE MAILULA	BRAAMFONTEIN NORTH
1001207205	2007/10/15	2/114 VER 21W DONT CLOSE SHIBAMBO	DALESIDE
1001207694	2007/10/16	2/123 EDC TUMBLER STOLEN(FK5)NJICO	BRAAMFONTEIN
1001208646	2007/10/19	2/140 LEF 21W NOT CLOSING G. SHIBAMBU	SASOLBURG
1001209475	2007/10/21	2/150 MTN POINTS PLATE STOLEN P MAILULA	BRAAMFONTEIN NORTH
1001210326	2007/10/23	2/175 ISO POINT HALF COCK (M. SEHLAKO)	MEYERTON
1001210451	2007/10/24	2/177 DEL POINTS LOCK LOOSE (JIMMY)	ELSBURG
1001211319	2007/10/27	2/200 LLA "W" LOCK CHAIN BROKEN(TSHIVULA	KASERNE HUMP
1001212914	200710/31	2/231 GMR POINT TO BE CLAMPED L MTSWENI	BRAAMFONTEIN NORTH
1001212916	2007/10/31	2/232 GMR POINT ROD LOOSE L MTSWENI	KASERNE
1001212912	2007/10/31	2/230 GMR POINT TO BE CLAMPED L MTSWENI	VILJOENSDRIF
1001213339	2007/11/02	2/6 SED POINT NOT LOCKING JOE MBANGA	KASERNE MARK
1001214102	2007/11/04	2/19 RPR POINTS STICKY (P.M.MAILULA)	GERMISTON
1001215354	2007/11/07	2/43 VER W'S NOT CLOSING G. SHIBAMBO	SASOLBURG
1001215357	2007/11/07	2/46 MTN 1621W CRACKED E. KHECHANE	GERMISTON - DELMORE

1001215577	2007/11/08	2/53 VER 4721W BLADE BROKEN G. SHIBAMBO	GERMISTON - Loco
1001216281	2007/11/10	2/68 WEL W /HALF COCK (JIMMY BAHULA)	GERMISTON - Loco
1001216705	2007/11/12	2/76 FAULTY POINTS MJ. TSHIVULA	KASERNE
1001217731	2007/11/14	2/87 ISE POINTS FAULTY (E.KHECHANE)	KASERNE MARK
1001217939	2007/11/15	2/89 SPR POINTS FAULTY (J.BAHULA)	LEEUHOF NOORD
1001218945	2007/11/18	2/109 LEF 3W NO CLOSE DALTON	LEEUHOF NOORD
1001218932	2007/11/18	2/107 KAZW 19W FAULTY S.TSHISWAISE	BOKSBURG-OOS
1001219714	2007/11/20	2/126 CTD W TO 31 NO CLOSE M.TSHIVUL	WESTONARIA
1001220752	2007/11/24	2/149 GMR H/W HALF COCK P.MAILULA	LEEUHOF NOORD
1001221632	2007/11/27	2/168 KZ 'W' HALF COCK E.KHECHANE	LEEUHOF NOORD
1001222625	2007/11/29	2/192 MTN W/1/2COCK S.NDHLELA	JOHANNESBURG
1001225332	2007/12/01	2/05 POINTS INDICATOR SCA (KHUMBULANI)	SASOLBURG
1001225155	2007/12/08	2/32 KYN 729W RODS BROKEN (JOE)	CITY DEEP
1001226752	2007/12/11	2/63 SPR_POINT BLADE MOVE JIMMY	KASERNE
1001227961	2007/12/15	2/95 YSPR W's NOT CLOSING (M.THWALA)	LANGLAAGTE OLD
1001228100	2007/12/15	2/101 WELA W's NOT CLOSING (M.THWALA)	JOHANNESBURG
1001228155	2007/12/16	2/108 YMTN W's NOT CLOSING(L.MTSWENI)	SASOLBURG
1001229342	2007/12/20	2/135 VER W'S STOLEN G. SHIBAMBU	BRAAMFONTEIN NORTH
1001229343	2007/12/20	2/136 LEF W'S NOT CLOSING G. SHIBAMBU	SASOLBURG
1001229492	2007/12/21	2/144 YGMR 3W NOT CLOSING L. MTSWENI	DUNSWART - APEX
1001232051	2008/01/02	2/02 LEFN 13W NOT OPENING D.KOKOME	GERMISTON
1001232893	2008/01/05	2/18 WEL W'S NOT CLOSING (LINDA)	DUNSWART - APEX
1001232639	2008/01/05	2/14 YWTI CLAMP W's (S.TSHISWAISE)	GERMISTON CENTRAL CABIN
1001232987	2008/01/06	2/20 YWEL WS HALFCOCK (JIMMY)	MICHAELSRAAD
1001233123	2008/01/06	2/25 TIT WS BLADE FAULT Y (JIMMY)	KASERNE
1001233218	2008/01/06	2/28 TIT CRACK RAIL ON POINTS (JIMMY)	JOHANNESBURG
1001234020	2008/01/08	2/47 YEFT WS NOT CLOSING (MOENG)	NATALSPRUIT
1001234408	2008/01/09	2/52 BXL BROKEN W" (JIMMY)	NATALSPRUIT
1001234162	2008/01/09	2/50 GRMG HALF COCK S. TSHISWAISE	MEYERTON
1001235196	2008/01/12	2/61 NT W'S TUMBLER BENT S. TSHISWAISE	LANGLAAGTE OTHER
1001235494	2008/01/13	2/65 YVER TUMBLER REPLACE (D.KOKOME)	LANGLAAGTE UP
1001237761	2008/01/13	2/70 TURNOUT NO 33 AT LEEUHOF DOES NOT	LEEUHOF CTC
1001236029	2008/01/14	2/75 YLEF 33W FAULTY (D.KOKOME)	CITY DEEP
1001236724	2008/01/16	2/91 STQ LOOSE TUMBLER (JOE MBANGA)	LANGLAAGTE OTHER
1001236758	2008/01/16	2/94 YLEF 12W FAULTY (D.KOKOME)	KASERNE MARK
1001236757	2008/01/16	2/93 YLEF 3W FAULTY	KASERNE MARK

1001236690	2008/01/17	2/89 BROKEN CROSSING37W (E KHECHANE)	MEYERTON
1001238030	2008/01/21	2/108 KDL WS TUMBLER LOOSE (M THWALA)	LANGLAAGTE OTHER
1001239271	2008/01/24	2/127 DGF 'W' NOT TURNING MUSA THWALA	LANGLAAGTE OTHER
1001240029	2008/01/27	2/139 WADEVILLE TUMBLER MISSING(DE BRUIN	LEEUHOF CTC
1001240249	2008/01/28	2/144 MIP 551W RUNTHROUGH J MBANGA	CITY DEEP
1001240443	2008/01/28	2/154 NLR POINT NO TUMBLER (JB6)KUMBULA	NATALSPRUIT
1001240451	2008/01/28	2/157 HAW W MFAULTY KHUMBULANI	KASERNE WEST
1001240694	2008/01/29	2/163 YKZ WS HALFCOCK (S TSHISWAISE)	KASERNE
1001241343	2008/01/31	2/181 KAZ_POINT BROKEN S.TSHISVAISE	ROOIKOP
1001241627	2008/02/02	2/4 LF 2W HARD TO USE G. SHIBAMBO	KASERNE
1001242243	2008/02/03	2/15 RD 9W HALF COCK M.SEHLAKO	SASOLBURG
1001242920	2008/02/05	2/38 YGMR W's FAULTY (L.MSTWENI)	LANGLAAGTE DOWN
1001243246	2008/02/06	2/48 KZ POINTS STAY OPEN SHANDU	LANGLAAGTE DOWN
1001243416	2008/02/07	2/53 SPR W. DON'T CLOSE RAYMOND	HOUTHEUWEL
1001243300	2008/02/07	2/51 ID OVERLAP IN 38BW Km0/19(MTSWENI)	ELANDSFONTEIN
1001244534	2008/02/10	2/73 IS POINTS NOT CLOSING NDHLELA	UNION
1001245523	2008/02/13	2/94 SPR W HALFCOCK MUSA THWALA	RANDWATER
1001246076	2008/02/15	2/102 BR TUMBLER MISSING(JT4)JOE	LANGLAAGTE OTHER
1001246280	2008/02/16	2/104 LEF 1W+20W NOT TURN G SHIBAMBO	SASOLBURG
1001246791	2008/02/17	2/111 IS W NOT CLOSING (M MOENG)	KASERNE WEST
1001246849	2008/02/17	2/112 RPR TUMBLERS STOLEN TSHIVULA	JOHANNESBURG
1001247284	2008/02/18	2/121 LF 29W G SHIBAMBO	ISCOR SIDING (E) - ISCOR SIDING (I)
1001248038	2008/02/20	2/135 KZ W'S NOT CLOSING MJ. TSHIVULA	GERMISTON GOODS CABIN
1001249770	2008/02/25	2/155 DAO W'S HARD 2 TURN N BALOYI	KASERNE
1001251853	2008/03/03	2/17 BRR 8W NOT CLOSING M. MOENG	ELSBURG
1001251930	2008/03/04	2/19 SPR W HAIFCOCK JIMMY	LEEUHOF CTC
1001252052	2008/03/04	2/21 HAW W'S NOT CLOSING J. BAHULA	LANGLAAGTE HOLLYWOOD
1001252499	2008/03/04	2/24 Y-POINTS NOT CLOSING JIMMY	NATALSPRUIT
1001252965	2008/03/07	2/34 SED TUMBLER FAILS (JOE)	SASOLBURG
1001253347	2008/03/09	2/46 ISO YARD "W" P/BLADE (SIDIMELA)	MEYERTON
1001254310	2008/03/11	2/72 KZ "W" DAMAGED -TSHISWASE	DALESIDE
1001254943	2008/03/13	2/83 SBG 126W HALF COCK A. RAKOTO	CITY DEEP
1001254946	2008/03/13	2/85 DEL W'S HALF COCK... M. THWALA	GERMISTON
1001255629	2008/03/16	2/98 KZ W'S NOT CLOSING MJ. TSHIVULA	INDIA
1001257216	2008/03/21	2/128 SPR W8 H-COCK(NICO)	HOUTHEUWEL
1001258469	2008/03/25	2/154 SPR W'S NOT CLOSING K. MATHEBULA	NATALSPRUIT

2. WRONG TRACK GAUGE

Order	Date	Description	Description
1000953162	2005/05/09	2/067 GMRG_RAIL GAUGE OPEN D.de LANGE	GERMISTON - Intake
1001143374	2007/03/07	2/46 DES closer rail S. NDHLELA	DALESIDE
201486975	2007/10/02	2/10 TDG GAUGE FAULTY SYDNEY	TWEEDRAG
1001107758	2006/10/16	2/148 REPAIR WIDDEN GAUGE	KASERNE MARK
201486975	2007/10/02	2/10 TDG GAUGE FAULTY SYDNEY	TWEEDRAG
201463044	2007/08/05	2/29 REPLACE THE GAUGE & MAINTANANCE ON	CITY DEEP
201431490	2007/05/15	2/112 EFT W' GAUGE OPEN SIDEMELA	ELANDSFONTEIN
201346268	2006/10/16	2/148 REPAIR WIDDEN GAUGE	KASERNE MARK
201322189	2006/08/17	2/104 ISO GAUGE IS OPEN PAUL	JOHANNESBURG
201137697	2005/05/09	2/067 GMRG_RAIL GAUGE OPEN D.de LANGE	GERMISTON - Intake
201517785	2007/11/30	2/194 CITYDEEP WIDE RAIL M.MOENG	CITY DEEP
201363057	2006/11/14	02/90 closer rails RAIL PM MAILULA	ROOIKOP

3. BROKEN RAIL

Order	Date	Description	Description
201111753	2005/03/05	2/35 GMRG BROKEN RAIL KM 1/9 (ZONDI)	GERMISTON GOODS CABIN
201114820	2005/03/13	2/68 DES R/BREAK KM35/4(TAKALANI)	DALESIDE
201119191	2005/03/23	2/155 JU/CTD R/BREAK KM5/7 (MOENG	CITY DEEP
201119211	2005/03/26	2/176 VFT R/BREAK KM17/2(BRITZ)	VOëLFONTEIN
201122095	2005/03/27	2/179 EHUP2LF BROKEN RAIL KM 62/3-4	HOUTHEUWEL - LEEUHOF CTC
201122230	2005/03/31	2/213 DRR R/BREAK "T"131" (STOLTZ)	DRIEHOEK
201122234	2005/04/01	2/001 ELS_RAIL BREAK J. BRITS	ELSBURG
201127552	2005/04/05	2/43 KPF R/BREAK KM64/13(RAKOTU)	KLIPDRIF
201128164	2005/04/12	2/97 KPF B/RAIL@63/13 (E. KEKANA)	KLIPDRIF
201128906	2005/04/12	2/99 LL W4 R/BREAK YARD (SIDIME	LANGLAAGTE OTHER
201128946	2005/04/14	2/111 WTL BROKEN RAIL (BRITS)	WATTLES
201128168	2005/04/17	2/121 EEKF2KPF BROKEN RAIL KM 55/14-15	ENSELSPRUIT-KLIPDRIF - KLIPDRIF
201129926	2005/04/19	2/146 ID_16W RAIL BREAK/JOINT J.BRITS	INDIA
201133084	2005/04/26	2/206 ISO R/BREAK KM2/40(TAKALANI)	ELANDSFONTEIN - JOHANNESBURG

201135381	2005/05/02	2/07 KZM YARD R./BREAK (MOENG)	KASERNE
201135197	2005/05/02	2/16 DES R/BREAK KM34/1(NAIDOO)	DALESIDE
201135187	2005/05/04	2/27 UN W391 R/BREAK KM8/2(BRITZ)	UNION
201135172	2005/05/04	2/28 DES R/BREAK KM37/12(BRITZ)	DALESIDE
201135157	2005/05/05	2/35 EKPF2TEL BROKEN RAIL KM 55/3	KLIPDRIF - TARENTAAL
201135138	2005/05/06	2/42 RTV BROKEN RAIL (RAKOTO)	RAATHSVLEI
201135350	2005/05/07	2/45 SBG BROKEN RAIL (RAKOTO)	SASOLBURG
201137492	2005/05/08	2/59 FCR R/BREAK "T362" (EUGENE)	FOCHVILLE
201137418	2005/05/09	2/065 SYA_RAIL BREAK 1699W D.de LANGE	SYBRAND - DALESIDE
201137511	2005/05/09	2/071 KPF_RAIL BREAK No.1 M/L EUGENE	KLIPDRIF
201137427	2005/05/10	2/078 PHP_RAIL BREAK P.BRUIN	PAARLSHOOP
201137649	2005/05/13	2/101 MSD RAILBREAK(EUGENE)	MICHAELSRAAD
201140701	2005/05/18	2/153 KZ YARD R/BREAK (DE BRUIN	KASERNE
201142605	2005/05/22	2/173 MSD BROKEN RAIL KM26-16-27-1 KHEKO	MICHAELSRAAD
201142576	2005/05/23	2/200 RTV BROKEN RAIL KM22/9 KHEKORE	RAATHSVLEI
201142585	2005/05/25	2/213 LL R/BREAK YARD (DE BRUIN)	LANGLAAGTE UP
201142730	2005/05/27	2/230 VER W4619 R/BREAK (EUGENE)	VEREENIGING
201142715	2005/05/28	2/235 SY BROKEN RAIL KM 33/18 (DE BRUIN)	SYBRAND - DALESIDE
201145519	2005/05/29	2/242 YKZ BROKEN RAIL (MOENG)	KASERNE
201145523	2005/05/29	2/243 HUP R/BREAK KM59/11(EUGENE)	HOUTHEUWEL
201145417	2005/06/01	2/006 LL_RAIL BREAK/88W P. de BRUIN	LANGLAAGTE OLD
201145593	2005/06/01	2/005 BRR_RAIL BREAK CONTR.53 M.MOENG	BRAAMFONTEIN NORTH
201145615	2005/06/02	2/22 LL W87 R/BREAK (DE BRUIN)	LANGLAAGTE OTHER
201147762	2005/06/05	2/50 RTV R/BREAK KM20/12(ANDRIES)	RAATHSVLEI
201147751	2005/06/06	2/55 FCR BROKEN RAIL KM 38/15 (MAILA)	FOCHVILLE
201147961	2005/06/06	2/61 JU BROKEN RAIL KM 5/20 (SIDEMELA)	JUPITER
201147808	2005/06/07	2/68 RTV Km23/13 B/RAIL (ANDRIES)	RAATHSVLEI
201147793	2005/06/07	2/70 YLL BROKEN RAIL (85-87W) (DE BRUIN)	LANGLAAGTE OTHER
201147928	2005/06/07	2/72 RN BROKEN RAIL KM 55/3 (TSHISEVHE)	REDAN
201148035	2005/06/07	2/76 ERD2UNKM3 BROKEN RAIL KM 3/4	ROOIKOP - UNION KM3
201148045	2005/06/11	2/106 KZW BROKEN RAIL (159W) (SIDEMELA)	KASERNE WEST
201150263	2005/06/12	2/118 LL_RAIL BREAK HOLLYWOOD P.de BRUIN	LANGLAAGTE HOLLYWOOD
201149811	2005/06/13	2/124 SBG BROKEN RAIL (E. KEKANE)	SASOLBURG
201149904	2005/06/15	2/142 ID Km2/8A B/RAIL (SIDIMELA)	INDIA
201156042	2005/06/20	2/181 KPF BROKEN RAIL KM64/13A ANDRIES	KLIPDRIF
201157530	2005/06/21	2/190 EFT BROKEN RAIL (ROOIVAL) FAUGHT	ELANDSFONTEIN

201157516	2005/06/22	2/201 BRR BROKEN RAIL KM21/09 DE BRUIN	LANGLAAGTE UP
201156029	2005/06/22	2/208 KPF BROKEN RAIL KM64/12-13 MAILA	KLIPDRIF
201155475	2005/06/25	2/235 KPR_BROKEN RAIL KM62/6A. BREYTENB	KLIPDRIF
201155379	2005/06/25	2/237 LFN_BROKEN RAIL.KM66/8. RAKOTO	LEEUHOF CTC
201156263	2005/06/26	2/244 ALY2DCV Km60/15 B/RAIL (KHEKORE)	VEREENIGING-SUID - LEEUHOF CTC
201156052	2005/06/26	2/245 RD Km3/13 B/RAIL (BRITS)	ROOIKOP
201156013	2005/06/26	2/247 DES BROKEN RAIL KM36/12 ZONDI	DALESIDE
201156062	2005/06/27	2/250 LF BROKEN RAIL (KEKANE)	LEEUHOF CTC
	2005/06/28	2/265 VBL YARD BROKEN RAIL (MYLA)	VEREENIGING-SUID - LEEUHOF CTC
201156085	2005/06/30	02/284 GMR BROKEN RAIL TSHISEVHE	GERMISTON EAST CABIN - ELSBURG
201156778	2005/07/01	2/05 RN BROKEN RAIL KM54/1 TSHISEVHE	REDAN
201156341	2005/07/02	2/09 MTN BROKEN RAIL - STATION TSHISEVHE	MEYERTON
201158050	2005/07/04	2/26 VFT Km16/10-11 R/BREAK (SIDIMELA)	VOëLFONTEIN
201158021	2005/07/05	2/33 VER Km68/12-13 B/RAIL (KHEKORE)	VEREENIGING-SUID - LEEUHOF CTC
201158041	2005/07/08	2/53 EKF BROKEN RAIL KM 55/5 (EUGENE)	ENSELSPRUIT-KLIPDRIF
	2005/07/10	2/59 LEFN BROKEN RAIL KM 66/7 (RAKOTO)	LEEUHOF NOORD
201162698	2005/07/10	2/59 LEFN BROKEN RAIL KM 66/7 (RAKOTO)	LEEUHOF NOORD
201160419	2005/07/13	2/103 DAA2WTL BROKEN RAIL KM6/13 SIDEMEL	WATTLES
201160385	2005/07/14	2/111 EBG BROKEN RAIL (TSHISEVHE)	ELSBURG
201162842	2005/07/20	2/164 ISO BROKEN RAIL KM 11,179	JOHANNESBURG
201162838	2005/07/20	2/168 MTN BROKEN RAIL (TSHISEVHE)	MEYERTON
201167276	2005/07/29	2/239 EDCV2VER BROKEN RAIL KM 60/15	VEREENIGING
201170756	2005/08/04	2/27 LL Km5/1 B/RAIL (SIDEMELA)	LANGLAAGTE OTHER
201170736	2005/08/07	2/46 RTV BROKEN RAIL KM23/3 RAKOTO	RAATHSVLEI
201174229	2005/08/15	2/95 LF2BJR Km63/5 B/RAIL (KEKANA)	LEEUHOF CTC - VEREENIGING
201175518	2005/08/15	2/96 MTN B/RAIL YARD (BRITS)	MEYERTON
201180179	2005/08/28	2/170 RDP B/RAIL KM5/2 TSHISEVHE	ROOIKOP
201183191	2005/08/29	2/178 ESBG2WHK BROKEN RAIL KM 26/12-13	SASOLBURG - WOLWEHOEK
201180136	2005/08/31	2/205 KPF Km65/9A B/RAIL (MAILA)	KLIPDRIF
	2005/08/31	2/211 CALL OUTBUT THERE WAS NO BRKEN RAI	GERMISTON GOODS CABIN
201180157	2005/09/01	2/10 EHUP2LF BROKEN RAIL KM 62/8 (MAILA)	HOUTHEUWEL - LEEUHOF CTC
201182778	2005/09/06	2/41 ISO Km10/736 B/RAIL (ZONDI)	JOHANNESBURG
201185375	2005/09/11	2/68 YGMR BROKEN RAIL (NAIDOO)	GERMISTON
201184998	2005/09/14	2/104 SBG BROKEN RAIL & SLEEPERS -	SASOLBURG

		YARD	
201188761	2005/09/18	2/124 KZM BROKEN RAIL (TSHISEVHE)	KASERNE MARK
201199256	2005/10/12	2/78 YLL BROKEN RAIL (DE BRUIN)	LANGLAAGTE OTHER
201199005	2005/10/15	2/100 BKG BROKEN RAIL (MAILA)	BLOEKOMHEUNING
201203016	2005/10/17	2/113 SY Km33/16 B/RAIL (SIDEMELA)	SYBRAND
201217418	2005/11/10	2/75 LF BROKEN RAIL E KHECHANE	LEEUHOF NOORD
201221736	2005/11/18	2/147 GMRC2GMRW B/RAIL M/P3 (ZONDI)	GERMISTON - GERMISTON WEST CABIN
201227275	2005/12/02	2/04 YLL Km19/8 B/RAIL (De BRUIN	LANGLAAGTE OTHER
201238050	2005/12/26	2/174 KZM BROKEN RAIL J. SIDEMELA	KASERNE MARK
201238065	2006/01/05	2/34 HOK R/BREAK KM43,7(NAIDOO)	HENLEY ON KLIP
201239174	2006/01/09	2/64 HOK BROKEN RAIL KM 43/7 (BRITS)	HENLEY ON KLIP
201289090	2006/01/13	2/104 RN Km54/8 B/RAIL (BRITS)	REDAN
201242114	2006/01/15	2/118 YLL BROKEN RAIL (MOENG)	LANGLAAGTE OTHER
201241562	2006/01/15	2/119 RN BROKEN RAIL KM 53/4 (POHOTONA)	REDAN - VEREENIGING
201241894	2006/01/19	2/157 ISO B/RAIL ON Rd.13 (POHOTONA)	JOHANNESBURG
201245047	2006/01/22	2/169 RN BROKEN RAIL M. POHOTONA	REDAN
201245005	2006/01/22	2/172 BRR B/RAIL Rd.7 CONT.39 (MOENG)	BRAAMFONTEIN B SID
201249497	2006/01/30	2/240 EBG BROKEN RAIL KM 6/8 (SIDEMELA)	ELSBURG - WATTLES
201249746	2006/01/30	2/243 BROKEN stock RAIL (SIDEMELA)	JOHANNESBURG
201252914	2006/02/05	2/40 JU BROKEN RAIL (MOENG)	JUPITER - KASERNE MARK
	2006/02/05	2/42 EDCV2VER B/J CLOSED KM 69/16-17	DUNCANVILLE
201255555	2006/02/12	2/97 RN Km54/5 B/RAIL (TSHISEVHE)	REDAN
201255464	2006/02/13	2/104 EMSD2FCR BROKEN RAIL KM 36/4	MICHAELSRAAD - FOCHVILLE
201255468	2006/02/13	2/106 EBKG2RTV BROKEN RAIL KM 16/16-17	BLOEKOMHEUNING - RAATHSVLEI
201255492	2006/02/14	2/121 YLL BROKEN RAIL No5 ROAD DE BRUIN	LANGLAAGTE OTHER
201257547	2006/02/20	2/174 GMRE Km2/4 B/RAIL (MOENG)	GERMISTON EAST CABIN - ELSBURG
201262018	2006/02/26	01/223 GMR BROKEN CHECK RAIL(POHOTONA	GERMISTON - GERMISTON WEST CABIN
201262032	2006/02/27	2/231 KPF Km64/13 B/RAIL (KHECHANE)	KLIPDRIF
201264678	2006/03/02	2/19 KZ_BROKEN RAIL. SEDIMELA	KASERNE
201267417	2006/03/17	2/159 YISO RAILS DAMAGED (TSHISEVHE)	JOHANNESBURG
201275263	2006/03/27	2/224 DALLAS BROKEN RAIL M. MOENG	ELSBURG - WATTLES
201279498	2006/04/03	2/08 HUP2LF Km59/17 B/RAIL (KHECHANE)	HOUTHEUWEL - LEEUHOF CTC
201279467	2006/04/04	2/16 RTV Km20/9 B/RAIL ON 303W (HERMAN)	RAATHSVLEI
201279918	2006/04/04	2/21 CTD BROKEN RAIL (SIDEMELA)	CITY DEEP
201279516	2006/04/05	2/24 KPF BROKEN RAIL E. KHECHANE	KLIPDRIF
201279930	2006/04/10	2/50 LL BROKEN RAIL UPYARD M.MOENG	LANGLAAGTE UP

201279882	2006/04/10	2/55 LL BROKEN RAIL M MOENG	LANGLAAGTE OTHER
201279455	2006/04/12	2/62 LHF BROKEN RAIL E.KCHECHANE	LEEUHOF CTC
201279448	2006/04/13	2/72 MTN BROKEN RAIL KM 47/7-8 KHECHANE	MEYERTON
201287385	2006/04/23	2/127 HUP BROKEN RAIL KM 60/11(MAILA	HOUTHEUWEL
201287383	2006/04/23	2/132 EST-FCR BROKEN RAIL E. KHECHANE	FOCHVILLE WEST - ENSELSPRUIT
201287269	2006/04/24	2/138 EKF2KPF Km59/13-14 B/RAIL (MAILA)	ENSELSPRUIT-KLIPDRIF - KLIPDRIF
201287387	2006/04/24	2/143 RN Km55/6 B/RAIL (TSHISEVE)	REDAN
201287253	2006/04/28	2/166 MSD Km29/8-8A B/RAIL (KHECHANE)	MICHAELSRAAD
201287186	2006/04/28	2/168 UN BROKEN RAIL (TSHISEVHE)	UNION
201287419	2006/04/29	2/172 KZW BROKEN RAIL KM 9/9 (SIDEMELA)	KASERNE WEST
201287180	2006/04/29	2/173 UN BROKEN RAIL KM 0,506 (TSHISEVHE	UNION
201287411	2006/04/29	2/174 HUP BROKEN RAIL KM 59/12 (KHECHANE	HOUTHEUWEL - LEEUHOF CTC
201287027	2006/04/30	2/183 VDB BROKEN RAIL KM 3/8-10 (MAILA)	VANDERBIJL
201287154	2006/05/01	2/1 ELS-DAA BROKEN RAIL T. TSHISEVHE	ELSBURG - WATTLES
201287278	2006/05/01	2/10 YLEF BROKEN RAIL (MAILA)	LEEUHOF CTC
201287391	2006/05/02	2/13 MTN BROKEN RAIL KM 49/9 (TSHISEVHE)	MEYERTON
201287045	2006/05/03	2/35 ISO BROKEN RAIL J.SIDEMELA	JOHANNESBURG
201287430	2006/05/03	2/36 NT BROKEN RAIL J. SIDEMELA	NATALSPRUIT
201287059	2006/05/05	2/51 ISO B/RAIL@188 (T. TSHISEVHE)	JOHANNESBURG
201287256	2006/05/05	2/53 RTV BROKEN RAIL A. MAILA	RAATHSVLEI
201289005	2006/05/08	2/68 SY BROKEN RAIL 1619W KM 33/11	SYBRAND
201288984	2006/05/09	2/82 repair broken rail (KHECHA	TARENTAAL
201288994	2006/05/10	2/83 KPF Km64/13 B/RAIL (KHECHANE)	KLIPDRIF
201289520	2006/05/11	2/91 ISO B/RAIL Km2/8-9 Rd.13 (TSHISEVHE	JOHANNESBURG
201289512	2006/05/11	2/96 ISO BROKEN RAIL T. TSHIVEVHE	JOHANNESBURG
201291872	2006/05/14	2/110 SBG BROKEN RAIL S. RAMOLOLA	SASOLBURG
201291895	2006/05/16	2/122 KPF BROKEN RAIL A. MAILA	KLIPDRIF
201291754	2006/05/17	2/132 KPF Km65/10 B/RAIL (MAILA)	KLIPDRIF
201291762	2006/05/17	2/136 DUN2ALY Km60/14 B/RAIL (KEKANE)	VEREENIGING
201296344	2006/05/22	2/171 JU Km5/12 B/RAIL (MOENG)	JUPITER
201296366	2006/05/23	2/186 GMR BROKEN RAIL J. SIDEMELA	GERMISTON
201296375	2006/05/23	2/190 RD BROKEN RAIL J. SIDEMELA	ROOIKOP
201296360	2006/05/23	2/194 ERN2ALY BROKEN RAIL KM 58/10-11	REDAN - ALLOY
201296270	2006/05/24	2/198 RN BROKEN RAIL M. POHOTONA	REDAN
201296243	2006/05/25	2/201 EHUP2LF BROKEN RAIL KM 59/16	HOUTHEUWEL - LEEUHOF CTC

201296274	2006/05/27	2/224 ELS Km4/26 B/RAIL (POHOTONA)	GERMISTON EAST CABIN - ELSBURG
201299040	2006/05/28	2/233 DCV Km60/14 B/RAIL (KECHANE)	DUNCANVILLE
201299018	2006/05/28	2/234 PHP Km1/11 B/RAIL (KLYNSMITH)	PAARLSHOOP
201299435	2006/05/29	2/238 YSBG BROKEN RAIL (MAILA)	SASOLBURG
201299028	2006/05/30	2/257 VER BROKEN RAIL KM 69/12	VEREENIGING
201299460	2006/06/02	2/11 RTV BROKEN RAIL A. MAILA	RAATHSVLEI
201301444	2006/06/04	2/25 RD BROKEN RAIL T. TSHISEVHE	ROOIKOP
201299830	2006/06/05	2/37 MTN/RN R/BREAK KM52(MOENG)	MEYERTON
201301494	2006/06/08	2/67 EHUP2BKG BROKEN RAIL KM 4/5-6	HOUTHEUWEL - BLOEKOMHEUNING
201301179	2006/06/09	2/70 EHUP2BKG BROKEN RAIL KM 4/6	HOUTHEUWEL - BLOEKOMHEUNING
201301391	2006/06/10	2/80 ESMB2WTI BROKEN RAIL KM 15/11-12	SUURBEKOM - WESTONARIA
201299460	2006/06/11	2/11 RTV BROKEN RAIL A. MAILA	RAATHSVLEI
201302975	2006/06/17	2/125 LEFN BROKEN RAIL A. RAKOTO	LEEUHOF NOORD
201303156	2006/06/17	2/133 ver BOKEN RAIL A. RAKOTO	LEEUHOF CTC - VEREENIGING
201310050	2006/06/18	2/140 ISO BROKEN RAIL S. NAIDOO	JOHANNESBURG
201305216	2006/06/19	2/158 RN BROKEN RAIL KM 54/7 (SIDEMELA)	REDAN
201305222	2006/06/22	2/186 ELS BROKEN RAIL KM5/16 POHOTONA	ELSBURG
201305184	2006/06/23	2/204 WST BROKEN RAIL KM19/1 POHOTONA	WESTONARIA
201305172	2006/06/24	2/206 LEFN BROKEN RAIL A. MAILA	LEEUHOF NOORD
201309368	2006/06/26	2/224 GMR BROKEN RAIL KM218/6 TEREBLANCH	INDIA
201310094	2006/06/27	2/228 TEL-KPF BROKEN RAIL E. KHECHANE	KLIPDRIF - TARENTAAL
201310913	2006/06/29	2/243 RTV BROKEN RAIL IKM 20/6 (RAKOTO)	BLOEKOMHEUNING - RAATHSVLEI
201309791	2006/06/30	2/248 VER BROKEN RAIL KM 59/9 (SIDEMELA)	VEREENIGING
201310118	2006/07/04	2/33 UN BROKEN RAIL M. MOENG	UNION
201310419	2006/07/06	2/44 RTV B/RAIL Km20/10 (E.KHECHANE)	RAATHSVLEI
201310411	2006/07/06	2/53 KPF_KM66/5 B/RAIL. A. RAKOTU	KLIPDRIF
201311625	2006/07/09	2/73 KZ BROKEN RAIL SIDIMELA	KASERNE WEST
201311800	2006/07/10	2/80 DES BROKEN RAIL S. NAIDOO	DALESIDE
201311818	2006/07/11	2/105 HUP2LEF BROKEN RAIL (A.MAILA)	HOUTHEUWEL - LEEUHOF CTC
201314446	2006/07/17	2/148 LHF B/RAIL NO4 YARD KECHAVE	LEEUHOF CTC
	2006/07/18	2/161 VER BROKEN RAIL KM60/16 HERMAN	VEREENIGING
201314472	2006/07/19	2/170 ISO BROKEN RAIL KM2/12-13 MOENG	JOHANNESBURG
201314459	2006/07/21	2/185 EKF BROKEN RAIL KM 55/3 (KHECHANE)	ENSELSPRUIT-KLIPDRIF

201315297	2006/07/23	2/195 NT_BROKEN RAIL KM13/16. POHOTONA	NATALSPRUIT
201316072	2006/07/24	2/204 LEFN BROKEN RAIL _ RAKOTU	ISCOR SIDING - LEEUHOF
201316140	2006/07/28	2/238 RTV/MSD BROKEN RAIL _RAKOTU	RAATHSVLEI - MICHAELSRAAD
201316055	2006/07/30	2/245 BKG BROKEN RAIL _ RAKOTU	BLOEKOMHEUNING
201318076	2006/07/30	2/248 UN BROKEN RAIL KM15/11 BRITS	UNION
201318061	2006/07/31	2/258 YISO BROKEN RAIL KM 2/12 (SIDEMELA	JOHANNESBURG
201318039	2006/08/01	2/02 YISO BROKEN RAIL KM 2/18 (SIDEMELA)	JOHANNESBURG
201318020	2006/08/04	2/19 UN BROKEN RAIL _ SEDIMELA	UNION
201322192	2006/08/13	2/56 YRPR BROKEN RAIL (DE BRUIN)	ROODEPOORT
201321622	2006/08/14	2/62 SBG BROKEN RAIL _ RAKOTU	SASOLBURG
201321699	2006/08/16	2/85 EBKG2RTV BROKEN RAIL KM 16/11-12	BLOEKOMHEUNING - RAATHSVLEI
201324158	2006/08/18	2/107 HOK BROKEN RAIL KM40/7 DE LANGE	HENLEY ON KLIP
201322666	2006/08/19	2/113 DES B/RAIL KM37/8 PAUL	DALESIDE
201324114	2006/08/24	2/162 SBG BROKEN RAIL A. MAILA	SASOLBURG
201325915	2006/08/28	2/184 LHF B/RAIL NO2 KM64/3 KECHANE	LEEUHOF NOORD
201325926	2006/08/28	2/189 VDB REPAIR BROKEN RAIL KM3/16	HOUTHEUWEL
	2006/09/12	2/78 ERTV2MSD BROKEN RAIL KM 22/15-17	RAATHSVLEI - MICHAELSRAAD
201335688	2006/09/25	2/186 SBG BROKEN RAIL (RAKOTU)	SASOLBURG
201335670	2006/09/26	2/191 GMRG BROKEN RAIL (BRITS)	GERMISTON WEST CABIN - DRIEHOEK
	2006/09/27	2/203 GMRG BROKEN RAIL (COETZEE)	GERMISTON WEST CABIN - DRIEHOEK
201340439	2006/10/02	2/13 GMRW BROKEN RAIL KM 0/5 POHOTONA	GERMISTON WEST CABIN
201343371	2006/10/11	2/100 ISO RAIL FAULTY BRITS	JOHANNESBURG
201343721	2006/10/13	2/123 YCTD BROKEN RAIL (MOENG)	CITY DEEP
201343724	2006/10/14	2/128 RTV BROKEN RAIL KM 20/9-10 RAKOTO	RAATHSVLEI
201346359	2006/10/14	2/131 YBRR BROKEN RAIL (33W) (MOENG)	BRAAMFONTEIN NORTH
201346077	2006/10/15	2/139 YSBG RUSTED RAIL (RAKOTO)	SASOLBURG
201346401	2006/10/20	2/186 UN BROKEN RAIL S. NAIDOO	UNION
201349811	2006/10/25	2/222 GMRS BROKEN RAIL J. SIDEMELA	GERMISTON GOODS CABIN
201359399	2006/11/05	2/41 YLF BROKEN RAIL (KHECHANE)	LEEUHOF CTC
201363056	2006/11/12	2/81 DCV BROKEN RAIL H.BREYTENBATCH	DUNCANVILLE
201363146	2006/11/17	2/119 B/RAIL@KM1/11 (POHOTONA)	INDIA
201370148	2006/11/20	2/129 KZ BROKEN RAIL DE BRUIN	KASERNE
201367701	2006/11/23	2/156 SBG B/RAIL KM 22/5-6 (A RAKOTO)	SASOLBURG
201367693	2006/11/23	2/158 LFN B/RAIL (A RAKOTO)	LEEUHOF CTC
201367728	2006/11/25	2/170 DES BROKEN RAIL J. SIDEMELA	DALESIDE
201369913	2006/11/26	2/180 RTV BROKEN RAIL E. KHECHANE	RAATHSVLEI

201369920	2006/11/26	2/181 LEFN BROKEN RAIL E. KHECHANE	LEEUHOF NOORD
201369903	2006/11/29	2/195 LEFN B/RAIL@61#2L (E. KHECHANE)	LEEUHOF NOORD
201369904	2006/11/30	2/207 EST BROKEN RAIL E.KHECHANE	ENSELSPRUIT
201371853	2006/12/07	2/043 HUP_CRACKED RAIL H.BREYTENBACH	HOUTHEUWEL
201373712	2006/12/08	2/048 BRR_38W CRACKED RAIL M. MOENG	BRAAMFONTEIN NORTH
201373672	2006/12/14	2/99 BOKSBURG BROKEN RAIL KM AG9/700-758	BOKSBURG-OOS
201375212	2006/12/19	2/129 VERS B/RAIL@1/12 (A. RAKOTO)	VEREENIGING-SUID
201375221	2006/12/24	2/163 LEF BROKEN RAIL E. KHECHANE	LEEUHOF CTC
201378684	2007/01/05	2/30 DES BROKEN RAIL KM 37/8 (SIDEMELA)	DALESIDE
201378659	2007/01/05	2/33 YLEF NOT BROKEN RAIL (KHECHANE)	LEEUHOF CTC
201378687	2007/01/06	2/35 UN BROKEN RAIL KM 0/12 (SIDEMELA)	UNION - ROOIKOP
201382857	2007/01/16	2/95 GMRG BROKEN RAIL KM 1/1 (BRITS)	GERMISTON GOODS CABIN
201381967	2007/01/18	2/115 VERS-LEFS BROKEN RAIL A. RAKOTO	VEREENIGING-SUID - LEEUHOF CTC
201384867	2007/01/25	2/174 DES B/RAIL KM37/2 (MAILULA)	DALESIDE
201387181	2007/02/02	2/11 VER W4833 R/BREAK (RAKOTO)	VEREENIGING
201390367	2007/02/09	2/74 ID BROKEN RAIL M. POHOTONA	INDIA
201393240	2007/02/14	2/112 HOK BROKEN RAIL S. NDHLELA	HENLEY ON KLIP
201392898	2007/02/14	2/116 KPF R/BREAK KM64(ALBERT)	KLIPDRIF
201393321	2007/02/14	2/119 VER BROKEN RAIL A. RAKOTO	VEREENIGING
201392890	2007/02/17	02/129 VER BROKEN RAIL A RAKOTO	VEREENIGING
201393310	2007/02/17	02/130 NT BROKEN RAIL S.NDHLELA	NATALSPRUIT
201395773	2007/02/21	2/166 JU BROKEN RAIL J. BRITS	JUPITER
201403479	2007/03/04	2/20 ISO YARD RUSTED RAIL	JOHANNESBURG
	2007/03/06	2/37 KN R/BREAK KM106(JOE)	KAALFONTEIN
201407941	2007/03/18	2/133 GMRG R/BREAK (SIDIMELA)	GERMISTON - GERMISTON EAST CABIN
201410836	2007/03/25	2/166 EKF R/BREAK KM56(GODFREY)	ENSELSPRUIT-KLIPDRIF
201414512	2007/04/02	2/21 RN BROKEN RAIL KM 53/4 (MOENG)	REDAN
201414531	2007/04/04	2/36 RN_BROKEN RAIL KM54/3. E. MOENG	REDAN
201416620	2007/04/08	2/58 EID2JU BROKEN RAIL KM 0/19-20	INDIA - JUPITER
201417992	2007/04/10	2/69 RTS BROKEN RAIL H.BREYTENBACH	RAATHSVLEI
201416556	2007/04/12	2/90 KZ BROKEN STOCK RAIL	KASERNE
201427468	2007/04/15	2/105 RTV R/BREAK KM17(DESMONT)	RAATHSVLEI
201419920	2007/04/18	2/125 RN BROKEN RAIL KM 53/1 (NDHLELA)	REDAN
	2007/04/18	2/126 YKR BROKEN RAIL (SIDEMELA)	KLIPRIVIER
201419999	2007/04/19	2/129 LEFN W6369 R/BREAK (ALBERT)	LEEUHOF NOORD
201419921	2007/04/19	2/131 EELS2WTL BROKEN RAIL KM 5/14	ELSBURG - WATTLES
201427480	2007/04/23	2/163 MTN BROKEN RAIL KM 48/7 POHOTONA	MEYERTON

201426937	2007/04/23	2/165 A BROKEN RAIL A. RAKOTO	REDAN - ALLOY
201430822	2007/04/25	2/189 SBG R/BREAK YARD(HERMAN)	SASOLBURG
1001257628	2008/03/23	2/134 DHK2LUD BROKEN RAIL JOE	CITY DEEP
1001257751	2008/03/23	2/135 SED BROKEN RAIL (J.MBANGA)	VOëLFONTEIN
1001257120	2008/03/21	2/126 DRR BROKEN RAIL (J.SIDEMELA)	HOUTHEUWEL - LEEUHOF CTC
1001256632	2008/03/19	2/117 CTA W641 R/BREAK (LINDA)	DRIEHOEK
1001256200	2008/03/18	2/107 RN R/BREAK KM54(SIDIMELA)	ELSBURG
1001255447	2008/03/16	2/95 ARM BROKEN RAIL L. SIKAMPULA	KLIPDRIF
1001255441	2008/03/16	2/94 BRR BROKEN RAIL S. TSHISWAISE	KLIPDRIF
1001255341	2008/03/15	2/91 ISO BROKEN RAIL S. TSHISWAISE	LANGLAAGTE OTHER
1001255135	2008/03/14	2/87 WEL BROKEN RAIL S. MOHLALA	WATTLES
1001254651	2008/03/12	2/75 SYB BROKEN RAIL - S TSHISWAISE	ENSELSPRUIT-KLIPDRIF - KLIPDRIF
1001253969	2008/03/10	2/63 KPF R/BREAK KM64(GODFREY/ALBE	INDIA
1001253863	2008/03/10	2/54 ALY B/RAIL (SHANDUKANI)	ELANDSFONTEIN - JOHANNESBURG
1001253242	2008/03/09	2/45 RTV R/BREAK KM19(SHIBAMBO)	KASERNE
1001251187	2008/03/02	2/07 REPAI BROKEN RAIL (L.MTSWENI)	DALESIDE
1001250958	2008/03/01	2/01 EST BROKEN RAIL (D.KOKOME)	UNION
1001250383	2008/02/27	2/166 DES BROKEN RAIL PM. MAILULA	DALESIDE
1001250066	2008/02/26	2/163 LEF BROKEN RAIL A RAKOTO	KLIPDRIF - TARENTAAL
1001249479	2008/02/25	2/151 LEF BROKEN RAIL D KOKOME	RAATHSVLEI
1001249846	2008/02/25	2/159 RDR BROKEN RAIL S NDHLELA	SASOLBURG
1001248593	2008/02/22	2/15 IS BROKEN RAIL SIDEMELA	FOCHVILLE
1001248482	2008/02/22	2/139 UN BROKEN RAIL J. SIDEMELA	SYBRAND - DALESIDE
1001245043	2008/02/12	2/88 SED BROKEN RAIL J MBANGA	KLIPDRIF
1001244444	2008/02/11	2/71 FCR BROKEN RAIL A. RAKOTO	PAARLSHOOP
1001241963	2008/02/03	2/11 EST/FCR BROKEN RAIL D. KOKOME	MICHAELSRAAD
1001241215	2008/02/01	2/177 EST_RAIL BREAK 48 Kg RAIL MHLAPO	KASERNE
1001238082	2008/01/21	2/110 ABD BROKEN RAIL M. THWALA	MICHAELSRAAD
1001236576	2008/01/16	2/85 KUTALO B/RAIL (S NDHLELA)	RAATHSVLEI
1001236709	2008/01/16	2/90 PHP B/RAIL (MAILULA)	LANGLAAGTE UP
1001233861	2008/01/08	2/43 ARM BROKEN RAIL (LINDA SIKAMPULA)	VEREENIGING
1001233219	2008/01/06	2/29 YBRR B/RAIL (MOENG)	SYBRAND - DALESIDE
1001230730	2007/12/27	2/169 WEL B/RAIL (NICO BALOYI)	KASERNE
1001226400	2007/12/10	2/57 ARM BROKEN RAIL L. SIKAMPULA	HOUTHEUWEL
1001224506	2007/12/05	2/26 VBD-BKG BROKEN RAIL H.BREITENBACH	LANGLAAGTE OLD
1001222495	2007/11/29	2/183 MTN BROKEN RAIL (S.NDLELA)	HOUTHEUWEL - LEEUHOF CTC
1001221484	2007/11/26	2/166 BKG2HUP BROKEN RAIL	LEEUHOF CTC

		G.SHIBAMBO	
1001219333	2007/11/19	2/114 DM BROKEN RAIL M.THWALA	VEREENIGING
1001219374	2007/11/19	2/116 SY NO BROKEN RAIL L. SIKAMPULE	JOHANNESBURG
1001218941	2007/11/18	2/110 SED BROKEN RAIL CROWN LINDA	ENSELSPRUIT-KLIPDRIF
1001216699	2007/11/12	2/74 SED BROKEN RAIL J. MBANGA	NATALSPRUIT
1001216907	2007/11/12	2/78 DRY/ARG BROKEN RAIL T.SIBEKO	ISCOR SIDING - LEEUHOF
1001215907	2007/11/10	2/59 FCR/MSD BROKEN RAIL (G. SHIBAMBO	RAATHSVLEI - MICHAELSRAAD
1001216196	2007/11/10	2/61 REPAIR BROKEN RAIL TSHIVULA	BLOEKOMHEUNING
1001216030	2007/11/10	2/60 ABD-ARG BROKEN RAIL J. BAHULA	UNION
1001215733	2007/11/09	2/58 WIK BROKEN RAIL 221W S. MOHLALA	JOHANNESBURG
1001215732	2007/11/09	2/57 DM BROKEN RAIL K. MATHEBULA	JOHANNESBURG
1001213070	2007/11/01	2/3 SED BROKEN RAIL JERRY MZI	UNION
1001212956	2007/10/31	2/235 CTB BROKEN RAIL J. MBANGA	ROODEPOORT
1001211269	2007/10/27	2/198 DMS 221W BROKEN RAIL (N.BALOYI)	SASOLBURG
1001209184	2007/10/21	2/147 CTD BROKEN RAIL MJ. TSHIVULA	BLOEKOMHEUNING - RAATHSVLEI
1001209177	2007/10/20	2/145 LLA BROKEN RAIL E. KHECHANE	HENLEY ON KLIP
1001208999	2007/10/20	2/144 SPR BROKEN RAIL NJICO	DALESIDE
1001208213	2007/10/17	2/132 KZ BROKEN RAIL MAILULA	SASOLBURG
1001206524	2007/10/13	2/92 SPR BROKEN RAIL N BALOYI	LEEUHOF NOORD
1001203733	2007/10/05	2/26 TT NOTHING RAIL BREAK JIMMY	HOUTHEUWEL
1001200879	2007/09/25	2/208 KZW B/RAIL (MAILULA)	RAATHSVLEI - MICHAELSRAAD
1001200746	2007/09/25	2/205 LM BROKEN RAIL P.M. MAILULA	SASOLBURG
1001200226	2007/09/22	2/181 WIK-VAN BROKEN RAIL S. MOHLALA	GERMISTON WEST CABIN - DRIEHOEK
1001199293	2007/09/19	2/155 KPF BROKEN RAL KM65/9 D. KOKOME	GERMISTON WEST CABIN - DRIEHOEK
1001197906	2007/09/15	2/132 KAZ B/RAIL (MOENG)	GERMISTON WEST CABIN
1001197584	2007/09/15	2/127 YLL BROKEN RAIL (TSHISWAISE)	JOHANNESBURG
1001197349	2007/09/14	2/121 ROV B/RAIL KM8/2-3 (S MOHLALA)	CITY DEEP
1001197369	2007/09/14	2/123 ARM B/RAIL (S MOHLALA)	RAATHSVLEI
1001197393	2007/09/14	2/124 YBR B/RAIL (LEON)	BRAAMFONTEIN NORTH
1001197181	2007/09/13	2/118 ROV B/RAIL KM8/8 (S MOHLALA)	SASOLBURG
1001197109	2007/09/13	2/114 BROKEN RAIL (TSHISWAISE)	UNION
1001196943	2007/09/12	2/109 YBRR B/RAIL (S TSHISWAISE)	GERMISTON GOODS CABIN
1001195793	2007/09/09	2/83 KDL BROKEN RAIL JIMMY	LEEUHOF CTC
1001194708	2007/09/06	2/48 WIK BROKEN RAIL J. MBANGA	DUNCANVILLE
1001194712	2007/09/06	2/52 ZFN BROKEN RAIL J. MBANGA	INDIA
1001194707	2007/09/06	2/47 RN BROKEN RAIL L. MTSWENI	KASERNE
1001194617	2007/09/06	2/46 JU-ID BROKEN RAIL L. MTSWENI	SASOLBURG
1001194346	2007/09/05	2/37 EMV-BKX BROKEN RAIL K.	LEEUHOF CTC

		MATHEBULA	
1001193985	2007/09/04	2/30 DHK-TDG BROKEN RAIL J BHANGA	DALESIDE
1001193803	2007/09/03	2/28 WEL BROKEN RAIL K. MATHEBULA	RAATHSVLEI
1001193737	2007/09/03	02/25 MTN-RN BROKEN RAIL L MTSWENI	LEEUHOF NOORD
1001190753	2007/08/25	02/181 WELA BROKEN RAIL (NJICO)	LEEUHOF NOORD
1001189392	2007/08/21	2/157 VAN R/BREAK KM5,3(JOE)	ENSELSPRUIT
1001189071	2007/08/20	2/145 YKZ R/BREAK (DE BRUIN)	HOUTHEUWEL
1001187599	2007/08/15	2/116 SPR BROKEN RAIL K. MATHEBULA	BRAAMFONTEIN NORTH
1001186997	2007/08/14	2/104 DMS BROKEN RAIL K.MATHEBULA	BOKSBURG-OOS
1001186894	2007/08/13	2/103 GMRG R/BREAK YARD(NDELA)	HOUTHEUWEL - LEEUHOF CTC
1001186559	2007/08/13	2/98 BRR BROKEN RAIL M.J TSHIVULA	LEEUHOF CTC
1001186202	2007/08/12	2/91 DRY BROKEN RAIL KM33/9-10 MATHEBULA	VEREENIGING
1001185798	2007/08/11	2/87 CTD R/BREAK YARD (TSHIVULA)	JOHANNESBURG
1001185552	2007/08/11	2/80 REPAIR BROKEN RAIL J. SIDEMELA	ENSELSPRUIT-KLIPDRIF
1001185410	2007/08/10	2/75 VJ R/BREAK YARD(KOKOME)	NATALSPRUIT
1001184845	2007/08/08	2/64 RD R/BREAK KM5(SISDIMELA)	ISCOR SIDING - LEEUHOF
1001184000	2007/08/06	2/51 WEL NO BROKEN RAIL S. MOHLALA	RAATHSVLEI - MICHAELSRAAD
1001183993	2007/08/06	2/47 MTN GAP IN RAIL J. SIDEMELA	BLOEKOMHEUNING
1001182311	2007/08/02	2/04 REPAIR BROKEN RAIL BREYTENBACH	UNION
1001182489	2007/08/01	2/08 WEL BROKEN RAIL KM 16/20 (THWALA)	JOHANNESBURG
1001181564	2007/07/30	2/234 NT/RDR R/BREAK KM17(EUGENE)	JOHANNESBURG
1001181465	2007/07/29	2/231 DHK R/BREAK KM66(JOE)	UNION
1001181401	2007/07/29	2/230 RN R/BREAK KM53(MTSWENI)	ROODEPOORT
1001180649	2007/07/27	2/215 MTN BROKEN RAIL J. BRITS	SASOLBURG
1001180647	2007/07/27	2/214 GUD-MRE RAIL CUT(BJ9) S. MOHLALA	BLOEKOMHEUNING - RAATHSVLEI
1001180148	2007/07/25	2/197 WIK R/BREAK KM24(SYDNEY)	HENLEY ON KLIP
1001180337	2007/07/25	2/203 EKF BROKEN RAIL H. BREYTENBACH	DALESIDE
1001180330	2007/07/25	2/200 MTN BROKEN RAIL E. KHECHANE	SASOLBURG
1001179236	2007/07/22	2/176 PHP BROKEN RAIL KM 1/14 (MOENG)	LEEUHOF NOORD
1001178247	2007/07/18	2/149 ISO R/BREAK YARD(PAUL)	HOUTHEUWEL
1001178365	2007/07/18	2/156 KPF R/BREAK KM64(GODFREY)	RAATHSVLEI - MICHAELSRAAD
1001177529	2007/07/16	2/130 CTD BROKEN RAIL MJ. TSHIVULA	SASOLBURG

1001177294	2007/07/15	2/126 WEL BROKEN RAIL N. BALOYI	GERMISTON WEST CABIN - DRIEHOEK
1001177298	2007/07/15	2/127 STQ BROKEN RAIL B. NTSHEHI	GERMISTON WEST CABIN - DRIEHOEK
1001176568	2007/07/13	2/113 YBRR BROKEN RAIL (TSHISWAISE)	GERMISTON WEST CABIN
1001176621	2007/07/13	2/117 YBRR BROKEN RAIL (TSHISWAISE)	JOHANNESBURG
1001176178	2007/07/11	2/99 ARM BROKEN RAIL KM 30/3 (SIKAMPULA)	CITY DEEP
1001175576	2007/07/09	2/79 LF BROKEN RAIL D. KOKOME	RAATHSVLEI
1001175439	2007/07/09	2/74 VER BROKEN RAIL D KOKOME	BRAAMFONTEIN NORTH
1001174902	2007/07/08	2/63 WEL BROKEN RAIL (KHUMBULANI)	SASOLBURG
1001174987	2007/07/08	2/64 ZFN_B/RAIL KM46/16. (LINDA)	UNION
1001174131	2007/07/05	2/042 MTN2RD_BROKEN RAIL J.SIDEMELA	GERMISTON GOODS CABIN
1001173899	2007/07/04	2/33 ELF_RAIL BREAK No. 1 M/L JIMMY	LEEUHOF CTC
1001173238	2007/07/02	2/21 DRY BROKEN RAIL KM 34/1 (JIMMY)	DUNCANVILLE
1001172952	2007/07/01	2/11 ARM BROKEN RAIL BARNARD	INDIA
1001172963	2007/07/01	2/12 KDL BROKEN RAIL JIMMY	KASERNE
1001172394	2007/06/30	2/225 MTN/HOK R/BREAK KM44(SIDIMEL	SASOLBURG
1001172140	2007/06/29	2/222 CTA R/BREAK YARD(LINDA)	LEEUHOF CTC
1001172126	2007/06/29	2/216 GMRG R/BREAK KM0(NDLELA)	DALESIDE
1001172134	2007/06/29	2/220 DCV R/BREAK KM69(GODFREY)	RAATHSVLEI
1001171599	2007/06/26	2/205 ARM-WIK BROKEN RAIL L. SIKAMPULA	LEEUHOF NOORD
1001171680	2007/06/26	2/207 EHUO2IS BROKEN RAIL KM 3/2 RAKOTO	LEEUHOF NOORD
1001171167	2007/06/25	2/197 ARG-ABT BROKEN RAIL M. THWALA	ENSELSPRUIT
1001171171	2007/06/25	2/199 WELB BROKEN RAIL M. THWALA	HOUTHEUWEL
1001170899	2007/06/24	2/189 ROV BROKEN RAIL B. NTSHEHI	BRAAMFONTEIN NORTH
1001170315	2007/06/23	2/183 WEL BROKEN RAIL KM 16/13-14	BOKSBURG-OOS
1001170129	2007/06/22	2/181 UN BROKEN RAIL KM 0/14 (SEHLAKO)	LEEUHOF CTC
1001169674	2007/06/20	2/166 VER BROKEN RAIL KM 60/6 BREYTENBAC	DALESIDE
1001168591	2007/06/17	2/136 ELF R/BREAK KM13(KHUMBULANI)	LEEUHOF CTC
1001168739	2007/06/17	2/145 WEL R/BREAK W2277 (NICO)	UNION - ROOIKOP
1001168595	2007/06/17	2/137 DCV/VER R/BREAK KM60(EUGENE)	GERMISTON GOODS CABIN
1001168296	2007/06/16	2/127 KDL BROKEN RAIL KM 58 (MATHEBULA)	VEREENIGING-SUID - LEEUHOF CTC
1001168325	2007/06/16	2/128 EFT BROKEN RAIL J. BRITS	DALESIDE
1001168229	2007/06/15	2/125 ABD BROKEN RAIL K. MATHEBULA	VEREENIGING
1001167791	2007/06/13	2/114 CD BROKEN RAIL P. DE BRUIN	INDIA
1001166764	2007/06/10	2/82 EARM2WIK BROKEN RAIL KM 30,3	HENLEY ON KLIP

1001166768	2007/06/10	2/83 EARM2WIK BROKEN RAIL KM28,11-12	KLIPDRIF
1001166799	2007/06/10	2/84 ECOD2ARM BROKEN RAIL KM 35/11	VEREENIGING
1001166070	2007/06/09	2/66 EST BROKEN RAIL E. KHECHANE	VEREENIGING
1001166108	2007/06/09	2/68 CTA R/BREAK YARD (BARNARD)	NATALSPRUIT
1001166376	2007/06/09	2/74 SY_A RAIL BREAK KM32(ENGELBRECHT)	JUPITER
1001165968	2007/06/08	2/61 RTV/MSD R/BREAK KM26(EUGENE)	JOHANNESBURG
1001165512	2007/06/06	2/47 REPAIR BROKEN RAILS (EUGENE)	KAALFONTEIN
1001165318	2007/06/06	2/42 NT R/BREAK KM13(SHANDU)	GERMISTON - GERMISTON EAST CABIN
1001163901	2007/06/05	2/09 YLL BROKEN RAIL KM 21/6 (MOENG)	ENSELSPRUIT-KLIPDRIF
1001164759	2007/06/04	2/23 CTA B/RAIL ARRIVAL YARD (SYDNEY)	REDAN
1001163321	2007/05/31	2/238 FCR R/BREAK W611 (ALBERT)	REDAN
1001162686	2007/05/29	2/221 SY BROKEN RAIL J. SIDEMELA	INDIA - JUPITER
1001162568	2007/05/28	2/220 WELA R/BREAK YARD(MUSA)	RAATHSVLEI
1001162247	2007/05/27	2/208 WIK R/BREAK KM24,2 (JOE)	KASERNE
1001162109	2007/05/27	2/202 DM R/BREAK KM23,9-10(MUSA)	RAATHSVLEI
1001162207	2007/05/27	2/207 DM R/BREAK KM23,13-14(MUSA)	REDAN
1001162056	2007/05/27	2/198 REPLACING BROKEN RAILLUCKY)	KLIPRIVIER
1001161556	2007/05/26	2/188 RD BROKEN RAIL KM 6/23 (MOENG)	LEEUHOF NOORD
1001161497	2007/05/25	2/185 WEL BROKEN RAIL B. NTENHI	ELSBURG - WATTLES
1001161318	2007/05/24	2/183 RIV BROKEN RAIL B. NTEHNI	MEYERTON
1001161316	2007/05/24	2/182 FCR BROKEN RAIL GODFREY	REDAN - ALLOY
1001160991	2007/05/23	2/176 WIK BROKEN RAIL B. NTEHNI	SASOLBURG
1001161108	2007/05/23	2/181 EARG2ABD BROKEN RAIL KM 44/15-16	CITY DEEP
1001160661	2007/05/22	2/171 ARM BROKEN RAIL KM 30/3-4 (NTENHI)	VOëLFONTEIN
1001160317	2007/05/21	2/159 JU BROKEN RAIL KM 15/4 (MOENG)	HOUTHEUWEL - LEEUHOF CTC
1001159550	2007/05/18	M/138 ABD R/BREAK W221(RAYMOND)	DRIEHOEK
1001159361	2007/05/17	2/127 GMRG R/BREAK KM1/25(NDLEHLA)	ELSBURG
1001159355	2007/05/17	2/126 KZ YARD R/BREAK (DE BRUIN)	KLIPDRIF
1001159341	2007/05/17	2/125 MTN R/BREAK KM45/10(NDLEHLA)	KLIPDRIF
1001159171	2007/05/16	2/118 VAN-ROV B/RAIL Km7/12-13 (MOHLALA	LANGLAAGTE OTHER
1001159145	2007/05/16	2/115 UN B/RAIL @MASTP.0/10(S.NDHLELA	WATTLES
1001158911	2007/05/15	2/99 GRMG BROKEN RAIL J. SIDEMELA	ENSELSPRUIT-KLIPDRIF - KLIPDRIF
1001158658	2007/05/14	2/93 E BROKEN RSIL M. MOENG	INDIA
1001158431	2007/05/13	2/84 COD BROKEN RAIL S. MOHLALA	ELANDSFONTEIN - JOHANNESBURG
1001158479	2007/05/13	2/87 DRY BROKEN RAIL R. DLAMINI	KASERNE

1001158485	2007/05/13	2/89 MTN BROKEN X J. BRITS	DALESIDE
1001158084	2007/05/12	2/74 HUP R/BREAK W2451-2421(HERMAN)	UNION
1001157974	2007/05/11	2/69 PHP BROKEN RAIL KM 19,491 MAILULA	DALESIDE
1001157859	2007/05/10	2/66 DM BROKEN RAIL (KHUMALO)	KLIPDRIF - TARENTAAL
1001157501	2007/05/08	2/57 ZFN/SMD R/BREAKS KM44(JOE)	RAATHSVLEI
1001157380	2007/05/08	2/49 RD R/BREAK YARD (MAILULA)	SASOLBURG
1001157340	2007/05/08	2/47 HOK B/RAIL Km43/7 (BRITZ)	FOCHVILLE
1001157114	2007/05/07	2/35 VAN2WIK Km4/15-16 B/RAIL (MBANGA)	SYBRAND - DALESIDE
1001157127	2007/05/07	2/36 TEL2KPF B/RAIL Km69/6 (BREYTENBACH)	KLIPDRIF
1001157262	2007/05/07	2/43 NT R/BREAK KM3/15(J BRITZ)	PAARLSHOOP
1001155123	2007/04/26	2/194 WIK/ARM R/BREAK KM26(SYDNEY	MICHAELSRAAD
1001158262	2007/04/25	REPAIR BROKEN RAILS /2/182	KASERNE
1001154932	2007/04/25	2/189 SBG R/BREAK YARD(HERMAN)	MICHAELSRAAD
1001154253	2007/04/23	2/163 MTN BROKEN RAIL KM 48/7 POHOTONA	RAATHSVLEI
1001154450	2007/04/23	2/165 A BROKEN RAIL A. RAKOTO	LANGLAAGTE UP
1001158271	2007/04/22	REPAIR BROKEN RAILS 2/158	VEREENIGING
1001153187	2007/04/19	2/129 LEFN W6369 R/BREAK (ALBERT)	SYBRAND - DALESIDE
1001153235	2007/04/19	2/131 EELS2WTL BROKEN RAIL KM 5/14	KASERNE
1001153030	2007/04/18	2/125 RN BROKEN RAIL KM 53/1 (NDHLELA)	HOUTHEUWEL
1001153110	2007/04/18	2/126 YKR BROKEN RAIL (SIDEMELA)	LANGLAAGTE OLD
1001152260	2007/04/15	2/105 RTV R/BREAK KM17(DESMONT)	HOUTHEUWEL - LEEUHOF CTC
1001151103	2007/04/10	2/69 RTS BROKEN RAIL H.BREYTENBACH	LEEUHOF CTC
1001150778	2007/04/08	2/58 EID2JU BROKEN RAIL KM 0/19-20	VEREENIGING
1001149995	2007/04/04	2/36 RN_BROKEN RAIL KM54/3. E. MOENG	JOHANNESBURG
1001149580	2007/04/02	2/21 RN BROKEN RAIL KM 53/4 (MOENG)	ENSELSPRUIT-KLIPDRIF
201310094	2006/06/27	2/228 TEL-KPF BROKEN RAIL E. KHECHANE	NATALSPRUIT
1001224710	2007/12/05	2/28 RPR CRACK ON RAIL M.J THSIVULA	ISCOR SIDING - LEEUHOF
1001205872	2007/10/11	2/84 WEL BROKEN RAIL Km16/14(MATHEBULA)	RAATHSVLEI - MICHAELSRAAD
1001199698	2007/09/21	2/167 MTN BROKEN RAIL KM45/13 E. KHECHAN	BLOEKOMHEUNING
1001195050	2007/09/07	2/57 ARG-ABD NO B/RAIL KHUMBULANI	UNION
1001187904	2007/08/17	2/118 GUD CUT RAILS NO THEFT(SYDNEY)	JOHANNESBURG
1001177299	2007/07/15	2/128 ISO RUSTED RAIL M. SEHLAKO	JOHANNESBURG
1001151682	2007/04/12	2/90 KZ BROKEN STOCK RAIL	UNION

4. SLACK

Order	Date	Description	Description
201111693	2005/03/01	2/006 MTN/RN SLACK KM50/15(ZONDI)	MEYERTON
201111744	2005/03/03	2/27 EMTN2RN SLACK KM 50/9-10 (ZONDI)	MEYERTON - REDAN
201114838	2005/03/13	2/61 BAK SLACK KM33/18(SIDIMELA)	WESTONARIA - BANK
201114816	2005/03/13	2/66 MTN SLACK KM45/13(TAKALANI)	MEYERTON
201116439	2005/03/16	2/104 YKZ SLACK (J CONTROL) (SIDEMELA)	KASERNE
201119219	2005/03/22	2/147 BAK SLACK KM32/18 (SIDIMELA)	WESTONARIA - BANK
201119227	2005/03/22	2/148 WTI SLACK KM18/5(J SIDIMELA	WESTONARIA
201119180	2005/03/22	2/149 GMRG W19 SLACK (JAKES)	GERMISTON GOODS CABIN
201122193	2005/03/27	2/181 EVERS2VJ SLACK KM 2/19-20 (RAKOTO)	VEREENIGING-SUID - VILJOENSDRIF
201122214	2005/03/27	2/183 YCTD SLACK (MOENG)	CITY DEEP
201122224	2005/03/29	2/189 RPR_SLACK ON GOODS LINE de BRUIN	ROODEPOORT PX
201127625	2005/04/09	2/070 VER_SLACK A. RAKOTO	VEREENIGING-SUID - VILJOENSDRIF
201128146	2005/04/10	2/77 LEF SLACK - YARD KEKANA	LEEUHOF CTC
201128962	2005/04/10	2/81 CTD SLACK (3W) CNTRL830 SIDEMELA	CITY DEEP
201130323	2005/04/18	2/133 KZE SLACK@KM216 (M. MOENG)	KASERNE
201130336	2005/04/19	2/143 LEF_26W SLACK RAKOTO	LEEUHOF CTC
201130353	2005/04/19	2/152 VJD2VER_SLACK /YARD/23W RAKOTO	VILJOENSDRIF
201132998	2005/04/24	2/187 BRR TURN TABLE SLACK(DE BRU	BRAAMFONTEIN NORTH
201133024	2005/04/30	2/225 KR2SY SLACK KM33/12-13 TSHISEVHE	KLIPRIVIER - SYBRAND
201137816	2005/05/08	2/53 YLL SLACK (DE BRUIN)	LANGLAAGTE OTHER
201137821	2005/05/08	2/58 GMRW W81B SLACK (J BRITZ)	GERMISTON WEST CABIN
201137663	2005/05/10	2/086 EFT_SLACK UNDER SLEEPERS SIDEMELA	ELANDSFONTEIN
201145568	2005/06/01	2/008 SBG_Repair slacksREYTENBACH	SASOLBURG
201145625	2005/06/04	2/043 JU/CD SLACK KM6/13(MOENG)	JUPITER - KASERNE MARK
201147918	2005/06/06	2/60 GMRG SLACK 28/29W X/ING (TSHISEVHE)	GERMISTON
201147897	2005/06/08	2/81 YRPR SLACK (SIDEMELA)	ROODEPOORT
201149921	2005/06/12	2/109 EFT_SLACK CONTR.129 6 ROAD NAIDOO	ELANDSFONTEIN
201149912	2005/06/16	2/148 YLEF SLACK (EUGENE)	LEEUHOF CTC
201158131	2005/07/09	2/57 LL YARD SLACK (SIDIMELA)	LANGLAAGTE DOWN
201160343	2005/07/14	2/110 RN SLACK KM 54/10 (TSHISEVHE)	REDAN
201162931	2005/07/18	2/143 EWTI2BAK SLACK KM 33/18-19	WESTONARIA - BANK
201162855	2005/07/19	2/159 EMTN2RN SLACK KM 52/16 TSHISEVHE	MEYERTON - REDAN
201166678	2005/07/29	2/240 VER/LEF SLACK KM 68/7-9	VEREENIGING

		(KHEKORE)	
201170746	2005/08/01	2/04 NT SLACK - YARD ZONDI	NATALSPRUIT
201172481	2005/08/09	2/65 EST SLACK KM 49/9 (MAILA)	ENSELSPRUIT - ENSELSPRUIT-KLIPDRIF
201177289	2005/08/16	2/105 KPF2EST Km54/16-17 SLACK (KEKANA)	KLIPDRIF
201177288	2005/08/25	2/155 RN Km53/17-18 SLACK (NAIDOO)	REDAN
201180256	2005/08/31	2/214 RN SLACK KM 53/17 (TSHISEVHE)	REDAN
201180443	2005/08/31	2/218 YKZ SLACK (MOENG)	KASERNE
201180269	2005/09/01	2/04 VJ SLACK - YARD RAKOTU	VILJOENSDRIF
201180291	2005/09/01	2/05 UN2NT SLACK KM9/2 TSHISEVHE	UNION
201182784	2005/09/07	2/48 RN2MTN Km54/9 SLACK (ZONDI)	MEYERTON - REDAN
201185397	2005/09/12	2/80 UN SLACK (294G) DE LANGE	UNION
201188645	2005/09/22	2/156 LEF SLACK - CNTRL 3 MAILA	LEEUHOF CTC
201193793	2005/09/28	2/193 repair slacks	MICHAELSRAAD - FOCHVILLE
201193932	2005/10/03	2/17 MTN SLACK KM46/14-15 J FAUGHT	MEYERTON
201199241	2005/10/09	2/55 KZ CONT.769 SLACK (KLYNSMITH)	KASERNE MARK
201199244	2005/10/10	2/69 VFT2RD Km17/4-5 SLACK (ZONDI)	ROOIKOP - VOëLFONTEIN
201212000	2005/11/03	2/15 FCR Km36/7-9 SLACK (MAILA)	FOCHVILLE
201211887	2005/11/03	2/16 EST Km51/5-10 SLACK (MAILA)	ENSELSPRUIT - ENSELSPRUIT-KLIPDRIF
201211900	2005/11/04	2/30 KAZ SLACK & SLEEPERS M. MOENG	KASERNE
201217330	2005/11/07	2/56 YCTD CONT.830 SLACK (KLYNSMITH)	CITY DEEP
201221535	2005/11/16	2/130 BRR SLACKS P. DE BRUIN	BRAAMFONTEIN
201221587	2005/11/17	2/142 ISO SLACKS (ZONDI)	JOHANNESBURG
201227261	2005/11/20	2/159 CTD Rd.4 CONT.814 SLACK (SIDEMELA)	KASERNE MARK
201224328	2005/11/20	2/167 SBG SLACK ON 34W (RAKOTO)	SASOLBURG
201227368	2005/11/22	2/191 RN 2X SLACKS D DE LANGE	REDAN
201252746	2005/11/27	2/238 RD/MTN SLACKS S NAIDOO	MEYERTON - REDAN
201227064	2005/11/30	2/260 LFN CONT.3 SLACK (KHECHANE)	LEEUHOF CTC
201231184	2005/12/08	2/47 YKZ SLACKS & B/CROWN (SIDEMELA)	KASERNE MARK
201233361	2005/12/12	2/74 YLL SLACK (MOENG)	LANGLAAGTE OTHER
201233366	2005/12/13	2/91 EWTL2EBG SLACK KM 6/19 (POHOTONA)	WATTLES - UNION
201233246	2005/12/14	2/109 HUP Km1/9 SLACK (KHECHANE)	HOUTHEUWEL - BLOEKOMHEUNING
201236736	2005/12/21	2/146 SBG SLACK @ "X"ing (KHECHANE)	SASOLBURG
201236749	2005/12/29	2/194 HUP W2469 SLACK (EUGENE)	HOUTHEUWEL
201239093	2006/01/10	2/77 RN SLACK ON 1421W (POHOTONA)	REDAN
201239112	2006/01/11	2/91 RN Km54/7-8 SLACK (BRITS)	REDAN
201241878	2006/01/16	2/128 RN SLACK M. POHOTONA	REDAN
201242129	2006/01/16	2/137 SMB-WTI SLACK P. DE BRUIN	SUURBEKOM - WESTONARIA
201242099	2006/01/17	2/145 RN SLACK & MUDHOLE M. POHOTONA	REDAN
201241903	2006/01/18	2/152 EST-KPF SLACK S. RAMALULA	ENSELSPRUIT-KLIPDRIF

201241900	2006/01/18	2/154 HUP SLACKS ON W'S S. RAMALULA	HOUTHEUWEL
201241863	2006/01/20	2/163 RN Km54/8 SLACK (POHOTONA)	REDAN
201244987	2006/01/22	2/174 ISO SLACKS @ Rd.2&3 (NAIDOO)	JOHANNESBURG
201244982	2006/01/24	2/190 HUP SLACK 2469W KM 1/9 (KHECHANE)	HOUTHEUWEL
201244993	2006/01/25	2/209 YSBG SLACK (KHECHANE)	SASOLBURG
201252869	2006/02/06	2/44 SMB Km16/15-14 SLACK (MOENG)	SUURBEKOM
201255433	2006/02/13	2/110 EHUP2BKG SLACK KM 3/12-13	HOUTHEUWEL - BLOEKOMHEUNING
201257936	2006/02/25	2/219 GMRG SLACK 28W (NAIDOO)	GERMISTON GOODS CABIN
201261792	2006/03/03	2/24 BRR_KM15/6 BAD SLACK. M. MOENG	BRAAMFONTEIN NORTH
201264736	2006/03/07	2/51 GMRG SLACK 17aW (SIDEMELA)	GERMISTON GOODS CABIN
201267459	2006/03/16	2/147 YKZ SLACK LINE 32 (MOENG)	KASERNE
201267404	2006/03/16	2/148 PHP SLACK Km 4/5 (DE BRUIN)	PAARLSHOOP
201267406	2006/03/16	2/150 YKZ SLACK (OLD BRIDGE) (TSHISEVHE)	KASERNE
201275417	2006/03/26	2/220 RPR SLACKS ON LINE (de BRUIN)	ROODEPOORT PX
201275381	2006/03/27	2/227 YSBG SLACK 15-18W (BREYTENBACH)	SASOLBURG
201275396	2006/03/31	2/269 GMR/ELS SLACK (POHOTONA)	GERMISTON EAST CABIN - ELSBURG
201279871	2006/04/12	2/70 RN SLACK MOENG	REDAN
201279876	2006/04/14	2/86 WTL Km6/17-19 SLACK 11W (MOENG)	WATTLES
201283142	2006/04/16	2/96 KZW SLACK TSHISEVHE	KASERNE WEST
201283132	2006/04/19	2/114 YRPR SLACK (DE BRUIN)	ROODEPOORT
201283117	2006/04/19	2/115 DCV SLACK KM 69/15 (MAILA)	DUNCANVILLE
201283111	2006/04/20	2/119 SBG 89W SLACK A. MAILA	SASOLBURG
201287170	2006/04/23	2/128 EFT SLACK T. TSHISEVHE	ELANDSFONTEIN
201286971	2006/04/25	2/151 SBG Km25-26 SLACK (KHEKORE)	SASOLBURG
201286974	2006/04/25	2/152 MTN Km48/6A SLACK (SIDEMELA)	MEYERTON
201287087	2006/04/26	2/159 YSBG SLACK LINE 15 (H BREYTENBACH)	SASOLBURG
201287148	2006/04/30	2/188 YBRR SLACK 38W (MOENG)	BRAAMFONTEIN NORTH
201291880	2006/05/14	2/115 BR SLACK SIDEMELA	BRAAMFONTEIN B SID
201291865	2006/05/18	2/150 YSBG SLACK (MAILA)	SASOLBURG
201299442	2006/05/29	2/244 MTN SLACK (M MOENG)	MEYERTON
201301352	2006/06/08	2/65 RD SLACK KM 6/23 (MOENG)	ROOIKOP
201315276	2006/06/17	2/122 CTD SLACK M. MOENG	CITY DEEP
201303096	2006/06/17	2/124 RTV-BKG SLACK A. RAKOTO	BLOEKOMHEUNING - RAATHSVLEI
201305118	2006/06/21	2/175 KPF SLACK KM62/5 MAILA	KLIPDRIF
201305128	2006/06/21	2/182 CTD2JU SLACK P.DE BRUIN	JUPITER
201305187	2006/06/23	2/197 SBG2WHK SLACK KM28/16-29-6 MAILA	SASOLBURG
201305175	2006/06/24	2/211 DES SLACK M.POHOTONA	DALESIDE
201314241	2006/07/03	2/22 SBG SLACK A. RAKOTO	SASOLBURG

201310387	2006/07/09	2/66 FCR SLACK A. RAKOTO	FOCHVILLE
201310371	2006/07/09	2/67 MSD SLACK 311W A. RAKOTO	MICHAELSRAAD
201311794	2006/07/11	2/103 KZ SLACK (J.SIDEMELA)	KASERNE
201311736	2006/07/12	2/113 SBG YARD 89W SLACK (A.MAILA)	SASOLBURG
201314458	2006/07/19	2/174 VDB SLACK NO1 KM4/5-6 KECHANE	VANDERBIJL
201316060	2006/07/24	2/200 HUP FISHPLATE OFF Km60/2(RAKOTO)	HOUTHEUWEL
	2006/07/24	2/200 HUP_F/PLATES MISSING KM60/2 No: 2#	HOUTHEUWEL
201316108	2006/07/26	2/229 DES SLACK _ BRITS	DALESIDE
201322685	2006/08/13	2/57 RDR SLACK KM 23/3 (SIDEMELA)	RANDWATER
201322679	2006/08/19	2/116 JUP SLACK KM 1/6 NAIDOO	JUPITER
201324117	2006/08/24	2/160 BKG/RTV SLACK A. MAILA	BLOEKOMHEUNING - RAATHSVLEI
201329085	2006/09/05	2/30 KZW SLACK M.J TSHIVULA	KASERNE WEST
201329096	2006/09/06	2/37 SBG SLACK A. RAKOTO	SASOLBURG
201329111	2006/09/07	2/49 RPR SLACK TSHIULA	ROODEPOORT
201333630	2006/09/12	2/74 TEL REPAIR SLACKS	TARENTAAL
201331336	2006/09/13	2/88 YLL SLACK (DE BRUIN)	LANGLAAGTE OTHER
201331333	2006/09/15	2/109 NT SLACK M. POHOTONA	NATALSPRUIT
201333607	2006/09/20	2/145 TEL SLACK ALBERT	TARENTAAL
201333615	2006/09/23	2/164 DES SLACK KM 37/7 (BRITS)	DALESIDE
201333616	2006/09/23	2/165 RDR SLACK KM 25/15 (BRITS)	RANDWATER
201335614	2006/09/28	2/216 RN SLACK MADIHLABA	REDAN
201346369	2006/10/03	2/21 YBRR SLACK (TSHIVULA)	BRAAMFONTEIN NORTH
201343677	2006/10/11	2/96 SBG SLACK&SKIDMARK RAKOTO	SASOLBURG
201346425	2006/10/17	2/154 TEL SLACK (RAKOTU)	TARENTAAL - CACHET
201346409	2006/10/18	2/164 SBG SLACK (RAKOTU)	SASOLBURG
201346106	2006/10/20	2/178 LEFN SLACK A. RAKOTO	LEEUHOF NOORD
201349793	2006/10/22	2/196 SBG SLACK ON 99W A. RAKOTO	SASOLBURG
201354557	2006/10/29	2/242 LIFTING OF SLACKS AT BOI1 LINE	RANDWATER
201354505	2006/10/30	2/250 EKF_SLACK @ KM51/4. A. RAKOTO	ENSELSPRUIT-KLIPDRIF
201356208	2006/10/31	2/256 SBG SLACK A.RAKOTO	SASOLBURG
201370140	2006/11/16	2/114 LLA SLACK@#5L (de BRUIN)	LANGLAAGTE GOODS
201367703	2006/11/22	2/140 LEF SLACK A. RAKOTO	LEEUHOF CTC
201369912	2006/11/28	2/192 KZM SLACK@W-CONT.775 (TSHIVULA)	KASERNE MARK
201373720	2006/12/03	2/13 MTN SLACK M.MOENG	MEYERTON
201373724	2006/12/07	2/038 ISO_SLACK No.1 ROOIWAL M.POHOTONA	JOHANNESBURG
201378650	2006/12/12	2/92 KZ SLACK P. MAILULA	KASERNE
201378623	2006/12/18	2/120 KZM SLACK@9/3 (P. de BRUIN)	KASERNE MARK
201375182	2006/12/23	2/160 SLACK KM23/2 B.S.ZONDI	RANDWATER
201378670	2006/12/31	2/183 RN SLACK@49/8-10#1L (J. SIDEMELA)	REDAN
201378680	2007/01/04	2/26 MTN SLACK@45/12#1L (J. SIDELELA)	MEYERTON
201378937	2007/01/08	2/47 SBG SLACK@3,4&6L (A. RAKOTO)	SASOLBURG
201384853	2007/01/23	2/152 LF YARD SLACKS	LEEUHOF CTC

		(BREYTENBACH)	
201384856	2007/01/24	2/160 WTL/UN SLACK 6/18(MAILULA)	WATTLES - UNION
201384864	2007/01/24	2/168 LLA MUDHOLE + SLACK P. DE BRUIN	LANGLAAGTE OTHER
201384884	2007/01/26	2/181 KZ NO 9 LINE SLACK DE BRUIN	KASERNE
201387247	2007/01/31	2/214 GMRG SLACK 81W MOENG	GERMISTON GOODS CABIN
201390360	2007/02/06	2/56 HUP SLACK W2441 (HERMAN)	HOUTHEUWEL - LEEUHOF CTC
201390392	2007/02/07	2/61 SY2KR SLACK (S.NDHLELA)	KLIPRIVIER - SYBRAND
201393337	2007/02/11	2/83 NT SLACK PM. MAILULA	NATALSPRUIT
201393336	2007/02/11	2/85 LLA SLACK P. DE BRUIN	LANGLAAGTE DOWN
201393335	2007/02/11	2/86 ISO W'S SLACK PM. MAILULA	JOHANNESBURG
201393324	2007/02/13	2/103 SBG W124 SLACK (ALBERT)	SASOLBURG
201393305	2007/02/16	02/126 MTN-RN SLACK PM MAILULA	MEYERTON
201393313	2007/02/17	02/133 MTN SLACK S NDHLELA	MEYERTON
201395802	2007/02/18	02/138 RD SLACK SHESHWAI	ROOIKOP
201395783	2007/02/20	2/158 GMR W'S SLACK (LOCO) J. BRITS	GERMISTON
201395813	2007/02/22	2/177 KPF SLACK KM65/10(ALBERT/DALT	KLIPDRIF
201395790	2007/02/23	2/191 SY-A/SDM SLACK KM34(CYDNEY)	SYBRAND - DALESIDE
201395758	2007/02/25	2/206 LEFN/BYL SLACKS KM36(ALBERT)	HOUTHEUWEL - LEEUHOF CTC
201401358	2007/02/26	02/214 LEF SLACK A RAKOTO	LEEUHOF NOORD
201401375	2007/02/28	02/229 LEF SLACK GODFREY	LEEUHOF NOORD
201402439	2007/03/04	2/22 LEF2BJR BAD SLACK RAKOTO	LEEUHOF SUID
201402492	2007/03/05	2/30 GMR YARD SLACK (NDHLELA)	GERMISTON
201402435	2007/03/05	2/29 YS SLACK YARD(ALBERT)	ISCOR SIDING
201402427	2007/03/06	2/43 SBG2 SLACK RAKOTO	WOLWEHOEK
201406817	2007/03/13	2/89 GMR 87W SLACK S. TSHISWAISE	GERMISTON
201406827	2007/03/15	2/110 MTN W1657 SLACK (BRITZ)	MEYERTON
201407900	2007/03/17	2/117 ISO YARD W3 SLACK (MAILULA)	JOHANNESBURG
201407874	2007/03/18	2/127 SBG SLACK KM 23/20 (RAKOTO)	SASOLBURG
201407934	2007/03/19	2/137 YLEF SLACK (SHUNT NECK) (RAKOTO)	LEEUHOF CTC
201407905	2007/03/20	2/143 RN SLACK KM 56/3 (SIDEMELA)	REDAN
201407937	2007/03/21	2/149 LEFN_SLACKS variouse Km E.KECHANE	ISCOR SIDING - LEEUHOF
201407914	2007/03/23	2/153 KZ SLACK P. DE BRUIN	KASERNE
201413153	2007/03/28	2/189 CTD SLACK (MAILULA)	CITY DEEP
201413182	2007/03/29	2/193 GMRG SLACK KM 0/21 (NDHLELA)	GERMISTON GOODS CABIN
201410849	2007/03/30	2/199 VJ/SBG SLACK KM13(GODFREY)	VILJOENSDRIF - SASOLBURG
201414552	2007/04/03	2/31 LEF SLACK E. KHECHANE	LEEUHOF CTC
201418001	2007/04/07	2/51 SSB_SLCK ON 34W IN THE YARD. BREYTE	VILJOENSDRIF - SASOLBURG
1001258453	2008/03/25	2/152 SBG SLACK G. SHIBAMBO	MEYERTON
1001258448	2008/03/25	2/150 SBG SLACK G. SHIBAMBO	MEYERTON - REDAN

1001258443	2008/03/25	2/149 GMRG SLACK BTWN G'S M. MOENG	WESTONARIA - BANK
1001258260	2008/03/25	2/143 BRR SLACK MJ. TSHIVULA	MEYERTON
1001257625	2008/03/23	2/133 CTA SLACK (J.MBANGA)	KASERNE
1001257218	2008/03/21	2/127 VER W4733 SLACK (DALTON)	WESTONARIA - BANK
1001256777	2008/03/19	2/120 WEL "W-4" SLACK (NJICO)	WESTONARIA
1001256564	2008/03/19	2/116 WIK-VAN SLACK LINDA	GERMISTON GOODS CABIN
1001256013	2008/03/17	2/104 BRR SLACK YARD(SHIVULA)	VEREENIGING-SUID - VILJOENSDRIF
1001255813	2008/03/17	2/100 BPR W4 SLACK -YARD LINDA	CITY DEEP
1001255624	2008/03/16	2/96 WEL SLACK N. BALOYI	ROODEPOORT PX
1001255343	2008/03/15	2/92 ISO SLACK S. TSHISWAISE	VEREENIGING-SUID - VILJOENSDRIF
1001254656	2008/03/12	2/76 TIT SLACK - MUSA THWALA	LEEUHOF CTC
1001254297	2008/03/11	2/69 SED SLACK - S MOHLALA	CITY DEEP
1001254236	2008/03/11	2/66 BRAAMFONTEIN SLACK -TSHIVULA M.J	KASERNE
1001253469	2008/03/09	2/50 VJ SLACK PLATFORM (ALBERT)	LEEUHOF CTC
1001252518	2008/03/05	2/27 WIK SLACK #1 M/LINE J. MBANGA	VILJOENSDRIF
1001251541	2008/03/03	2/11 PHP SLACK KM2/210(LUCKY)	BRAAMFONTEIN NORTH
1001251167	2008/03/02	2/05 PHP2CRN SLACK/MUDHOLE (M.TSHIVULA)	KLIPRIVIER - SYBRAND
1001250675	2008/02/27	2/174 DM/LEU SLACK KM24 (NICO)	LANGLAAGTE OTHER
1001250670	2008/02/27	2/171 VJ2SBG SLACK (A.RAKOTO)	GERMISTON WEST CABIN
1001250773	2008/02/27	2/175 BRR SLACK (M.SEHLAKO)	ELANDSFONTEIN
1001250414	2008/02/27	2/168 ELS/WTL SLACKS (M.SEHLAKO)	SASOLBURG
1001247724	2008/02/19	2/125 DON/LES SLACK KHUMBULANE	JUPITER - KASERNE MARK
1001247725	2008/02/19	2/126 LES SLACK KHUMBULANE	GERMISTON
1001247387	2008/02/18	2/123 CTA LONG SLACK LINDA	ROODEPOORT
1001246545	2008/02/17	2/107 VJ SLACK G SHIBAMBO	ELANDSFONTEIN
1001244672	2008/02/11	2/78 ARM SLACK + S/MARKS J. MBANGA	LEEUHOF CTC
1001244633	2008/02/11	2/77 SBG 96W SLACK... A. RAKOTO	LANGLAAGTE DOWN
1001243175	2008/02/06	2/46 SY/KR BAD SLACK JOE MBANGA	REDAN
1001243075	2008/02/06	2/41 mtn bad slack l mtseni	WESTONARIA - BANK
1001241845	2008/02/02	2/008 RDR_SLACK No.2 L. MTSWENI	MEYERTON - REDAN
1001241264	2008/01/31	2/179 CTA_SLACK JOE. MBANGA	VEREENIGING
1001241322	2008/01/31	2/180 LEU2DRY_SLACK KHUMBULANI	NATALSPRUIT
1001240441	2008/01/28	2/152 GMRW SLACK KHUMBULA	ENSELSPRUIT - ENSELSPRUIT-KLIPDRIF
1001236434	2008/01/15	2/83 TEL-PCM SLACK D. KOKOME	KLIPDRIF
1001236294	2008/01/15	2/82 NT SLACK Km15/15 (S.NDLELA)	REDAN
1001236291	2008/01/15	2/81 EDC-DON SLACK Km32-32,5(NJICO)	REDAN
1001236023	2008/01/14	2/73 HUP SLACK IN 303W (D.KOKOME)	KASERNE
1001236025	2008/01/14	2/74 YSPR SLACK (NJICO)	VILJOENSDRIF
1001235539	2008/01/13	2/69 YHAW SLACK ON 4W (NJICO)	UNION
1001234448	2008/01/09	2/57 KIP SLACK (JIMMY)	MEYERTON - REDAN

1001233747	2008/01/08	2/41 SBG SLACK ON 95W (G SHIBAMBO)	UNION
1001233797	2008/01/08	2/42 YKZ DERAILMENT (E KHECHANE)	LEEUHOF CTC
1001233439	2008/01/07	2/33 KOF/KSY SLACK (LINDA)	MICHAELSRAAD - FOCHVILLE
1001233534	2008/01/07	2/36 VEN SLACK (LINDA SIKAMPULA)	MEYERTON
1001232988	2008/01/06	2/22 YWEL SLACK ON WS (JIMMY)	KASERNE MARK
1001232989	2008/01/06	2/23 YWEL 37W SLACK ON 37W (JIMMY)	ROOIKOP - VOëLFONTEIN
1001232635	2008/01/05	2/13 YTIT SLACK ON W's(JIMMY BAHULA)	FOCHVILLE
1001232476	2008/01/04	2/11 NT-RDR SLACK M. SEHLAKO	ENSELSPRUIT - ENSELSPRUIT-KLIPDRIF
1001231736	2007/12/31	2/191 JU SLACK@km013 (M. SEHLAKO)	KASERNE
1001231728	2007/12/31	2/190 ID SLACK@km3,3 (M. SEHLAKO)	CITY DEEP
1001231561	2007/12/30	2/184 ID-RFI BAD SLACK M. SEHLAKO	BRAAMFONTEIN
1001231560	2007/12/30	2/183 REPAIR SLACK M. SEHLAKO	JOHANNESBURG
1001231171	2007/12/29	2/177 YEFT SLACK (M SEHLAKO)	KASERNE MARK
1001230942	2007/12/28	2/172 NT SLACK (J SEDIMELA)	SASOLBURG
1001230472	2007/12/24	2/164 YLEF SLACK IN 22W (G.SHIBAMBO)	REDAN
1001230148	2007/12/23	2/152 YGMR SLACK IN 3W (J.SEDEMELA)	MEYERTON - REDAN
1001229942	2007/12/22	2/151 JU SLACK J.SIDIMELA	LEEUHOF CTC
1001229294	2007/12/20	2/134 SED SLACK L.SIKAMPULA	KASERNE MARK
1001229410	2007/12/20	2/140 NLR SLACK X2 M. THWALA	LANGLAAGTE OTHER
1001228771	2007/12/18	2/122 GMR SLACK L.MOTSWENI	WATTLES - UNION
1001228686	2007/12/18	2/120 AGS-NT SLACK Km16/1 (MTSWENI)	HOUTHEUWEL - BLOEKOMHEUNING
1001228964	2007/12/18	2/126 DRY SLACK M.THWALA	SASOLBURG
1001227999	2007/12/16	2/99 YRPR SLACK IN 201W (L.MTSWENI)	HOUTHEUWEL
1001227423	2007/12/13	2/82 WIK SLACK IN 231W (L.SIKAMPULA)	REDAN
1001227253	2007/12/12	2/77 YCTD SLACK @ SHUNTING NECK(TSHIVULA	REDAN
1001225998	2007/12/09	2/49 GUD SLEEPERS STOLEN(HQ2) LINDA	REDAN
1001226000	2007/12/09	2/51 SPR 13W SLACK J. BAHULA	SUURBEKOM - WESTONARIA
1001225385	2007/12/08	2/44 MTN SLACK E.KHECHANE	REDAN
1001225170	2007/12/08	2/40 ISO SLACK E.KHECHANE	ENSELSPRUIT-KLIPDRIF
1001223725	2007/12/03	2/15 YTIT SLACK BETWEEN W's(MATHEBULA)	HOUTHEUWEL
1001223250	2007/12/01	2/01 BXL2TT SLACK (K.MATHEBULA)	REDAN
1001222592	2007/11/29	2/189 WIK SLACK L.SIKAMPULA	JOHANNESBURG
1001222581	2007/11/29	2/187 BXL SLACK K.MATHEBULA	HOUTHEUWEL
1001222439	2007/11/28	2/178 SRD SLACK MJ.TSHIVULA	SASOLBURG
1001221999	2007/11/27	2/172 ABD SLACK N.BALOYI	SUURBEKOM
1001221726	2007/11/26	2/170 NT2KM3 SLACK S.NDLELA	HOUTHEUWEL - BLOEKOMHEUNING
1001220971	2007/11/24	2/158 RFI SLACK S. TSHISWAISE	GERMISTON GOODS CABIN
1001219855	2007/11/21	2/129 GRV2SY BAD SLACK (LINDA)	BRAAMFONTEIN NORTH
1001217140	2007/11/13	2/83 TIT/EMV SLACK JIMMY BAHULA	GERMISTON GOODS

			CABIN
1001212594	2007/10/30	2/219 NT SLACK ON 377W L. MTSWENI	KASERNE
1001211822	2007/10/28	2/210 WELB_SLACK NJICO	PAARLSHOOP
1001210844	2007/10/25	2/189 RTV SLACK (H.BREYTENBACH)	KASERNE
1001210509	2007/10/24	2/180 SBG 128W SLACK (H.BREYTENBACH)	ROODEPOORT PX
1001210492	2007/10/24	2/178 CTB SLACK (S.MOHLALA)	SASOLBURG
1001209745	2007/10/22	2/156 ZFN SLACK SYDNEY MOHLALA	GERMISTON EAST CABIN - ELSBURG
1001209814	2007/10/22	2/158 ISO SLACK E KHECHANE	REDAN
1001207692	2007/10/16	2/122 GMR SLACK SIDEMELA	WATTLES
1001205940	2007/10/11	2/85 CTA NO SLACK BUT X-BONDS OFF J. MZI	KASERNE WEST
1001205610	2007/10/10	2/73 ISO SLACK L.MTSWENI	ROODEPOORT
1001205305	2007/10/09	2/61 RDR SLACK L. MTSWENI	DUNCANVILLE
1001205301	2007/10/09	2/60 JU SLACKS X5 L. MTSWENI	SASOLBURG
1001203906	2007/10/06	2/28 WEL SLACK THOMAS	ELANDSFONTEIN
1001203375	2007/10/03	2/18 WEL SLACK JIMMY	SASOLBURG
1001203379	2007/10/03	2/20 KYN SLACK LINDA	MEYERTON
1001202175	2007/09/29	2/230 LUD SLACK (S MOHLALA)	SASOLBURG
1001201277	2007/09/26	2/216 CTB SLACK ON 829W S. MOHLALA	BRAAMFONTEIN NORTH
1001200880	2007/09/25	2/209 YCTD SLACK (MAILULA)	BRAAMFONTEIN B SID
1001201152	2007/09/25	2/215 SED SLACK (S MOHLALA)	SASOLBURG
1001200426	2007/09/23	2/186 STQ SLACK (BARNARD)	MEYERTON
1001198698	2007/09/17	2/144 VFT SLACK P. MADIHLABA	ROOIKOP
1001197834	2007/09/15	2/130 REPAIR SLACKS 3029W (KOKOME)	CITY DEEP
1001197582	2007/09/15	2/126 TIT SLACK (SASOL YARD)KHUMBULANI	BLOEKOMHEUNING - RAATHSVLEI
1001196682	2007/09/11	2/99 SMB SLACK M. TSHIVULA	KLIPDRIF
1001196119	2007/09/10	2/93 SMB SLACK KM17/9-12 M.J.TSHIVULA	JUPITER
1001195691	2007/09/09	2/77 SLACK SIDING742481 E. KHECHANE	SASOLBURG
1001194343	2007/09/05	2/36 EMV-BKX SLACK K. MATHEBULA	DALESIDE
1001193861	2007/09/03	2/29 DHK SLACK KM67/7-8 JOE MBANGA	SASOLBURG
1001191177	2007/08/26	2/191 RKS SLACK S. MOHLALA	FOCHVILLE
1001190758	2007/08/25	02/183 TIT SLACK NJICO	MICHAELSRAAD
1001189369	2007/08/21	2/156 FBG/SYA SLACK KM30,12(JOE)	KASERNE
1001188572	2007/08/19	2/136 ARM SLACK J.MBANGA	SASOLBURG
1001188718	2007/08/19	2/140 NT SLACK YARD(MAILULA)	VANDERBIJL
1001188390	2007/08/18	2/126 KOF-KSY SLACK J. MBANGA	HOUTHEUWEL
1001187991	2007/08/17	2/119 ARG-ABD SLACK K. MATHEBULA	HOUTHEUWEL
1001188002	2007/08/17	2/124 DRY SLACK K. MATHEBULA	DALESIDE
1001187327	2007/08/15	2/113 YKZ YARD SLACK (EUGENE)	RANDWATER
1001182528	2007/08/11	2/11 WTL SLACK KM 7/14 (MTSWENI)	JUPITER
1001183665	2007/08/05	2/33 TDG-DHK SLACK L. SIKAMPULA	BLOEKOMHEUNING - RAATHSVLEI
1001183262	2007/08/04	2/26 SLACK KM 7/5 - 9/2 (JIMMY)	KASERNE WEST
1001182067	2007/07/31	2/247 WEL YARD SLACK(MUSA)	SASOLBURG

1001182183	2007/07/31	2/255 RT YARD SLACK (MAILULA)	ROODEPOORT
1001182090	2007/07/31	2/249 ISO YARD SLACK (EUGENE)	TARENTAAL
1001179623	2007/07/24	2/183 YCTD SLACK (MOENG)	LANGLAAGTE OTHER
1001179336	2007/07/22	2/180 MTN SLACK KM 46/15 (KHECHANE)	NATALSPRUIT
1001178591	2007/07/20	2/163 ABD SLACK N. BALOYI	TARENTAAL
1001177909	2007/07/17	2/139 SBG 95W SLACK G. SHIBAMBU	DALESIDE
1001173131	2007/07/02	2/17 DTT SLACK (JIMMY)	RANDWATER
1001172828	2007/07/01	2/06 CTA SLACK BARNARD	REDAN
1001172673	2007/06/30	2/233 CTB SLACK B. NTSHEHI	BRAAMFONTEIN NORTH
1001172137	2007/06/29	2/221 WIK SLACK KM24(LINDA)	SASOLBURG
1001171788	2007/06/27	2/209 WIK SLACK KM23(LINDA)	TARENTAAL - CACHET
1001171853	2007/06/27	2/211 RPR YARD SLACK (TSIVULA)	SASOLBURG
1001170021	2007/06/21	2/176 WIK SLACK KM 24/1-2 (LINDA)	LEEUHOF NOORD
1001170023	2007/06/21	2/177 WIK SLACK KM 0/8-10 (LINDA)	SASOLBURG
1001170034	2007/06/21	2/179 YWEL SLACK KM 1/1-2 (NICO)	RANDWATER
1001169369	2007/06/19	2/160 VER YARD W5 SLACK (GODFREY)	ENSELSPRUIT-KLIPDRIF
1001168406	2007/06/16	2/129 WIK SLACK B. NTSHEHI	SASOLBURG
1001167794	2007/06/13	2/117 TDG-KSH SLACK B. NTSHEHI	LANGLAAGTE GOODS
1001167797	2007/06/13	2/118 WIK SLACK ON 241W B. NTSHEHI	LEEUHOF CTC
1001167287	2007/06/12	2/104 GUD SLACK MP/S14 (BARNARD)	KASERNE MARK
1001166572	2007/06/10	2/78 YSPR SLACK (MATHEBULA)	MEYERTON
1001165406	2007/06/06	2/45 SBG SLACK KM26/4(EUGENE)	JOHANNESBURG
1001165149	2007/06/05	2/33 MTN SLACK S. NDLELA	KASERNE
1001164741	2007/06/04	2/19 WIK SLACK MOHLALA	KASERNE MARK
1001163712	2007/06/02	2/04 ETT2BKX SLACK KM 115 (JIMMY)	RANDWATER
1001163781	2007/06/02	2/05 YTT SLACK (SHUNTNECK) (JIMMY)	REDAN
1001163214	2007/05/30	2/233 YCTD SLACK (MOENG)	MEYERTON
1001162960	2007/05/29	2/227 CDCD "W " SLACK (MOENG)	SASOLBURG
1001162797	2007/05/29	2/224 UN/WTL SLACK KM9(SIDIMELA)	LEEUHOF CTC
1001162485	2007/05/28	2/217 WEL SLACK KM20(MUSA)	WATTLES - UNION
1001162051	2007/05/27	2/197 MTN SLACK KM43(SIDIMELA)	LANGLAAGTE OTHER
1001161078	2007/05/23	2/178 SYB2FBG SLACK B. NTENHI	KASERNE
1001159718	2007/05/19	2/147 KIP/BXL SLACK KM138(NICO)	GERMISTON GOODS CABIN
1001158910	2007/05/15	2/98 SY SLACK@KM30 (SYDNEY)	HOUTHEUWEL - LEEUHOF CTC
1001158659	2007/05/14	2/94 SBG SLACK D. KOKOME	KLIPRIVIER - SYBRAND
1001158482	2007/05/13	2/88 SBG SLACK 99W D. KOKOME	NATALSPRUIT
1001158429	2007/05/13	2/82 BXL SLACK@131 R. DLAMINI	LANGLAAGTE DOWN
1001158308	2007/05/12	2/80 TT SLACK KM 100/9 (DLAMINI)	JOHANNESBURG
1001157426	2007/05/08	2/53 WEL YARD SLACK (KHUMBULANI	SASOLBURG
1001157381	2007/05/08	2/51 SBG W41 SLACK YARD(HERMAN)	MEYERTON
1001157276	2007/05/07	2/45 CTA SLACK W509 (JOE)	MEYERTON
1001157176	2007/05/07	2/39 KZ SLACK KM9/1 (MAILULA)	ROOIKOP
1001157199	2007/05/07	2/40 RPR SLACK YARD(DE BRUIN)	GERMISTON
1001156961	2007/05/06	2/30 RD SLACK ROAD # 9 (PAUL)	KLIPDRIF
1001157045	2007/05/06	2/24 LL SLACK W9 (DE BRUIN)	SYBRAND - DALESIDE

1001156817	2007/05/05	2/23 RZE SLACK J. BANGA	HOUTHEUWEL - LEEUHOF CTC
1001156826	2007/05/05	2/26 R SLACK J. SIDEMELA	LEEUHOF NOORD
1001156483	2007/05/04	2/16 WEL SLACK B. NTENHI	LEEUHOF NOORD
1001155261	2007/04/27	2/204 TIT SLACK YARD (MUSA)	LEEUHOF SUID
1001155262	2007/04/27	2/205 TIT SLACK KM98/7(MUSA)	GERMISTON
1001150518	2007/04/07	2/51 SSB_SLCK ON 34W IN THE YARD. BREYTE	ISCOR SIDING
1001149770	2007/04/03	2/31 LEF SLACK E. KHECHANE	WOLWEHOEK
1001148777	2007/03/30	2/199 VJ/SBG SLACK KM13(GODFREY)	GERMISTON
1001148517	2007/03/29	2/193 GMRG SLACK KM 0/21 (NDHLELA)	MEYERTON
1001148323	2007/03/28	2/189 CTD SLACK (MAILULA)	JOHANNESBURG
1001210296	2007/10/23	2/174 ARM SLACK SYDNEY	SASOLBURG
1001159337	2007/05/17	2/123 TIT YARD SLACK(RAYMOND)	LEEUHOF CTC

APPENDIX C. THE TRAIN DERAILMENT CONDITIONAL PROBABILITY ELICITATION INTERVIEW QUESTIONNAIRE

THE TRAIN DERAILMENT CONDITIONAL PROBABILITY INTERVIEW QUESTIONNAIRE QUESTION SHEET

1 INTRODUCTION

1.1 PURPOSE OF THE INTERVIEW

I am currently surveying experts in track maintenance in order to obtain their opinions on some issues that are related to railway infrastructure maintenance. The results of this research will be used in my dissertation which forms part of the University of Johannesburg's engineering management master's degree programme that I am participating in. The interview takes approximately 45 minutes. Please be assured that your participation is voluntary and that I will skip any questions that you don't feel that you can answer.

1.2 INSTRUCTIONS

Answer the all the questions in the questions section with honesty.

2 QUESTIONS

2.1 TRAIN DERAILMENT FREQUENCY CONDITIONAL PROBABILITIES

Estimate the two state conditional probability distributions of train derailments occurring in the following scenarios:

2.1.1 When a train passes an area that has a defective points machine, incorrect rail gauge, defective retarder/advancer, broken rail and slack.

2.1.2 When a train passes an area that a defective points machine, incorrect rail gauge, defective retarder/advancer and broken rail.

2.1.3 When a train passes an area that has a defective points machine, incorrect rail gauge, defective retarder/advancer and slack.

2.1.4 When a train passes an area that has a defective points machine, incorrect rail gauge and defective retarder/advancer.

2.1.5 When a train passes an area that has a defective points machine, incorrect rail gauge, broken rail and slack.

2.1.6 When a train passes an area that has a defective points machine, incorrect rail gauge and broken rail.

2.1.7 When a train passes an area that has a defective points machine, incorrect rail gauge and slack.

2.1.8 When a train passes an area that has a defective points machine and incorrect rail gauge.

2.1.9 When a train passes an area that has a defective points machine, defective retarder/advancer, broken rail and slack.

2.1.10 When a train passes an area that has a defective points machine, defective retarder/advancer and broken rail.

2.1.11 When a train passes an area that has a defective points machine, defective retarder/advancer and slack.

2.1.12 When a train passes an area that has a defective points machine, defective retarder/advancer.

2.1.13 When a train passes an area that has a defective points machine, broken rail and slack.

2.1.14 When a train passes an area that has a defective points machine and broken rail.

2.1.15 When a train passes an area that has a defective points machine and slack.

2.1.16 When a train passes an area that has a defective points machine.

2.1.17 When a train passes an area that has an incorrect rail gauge, defective retarder/advancer, broken rail and slack

2.1.18 When a train passes an area that has an incorrect rail gauge, defective retarder/advancer and broken rail.

2.1.19 When a train passes an area that has an incorrect rail gauge, defective retarder/advancer and slack.

2.1.20 When a train passes an area that has an incorrect rail gauge, defective retarder/advancer.

2.1.21 When a train passes an area that has an incorrect rail gauge, broken rail and slack.

2.1.22 When a train passes an area that has an incorrect rail gauge and broken rail.

2.1.23 When a train passes an area that has an incorrect rail gauge and slack.

2.1.24 When a train passes an area that has an incorrect rail gauge.

2.1.25 When a train passes an area that has a defective retarder/advancer, broken rail and slack.

2.1.26 When a train passes an area that has a defective retarder/advancer and broken rail.

2.1.27 When a train passes an area that has a defective retarder/advancer and slack.

2.1.28 When a train passes an area that has a defective retarder/advancer .

2.1.29 When a train passes an area that has a broken rail and slack.

2.1.30 When a train passes an area that has a broken rail.

2.1.31 When a train passes an area that has slack.

2.1.32 When a train passes an area with no defects.

2.2 DEFECTIVE POINTS MACHINE CONDITIONAL PROBABILITIES

Estimate the two state conditional probability distributions of a points machine being defective in the following scenarios:

2.2.1 When an existing points machine defect was not detected during visual inspection.

2.2.2 When a points machine defect was detected during visual inspection but caused a train derailment before the date in which the defect was scheduled to be repaired.

2.2.3 When a points machine defect was detected during visual inspection and was ineffectively repaired.

2.2.4 When a points machine defect was detected during visual inspection and was effectively repaired.

2.3 DEFECTIVE RETARDERS/ ADVANCER CONDITIONAL PROBABILITIES

Estimate the two state conditional probability distributions of a retarder/advancer being defective in the following scenarios:

2.3.1 When a existing retarder/advancer defect was not detected during visual inspection.

2.3.2 When a retarder/advancer defect was detected during visual inspection but caused a train derailment before the date in which the defect was scheduled to be repaired.

2.3.3 When a retarder/ advancer defect was detected during visual inspection and was ineffectively repaired.

2.3.4 When a retarder/advancer defect was detected during visual inspection and was effectively repaired.

2.4 INCORRECT RAIL GAUGE CONDITIONAL PROBABILITIES

Estimate the two state conditional probability distributions of an incorrect rail gauge in the following scenarios:

2.4.1 When an existing incorrect rail gauge was not detected during visual inspection.

2.4.2 When an incorrect rail gauge was detected during visual inspection but caused a train derailment before the date in which the defect was scheduled to be repaired.

2.4.3 When an incorrect rail gauge was detected during visual inspection and was ineffectively repaired.

2.4.4 When an incorrect rail gauge was detected during visual inspection and was effectively repaired.

2.5 BROKEN RAIL CONDITIONAL PROBABILITIES

Estimate the two state conditional probability distributions of a broken rail in the following scenarios:

2.5.1 When an existing broken rail was not detected during visual inspection.

2.5.2 When an incorrect broken rail was detected during visual inspection but caused a train derailment before the date in which the defect was scheduled to be repaired.

2.5.3 When an incorrect broken rail was detected during visual inspection and was ineffectively repaired.

2.5.4 When an incorrect broken rail was detected during visual inspection and was effectively repaired.

2.6 SLACK CONDITIONAL PROBABILITIES

Estimate the two state conditional probability distributions of a slack occurring in the following scenarios:

2.6.1 When existing slack was not detected during visual inspection.

2.6.2 When an incorrect slack was detected during visual inspection but caused a train derailment before the date in which the defect was scheduled to be repaired.

2.6.3 When slack was detected during visual inspection and was ineffectively repaired.

2.6.4 When slack was detected during visual inspection and was effectively repaired.

THE TRAIN DERAILMENT CONDITIONAL PROBABILITY DISTRIBUTION INTERVIEW QUESTIONNAIRE ANSWER SHEET 1

1. INTRODUCTION

1.1 Name: Chris Norden

1.2 Date: 2009/11/16

1.3 Venue: Braamfontein, Johannesburg

1.4 Job Title: Senior Track Engineer

1.5 Nature of work: Track maintenance

1.6 Number of years working in railway infrastructure maintenance environment: 35 years

1.7 Number of years working in current position: 10 years

2. ANSWERS

2.1 TRAIN DERAILMENT CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.1.1) to (2.1.32) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.1.1) to (2.1.32).

	Defective points machine															
	Incorrect rail gauge								Correct rail gauge							
	Defective retarder/advancer				Operating retarder/advancer				Defective retarder/advancer				Operating retarder/advancer			
	Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail	
	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack
Train derailment	2.1.1. 0.56	2.1.2. 0.55	2.1.3. 0.41	2.1.4. 0.4	2.1.5. 0.51	2.1.6. 0.4	2.1.7. 0.36	2.1.8. 0.15	2.1.9. 0.3	2.1.10. 0.25	2.1.11. 0.25	2.1.12. 0.2	2.1.13. 0.15	2.1.14. 0.12	2.1.15. 0.1	2.1.16. 0.1
No train derailment	2.1.1. 44	2.1.2. 0.45	2.1.3. 0.59	2.1.4. 0.6	2.1.5. 0.49	2.1.6. 0.6	2.1.7. 0.64	2.1.8. 0.85	2.1.9. 0.7	2.1.10. 0.75	2.1.11. 0.75	2.1.12. 0.8	2.1.13. 0.85	2.1.14. 0.88	2.1.15. 0.9	2.1.16. 0.9

	Operating points machine															
	Incorrect rail gauge								Correct rail gauge							
	Defective retarder/advancer				Operating retarder/advancer				Defective retarder/advancer				Operating retarder/advancer			
	Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail	
	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack
Train derailment	2.1.17. 0.26	2.1.18. 0.15	2.1.19. 0.11	2.1.20. 0.1	2.1.21. 0.21	2.1.22. 0.1	2.1.23. 0.06	2.1.24. 0.01	2.1.25. 0.1	2.1.26. 0.08	2.1.27. 0.04	2.1.28. 0.03	2.1.29. 0.005	2.1.30. 0.005	2.1.31. 0.001	2.1.32. 0
No train derailment	2.1.17. 0.74	2.1.18. 0.85	2.1.19. 0.89	2.1.20. 0.9	2.1.21. 0.79	2.1.22. 0.9	2.1.23. 0.94	2.1.24. 0.99	2.1.25. 0.9	2.1.26. 0.92	2.1.27. 0.96	2.1.28. 0.97	2.1.29. 0.995	2.1.30. 0.995	2.1.31. 0.999	2.1.32. 1

2.2 DEFECTIVE POINTS MACHINE CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.2.1) to (2.2.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.2.1) to (2.2.4).

	Undetected points machine defect				Detected points machine defect			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Defective points machine	2.2.1. 0.24	2.2.1. 0.24	2.2.1. 0.24	2.2.1. 0.24	2.2.2. 0.05	2.2.2. 0.05	2.2.3. 0.1	2.2.4. 0
Operating points machine	2.2.1. 0.76	2.2.1. 0.76	2.2.1. 0.76	2.2.1. 0.76	2.2.2. 0.95	2.2.2. 0.95	2.2.3. 0.9	2.2.4. 1

2.3 INCORRECT RAIL GAUGE CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.3.1) to (2.3.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.3.1) to (2.3.4).

	Undetected incorrect rail gauge				Detected incorrect rail gauge			
	Uncorrected detected rail gauge		Corrected detected rail gauge		Uncorrected detected rail gauge		Corrected detected rail gauge	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Incorrect rail gauge	2.3.1. 1	2.3.1. 1	2.3.1. 1	2.3.1. 1	2.3.2. 0	2.3.2. 0	2.3.3. 0	2.3.4. 0
Correct rail gauge	2.3.1. 0	2.3.1. 0	2.3.1. 0	2.3.1. 0	2.3.2. 1	2.3.2. 1	2.3.3. 1	2.3.4. 1

2.4 DEFECTIVE ADVANCER/RETARDER CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.4.1) to (2.4.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.4.1) to (2.4.4).

	Undetected retarder/advancer defect				Detected retarder/advancer defect			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Defective retarder/advancer	2.4.1. 0.89	2.4.1. 0.89	2.4.1. 0.89	2.4.1. 0.89	2.4.2. 0	2.4.2. 0	2.4.3. 0.1	2.4.4. 0
Operating retarder/advancer	2.4.1. 0.11	2.4.1. 0.11	2.4.1. 0.11	2.4.1. 0.11	2.4.2. 1	2.4.2. 1	2.4.3. 0.9	2.4.4. 1

2.5 BROKEN RAIL CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.5.1) to (2.5.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.5.1) to (2.5.4).

	Undetected broken rail				Detected broken rail			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Broken rail	2.5.1. 0.875	2.5.1. 0.875	2.5.1. 0.875	2.5.1. 0.875	2.5.2. 0.125	2.5.2. 0.125	2.5.3. 0	2.5.4. 0
No broken rail	2.5.1. 0.125	2.5.1. 0.125	2.5.1. 0.125	2.5.1. 0.125	2.5.2. 0.875	2.5.2. 0.875	2.5.3. 1	2.5.4. 1

2.6 SLACK CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.6.1) to (2.6.4) that correspond to the answers from the Train derailment conditional probability interview distribution questionnaire questions (2.6.1) to (2.6.4).

	Undetected slack				Detected slack			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Slack	2.6.1. 0.04	2.6.1. 0.04	2.6.1. 0.04	2.6.1. 0.04	2.6.2. 0	2.6.2. 0	2.6.3. 0	2.6.4. 0
No slack	2.6.1. 0.96	2.6.1. 0.96	2.6.1. 0.96	2.6.1. 0.96	2.6.2. 1	2.6.2. 1	2.6.3. 1	2.6.4. 1

THE TRAIN DERAILMENT CONDITIONAL PROBABILITY DISTRIBUTION INTERVIEW QUESTIONNAIRE ANSWER SHEET 2

1. INTRODUCTION

1.1 Name: Yaseen Scott

1.2 Date: 2009/11/16

1.3 Venue: Braamfontein, Johannesburg

1.4 Job Title: Track manager- Chief Engineering Technician

1.5 Nature of work: Track maintenance

1.6 Number of years working in railway infrastructure maintenance environment: 6 years

1.7 Number of years working in current position: 1 year

2. ANSWERS

2.1 TRAIN DERAILMENT CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.1.1) to (2.1.32) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.1.1) to (2.1.32).

	Defective points machine															
	Incorrect rail gauge								Correct rail gauge							
	Defective retarder/advancer				Operating retarder/advancer				Defective retarder/advancer				Operating retarder/advancer			
	Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail	
	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack
Train derailment	2.1.1. 0.7	2.1.2. 0.6	2.1.3. 0.38	2.1.4. 0.15	2.1.5. 0.15	2.1.6. 0.15	2.1.7. 0.15	2.1.8. 0.05	2.1.9. 0.35	2.1.10. 0.15	2.1.11. 0.1	2.1.12. 0.15	2.1.13. 0.15	2.1.14. 0.15	2.1.15. 0.1	2.1.16. 0.1
No train derailment	2.1.1. 0.3	2.1.2. 0.4	2.1.3. 0.62	2.1.4. 0.85	2.1.5. 0.85	2.1.6. 0.85	2.1.7. 0.85	2.1.8. 0.95	2.1.9. 0.65	2.1.10. 0.85	2.1.11. 0.9	2.1.12. 0.85	2.1.13. 0.85	2.1.14. 0.85	2.1.15. 0.9	2.1.16. 0.9

	Operating points machine															
	Incorrect rail gauge								Correct rail gauge							
	Defective retarder/advancer				Operating retarder/advancer				Defective retarder/advancer				Operating retarder/advancer			
	Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail	
	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack
Train derailment	2.1.17. 0.3	2.1.18. 0.1	2.1.19. 0.1	2.1.20. 0.15	2.1.21. 0.18	2.1.22. 0.08	2.1.23. 0.1	2.1.24. 0.01	2.1.25. 0.05	2.1.26. 0.05	2.1.27. 0.05	2.1.28. 0.03	2.1.29. 0	2.1.30. 0	2.1.31. 0	2.1.32. 0
No train derailment	2.1.17. 0.7	2.1.18. 0.9	2.1.19. 0.9	2.1.20. 0.85	2.1.21. 0.82	2.1.22. 0.92	2.1.23. 0.9	2.1.24. 0.99	2.1.25. 0.95	2.1.26. 0.95	2.1.27. 0.95	2.1.28. 0.97	2.1.29. 1	2.1.30. 1	2.1.31. 1	2.1.32. 1

2.2 DEFECTIVE POINTS MACHINE CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.2.1) to (2.2.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.2.1) to (2.2.4).

	Undetected points machine defect				Detected points machine defect			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Defective points machine	2.2.1. 0.25	2.2.1. 0.25	2.2.1. 0.25	2.2.1. 0.25	2.2.2. 0	2.2.2. 0	2.2.3. 0.1	2.2.4. 0.1
Operating points machine	2.2.1. 0.75	2.2.1. 0.75	2.2.1. 0.75	2.2.1. 0.75	2.2.2. 1	2.2.2. 1	2.2.3. 0.9	2.2.4. 0.9

2.3 INCORRECT RAIL GAUGE CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.3.1) to (2.3.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.3.1) to (2.3.4).

	Undetected incorrect rail gauge				Detected incorrect rail gauge			
	Uncorrected detected rail gauge		Corrected detected rail gauge		Uncorrected detected rail gauge		Corrected detected rail gauge	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Incorrect rail gauge	2.3.1. 0.1	2.3.1. 0.1	2.3.1. 0.1	2.3.1. 0.1	2.3.2. 0.1	2.3.2. 0.1	2.3.3. 0.1	2.3.4. 0.1
Correct rail gauge	2.3.1. 0.9	2.3.1. 0.9	2.3.1. 0.9	2.3.1. 0.9	2.3.2. 0.9	2.3.2. 0.9	2.3.3. 0.9	2.3.4. 0.9

2.4 DEFECTIVE RETARDER/ADVANCER CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.4.1) to (2.4.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.4.1) to (2.4.4).

	Undetected retarder/advancer defect				Detected retarder/advancer defect			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Defective retarder/advancer	2.4.1. 0.9	2.4.1. 0.9	2.4.1. 0.9	2.4.1. 0.9	2.4.2. 0	2.4.2. 0	2.4.3. 0.1	2.4.4. 0
Operating retarder/advancer	2.4.1. 0.1	2.4.1. 0.1	2.4.1. 0.1	2.4.1. 0.1	2.4.2. 1	2.4.2. 1	2.4.3. 0.9	2.4.4. 1

2.5 BROKEN RAIL CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.5.1) to (2.5.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.5.1) to (2.5.4).

	Undetected broken rail				Detected broken rail			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Broken rail	2.5.1. 0.15	2.5.1. 0.15	2.5.1. 0.15	2.5.1. 0.15	2.5.2. 0.15	2.5.2. 0.15	2.5.3. 0.45	2.5.4. 0.45
No broken rail	2.5.1. 0.85	2.5.1. 0.85	2.5.1. 0.85	2.5.1. 0.85	2.5.2. 0.85	2.5.2. 0.85	2.5.3. 0.55	2.5.4. 0.55

2.6 SLACK CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.6.1) to (2.6.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.6.1) to (2.6.4).

	Undetected slack				Detected slack			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Slack	2.6.1. 0.02	2.6.1. 0.02	2.6.1. 0.02	2.6.1. 0.02	2.6.2. 0	2.6.2. 0	2.6.3. 0	2.6.4. 0
No slack	2.6.1. 0.98	2.6.1. 0.98	2.6.1. 0.98	2.6.1. 0.98	2.6.2. 1	2.6.2. 1	2.6.3. 1	2.6.4. 1

THE TRAIN DERAILMENT CONDITIONAL PROBABILITY DISTRIBUTION INTERVIEW QUESTIONNAIRE ANSWER SHEET 3

1. INTRODUCTION

1.1 Name: Humphrey Mashamba

1.2 Date: 2009/11/13

1.3 Venue: Braamfontein, Johannesburg

1.4 Job Title: Engineering Track Technician

1.5 Nature of work: Track maintenance

1.6 Number of years working in railway infrastructure maintenance environment: 4 years

1.7 Number of years working in current position: 4 years

2. ANSWERS

2.1 TRAIN DERAILMENT CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.1.1) to (2.1.32) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.1.1) to (2.1.32).

Defective points machine															
Incorrect rail gauge								Correct rail gauge							
Defective retarder/advancer				Operating retarder/advancer				Defective retarder/advancer				Operating retarder/advancer			
Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail	
Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack
2.1.1. 0.75	2.1.2. 0.538	2.1.3. 0.3	2.1.4. 0.11	2.1.5. 0.025	2.1.6. 0.074	2.1.7. 0.09	2.1.8. 0.07	2.1.9. 0.25	2.1.10. 0.164	2.1.11. 0.19	2.1.12. 0.13	2.1.13. 0.2	2.1.14. 0.174	2.1.15. 0.22	2.1.16. 0.16
2.1.1. 025	2.1.2. 0.462	2.1.3. 0.7	2.1.4. 0.89	2.1.5. 0.975	2.1.6. 0.926	2.1.7. 0.91	2.1.8. 0.93	2.1.9. 0.75	2.1.10. 0.836	2.1.11. 0.81	2.1.12. 0.87	2.1.13. 0.8	2.1.14. 0.826	2.1.15. 0.78	2.1.16. 0.84

	Operating points machine															
	Incorrect rail gauge								Correct rail gauge							
	Defective retarder/advancer				Operating retarder/advancer				Defective retarder/advancer				Operating retarder/advancer			
	Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail		Broken rail		No broken rail	
	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack	Slack	No slack
Train derailment	2.1.17. 0.33	2.1.18. 0.13	2.1.19. 0.15	2.1.20. 0.15	2.1.21. 0.1	2.1.22. 0.02	2.1.23. 0.08	2.1.24. 0.01	2.1.25. 0.11	2.1.26. 0.07	2.1.27. 0.03	2.1.28. 0.03	2.1.29. 0.02	2.1.30. 0.01	2.1.31. 0.01	2.1.32. 0
No train derailment	2.1.17 0.67	2.1.18 0.87	2.1.19 0.85	2.1.20 0.85	2.1.21 0.9	2.1.22 0.98	2.1.23 0.92	2.1.24 0.99	2.1.25 0.89	2.1.26 0.93	2.1.27 0.97	2.1.28 0.97	2.1.29 0.98	2.1.30 0.99	2.1.31 0.99	2.1.32 1

2.2 DEFECTIVE POINTS MACHINE CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.2.1) to (2.2.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.2.1) to (2.2.4).

	Undetected points machine defect				Detected points machine defect			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Defective points machine	2.2.1. 0.3	2.2.1. 0.3	2.2.1. 0.3	2.2.1. 0.3	2.2.2. 0.05	2.2.2. 0.05	2.2.3. 0.1	2.2.4. 0.1
Operating points machine	2.2.1. 0.7	2.2.1. 0.7	2.2.1. 0.7	2.2.1. 0.7	2.2.2. 0.95	2.2.2. 0.95	2.2.3. 0.9	2.2.4. 0.9

2.3 INCORRECT RAIL GAUGE CONDITIONAL PROBABILITIES

A. Enter the conditional probability distributions in blocks (2.3.1) to (2.3.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.3.1) to (2.3.4).

	Undetected incorrect rail gauge				Detected incorrect rail gauge			
	Uncorrected detected rail gauge		Corrected detected rail gauge		Uncorrected detected rail gauge		Corrected detected rail gauge	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Incorrect rail gauge	2.3.1. 0.05	2.3.1. 0.05	2.3.1. 0.05	2.3.1. 0.05	2.3.2. 0.1	2.3.2. 0.1	2.3.3. 0	2.3.4. 0
Correct rail gauge	2.3.1. 0.95	2.3.1. 0.95	2.3.1. 0.95	2.3.1. 0.95	2.3.2. 0.9	2.3.2. 0.9	2.3.3. 1	2.3.4. 1

2.4 DEFECTIVE RETARDER/ADVANCER CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.4.1) to (2.4.4) that correspond to the answers from the Train derailment conditional probability interview distribution questionnaire questions (2.4.1) to (2.4.4).

	Undetected retarder/advancer defect				Detected retarder/advancer defect			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Defective retarder/ advancer	2.4.1. 0.9	2.4.1. 0.9	2.4.1. 0.9	2.4.1. 0.9	2.4.2. 0	2.4.2. 0	2.4.3. 0.1	2.4.4. 0
Operating retarder/ advancer	2.4.1. 0.1	2.4.1. 0.1	2.4.1. 0.1	2.4.1. 0.1	2.4.2. 1	2.4.2. 1	2.4.3. 0.9	2.4.4. 1

2.5 BROKEN RAIL CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.5.1) to (2.5.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.5.1) to (2.5.4).

	Undetected broken rail				Detected broken rail			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Broken rail	2.5.1. 0.15	2.5.1. 0.15	2.5.1. 0.15	2.5.1. 0.15	2.5.2. 0.45	2.5.2. 0.45	2.5.3. 0.1	2.5.4. 0.1
No broken rail	2.5.1 0.85	2.5.1 0.85	2.5.1 0.85	2.5.1 0.85	2.5.2 0.55	2.5.2 0.55	2.5.3 0.9	2.5.4 0.9

2.6 SLACK CONDITIONAL PROBABILITIES

Enter the conditional probability distributions in blocks (2.6.1) to (2.6.4) that correspond to the answers from the Train derailment conditional probability distribution interview questionnaire questions (2.6.1) to (2.6.4).

	Undetected slack				Detected slack			
	Unrepaired detected defect		Repaired detected defect		Unrepaired detected defect		Repaired detected defect	
	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair	Ineffective repair	Effective repair
Slack	2.6.1. 0.3	2.6.1. 0.3	2.6.1. 0.3	2.6.1. 0.3	2.6.2. 0	2.6.2. 0	2.6.3. 0	2.6.4. 0
No slack	2.6.1 0.7	2.6.1. 0.7	2.6.1. 0.7	2.6.1 0.7	2.6.2 1	2.6.2 1	2.6.3 1	2.6.4 1

APPENDIX D. THE JOHANNESBURG DEPOT 2005-2009 FINANCIAL YEAR TRAIN DERAILMENT CLAIMS DATABASE

1. 2005/2006 FINANCIAL YEAR

Description	Place	Rehabilitation cost
Derailment running line	Bronkhorstspruit	R 1,015,000.00
Derailment running line	Natalspruit	R 184,000.00
Derailment running line	Vlakfontein	R 13,080,000.00
Derailment running line	Welgedag	R 345,000.00
Derailment running line	Sentrarand	R 15,000.00
Derailment running line	Brakpan	R 15,000.00
Derailment running line	Sentrarand	R 15,000.00
Derailment-wagon	Sentrarand	R 45,000.00
Derailment running line	Roodepoort	R 15,000.00
Derailment running line	Bijlkor	R 1,015,000.00
Derailment running line	Sentrarand	R 15,000.00
Derailment running line	Sentrarand	R 15,000.00
Derailment running line	Natalspruit	R 75,000.00
Derailment running line	Kaserne	R 15,000.00
Derailment running line	Sentrarand	R 17,000.00
Derailment shunt	Johannesburg	R 47,800.00
Derailment running line	Pretoria West	R 17,000.00

Derailment running line	Isando	R 17,000.00
Derailment running line	Bronkhorstfontein	R 8,137,000.00
Derailment running line	Langlaagte	R 7,325,999.00
Derailment running line	Kaserne	R 22,000.00
Derailment running line	Enselspruit-Klipdrift	R 297,153.00
Derailment running line	Dalton-Jaagbaan	R 20,000.00
Derailment running line	Michaelsraad - Fochville	R 7,325,999.00
Derailment running line	Geduld - Welgedag	R 17,901,861.00
Derailment running line	Bloekomheuning - Vanderbijl	R 10,000.00
Derailment running line	Houtheuwel	R 1,360.00
Derailment running line	Germiston	R 10,000.00
Derailment running line	Braamfontein	R 1,015,000.00
Derailment running line	City Deep	R 15,000.00
Derailment running line	Sentrarand	R 15,000.00
Derailment running line	Meyerton Siding	R 200,500.00
Derailment running line	Jupiter	R 15,000.00
Derailment shunt	City Deep	R 38,400.00
Derailment running line	Natalspruit	R 15,000.00
Derailment	Iscor - v d Bijl	R 8,500,000.00
Derailment running line	Welgedag	R 1,570,000.00
Derailment shunt	Sentrarand	R 49,700.00
Derailment running line	Springs	R 15,000.00
Derailment running line	Springs	R 709,000.00
Derailment running line	Germiston Transwerk	R 1,700,000.00
Derailment running line	Germiston Transwerk	R 3,800,000.00

Derailment running line	Meyerton Yard	R 718,367.80
Derailment running line	Welgedag	R 1,570,000.00
Derailment running line	Balfour North	R 2,090,000.00
Derailment running line	Dryden	R 4,800,000.00
Derailment running line	Alloy - Duncanville	R 530,000.00
Derailment running line	Sentrarand	R 709,000.00
Derailment running line	Jupiter Ppc Cement	R 21,600,000.00
Derailment running line	Sasolburg	R 31,510,000.00

2. 2006/2007 FINANCIAL YEAR

Description	Place	Rehabilitation cost
Derailment running line	Vereeniging -Duncanville	R 1,009,000.00
Derailment running line	Sentrarand	R 1,060,000.00
Derailment running line	Sentrarand	R 2,017,000.00
Derailment running line	Sentrarand	R 1,115,000.00
Derailment running line	Sentrarand	R 1,015,000.00
Derailment running line	Pretoria-Wes	R 2,021,000.00
Derailment running line	Bleskop	R 1,115,000.00
Derailment running line	Sentrarand	R 21,200.00
Derailment running line	Johannesburg	R 15,000.00
Derailment running line	Elandsfontein	R 7,015,000.00
Derailment running line	Elandsfontein	R 12,009,000.00

Derailment running line	Kaserne	R 75,000.00
Derailment running line	Springs	R 3,015,000.00
Derailment running line	Natalspruit	R 15,000.00
Derailment running line	Vlakfontein	R 15,000.00
Derailment running line	Welgedag	R 21,000.00
Derailment running line	Sentrarand	R 1,071,000.00
Derailment running line	Brakpan	R 1,000.00
Derailment running line	Sentrarand	R 5,015,000.00
Derailment running line	Sentrarand	R 10,000.00
Derailment running line	Roodepoort	R 15,000.00
Derailment running line	Bijlkor	R 1,121,500.00
Derailment running line	Sentrarand	R 15,000.00
Derailment running line	Sentrarand	R 13,080,000.00
Derailment running line	Natalspruit	R 3,007,000.00
Derailment running line	Kaserne	R 8,017,000.00
Derailment running line	Springs	R 15,000.00
Derailment shunt	Braamfontein	R 410,009.00
Derailment running line	Springs	R 15,000.00
Derailment running line	Germiston Transwerk	R 1,115,000.00
Derailment running line	Germiston Transwerk	R 15,000.00
Derailment running line	Meyerton Yard	R 15,000.00
Derailment running line	Welgedag	R 15,000.00
Derailment running line	Balfour North	R 15,000.00
Derailment running line	Dryden	R 75,000.00
Derailment running line	Alloy - Duncanville	R 15,000.00

Derailment running line	Michaelsraad - Fochville	R 15,000.00
Derailment running line	Geduld - Welgedag	R 115,000.00
Derailment running line	Bloekomheuning - Vanderbijl	R 680,000.00
Derailment running line	Houtheuwel	R 101,000.00
Derailment running line	Germiston	R 111,000.00
Derailment running line	City Deep	R 231,000.00
Derailment running line	Sentrarand	R 10,000.00
Derailment running line	Meyerton Siding	R 21,000.00
Derailment running line	Jupiter	R 15,000.00
Derailment running line	Iscor - v d Bijl	R 15,000.00
Derailment running line	Welgedag	R 10,000.00
Derailment running line	Sentrarand	R 10,000.00
Derailment running line	Sentrarand	R 10,000.00
Derailment running line	Springs	R 10,000.00
Derailment running line	Springs	R 15,000.00
Derailment running line	Germiston Transwerk	R 9,700,000.00
Derailment running line	Germiston Transwerk	R 4,615,000.00
Derailment running line	Meyerton Yard	R 15,200,000.00
Derailment running line	Welgedag	R 1,009,340.00
Derailment running line	Balfour North	R 1,051,000.00
Derailment running line	Dryden	R 1,091,000.00
Derailment running line	Braamfontein	R 1,071,000.00
Derailment running line	City Deep	R 3,000,161.00
Derailment running line	Natalspruit	R 9,010,000.00
Derailment running line	Sentrarand	R 7,115,000.00

Derailment running line	Bijlkor	R 9,300,000.00
Derailment running line	Germiston - Transwerk	R 1,117,000.00
Derailment running line	Sentrarand	R 1,009,000.00
Derailment running line	Vereeniging -Duncanville	R 6,300,000.00
Derailment running line	Kaserne	R 115,000.00
Derailment running line	Springs	R 900,000.00
Derailment running line	Alloy - Duncanville	R 18,399.00
Derailment running line	Natalspruit	R 7,704,000.00
Derailment running line	Vlakfontein	R 1,091,000.00
Derailment	Springdale	R 6,939,900.00
Derailment running line	Welgedag	R 107,000.00
Derailment running line	Sentrarand	R 1,315,000.00
Derailment running line	Brakpan	R 101,000.00

3. 2007/2008 FINANCIAL YEAR

Description	Place	Rehabilitation cost
Derailment running line	Germiston	R 2,325,000.00
Derailment running line	Isando	R 3,00,000.00
Derailment running line	Welgedag	R 2,000,000.00
Derailment running line	Houtheuwel	R 3,010,360.00
Derailment running line	Germiston	R 18,000,000.00
Derailment shunt	Braamfontein	R2,015,000.00
Derailment shunt	City Deep	R1,080,340.00

Derailment shunt	Natalspruit	R 1,015,999.00
Derailment running line	Iscor - v d Bijl	R 1,031,340.80
Derailment running line	Bloekomheuning - Vanderbijl	R 1,000,000.00
Derailment running line	Sentrarand	R 9,000,640.00
Derailment running line	Sentrarand	R 1,000,261.00
Derailment running line	Springs	R 1,500,000.00
Derailment running line	Springs	R 170,000.00
Derailment shunt	Sentrarand	R 916,000.00
Derailment shunt	Bijlkor	R 15,400.00
Derailment running line	Brakpan	R 65,000.00
Derailment running line	Germiston	R1, 15,000.00
Derailment running line	Vereeniging	R 5,100,058.00
Derailment running line	Blinkpan	R 15,000.00
Derailment running line	Welgedag	R 7,005,000.00
Derailment running line	City Deep	R 15,000.00
Derailment running line	Sentrarand	R 15,000.00
Derailment-wagon	Trichardt Sasol 2	R 3,058,991.00
Derailment running line	Modderfontein	R 1,900,000.00
Derailment running line	Isando	R 11,001,530.00
Derailment shunt	Germiston - Transwerk	R 15,000.00
Derailment running line	Mpilisweni - Angus	R 170,030.00
Derailment running line	Leeuhof	R 12,240.00
Derailment running line	Rooikop - Natalspruit	R 2,500,000.00
Derailment running line	Sentrarand	R 105,000.00
Derailment	Roode-Roovlei	R 15,000.00

Derailment running line	Germiston	R 15,000.00
Derailment shunt	Sentrarand	R 14,669.00
Derailment running line	Argent	R 1,920,000.00
Derailment	Welgedat	R 1,840,000.00
Derailment shunt	Vereeniging -Duncanville	R 1,010,000.00
Derailment shunt	Kaserne	R 15,000.00
Derailment shunt	Springs	R 25,000.00
Derailment running line	Natalspruit	R 1,720,000.00
Derailment running line	Vlakfontein	R 3,065,000.00
Derailment running line	Welgedag	R 15,000.00
Derailment	Sentrarand	R 15,000.00
Derailment running line	Brakpan	R 4,005,000.00
Derailment running line	Sentrarand	R 20,075,000.00
Derailment running line	Natalspruit	R 8,505,000.00
Derailment running line	Kaserne	R 75,000.00
Derailment running line	Springs	R 15,000.00
Derailment running line	Springs	R 1,500,000.00
Derailment running line	Germiston Transwerk	R 15,000.00
Derailment running line	Germiston Transwerk	R 100,000.00
Derailment running line	Meyerton Yard	R 1,201,000.00

4. 2008/2009 FINANCIAL YEAR

Derailment type	Derailment place	Rehabilitation cost
Derailment running line	Michaelsraad - Fochville	R 7,325,999.00
Derailment running line	Geduld - Welgedag	R 17,901,861.00
Derailment running line	Bloekomheuning - Vanderbijl	R 10,000.00
Derailment-loco	Houtheuwel	R 1,360.00
Derailment shunt Spoornet	Germiston	R 10,000.00
Derailment shunt Private	Bijlkor	R 10,000.00
Derailment shunt Private	Bijlkor Mittal Steel	R 15,119.00
Derailment shunt Private	City Deep	R 15,000.00
Derailment shunt Spoornet	Braamfontein	R 15,000.00
Derailment shunt Spoornet	City Deep	R 15,000.00
Derailment shunt Spoornet	Sentrarand	R 15,000.00
Derailment crane machine	Meyerton Siding	R 500.00
Derailment shunt Spoornet	Jupiter	R 15,000.00
Derailment shunt Spoornet	City Deep	R 340.00
Derailment shunt Spoornet	Natalspruit	R 15,000.00
Derailment wagons	Iscor - v d Bijl	R 131,340.80
Derailment-wagon	Welgedag	R 1,000.00
Derailment shunt spoornet	Sentrarand	R 9,640.00
Derailment-wagon	Sentrarand	R 1,000.00
Derailment shunt Spoornet	Springs	R 15,000.00
Derailment shunt spoornet	Springs	R 15,000.00

Derailment-wagon	Germiston Transwerk	R 1,000.00
Derailment-wagon	Germiston Transwerk	R 1,000.00
Derailment rrv	Meyerton Yard	R 1,000.00
Derailment shunt Spoornet	Welgedag	R 15,000.00
Derailment-wagon	Balfour North	R 10,000.00
Derailment shunt Spoornet	Dryden	R 15,000.00
Derailment running line	Alloy - Duncanville	R 15,000.00
Derailment shunt Spoornet	Sentrarand	R 15,000.00
Derailment-wagon	Jupiter Ppc Cement	R 1,000.00
Derailment-wagon	Sasolburg	R 18,399.00
Derailment shunt	Natalspruit	R 15,000.00
Derailment-wagon	Germiston Scaw-Metals	R 1,000.00
Derailment tanker	Germiston Transwerk	R 1,000.00
Derailment shunt Spoornet	Sentrarand	R 5,000.00
Derailment shunt Spoornet	Bijlkor	R 15,000.00
Derailment shunt Private	Brakpan	R 15,000.00
Derailment shunt Spoornet	Germiston	R 15,000.00
Derailment-wagon	Vereeniging	R 5,158.00
Derailment shunt Spoornet	Blinkpan	R 15,000.00
Derailment shunt Spoornet	Welgedag	R 15,000.00
Derailment shunt Spoornet	City Deep	R 15,000.00
Derailment shunt Spoornet	Sentrarand	R 15,000.00
Derailment-wagon	Trichardt Sasol 2	R 1,000.00
Derailment-wagon	Germiston	R 1,000.00
Derailment shunt Spoornet	Leeuhof	R 15,000.00
Derailment-wagon	Germiston - Scaw Metals	R 15,000.00
Derailment-wagon	Vanderbijlpark Iscor	R 1,000.00

Derailment-wagon	Vanderbijlpark Iscor	R 2,000.00
Derailment-wagon	Modderfontein	R 1,000.00
Derailment shunt Spoornet	Johannesburg	R 1,530.00
Derailment shunt	Germiston - Transwerk	R 15,000.00
Derailment shunt	Mpilisweni - Angus	R 12,240.00
Derailment shunt Spoornet	Leeuhof	R 15,000.00
Derailment shunt Private	Union Wadeville	R 15,000.00
Derailment shunt Private	Blinkpan	R 15,000.00
Derailment	Rooikop - Natalspruit	R 15,000.00
Derailment shunt Freight Rail	Sentrarand	R 15,000.00
Derailment	Springdale	R 15,000.00
Derailment	Roode-Roovlei	R 15,000.00
Derailment shunt	Germiston - Transwerk	R 15,000.00
Derailment shunt Private	Blinkpan	R 300,000.00
Derailment shunt Freight Rail	Sentrarand	R 150,000.00
Derailment running line	Argent	R 1,920,000.00
Derailment	Welgedat	R 1,840,000.00

APPENDIX E. TRAIN DERAILMENT COST CONTRIBUTING FACTOR NODES STATES

	Probability of derailment types Td	Probability of derailment types per trip Fk	State1 (P=TdFk)	State2 P'=1-TdFk
Derailment running line probability (d=1, k=0)	0.8713	0.0402	0.03502626	0.96497374
Derailment shunt probability (d=2, k=0)	0.09	0.0402	0.003618	0.996382
Derailment-wagon probability (d=3, k=0)	0.0117	0.0402	0.00047034	0.99952966
Derailment probability (d=4, k=0)	0.027	0.0402	0.0010854	0.9989146
Annual train derailment probability (k=0)			0.0402	0.9598
Derailment running line probability (d=1, k=1)	0.8713	0.038	0.0331094	0.9686332
Derailment shunt probability (d=2, k=1)	0.09	0.038	0.00342	0.99676
Derailment-wagon probability (d=3, k=1)	0.0117	0.038	0.0004446	0.9995788
Derailment probability (d=4, k=1)	0.027	0.038	0.001026	0.999028
Annual train derailment probability			0.038	0.962

(k=1)				
Derailment running line probability (d=1, k=2)	0.8713	0.036	0.0313668	0.9668906
Derailment shunt probability (d=2, k=2)	0.09	0.036	0.00324	0.99658
Derailment-wagon probability (d=3, k=2)	0.0117	0.036	0.0004212	0.9995554
Derailment probability (d=4, k=2)	0.027	0.036	0.000972	0.998974
Annual train derailment probability (k=2)			0.036	0.964
Derailment running line probability (d=1, k=3)	0.8713	0.034	0.0296242	0.9686332
Derailment shunt probability (d=2, k=3)	0.09	0.034	0.00306	0.99676
Derailment-wagon probability (d=3, k=3)	0.0117	0.034	0.0003978	0.9995788
Derailment probability (d=4, k=3)	0.027	0.034	0.000918	0.999028
Annual train derailment probability (k=3)			0.034	0.966

Derailment running line probability (d=1, k=4)	0.8713	0.032	0.0278816	0.9703758
Derailment shunt probability (d=2, k=4)	0.09	0.032	0.00288	0.99694
Derailment-wagon probability (d=3, k=4)	0.0117	0.032	0.0003744	0.9996022
Derailment probability (d=4, k=4)	0.027	0.032	0.000864	0.999082
Annual train derailment probability (k=4)			0.032	0.968
Derailment running line probability (d=1, k=5)	0.8713	0.03	0.026139	0.9721184
Derailment shunt probability (d=2, k=5)	0.09	0.03	0.0027	0.99712
Derailment-wagon probability (d=3, k=5)	0.0117	0.03	0.000351	0.9996256
Derailment probability (d=4, k=5)	0.027	0.03	0.00081	0.999136
Annual train derailment probability (k=5)			0.03	0.97
Derailment running line probability (d=1, k=6)	0.8713	0.026	0.02465779	0.97534221

Derailment shunt probability (d=2, k=6)	0.09		0.002547	0.997453
Derailment-wagon probability (d=3, k=6)	0.0117		0.00033111	0.99966889
Derailment probability (d=4, k=6)	0.027		0.0007641	0.9992359
Annual train derailment probability (k=6)			0.0283	0.9717
Derailment running line probability (d=1, k=7)	0.8713	0.024	0.0226538	0.97534221
Derailment shunt probability (d=2, k=7)	0.09		0.00234	0.997453
Derailment-wagon probability (d=3, k=7)	0.0117		0.0003042	0.99966889
Derailment probability (d=4, k=7)	0.027		0.000702	0.9992359
Annual train derailment probability (k=7)			0.026	0.974
Derailment running line probability (d=1, k=8)	0.8713	0.022	0.0209112	0.9773462
Derailment shunt probability (d=2, k=8)	0.09		0.00216	0.99766
Derailment-wagon probability (d=3, k=8)	0.0117		0.0002808	0.9996958

Derailment probability (d=4, k=8)	0.027		0.000648	0.999298
Annual train derailment probability (k=8)			0.024	0.976
Derailment running line probability (d=1, k=9)	0.8713	0.02	0.0191686	0.9790888
Derailment shunt probability (d=2, k=9)	0.09		0.00198	0.99784
Derailment-wagon probability (d=3, k=9)	0.0117		0.0002574	0.9997192
Derailment probability (d=4, k=9)	0.027		0.000594	0.999352
Annual train derailment probability (k=9)			0.022	0.978
Derailment running line probability (d=1, k=10)	0.8713		0.017426	0.9808314
Derailment shunt probability (d=2, k=10)	0.09		0.0018	0.99802
Derailment-wagon probability (d=3, k=10)	0.0117		0.000234	0.9997426
Derailment probability (d=4, k=10)	0.027		0.00054	0.999406
Annual train derailment probability (k=10)			0.02	0.98