

**A BOOKLET ON**

**CAUSES OF TRANSPORT AND TRAMMING  
ACCIDENTS ASSOCIATED WITH TRACKLESS  
MOBILE MACHINES**



**Prof. G.A.FOURIE**

**Mine Health and Safety Council  
October 2003**



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**October 2003**

Published by The Mine Health and Safety Council, Braamfontein Centre, 23 Jorrison Street, Braamfontein, South Africa.

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ISBN 1-919853-12-X

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## 1.INTRODUCTION

Analyses of South African mine safety statistics and records rank accidents associated with transport and the use of heavy plant and machinery as a close second to accidents resulting from falls of ground. Transport and machinery related accidents have the highest significance in terms of the number of incidents and the number of injuries. While failures of a mechanical or environmental nature are major contributors, the human factor, which is the least understood and the least predictable, has a significant influence on the greatest number of these types of accidents.

The emphasis on human error goes beyond the traditional narrow concept, which has tended to be restricted to simply operator error being exemplified as "*pilot error*" and "*driver error*". This wider concept includes all those aspects generally associated with an operation or system – from design, through education and training, installation, management and operating staff.

Traditionally, safety assurance has been largely reactive, with the primary aim of accident investigations focused on apportioning blame and avoiding repeat events. In part, this focus arose from the adoption of an over-simplistic approach when establishing the causes of accidents. The approach was based on the concept of identifying a single primary cause – either an unsafe act or an unsafe condition. In the former case, responsibility was clear and blame could be apportioned. In the latter case, a technical solution could be sought. In part this approach to accident investigation also arose from the fact that a reactive approach, based on identifying a single primary cause, was an easier one to handle.

This narrow, blame oriented, perception of accident causation has, however, often missed three important, and inter-related, issues:

1. The idea that accidents happen as a result of a single primary cause is a gross simplification of what is often a highly complex event having several contributing causes. In addition, the term "unsafe act" embraces a wide range of human errors, equating, even at the most basic level, both deliberate and unintentional errors and assuming that "blame" is the best means of understanding and dealing with such errors.
2. The consideration of unsafe acts and unsafe conditions as independent causes of accidents does not allow for the fact that an unsafe act can create an unsafe condition, or for the fact that an unsafe condition can predispose an unsafe act.

3. Attention to unsafe acts has focused almost exclusively on errors made by the people who had the accidents, or those close to hand when the accident occurs. Those managers, designers, engineers, etc. whose action (or inaction) may have created the circumstances whereby "operator error" became more likely, have often escaped attention. Such an analysis leaves out the all-important question of what caused the operator to err. Often the cause can be attributed to faulty equipment design, inadequate or improper instruction and training or unsafe management policies.

Taking a reactive "blame" approach to human error in accidents has limited value in terms of future accident prevention. Unfortunately this is a reasonably accurate description of the approach to reducing human error accidents that has been adopted in most organisations, including mining, for many years.

## **2. OBJECTIVES**

If accidents, and particularly transport and tramming accidents, are to be prevented in future, there is little value in simply blaming people for their mistakes unless a detailed understanding of what caused the mistake can be initially established. Only by understanding all the issues, that caused, or could cause, an accident, is it possible to effectively prevent future occurrences.

In this regard, the primary objective of this booklet is to create a better understanding of the wide-ranging factors that are likely to contribute to transport and tramming accidents. The contents of this booklet is primarily based on the research findings as detailed in SIMRAC Research Report number COL 506, entitled "Investigate the causes of transport and tramming accidents in coal mines".

Suggestions for possible solutions to both specific and generic potential accident causes are presented to aid mine personnel in their endeavour to eliminate accidents of a similar nature.

### 3. CAUSES OF TRANSPORT AND TRAMMING ACCIDENTS

Given the now widespread acceptance that human error is a common cause failure in accident patterns, it is clearly a logical step to try and understand such errors within a framework that provides an effective route to error and, therefore accident reduction. However, the phrase “human error” covers an extremely wide range of circumstances, causes and potential consequences. Potential human error audits distinguish between Active Failures and Latent Failures.

#### 3.1 Active failures

**Active failures** are errors made by operators and maintenance staff i.e. those with hands-on control of the system or equipment. They occur immediately prior to the accident event and are often seen as the “immediate cause”. **Active failures** are those errors, which traditionally have been described as human error – driver error and pilot error being typical examples. **Active failures** can be extremely varied and occur as a result of **unintentional** or **intentional errors**. Three types of active failures can be identified. These are:

- ✍ **Slips or lapse errors:** Slips or lapse errors occur in well-known tasks with operators who know the process well and are experienced in the work. They are ‘action errors’, which occur while the task is being carried out. They often involve missing a step out of the sequence, or getting steps in the wrong order, and frequently arise through a lapse of attention or concentration. Operating the wrong control through a lapse in attention or accidentally selecting the wrong gear are good examples of slips and/or lapses in the mining context.
- ✍ **Mistake errors:** Mistake errors occur when the elements of a task are being “planned”. They are decisions, which are subsequently found to be wrong, although at the time of action the operator does not consider them to be incorrect. A **mistake** is therefore an inadvertent error. For example, the driver of a vehicle who decides to set off in second gear and later realises that he should have set off in first has made a mistake. Similarly, a driver, when considering that he is traveling at a safe speed to negotiate a bend in the road and then realises that he is going too fast, has made a mistake.
- ✍ **Violations:** Violations occur when the plan of action is decided upon in full knowledge that it is a breach of the rules or codes of safe working practice. Taking short cuts or failing to take the prescribed precautions in order to enhance performance, are typical



**violations.** There are often “good” reasons why **violations** occur, for example, a rule may be impractical, or all the necessary equipment to follow a rule may not be available. A poorly designed vehicle cab may predispose the adoption of unsafe operating practices as standing and leaning out of the cab to overcome sightline restrictions.

The definition of **Active Failures** given above indicates that they occur at the interface of the man and his equipment, machine or system. Therefore, the traditional ergonomic man-machine system, as shown in Figure 1, represents an ideal starting point for the identification of **Active Failures**.

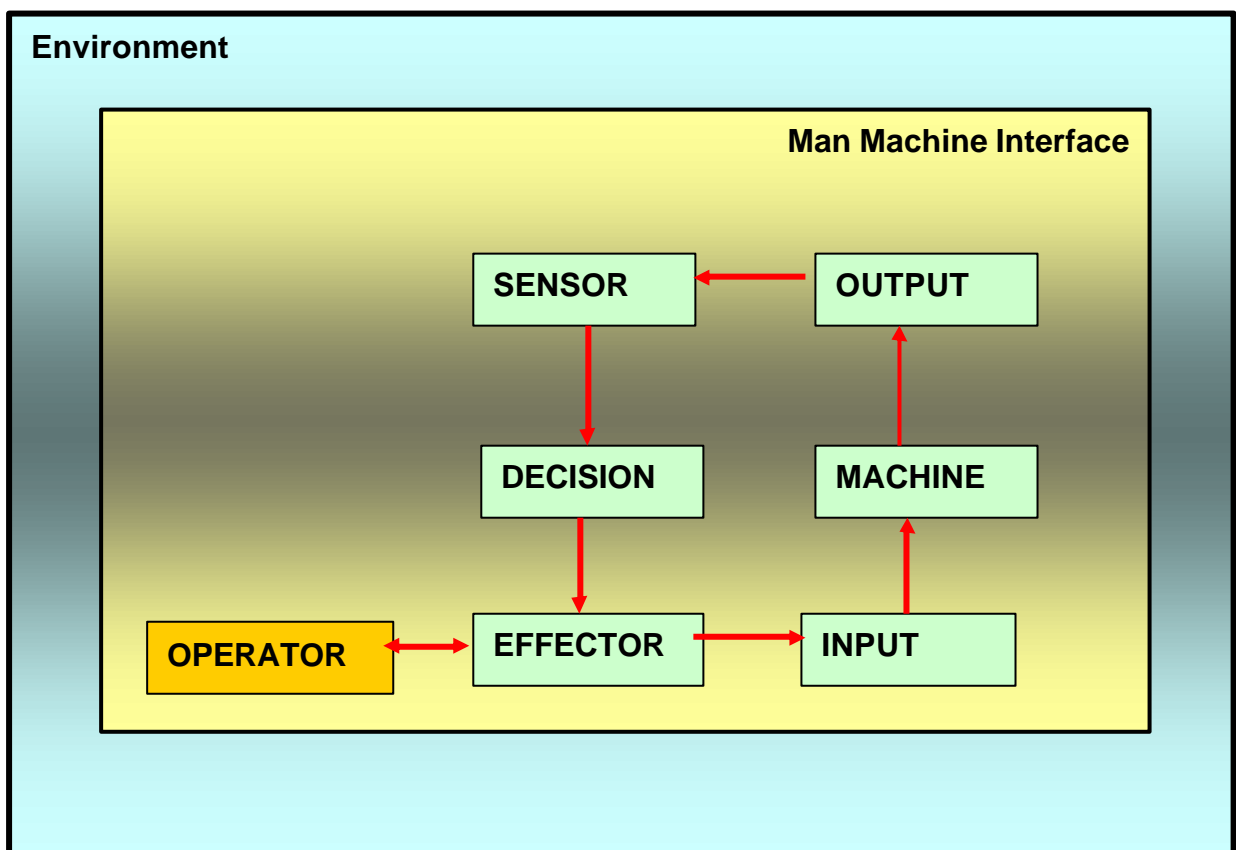


Figure 1

### Typical Man-Machine System

In this diagram it is evident that the operator receives information from the machine about the state of the operation, for example, whether the machine is doing what the operator wants it to do, e.g. whether it is in the correct position, moving at the required speed, etc. He uses

this information to make a decision as to whether he needs to change the operation of the machine in any way, and if so, to take the appropriate control action. The system works therefore as two superimposed feedback loops, the man providing the feedback to the machine and the machine to the man. If the system is to work safely and efficiently, these two loops must be working effectively. In the context of human error potential, there are four basic elements which can denigrate the safety and efficiency of an operation:

a) Information input

The information input to the sensors i.e. vision, hearing and touch, may be insufficient. This can be as a result of:

- ? physical disabilities of the operator,
- ? the information source of the machine may be obscured,
- ? the correct information may not be available when the operator needs it,
- ? the information may not be presented accurately enough or
- ? the information may be too accurately, thereby causing confusion.

Sight and hearing are the two senses most commonly used by operators to evaluate input information.

b) Decision

Good quality information needs to be received in order to enable a reliable decision to be made. If the information is inadequate or confusing, then the reliability of the decision is likely to suffer. Similarly, the information received often needs to be compared with the operator's mental picture of what he is trying to achieve. If there are incompatibilities, then there is an increased probability of error. If the decision is based on some form of operating rule, the quality of the decision is influenced by whether the operator knows the rule, whether he remembers it and whether the information is presented in a reasonable way.

c) Output

The successful completion of any task depends on the undertaking of output actions. Users commonly interface with machinery by operation of controls. Errors are likely to result if the operator is unable to reach a control, if he is unable to activate it accurately enough, or if a series of similar controls are placed close together, thereby causing confusion and activation of the wrong control. In addition to operational controls, machine operators may have to action other decisions by giving verbal or written instructions to others, or by performing other physical tasks.

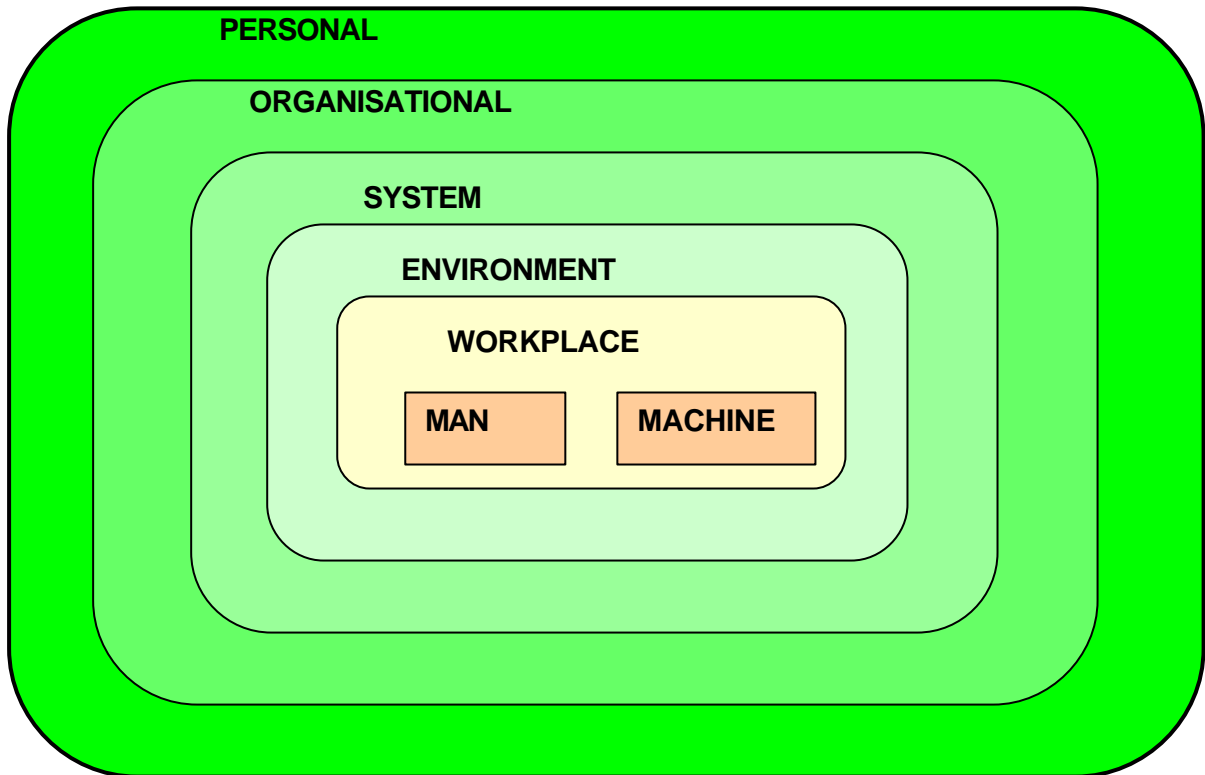
d) Feedback

The feedback element concerns the question of how an operator knows when he has completed a task. Operators rely on two forms of feedback:

- ? **Internal feedback** occurs through a series of sensors in the body which ensure that, for example, they know where their limbs are without having to look at them. These feedback sensors are crucial to safe operation, but it can be assumed, under normal circumstances with healthy individuals, that they function effectively.
- ? **External feedback** concerns any information about the change to the system which comes from outside the operator. This can be, for example, direct visual information (e.g. you see the vehicle beginning to turn the bend after you have turned the steering wheel) or “artificial” information presented by a dial, computer screen or other type of instrument. In the latter case the operator would see the reading begin to fall on a speedometer as he applies the brake. External feedback can, therefore, be regarded as a special form of input

e) External influences

The operator control functions described above should not be considered in isolation. It is also essential to take cognisance of the wide range of external factors that may influence operator performances as illustrated in Figure 2.



**Figure 2**  
**Spheres of external influences**

The central area within the figure above represents the traditional man-machine system, but it is shrouded by clearly defined, though complex, spheres of influence. These include:

- ? The working environment e.g. working headroom, air temperature, humidity, presence of dust or noise, etc.
- ? The working system which addresses interaction with other interdependent equipment or processes
- ? Organisational issues which include training, communications, supervision, management style, etc.
- ? Personal factors, which refer to the difficulties and problems that people bring to the job. All people are different, both mentally and physical. Personal factors are therefore behavioural problems and different attitudes to safety to contend with.

These spheres of influence can have both a direct and indirect influence on the efficiency of the man-machine system and therefore can contain factors that are likely to predispose error potential, i.e. **Active Failures**.

### 3.2 Latent failures

**Latent failures** are those factors or circumstances that reside within an organisation which increases the likelihood of **Active Failures**. They are the broader issues with the potential to influence a wide range of **Active Failures**. Typical **Latent Failures** include, inadequate training provision, poor equipment design (particularly in terms of ergonomics), poor attitudes to safety, work organisational problems, limitations in occupational safety, codes, rules and procedures, etc.

The distinction between **Active** and **Latent** Failures is important for several reasons:

1. If consideration is focused only on **Active Failures**, then the natural tendency is to focus on blame, which has little value in accident prevention terms.
2. If the **Latent Failures** are not recognised, then repeat or similar accidents are inevitable. For example, consider an operator who makes a mistake which leads directly to an accident. If the investigation focuses only on the Active Failure, it overlooks the fact that the training, which the operator received, was most probably inadequate. In this case training is the Latent Failure and is the true cause of both the error and the accident. Failure to recognize the training inadequacies perpetuates the likelihood that other operators will make the same mistake.
3. A **Latent Failure** has the potential to influence a wide range of errors and thereby accidents, e.g. poor ergonomic considerations resulting in restricted driver vision on LHDs increases the risk of collisions and of drivers being injured as a result of leaning out of the cab and adopting other unauthorised practices to overcome visual limitations. It follows logically that removing a Latent Failure is an extremely powerful and cost-effective accident prevention measure.

Examination of the factors influencing potential **Active Failures** in the mining industry indicated underlying causes, i.e. **Latent Failures**, in the following eight major areas:

1. Equipment design
2. Maintenance

3. Organisation and working methods
4. Rules and procedures
5. Management of contractors
6. Attitudes to safety
7. Education and training in occupational health and safety issues
8. Safety assurance systems.

Each of the ***Latent Failures*** identified encompasses a number of individual components as detailed in Chapter 4.

#### 4. COMPONENTS OF LATENT FAILURES, CONTRIBUTING FACTORS AND POSSIBLE CORRECTIVE ACTION

##### 4.1. Equipment design

*“The majority of the problems in relation to error and accident potential stemming from inadequacies in equipment design arose from a failure, on the part of the designers and/or manufacturers of the equipment, to adequately consider the ergonomic implications of their designs”*

FAILURE COMPONENT	CAUSES	POSSIBLE CORRECTIVE ACTION
<p>Limitations in the original design of transport equipment</p>	<p>? Designers and manufacturers of mobile trackless equipment fail to adequately consider the requirements of the operators and other members of the transport teams in the original design of the equipment used.</p>	<p>? <b><u>Designers and manufacturers</u></b> must ensure, as far as reasonably practicable, that the ergonomic principles are considered and implemented during the design, manufacture, erection or installation of the equipment (Section 21 of the MHSA)</p> <p>? <b><u>Employers</u></b> to conduct pre-emptive or “issue-based” risk assessments, on all new equipment (Section 21 of the MHSA)</p> <p>? <b><u>Employers</u></b> to conduct “routine” risk assessments on all existing equipment (Section 21 of the MHSA)</p>
<p>Limitations associated with in-house design and manufacturing</p>	<p>? In-house designers and manufacturers of mobile trackless equipment fail to adequately consider the requirements of the operators and other members of the transport teams in the design of the equipment to be used.</p>	<p>? <b><u>In-house designers and manufacturers</u></b> must ensure, as far as reasonably practicable, that the ergonomic principles are considered and implemented during the design, manufacture, erection or installation of the equipment (Section 21 of the MHSA)</p> <p>? <b><u>Employers</u></b> to conduct pre-emptive or “issue-based” risk assessments, on all new equipment (Section 21 of the MHSA)</p> <p>? <b><u>Employers</u></b> to conduct “routine” risk assessments on all existing equipment (Section 21 of the MHSA)</p>

Vehicle modifications	<p>? On-mine workshop modifications, involving new arrangements, often introduce operational inconsistencies, problems of compatibility and generally exacerbate the ergonomic limitations.</p>	<p>? <b>Employers</b> to conduct pre-emptive or "issue-based" risk assessments, on all modified equipment (Section 21 of the MHSA)</p> <p>? <b>Employers</b> to conduct "routine" risk assessments on all existing equipment (Section 21 of the MHSA)</p>
Roadways and ancillary equipment	<p>? Insufficient consideration is given of the safety requirements in the design of roadways and transport activities of ancillary equipment</p>	<p>? Reduce the risk of speed related transport accidents</p> <p>? Improve road safety standards</p> <p>? Reduce accident potential resulting from unsafe parking practices</p> <p>? Improve the deployment of materials handling and transport vehicles</p> <p>? Improve warning signs, road signs and related information</p> <p>? Improve vehicle and general lighting standards</p> <p>? Reduce the risk of accidents in all surface areas, including store yards, metallurgical plants, etc.</p> <p>? Reduce the risk of accidents at loading, tipping and dumping points.</p> <p>? Reduce the risk of accidents on ramps and incline shafts.</p>
Transport system design	<p>? Mine planning and the design of general mine infrastructure fail to provide for a safe transport and tramming operation</p>	<p>? The provision of safety systems must form an integral part of all mine planning and design studies</p> <p>? Ensure the right machine for the job</p>
Design factors influencing potential for violations	<p>? Poor design features often contribute to the difficulties in operating a machine and can act as a motive for operators to violate safety rules</p>	<p>? Ensure adequacy of the equipment design for effective and safe use</p> <p>? <b>Employers</b> to conduct pre-emptive or "issue-based" risk assessments on all new equipment (Section 21 of the MHSA)</p> <p>? <b>Employers</b> to conduct "routine" risk assessments on all existing equipment (Section 21 of the MHSA)</p>



## 4.2. Maintenance

*"Maintenance is important in the context of occupational health and safety since poor maintenance activities are associated with excessive accident rates"*

FAILURE COMPONENT	CAUSES	POSSIBLE CORRECTIVE ACTION
<p>Poor maintenance of plant and equipment</p>	<p>? Poorly maintained plant and equipment is a significant latent failure and there is sufficient evidence to prove that serious accidents can be the result of mobile plant and equipment being used in a neglected condition.</p>	<ul style="list-style-type: none"> <li>? Undertake regular pre-use inspections</li> <li>? Initiate appropriate remedial action following pre-use inspections</li> <li>? Encourage commitment by both maintenance and production staff towards efficient operation of planned maintenance systems</li> <li>? Vehicles with critical defects to be withdrawn from service</li> <li>? Replacement components to be ordered and delivered timeously</li> <li>? Maintain adequate stock levels of safety critical spares</li> <li>? Introduce hazard identification and risk assessment into operator and maintenance staff training modules</li> <li>? Ensure that sufficient resources are available to deal with unexpected demands</li> <li>? Do not take short cuts</li> </ul>
<p>Poor maintenance of environmental conditions</p>	<p>? The failure to adequately maintain environmental conditions is an underlying cause of many potential active failures</p>	<ul style="list-style-type: none"> <li>? Improve vehicle and general lighting standards</li> <li>? Maintain good road and working conditions</li> </ul>

### 4.3. Organisation and working methods

*“Organisation and working methods refer to a failure to ensure that tasks and activities are organised and planned in the safest practical way. It also includes situations where there are failures to provide adequate resources to enable operations to be undertaken safely”*

FAILURE COMPONENT	CAUSES	POSSIBLE CORRECTIVE ACTION
Poor organisation and planning	? A lack of effective planning and organisational structures can have serious safety implications and can lead to unsafe acts and behaviour	? Plan and organise all task to ensure maximum safety to personnel and equipment ? Ensure that the required organisational structures are in place to manage and oversee the planned activities with a view to maximise safety.
Failure to provide adequate resources	? The failure to provide adequate resources results in improvisation and the failure to take the appropriate precautionary measures and the standard of safety begins to deteriorate	? Provide sufficient and reliable <b>safety information</b> for each task to be performed ? Provide sufficient <b>manpower</b> to perform the task safely and effectively ? Provide the correct <b>safety equipment</b> that is required for the task ? Provide the correct and most suitable <b>plant and equipment</b> for the task to be performed safely and effectively.

#### 4.4. Codes, rules and procedures

*“Written codes, rules and procedures are currently regarded as the main pillar of the approach to safety assurance on South African mines. It is clear, however, from the results of previous research studies, that serious flaws exist in the current provision of codes, rules and procedures”*

FAILURE COMPONENT	CAUSES	POSSIBLE CORRECTIVE ACTION
Formulation	? The formulation of written procedures is often a reactive response to accidents rather than the product of a successful pro-active safety policy	? New codes, rules and procedures should be created pro-actively through the process of risk assessment
Review, update and maintenance	? Codes, rules and procedures are often outdated and do not reflect reality or changing conditions and working standards	? Risk assessments to be undertaken in order to identify limitations and shortcomings in the existing written codes, rules and procedures ? The workforce should be involved in the process of reviewing codes, rules and procedures and the creation of new ones ? Codes, rules and procedures should clearly indicate the hazards they are designed to address and should form a foundation for the development of effective safety training material ? Codes, rules and procedures need to be communicated to all personnel concerned through effective systematic training material. ? All rule sets should be critically re-examined to ensure practicality, ease of understanding and to eliminate conflict.
Conflicts	? Where written procedures which are in conflict exist at a mine, there is a high probability that the easiest or most advantageous to work with will be the one complied with.	? Codes, rules and procedures need to be clear, concise and not in conflict with one another. ? All rule sets should be critically re-examined to ensure practicality, ease of understanding and to eliminate conflict
Vagueness	? Written procedures can be vague, imprecise and open to mis-interpretation ? Insufficient information is provided to enable the requirements of a rule to be fully understood and reliably complied with.	? Codes, rules and procedures need to be clear, concise and not in conflict with one another. ? Sufficient information to be provided as part of the code, rule or procedure to enable the requirements of the code, rule or procedure to be fully understood.

<b>Coverage and omissions</b>	<ul style="list-style-type: none"> <li>? Critical situations and activities are not adequately covered by codes, rules and procedures or because the rules lack certain vital information.</li> </ul>	<ul style="list-style-type: none"> <li>? Codes, rules and procedures need to be clear, concise and not in conflict with one another.</li> <li>? Codes, rules and procedures should clearly indicate the hazards they are designed to address and should form a foundation for the development of effective safety training material</li> <li>? Risk assessments should be undertaken to identify limitations and shortcomings in the existing written codes, rules and procedures</li> <li>? The workforce should be involved in the process of reviewing codes, rules and procedures and the creation of new ones in order to ensure effective coverage</li> </ul>
<b>Impracticalities</b>	<ul style="list-style-type: none"> <li>? Written procedures can lack credibility because they do not accurately reflect the hazards and practical difficulties associated with the tasks for which they are formulated.</li> </ul>	<ul style="list-style-type: none"> <li>? The workforce should be involved in the process of reviewing codes, rules and procedures and the creation of new ones in order to ensure that they are practical and easy to implement</li> <li>? Codes, rules and procedures should be reviewed regularly to ensure their practicality and relevance.</li> </ul>
<b>Communication</b>	<ul style="list-style-type: none"> <li>? Failures in the reliable communication of new rules and procedures to the workforce.</li> <li>? Problems exist in terms of inconsistencies in the methods used to communicate codes, rules and procedures and interpretation problems, which stem from the variety of languages and level of literacy experienced on South African Mines.</li> </ul>	<ul style="list-style-type: none"> <li>? Codes, rules and procedures need to be communicated to all personnel concerned through effective and systematic training programmes.</li> <li>? Supervisors are to play a major role in the communication of codes, rules and procedures. The mine should actively support them, both in the development of their training skills and the provision of better quality training aids and material.</li> </ul>

#### 4.5. Management of contractors

*"The incidence of active failures is often greater in the areas where work is undertaken by contractors and it can therefore be concluded that the failure by the mines to effectively manage these activities constituted a significant latent failure"*

FAILURE COMPONENT	CAUSES	POSSIBLE CORRECTIVE ACTION
Failure to comply with regulations and written procedures	<ul style="list-style-type: none"> <li>? Contractors are often not aware of the relevant regulations and safety standards applicable to mining operations</li> <li>? Failure by mines to adequately vet the safety management systems of contractors prior to their appointment</li> <li>? Failure by mines to effectively monitor contractor activities</li> </ul>	<ul style="list-style-type: none"> <li>? Mine management must increase their level of monitoring and control over activities undertaken by contractors.</li> <li>? Mine management must institute a system for checking the condition of all vehicles entering the mine property, and ensure that drivers and passengers in these vehicles are fully aware of and understand the safe working standards and procedures</li> </ul>
Inadequate training	<ul style="list-style-type: none"> <li>? Little or no emphasis placed by contractors on training</li> <li>? Hazard identification and risk assessment does not generally form part of contractor training programmes</li> <li>? Failure by mines to adequately vet the training and safety management systems of contractors prior to their appointment</li> <li>? Failure by mines to effectively monitor contractor activities and training programmes</li> </ul>	<ul style="list-style-type: none"> <li>? Mine management must increase their level of monitoring and control over activities undertaken by contractors.</li> </ul>
Inadequate maintenance	<ul style="list-style-type: none"> <li>? Limited and/or inadequate maintenance facilities resulting in poor maintenance standards</li> <li>? Failure by mines to control the condition of plant/equipment used by contractors</li> </ul>	<ul style="list-style-type: none"> <li>? Mine management must increase their level of monitoring and control over activities undertaken by contractors.</li> <li>? Mine management must institute a system for checking the condition of all vehicles entering the mine property, and ensure that the required standards in terms of health and safety are maintained.</li> </ul>
Poor and/or inadequate operating standards and procedures	<ul style="list-style-type: none"> <li>? Little or no operator training provided by contractors</li> <li>? Inadequate supervision by contractor personnel</li> <li>? Lack of general standards and operating procedures, especially as it applies to mining</li> <li>? Failure by mines to adequately vet the safety management systems of contractors prior to their appointment</li> <li>? Failure by mines to effectively monitor contractor activities</li> </ul>	<ul style="list-style-type: none"> <li>? Mine management must increase their level of monitoring and control over activities undertaken by contractors.</li> <li>? Mine management must institute a system for checking the condition of all vehicles entering the mine property, and ensure that drivers and passengers in these vehicles are fully aware of and understand the safe working standards and procedures</li> </ul>

#### 4.6. Attitudes to safety

*“Attitudes to SAFETY is the most influential of all the latent failures which contribute to transport and tramming accidents. The tenor of the safety culture of an organization is established essentially by the attitudes to safety shown by management and, in turn, by the supervisory staff.”*

FAILURE COMPONENT	CAUSES
Management attitudes to safety	<ul style="list-style-type: none"> <li>? No amount of hard work and careful preparation in the establishment of codes, rules and procedures, in the development of training, etc. will have any lasting effect if those “safe working practices” are not routinely supported by high standards of managerial and supervisory commitment to both encourage and monitor compliance.</li> </ul>
Failure to take appropriate action	<ul style="list-style-type: none"> <li>? Failure by management to take appropriate action in situations where potentially unsafe conditions/behaviour is known to exist.</li> <li>? Failure by management to constructively address specific problems has the effect of dispelling any incentive among the workforce to report their safety related concerns.</li> <li>? Inadequate monitoring and disciplining of unsafe behaviour by supervisors.</li> </ul>
Failure to pay regards to rules	<ul style="list-style-type: none"> <li>? Failure by managers and supervisors to obey rules, and consequently adopt unsafe working practices in front of the workforce.</li> </ul>
Failure to control unsafe behaviour	<ul style="list-style-type: none"> <li>? Inadequate monitoring and disciplining of unsafe behaviour by supervisors.</li> <li>? Lack of involvement in ensuring compliance.</li> </ul>
Encouragement to break rules	<ul style="list-style-type: none"> <li>? Conflicting responsibilities for safety and production can lead to “condoning” unsafe working practices.</li> </ul>
Workforce attitudes to safety	<ul style="list-style-type: none"> <li>? Lack of clarity amongst the workforce regarding their corporate and personal responsibility for safety</li> <li>? A general lack of safety commitment by the workforce.</li> <li>? Poor attitudes to safety as a result of limited hazard awareness and/or risk perception.</li> </ul>
Attitudes to codes, rules and procedures	<ul style="list-style-type: none"> <li>? A poor understanding and application of written codes, rules and procedures</li> </ul>

#### 4.7. Education and training on occupational health and safety issues

*“More than half of the potential active failures identified could be related, at least in part, to a lack of competence i.e. the need for additional training. These ranged from the need for relatively simple ‘reminders’, such as the importance of wearing stipulated personal protective equipment, to more formal training programmes to overcome, for example the proliferation of unsafe driving/operating practices”*

FAILURE COMPONENT	CAUSES	POSSIBLE CORRECTIVE ACTION
Training course content	? Training course content can be irrelevant, inaccurate or major omissions can occur	? Training needs analysis should be used to identify the required content of training courses/programmes. Training needs analysis should be based on: the results of risk assessments, knowledge of written procedures and instructions and codes of practice.
Education and training on hazards and risks	? Education and training on hazards and risks in the workplace are often not adequately covered in the training programmes.	? The adoption of training methods and approaches that will ensure competencies in risk perception and hazard awareness are of paramount importance.
Identification of training needs	? Mines often fail to recognize specific training needs of the workforce	? Training needs analysis should be used to identify the required content of training courses/programmes. Training needs analysis should be based on: the results of risk assessments, knowledge of written procedures and instructions and codes of practice.
Upgrading the competence of supervisors in terms of occupational health and safety training	? Supervisors are often less than competent in many potentially safety-critical areas and have potentially conflicting responsibilities for both safety and production	? Consideration should be given to the introduction of specific occupational health and safety training courses to upgrade the competence of supervisory staff if they are to continue in their training role.
Training evaluation	? Lack of effective measurements to assess the competency of trainees accurately ? No systematic process to evaluate the effectiveness of training programmes	? There is an urgent need to develop standard approaches to the measurement of safety training effectiveness. Training effectiveness, and its impact on worker hazard awareness, should be routinely assessed using risk perception and hazard awareness assessment techniques.

#### 4.8. Safety assurance systems

*"Accident potential must be actively and systematically controlled if reliable and improving safety standards are to be achieved. In order to achieve the required level of control, it is essential that mines have a wide range of effective safety assurance systems in place."*

FAILURE COMPONENT	CAUSES	POSSIBLE CORRECTIVE ACTION
Safety inspections	? Routine and ad-hoc safety inspections are not being performed by responsible personnel on a regular basis	? All safety inspections to be planned and controlled. A regular feedback reporting system to be introduced and maintained.
Pre-use checks	? Equipment continued to be used even when defects of a potentially critical nature have been recorded ? Supervisors fail to regularly over-inspect pre-use checks ? Incomplete or incorrect checklists ? Lack of communication of problems between operators during shift changes ? No follow-up procedure to ensure that problems had been dealt with	? All safety inspections to be planned and controlled. A regular feedback reporting system to be introduced and maintained.
Security of mine entry and exit systems	? Failure to have systems in place to prevent unauthorized access of unsafe equipments or untrained people onto mine property	? Mining areas to be securely fenced off and all access gates/entrances continuously monitored and controlled. ? Mine management must institute a system for checking the condition of all vehicles entering the mine property, and ensure that drivers and passengers in these vehicles are fully aware of and understand the safe working standards and procedures
Planned task observations	? Planned task observations not conducted systematically	? All safety inspections to be planned and controlled. A regular feedback reporting system to be introduced and maintained
Feedback from incident and accident reports	? Feedback from incidents and accident reports not always used effectively to identify root causes and/or possible solutions to equipment and tramming accidents.	? Information from near-miss incidents can prove valuable to prevent further, more serious accidents.