SAFETY IN MINES RESEARCH ADVISORY COMMITTEE

SIMRAC

DRAFT (REVISED)

Final Project Report

Title: GUIDELINES FOR THE DEVELOPMENT OF TRAINING MANUALS FOCUSED ON THE SAFER USE OF UNDERGROUND MACHINERY

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EXECUTIVE SUMMARY

This project is focused on the development of guidelines for the training of operators using high risk underground coal mining machinery.

The project involved three distinct phases:

- Visiting a representative sample of South African collieries to gather information using a structured questionnaire specially developed for this purpose. Other interested parties, local and overseas were also involved in the information gathering process.

- A risk assessment process based on the information gathered and a systematic causal analysis of incidents during the period 1992 to 1994.

- Drawing of conclusions and formulating recommendations.

During the survey conducted it was noted that the multi-ethnic nature of the machine operators made training and instruction extremely difficult.

It was however concluded that literacy is only an essential element should reading and writing be required to perform that work in a correct and safe manner. However competence can only be judged to be adequate when the individual being trained has complete understanding of the language of training.

From the risk assessment arose the broad conclusion that attention to training, specifically for maintenance or repair activities, could have a significant impact on the number and severity of incidents involving underground coal mining machinery. Furthermore, training for operators only is not sufficient, it must extend to all those people who may be affected, because it was found that practices exist which allow persons to get access into jobs without passing selection criteria or being suitably trained, licensed and authorised e.g. cable handlers or assistant operators.

The project also considered the question of training, both on the job and off the job, as well as the commonly accepted principles of learning and concluded that training programmes for operators and assistants should include general basic principles, task and also machine specific operating procedures. Furthermore workers can only remain competent if they are regularly retrained on revised and updated training programmes.

In this project the practical training given to operators of underground mobile machinery on coal mines in the United Kingdom and Australia were assessed and the common principles enumerated. It was concluded that the Australian model, which separates licensing from authorisation, be adopted.

As the Mine Health and Safety Act places ultimate responsibility on the employer to ensure the competence of workmen, the report also considered the implied legal requirements and possible pitfalls.

In order to ensure that training is cost effective it is essential that the right employee be selected to match the job specifications. Training must however be seen within the context of establishing a cycle of learning.

In the project guidelines for selection criteria including such items as physical capability, education, medical examination and psychometric testing are referred to.

Training criteria for competence are considered including licensing and authorisation as well as the possible involvement of the Mining Qualification's Authority. Included in the report are also a number of other pertinent related issues which require addressing as well as areas of suggested further research.

1. INTRODUCTION

1.1 BACKGROUND

The new Mine Health and Safety Act, lists as its first purpose, the promotion of a culture of health and safety. It is generally accepted that there are three components to this:

- the raising of awareness at all levels in an organisation;
- the provision of motivation to achieve the desired performance;
- the provision of systems which promote and support positive behaviour.

Short term changes can be achieved by undertaking any of these steps, but sustained change can only be achieved by implementation of all three measures together.

Training is one of the primary means to raise awareness, motivate people and to implement control systems. The undertaking of effective training is therefore critical in terms of reducing the number of accidents occurring in the South African mining industry and thereby satisfying the broad aims of the new Act. Indeed, one of the other purposes of the Act is to improve training and human resources development and one of the major duties upon Mine Managers is to provide information, instruction, training and supervision to enable employees to perform their work safely.

SIMRAC commissioned an earlier project (COL 203) to examine the nature and magnitude of the human and engineering factors to the risk of injury and fatality caused by underground machinery in coal mines. The report used a form of risk assessment which prioritised:

- shuttle cars;
- tractor trailers;
- load haul dumpers;
- front-end loaders;

as the major hazards which warranted further research. This project, COL 341, is focused on the development of guidelines for training of operators using high risk underground coal mining machinery. It is believed that these guidelines will assist mines in the development of site specific skills training programmes, which will act to reduce the risks of injury, damage, environmental and health factors and so enhance productivity. It is also believed that the newly created Mining Qualifications Authority can draw upon the guidelines when setting standards of competency in this area.

While any training developed on the basis of the guidelines reported here must be in keeping with the social, cultural and legal environment of South Africa, an essential part of the project has been to gather information from overseas, where similar situations exist.

The study has also addressed the question of risk, from a fundamental perspective, by reanalysing the relevant accident data. This risk analysis has been conducted in keeping with the published Guidelines for Risk Assessment in the Mining Industry, development of which is also funded by SIMRAC.

Another important starting point for the study has been past research on training and the principles which should be borne in mind when designing specific training programmes.

1.2 PROJECT TEAM

This study has been conducted with a team of staff drawn from IRCA and its consultants. The team were:

Project Leader	Grant Purdy
Project Co-ordinator	Charles van Breda
Project Consultant	Jan Raath
Project Consultant	Heinz Strohbach
Project Engineer	Herbie Godfrey
Project Legal Advisor	Michael Kruger
Project Administrator	Othene van Zyl

1.3 ACKNOWLEDGEMENTS

This project would not have been possible without the tremendous assistance of all those who the project team met, particularly those at South African mines who contributed freely of information and views.

The team would particularly like to thank:

Company	Team Leader	
New Denmark Colliery	Mine Manager	Mr M Rutherford and Team
Sasol Secunda - Middelbult Colliery	Mine Manager	Mr J A van Niekerk and Team
Matla Colliery	General Manager	Mr J D Stone and Team
Tavistock Collieries	General Manager	Mr P M Coetzer and Staff
Hlobane	General Manager	Mr C R Edwards and Team
Durnacol	General Manager	Mr S A Oosthuizen and Team
Department of Mineral Affairs Witbank		Mr L Bezuidenhout & Mr C Lewis
Manufacturers and Suppliers		
Joy Manufacturing		
Voest Alpine		
Bird Machines (Pty) Ltd		

2. RISK ANALYSIS

2.1 HAZARD IDENTIFICATION

The information gathering for this project involved three distinct phases. The first phase consisted of visiting a representative sample of South African collieries to gather information. Underground visits were made to see the various machines in operation at the workfront. Interviews were conducted with operators, front-line supervisors and all other levels of management. To facilitate this assessment, a structured questionnaire was developed and used. This is described in Appendices I and II. At each mine, the mine training centre was also visited to collect related training materials and manuals. This was the ideal opportunity to discuss the training programme in detail and to assess the contributions currently being made by the manufacturers and suppliers of machinery. To facilitate the most open and frank exchange of information, a special effort was made to keep all discussions informal, especially when speaking to operators.

The information gathered during the mine visits was the primary basis for the development of guidelines. This was focused by a second phase involving a risk assessment process based on a systematic causal analysis of previous incidents.

The project team carefully considered and reviewed report COL 203 which contained an earlier data analysis but found that although this was helpful, it was inadequate for the purpose of this project. A further risk assessment was therefore conducted on the basic data set, and this is shown below, both qualitatively and quantitatively.

The recently published Practical Guide to the Risk Assessment Process[13] under the new Mine Health and Safety Act, defines a 'hazard' as something which has the potential to cause harm or loss. Risk assessment involves, firstly, the assessment of consequences, where the degree of harm from the identified hazard is assessed in terms of the potential severity of the injuries and the number of people potentially affected. This is followed by a frequency analysis which looks at the degree of exposure to the hazard and the probability that persons will be harmed during the exposure period. This protocol has been adopted in the analysis of underground machinery accidents for the years 1992 to 1994. The hazard identification exercise follows the general model shown in Figure 2.1.

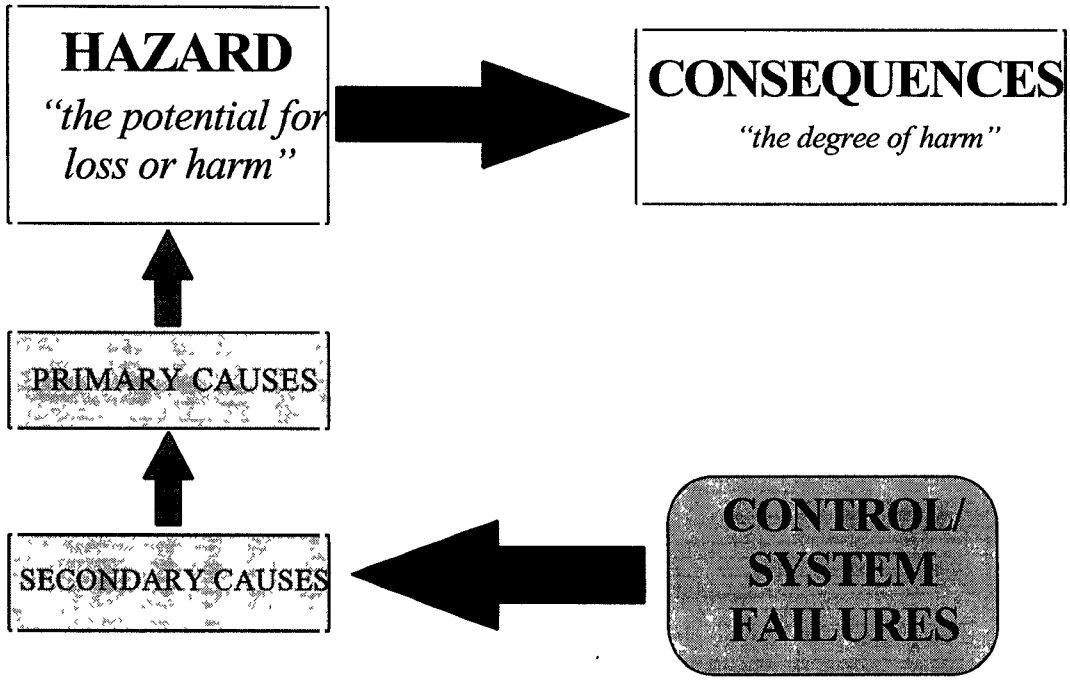

FIGURE 2.1 Hazard Identification Model

Tables VIII.1 to VIII.10 in Appendix VIII, show the results of a hazard identification exercise for each type of machine. Inspection of the results of this exercise shows that inadequate training was judged to be one of the major risk management control failures that led to accidents.

2.2 INCIDENT DATA ANALYSIS

The incident data has also been analysed quantitatively using the same scheme of analysis. The graphical results of this analysis is shown in Figures IX.1 to IX.12 in Appendix IX.

The analysis of all accidents shows that:

- coal transporters are involved with the largest number of accidents, both those involving injury and those involving death;
- while hand tramming is a major cause of injuries, it is not (for the data analysed) the major cause of fatalities. It also seems to be underrepresented in terms of Penalty Shifts; and
- coal mining machines are the second largest cause of accidents.

Analysis of incidents for coal transporters show that, while shuttle cars cause most accidents, scoop and front-end loader accidents (17% and 18% respectively) lead to more fatalities. In other words, the injuries sustained in scoop and front-end loader accidents are more severe.

The major time for injuries on shuttle cars is during maintenance and repairs, but where the accident involves the striking of a worker by the shuttle car, on two out of three occasions, that worker was not the operator.

For scoops, the major cause of injury is being struck by the scoop, not through maintenance or repairs. Similarly, more workers working nearby are injured than operators.

For front-end loaders, the major cause of accidents is maintenance and repairs. In this case there is the same proportion of operators to pedestrians who are injured by being struck. If we examine fatal accidents only, the involvement of persons other than the operator is even more pronounced: 75% of fatal accidents for scoops and 50% each for scoops and front-end loaders involve third parties.

For coal mining machines, while maintenance is the major cause of accidents, these are never fatal. Again here, it is people other than the operator who bear the major risk of fatality.

For tractor trailers, maintenance is again the major cause of accidents, but striking the operator is the major cause of fatality. Being caught in the roller of a conveyor is the sole cause of death recorded for conveyors.

From this, one might draw the broad conclusion that attention to training, specifically for maintenance or repair activities, could have a significant impact on the number and severity of accidents. Furthermore, training for operators only is not sufficient, it must extend to all those who may be affected. Mostly, the injured or killed 'Pedestrian', has been the 'No. 2' or 'Cable handler'. The survey of mines (see Section 3) found that the assistant operator was rarely formally trained or licensed. This report therefore considers how this person can be incorporated into training for underground machines and how his competence could be assured.

2.3 RISK ANALYSIS

Using the incident data shown in Appendix IX, and using the approximate numbers of machines in use in the South African Coal Mines, it is possible to estimate the rate of accidents per machine and per exposed employee. This latter value is, effectively, individual risk. The assumptions made on machinery numbers are shown in Table 2.1. The exact number of the different machines is unknown, but expert judgement has generated lower and upper bound figures for the population sizes.

Table 2.2 shows the results of the risk analysis.

2.4 RISK RANKING AND ASSESSMENT

Tables 2.3 and 2.4 below show the mean risks in terms of fatality rate per expected employee per year and accident rate per machine per year. These have been ranked.

TABLE 2.1 Assumptions on Machinery Numbers

Machine	Number in Use	
	Lower Bound	Upper Bound
Shuttle Cars	750	850
Scoops	35	45
LHDs	120	150
CM and Road Headers	25	35
Loaders	380	440
Tractor Trailers	480	520
Mobile Drills	350	400
Roof Bolters	350	400

These results can be placed into context in terms of the other risks to life and normally used risk criteria. Table 2.5 shows some of the other risks that people face in South Africa. It can be seen that Scoop Operators face an average risk of 1 in 59 chances per year of death. This means that the risk of dying from their work activities is comparable or even greater than their risk of dying from natural causes!

Currently, there are no accepted criteria for risks in South Africa. However, many other countries (and companies) have developed criteria for acceptable and intolerable risks in the workplace. For example, in the North Sea, the UK Health and Safety Executive prescribes a maximum tolerable risk level of 1×10^{-4} per year for employee fatalities (or one chance in 10 000 per year of fatality). It can be seen how far the historically derived figures for South African Coal Mining Machines differ from this.

Figures IX.11 and IX.12 in Appendix IX also show us that if there is an accident involving a scoop, there is a 1 in 10 chance of it being fatal. Similarly, although mining machines and road headers have the lowest accident rate, again 1 in 10 accidents lead to fatality. These ratios are considered very high.

TABLE 2.2 Risk Analysis Results

	Scoops		Shuttle Cars		Front End Loaders		Coal Mining and Road Headers		Tractor Trailers	
No. of Units	LB	UB	LB	UB	LB	UB	LB	UB	LB	UB
	35	45	750	850	120	150	785	915	480	520
No of People Exposed	70	90	1500	1700	240	300	1570	1830	960	1040
No of Fatalities Per Year	1.3	1.3	1.3	1.3	0.7	0.7	2.0	2.0	0.3	0.3
No of Injuries Per Year	3.3	5.7	4.0	10.3	0.7	2.3	3.3	10.0	3.0	8.3
No of Accidents Per Year	7.0	7.0	11.7	11.7	3.0	3.0	12.0	12.0	8.7	8.7
Fatalities Rate (Per Person Year)	1.5×10^{-2}	1.9×10^{-2}	7.8×10^{-4}	8.9×10^{-4}	2.2×10^{-3}	2.8×10^{-3}	1.1×10^{-3}	1.3×10^{-3}	3.3×10^{-4}	3.5×10^{-4}
Injury Rate (Per Person Year)	3.7×10^{-2}	8.1×10^{-2}	2.4×10^{-3}	6.9×10^{-3}	2.2×10^{-3}	9.7×10^{-3}	1.8×10^{-3}	6.4×10^{-3}	2.9×10^{-3}	8.7×10^{-3}
Accident Rate (Per Machine Year)	1.6×10^{-1}	2.0×10^{-1}	1.4×10^{-2}	1.6×10^{-2}	2.0×10^{-2}	2.5×10^{-2}	1.3×10^{-2}	1.5×10^{-2}	1.7×10^{-2}	1.8×10^{-2}

TABLE 2.3 Risk Ranking - Fatalities

Machine	Mean Risk Individual Risk of Death per year	Ranking
Scoops	1.7×10^{-2}	1
Front End Loaders	2.5×10^{-3}	2
Coal Mining and Road Headers	1.2×10^{-3}	3
Shuttle Cars	8.4×10^{-4}	4
Tractor Trailers	3.4×10^{-4}	5

TABLE 2.4 Risk Ranking - Accident Rate per Machine

Machine	Mean Risk Accident Rate per Machine per year	Ranking
Scoops	1.8×10^{-1}	1
Front End Loaders	2.3×10^{-2}	2
Tractor Trailers	1.75×10^{-2}	3
Shuttle Cars	1.5×10^{-2}	4
Coal Mining and Road Headers	1.4×10^{-2}	5

TABLE 2. 5 Individual Risks for South Africa (Taken from Reference 9)

Description	Risk (per year)
Death due to motor vehicle accident in South Africa, per capita	5.0×10^{-4}
Death due to motor vehicle accident in Johannesburg	5.3×10^{-3}
Average fatality rate in Mining Industry#	9.0×10^{-4}
Average murder rate in South Africa	5.0×10^{-4}

(Reference 1)

3. PAST RESEARCH

3.1 WHY TRAIN EMPLOYEES?

South African collieries are faced with numerous challenges as they approach the 21st century. The prospect of increased international competition, relatively high labour costs and low productivity puts pressure on mines to become more efficient if they wish to remain competitive in the international market.

It is generally accepted that a comprehensive orientation and training programme can usually get a mining system into operation faster, keep it producing at an acceptable rate and reduce breakdowns and accidents[6].

There is also a general awareness of the emphasis which is being placed by the Government on the training and development of employees. This is evidenced in the allocation of funds in the Reconstruction and Development Programme, as well as in the move towards a National Qualifications Framework and the integration of Education and Training in South Africa.

The new Mine Health and Safety Act also demonstrates the Government's emphasis on training. Section 7(d) of this Act places the onus on the manager to consider an employee's training and capabilities in respect of health and safety before assigning a task to him. Section 10 of the Act deals in detail with the manager's duties to provide health and safety training for all employees.

The regulations under the Act require the manager not to permit any incompetent workman who will endanger his safety and the safety of others to operate. These regulations therefore highlight the following requirements and associated pitfalls:

Requirements

- persons operating machinery, either fixed or mobile have to be appointed by the mine manager;
- such appointments can therefore be construed to be an acceptance of competence by the mine manager; and
- elsewhere, such as in the case of vehicles which operate on the public roads, driving licences are issued on a probationary basis until the trainee passes an independently verified practical examination and theoretical test. In the case of road vehicles therefore, such licensing is a proof of competency.

Pitfalls

- the most obvious pitfall is the lack of any national standard in terms of consistency and content of training;
- furthermore, once training has been conducted there is no national standard in terms of the testing of competence;
- often, the quality of competence testing is only highlighted after an accident such as that at Vaal Reefs (see Section 3.7);
- our review of training programmes on the collieries show that in many cases, obsolete equipment or operational methods were used as the basis of training and testing; and
- our survey also showed major differences between the standards of training and the method of competence testing between different mines.

It would therefore seem that there is no standard at present in terms of the training of such operators and the testing of their competence. Furthermore, the appointments issued by mine managers have to be questioned because of the appropriateness of some training and the inadequacy of the competence testing.

The magistrate in a recent South African mining case recorded[14]:

> *"Where lack or inadequacy of training is deemed to be the cause or to have aggravated the cause of an occurrence, the manager will have failed to have taken reasonable measures to ensure the competency of the workman involved".*

In other words, the presently observed conditions must raise doubts as to whether the collieries and mine managers are satisfactorily discharging the legal duties placed upon them.

3.2 LITERACY SKILLS

One of the most effective and efficient ways of conveying information is through the written medium. Certainly, for technical information, it is more difficult to convey this in a verbal format, but literacy is not essential.

During the survey, it was noted that the multi-ethnic nature of the machine operators made training and instruction extremely difficult. We found that few mines actually trained in indigenous languages and that most training was conducted in mine vernacular with its limited vocabulary. The view was often expressed that this may be a major cause of inadequacy in the training being delivered.

During research in Australia, on the training of indigenous people (Aborigines, Solomon Islanders and Indonesians), we found that the Australians had recognised that an ability to fully communicate in the language of training, was essential. The trainees did not necessarily have a technical vocabulary when they started training. The training establishments preferred to grow this aspect of language as the trainee was trained in the relevant skills. The ability to read and write was also not considered essential.

Our conclusions are therefore:

- literacy should only be considered an essential requirement if reading and writing are required to perform the job in a correct and safe manner;
- as teaching and competence testing can be conducted by oral and visual methods, literacy is therefore not considered essential to obtain competency in operating underground machinery;
- on the other hand, understanding and therefore competence can only be judged to be adequate when the individual being trained has a full and adequate understanding of the language of training.

3.3 WHAT IS TRAINING?

Training is a learning experience in that it seeks a relatively permanent change in an individual that will improve his ability to consistently perform his job to the appropriate performance standard. This can be achieved through direct experience - by doing - or indirectly through observation[8].

Regardless of the means by which learning takes place, learning cannot be measured as such. Changes can only be measured in attitudes, understanding, behaviour and perception, that occur as a result of learning[7].

Figure 3.1 shows a generally accepted model for learning.

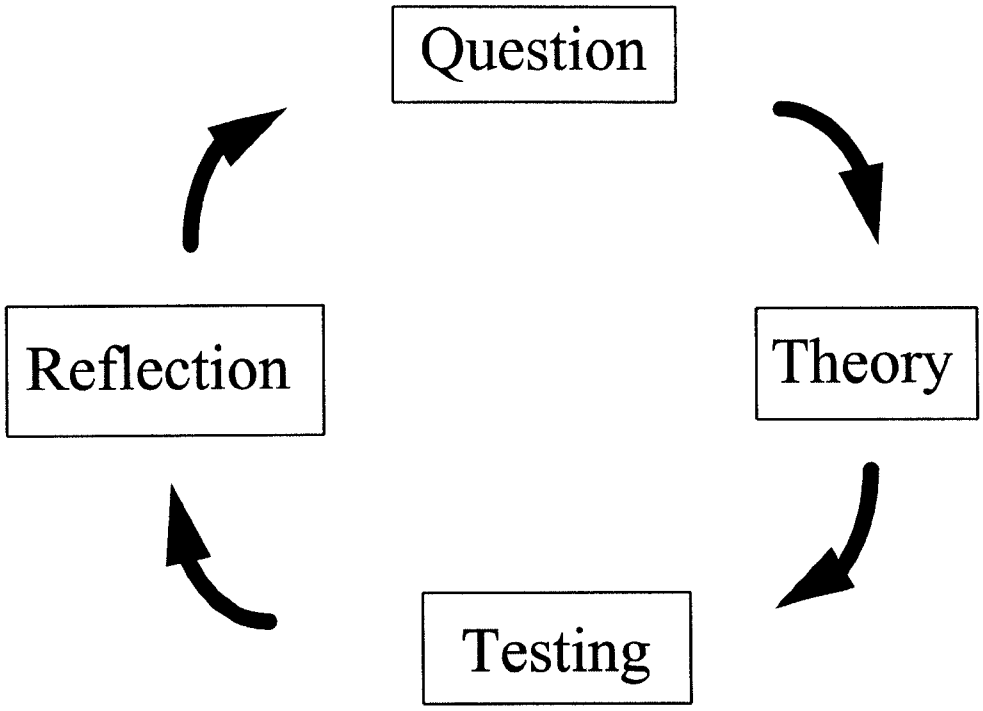

FIGURE 3.1 Model for Learning[7]

Logically, we start at the top of the model with a question. This is a problem to be solved, a dilemma to be resolved or a challenge to be met. Questions need possible answers and the next stage provides them. Theory is a rather grand term and is about investigating possible ideas. The value of a properly structured training environment where operators draw their own conclusions on the most appropriate way to act, based on advice, guidance and the suggestions of the trainers, can be seen here.

However, ideas and theories are never enough. No one will accept them unless they have been tested in reality. This is the importance of practical training and why all training courses should involve the supervised implementation of what has been taught in a work situation. When the trainee tries what he believes, sometimes it works and sometimes it doesn't. For the training to work and therefore his behaviour to be changed, he has to reflect upon what has happened in order to produce his own 'Theory'. Inevitably, this produces more questions and we commence the cycle again. Training courses can only initiate this cycle; continued education, proper supervision, coaching and mentoring sustain the learning cycle, leading to continued improvements and complete, sustained cultural and behavioural change.

Although this project principally concerns training, this must be seen within the context of establishing a cycle of learning. It is therefore important to understand what learning is and what it is not.

For example, learning is not[3]:

- the same as just knowing the answers;
- the same as studying or training, it is a way of thinking and of growing knowledge and skill;
- measured by examination;
- automatic, it requires the expenditure of energy and effort; or
- finding out what others already know.

In essence, learning is about solving your own problems for your own purposes by questioning, thinking and testing until the solution is part of your life. The training process must become part of the establishment of a learning cycle and therefore the design of training is critical.

3.4 PRINCIPLES OF LEARNING[2]

The following may be regarded as the principles of learning aligned to the social learning theory:

(a) Learning is enhanced when the learner is motivated. An individual must want to learn and must not be instructed to do so. When that desire exists, the learner will exert a high level of effort.

(b) Learning requires feedback. Feedback, or knowledge of results, is necessary so that the learner can correct his mistakes.

(c) Reinforcement increases the likelihood that a learned behaviour will be repeated. Learning will be facilitated by providing feedback through positive reinforcement.

(d) Practice increases a learner's performance. There are three ways in which a learner can practice a job. One is to practice the whole job at once. The second is to break the job into parts and practice each part independently. The third is to break the job into parts and practice them progressively. Which way is best? The answer lies in the type of job being done and must be decided by the training provider.

(e) Learning begins rapidly, then reaches a plateau. Exactly when a plateau is reached depends on an individual, but must be considered when training periods are evaluated. At the commencement of the plateau, learning slows as progress evolves into the refinement of technique. Because of the differences between individuals, the modular system of instruction in which trainees can progress at their own pace usually provides the best results.

(f) Learning must be transferable to the job. It does not make much sense to perfect a skill in training and then to find that it cannot be successfully transferred to the actual job. Knowledge imparted during training need not always be directly transferable, as long as it is relevant and results in a better understanding of the company's goals.

(g) What is learnt rapidly decays rapidly unless it is supported and implemented on a day to day basis. The continual application of what is learnt, particularly when it is supported by coaching and supervision, will counteract this decay. Periodically, however, it will be necessary for people to be retrained, to realign their views and correct some of the deviations which occur naturally over time. However, to be effective, this retraining needs careful design. It should not just involve the repeating of the original training, but should be tailored to address the specific areas where changes and deviations have been noted. For example, where planned task observation has revealed a deviation from acceptable practice.

3.5 KNOWLEDGE AND SKILL TRAINING PRIORITIES

The statutory requirements contained in the Mine Health and Safety Act place an onus on the manager to provide employees *inter alia*, with information, instruction and training to enable them to perform their work safely and without risks to health.

Training for doing a job safely should not be separated from doing it efficiently and to an acceptable level of quality.

It is imperative that a formal approach to systematically identifying knowledge and skill training needs be used to ensure that all the necessary training is made available to the employees. (See Appendix 3). This systematic approach should entail more than just a critical task inventory or identification, but should also include such human factors techniques as task analysis, error prediction, consequence analysis, consideration of remedial actions and preventative strategies etc.

In establishing these training needs it is essential to ensure that training is structured so that it will meet the organisation's goals and that it is provided for all the tasks necessary to be completed to achieve those goals.

Training programmes for operators should include task procedures as well as machine operating procedures[3].

3.6 FORMAL TRAINING METHODS

The most widely used training methods, which also find application in operator training are:

- On-the-job training or job instruction training; and
- Off-the-job training, including lectures, films, videos and programmed instruction.

The selection of training staff is always critical to the success of any operation. Trainers, whether on-the-job or off-the-job, must be well versed with the methodologies involved in the science of training.

As far as the training of operators of underground machines is concerned, it is also essential that their line management and especially first line supervisors be trained to train.

3.7 OPERATOR TRAINING

Learning principles suggest that training should provide the trainee operator with a given model to follow, specific goals to achieve, an opportunity to perfect certain skills, feedback on how well he is progressing, and encouragement for transferring the acquired skills to the job.

The influence of models is central to the viewpoint of social learning. Early research indicates that much of what we have learned comes from watching models - parents, teachers, peers, instructors, bosses etc.

It is essential to ensure that the money invested in the training of individuals or teams will result in a value-adding change occurring in the long term. Evaluation of the effectiveness of training is therefore important. The effectiveness of the training programme should not only be measured by the number of employees who went through the programme and the cost per employee, but should also provide answers to questions such as:

- did the training contribute to corporate objectives;
- by how much did training contribute; or
- how is this effectiveness measured?

In terms of the new Mine Health and Safety Act it is essential that the manager provides employees with the information and training they need to do their jobs safely. Section 2.10.2 makes the training of machine operators imperative, as it prohibits the manager from permitting any incompetent or inexperienced

workman to be employed on dangerous work, or work on machines which the safety of others might depend on.

Research in the United States of America[4] revealed that despite massive training efforts by the mining industry, a puzzling and highly "training-resistant" accident category remains undiminished: that in which experienced, well-trained workers suddenly step out-of-character and do something reckless or unsafe that often results in disabling injury or death. These random, seemingly freakish incidents are referred to as "behavioural accidents". The study also indicated that several contributing factors were common to behavioural accidents:

- failure by management to enforce safety rules made by the company or contained in legislation;
- failure to eliminate known hazards;
- poor judgement by employees; and
- lax or misdirected supervision.

The report suggested that employees should be trained to have greater self-control, to become less impulsive in crises (e.g. production pressure), to be more alert, and to react more appropriately to accident or emergency situations. The survey found that most workers in the South African coal mining industry were trained mainly to act on instruction only. Most of their training is limited to task-related information. If better safety performance is to be achieved and workers are to meet expectations in relation to taking initiative, being self-directed, recognising hazards and using supervisory channels and support services, training courses will have to be revised for them and their supervisors.

Training courses should include topics such as the overall mining method, health and safety hazards, safe working practices and hazard identification. Mine safety standards and legal requirements should be strongly emphasised. Also, in terms of the participative nature of risk assessment under the new Mine Health and Safety Act, those workers would also need to be trained in the skills necessary to play their part in the process. This process is clearly described in the SIMRAC, Practical Guide to the Risk Assessment Process[13]. Certainly, underground machinery operators should become involved in 'continuous risk assessment' as defined in the Guide.

The survey found that a number of mines trained for technical competence only had neglected to train for the understanding of how one activity impacts on another, or how an operator's actions or omissions can impact on safety and profitability. Such training will result in the operator having a far greater understanding and appreciation of the operation, and to understand the importance of his role therein.

It is evident that the industry is trying to train a vast employee body which has received very little formal education[5], whilst the key to achieving 'operational excellence' is using knowledgeable workers effectively.

While this project primarily concerns the training of operators for underground coal mining machinery, it is important to note that those supervising these operations also require training in the skills of supervision, coaching and management. Often, the good done in a training course is undone at the workplace due to poor supervision and mentoring. These supervisory skills are not naturally present and have to be learnt.

3.8 VAAL REEFS INQUIRY

These points have been emphasised in relation to the Vaal Reefs Number 2 shaft accident which occurred in 1995. The reports of the joint inquest/inquiry into the accident examines, in detail, the training provided for electricians at the mine on electronic controllers. The Inquiry report (Page 80) found that the training of the electricians was less than satisfactory in respect of the relationship between formal training and on-the-job training. Critically, the electricians received a one-day course on electronic controllers, run by the manufacturers, to familiarise them with the device. The understanding of the electricians of the course content and their competency to identify faults was not ascertained. The report describes, at Page 88, that:

> *"the course was run as a presentation (literally a lecture) and questions by the presenter to the group to the effect of whether they had followed what he was saying, were meant to establish whether the material was understood. This is not an acceptable method of assessing comprehension....."*

Subsequently, the electricians in that case did not receive on-the-job training although it is accepted that:

> *".... by attending a course like that on its own would not make any person competent. One has to be exposed on the job and perform certain tasks on the particular unit and be coached by a qualified individual to be able to become competent".*

The Inquiry report concludes that weaknesses in training were one of the underlying causes of the accident.

The report (at Page 82) also acknowledges that Task Observation has an important role in the learning cycle. When workmen are being watched:

"the mistakes which they make whilst being observed is usually due to nervousness, a lack of knowledge or lapsed standards. In the two latter instances further training and counselling is indicated".

3.9 REVIEW OF TRAINING

Workers can only really be knowledgeable if their training programmes are regularly revised and updated and they are retrained in accordance with the updated programme. This requirement can also be regarded as being implied by Sections 8(1)(d) and 10(2) of the Mine Health and Safety Act.

All such training programmes should be reviewed at least annually by asking the following questions:

a) Does the training programme highlight those regulations pertaining to the performance and operation of such machinery and explain reasons and consequences of failing to comply with such regulations?

b) Has the training programme taken into consideration the results of a comprehensive risk assessment of the machine and the environment in which it will be required to operate and does it emphasise the hazards likely to be encountered and the controls introduced to reduce the risk?

c) Is the technical information on the functioning of the machine included and explained in such a way that the operator can easily understand?

d) Has the manufacturer's training / operating manual been used to assist in the content of technical and operational training?

e) Is the medium (language) and method (show / tell) of instruction conducted in a language which is understood by both the trainee and the instructor?

f) Have experienced operators of such machines been involved in the compiling of, or review of, the training programmes?

g) Has the accident / incident history of such machinery been considered as part of the compiling of, or review of, the training programmes?

h) As for g) above, have results from pre-use checks been reviewed for recurring problems, have these been analysed for causes and have the recommended corrective actions been included in the training programmes?

i) Has the training programme been updated whenever a modification has been made or a new model of the machine purchased?

j) Does the training programme reflect the requirements of the Code of Practice for the safe operating procedure for such machinery?

k) Has the training programme been tested against actual practice by a process of task observation?

l) Has the training programme been evaluated by an independent training authority against National Qualifications for machinery of the same degree of risk and difficulty?

Further details of Training Needs analysis are continued in Appendix III.

3.10 ASSESSMENT OF THE PRACTICAL TRAINING GIVEN TO OPERATORS OF UNDERGROUND MOBILE MACHINERY ON COAL MINES IN THE UK AND AUSTRALIA

Although there are differences in the approach to training in Europe and the South Pacific Rim, many common principles exist. They include the following:

a) No person will be accepted as a learner unless he has worked in an underground operation and as such is familiar with the basic process and the environment. (The normal requirement is 1 year).

b) No person will be accepted as a learner of a coal winning machine such as continuous miner or road header unless he has qualified and has been licensed to operate the associated machinery i.e. shuttle car and front-end loader. (The operation of simpler machinery is therefore a pre-requisite for more complex machinery). (This is a legal requirement in Queensland.)

c) No person is allowed to operate a machine for which he only has a learner's licence unless he works under the direct supervision of a competent driver who has been authorised to train learners.

d) All learners are required to assist with the maintenance of the machinery they are being trained on. To develop the ability to assist with the maintenance of machinery and to have the required knowledge for maintenance, practical training is required.

e) Safe work practices are consistently reinforced by questioning by the 'supervising worker' and safety representative.

f) The duration of training before licensing depends on the learner's ability. No fixed time period appears to exist.

g) Learners are clearly identified. It allows others to be aware of the specific machine being operated by a learner. This would appear to have two benefits. Firstly employees take care when they see they are in the vicinity of a learner driven machine and secondly they give advice to the learner when they note that something is not being done correctly.

h) It was noted in some instances that operators were graded and possessed advanced licences. (Advanced licensing can be compared to an advanced drivers licence). It was noted that these operators showed great skill and were responsible for the basic maintenance of their machinery.

4. FINDINGS AND GUIDELINES

4.1 SELECTION CRITERIA

Compiling a suitable training programme and training in accordance with such a programme can be a costly process. In order to ensure that the training is cost effective it is essential that the right employee is selected to match the job specifications. Selection criteria are normally drawn from job and needs analyses, physical and psychometric testing and is usually supported by interviews by a panel of competent interviewers.

Table 4.1 reflects the selection criteria found to be used at the mines visited. Evidence of other selection criteria was found in training manuals. These had apparently fallen into disuse in all cases.

TABLE 4.1 Selection Criteria

Mine	Physical	Medical	Educational	Psychological	Other	TOTAL
1	1	1				2
2	1	1	1	1		4
3	1	1		1		3
4	1	1				2
5		1				1
6		1	1			2
TOTAL	4	6	2	2	-	

It was found that on a number of mines, use was being made of a Position Analysis Questionnaire (PAQ). This is a structured job analysis questionnaire which provides for a quantitative analysis of an individual job in terms of a number of job elements, referred to as items.

The PAQ[6] consists of 194 items, which are organised into six divisions:

(a) *Information Input* (Where and how does the worker get the information that he uses in performing his job?);

(b) *Mental Process* (What reasoning, decision making, planning and information processing activities are involved in performing the job?);

(c) *Work Output* (What physical activities does the worker perform and what tools or devices does he use?);

(d) *Relationships* with other persons (What relationships with other people are required in performing the job?);

(e) *Job Context* (In what physical and social context is the work performed?);

(f) *Other Job Characteristics* (What activities, conditions, or characteristics other than those described above are relevant to the job?).

These six divisions provide the analyst (the person who is analysing the job), with a logical approach to the analysis of any job.

As a selection tool, the PAQ is very:

- scientific;
- fair;
- objective; and
- defensible.

Guidelines

(i) The starting point for developing selection criteria for a particular position should be a thorough job analysis resulting in a qualitative job dimension profile. This profile should then, in turn, be used to compile a selection test battery.

Normally the determination of suitable tests, with the correct cut-off point for the test battery, is the work of an industrial psychologist. The PAQ referred to earlier, if properly conducted, may be used as a technique for the job analysis.

The development of a selection test battery is shown in Figure 4.2.

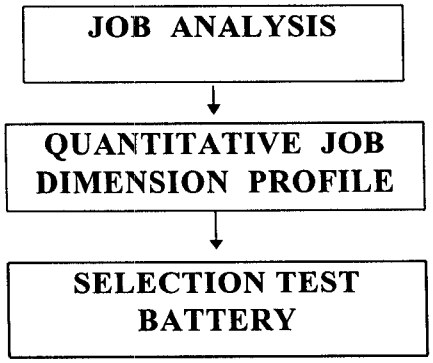

FIGURE 4.2 The Development of a Selection Test Battery

Figure 4.3 is an example of a test battery developed for operators in industry which should be used to measure the profile dimensions as identified by a job analysis:

TEST	*DIMENSION*
1. Aptitude test	° dexterity ° eye hand co-ordination ° perceptual speed ° non-verbal reasoning ° vocabulary (optional)
2. Personality factor questionnaire	° personality profile
3. Vienna test system	° eye hand co-ordination ° attention ° information processing ° reaction time ° sensormotor co-ordinator

FIGURE 4.3 Example Test Battery

(ii) A tailored biographical information questionnaire should be drawn up and this together with the test results is used to obtain a total profile of the individual.

4.2 PHYSICAL CAPABILITY

A physical capability analysis should be conducted to determine size, strength, endurance, acclimatization, visual acuity or other physical qualifications needed to perform a task properly.

Guidelines

Physical capability testing should be conducted and should include:

(i) Physical capability testing according to the analysis which should include gender specific capabilities;
(ii) Two-handed co-ordination testing;
(iii) Reaction time testing;
(iv) Hands on tests for example, ability to:
- check the unit;
- manipulate controls;
- observe and appreciate critical elements in the work environment; and

- manoeuvre in confined spaces.

4.3 PRE-PLACEMENT MEDICAL EXAMINATION

A number of the physical capabilities required of an operator can best be determined by a medically qualified person[7]. These requirements should be provided to the medical officer conducting the pre-placement medical examination. This pre-placement examination is considered necessary as productivity can easily be influenced by the fitness of an operator. Consideration should also be given to a suitable physical training programme for mobile machine operators.

Guidelines

For underground machine operators, a pre-placement medical examination should include the following:

(i) medical fitness - general. In particular operators must be free from epilepsy / fainting spells / diabetes / heart disease;

(ii) eye sight
- phoria
  - vertical and lateral
  - near vision
- acuity
  - vision on both eyes
  - left eye and right eye
  - near vision
- colour perception
- depth perception
- field of vision (confrontation test)
- night vision tests
  - normal
  - glare
  - glare recovery;

(iii) hearing test - category
- normal level
- warning level
- referral level;

(iv) cannabis tests (dagga) (See Appendix IV).

4.4 EDUCATION

Together with many other initiatives, the current South African economy needs a skilled workforce to recover its position in the international market place.

It may be found that employees with excellent performance records and whom the company wishes to promote, fail to pass the selection criteria because of lack of technical or academic education.

Guidelines

Literacy will be an essential prerequisite for high technology machinery or where reading and writing are an essential part of the work associated with the machine. In all other cases, training may involve using appropriate oral and visual techniques. However, the language of instruction and training should either be the native language of the trainee or he should be trained to be fully conversant with the language of training. This includes extending his vocabulary to cover technical terms to the extent where he can understand their meaning and implication.

Skills training alone is unlikely to solve a problem which is connected to attitude and motivation. To address the attitudes which often act as barriers to productivity a process is required through which issues of disenchantment and demotivation are evaluated. In these cases, a suitable Adult Basic Education & Training (ABET) programme should accompany the training and development process.

4.5 PSYCHOMETRIC TESTING

Standard norms and psychometric tests to assess the mental acuteness of the trainee operator should be decided by management in consultation with a registered industrial psychologist.

Guidelines

It is essential that a testee's ability with regard to the following should be measured:

(i) Reasoning by means of verbal, non-verbal and mathematical material;
(ii) Two and three dimensional spatial visualisation;
(iii) Perception of relationships;
(iv) Solving of mechanical problems;
(v) Identification of parts; and
(vi) Basic Hazard identification.

Psychological tests are only to be used as a means to an end and not as an end in themselves.

4.6 OTHER

Various other selection criteria could be relevant which may not have been covered in detail above.

Guidelines

The following guidelines are suggested:

(i) Preference should be given to mature, experienced employees with previous underground experience;
(ii) Reference checks should be conducted on respective candidates; and
(iii) Interviews should be conducted by a panel of competent interviewers.

If it is mine policy to have multi-trained operators or to use experience on various types of machines as a route to promotion, then it is recommended that the selection criteria for the most complex machine be used as a benchmark for the selection of all operators.

5. TRAINING CRITERIA FOR COMPETENCE

5.1 LEARNER'S LICENCE

5.1.1 Introduction

It is common practice that a learner's licence be obtained as part of training before a full licence to operate a vehicle can be issued. To obtain a learner's licence it is necessary to acquire a certain amount of knowledge and pass a set test. This is not the current case with underground machine operators in the coal mining industry.

5.1.2 Findings

In many instances a second person, in the form of a cable handler or an assistant operator (who is in a lower grade), is used to assist the operator. In practice it was found that this person tended to be used as an unlicensed operator and by virtue of this experience he tended to be selected as the next operator without going through the proper selection channels. Our risk assessment has showed that this person is at a high risk and is often the victim of accidents.

As the degree of difficulty and the degree of risk will vary depending on the type and complexity of the machines being operated, it is logical that the level of testing which the employee would be subjected to, should reflect the degree of difficulty and the risks involved.

Guidelines

(i) The position of the so called cable handler or "number two" or assistant, should be formalised and changed to that of a learner operator. This will ensure proper selection according to laid down criteria.

(ii) To enable a trainee operator to sit for the examination for a learner's licence, training in the theory associated with the work should be conducted (See 5.2).

(iii) A learner's licence should be issued only on the successful completion of a set examination (oral or written). The licence will permit the holder to perform the work of the present 'number two' or cable handler and/or to gain practical operating experience as a trainee only.

(iv) The training centre should issue this licence.

5.2 THEORETICAL TRAINING

5.2.1 Introduction

Theoretical training is designed to prepare the trainee for the environment in which he will be operating and to appreciate the company's goals. This includes a wide range of subjects not directly related to machinery operation.

5.2.2 Findings

Theoretical training was found to range from very little to fairly extensive. However, the requirement to achieve a certain minimum standard of comprehension existed nowhere. Even the more progressive training programmes did not include comprehension testing.

Guidelines

Theoretical training is an integral part of training and, as such, it must play a prominent role in the process of preparing the candidates for the eventual role as an underground machine operator.

As machinery varies, both in the intricacies of operation and in the consequences of incorrect operation, it is important that a risk assessment is conducted. This should be done for each type of machine in the environment in which it is operating to identify the hazards which relate to that specific machine in that specific environment, so that both the theoretical and practical training can be influenced accordingly.

The following modules should be considered:

Legal

(i) All legal requirements pertaining to workmen.
(ii) Regulations pertaining to the type of machine for which the operator wishes to obtain a learner's licence.
(iii) In the case of mobile machinery used for transport, a 'road ordinances and rules as for a Code 11 licence' is suggested.
(iv) Mine Code of Practice and standards / procedures pertaining to that machinery.
(v) In the case of machinery being used in a gaseous environment, information about gas testing and basic flame proofing.

Machine Knowledge

(i) Purpose and use.
(ii) Machine familiarisation.
(iii) Pre-start testing.
(Points (ii) & (iii) should take the same format as those in the standard K53 for Code 11 vehicle licences).
(iv) Maintenance and lubrication.
(v) Safety features and machine specific emergency preparedness.

Site Specific Knowledge

(i) Know of potential hazards in the environment which could affect the safe and proper operation of the machinery. (Should be taken from the risk assessment.)
(ii) Hazard identification techniques. Note that the practical application of this should be reinforced during practical training.

General

(i) Emergency procedures.
(ii) Effective communication.
(iii) Defect reporting.
(iv) Any further subjects relevant to a particular mine; and mine production process.

5.3 PRACTICAL TRAINING

5.3.1 Introduction

Practical training should be formalised to ensure that proper programmes, instead of bad habits are practised. Furthermore, the practical training must include reference to all machine and site related hazards and potential hazards and the safe operating procedures arising from any risk assessment (see Section 5.4).

Use should be made of highly competent and experienced drivers / operators to show the trainee driver / operator, on the job, what should be done.

5.3.2 Findings

It was found that on all mines the existing operators are responsible for the training of their cable handlers ('number two' operators). **This method is acceptable provided the operators are competent to train.**

Guidelines

(i) Practical training should include:

- start-of-shift procedure;
- pre-use inspection or pre-use checklist of machine with special reference to the reporting and repairs of defects;
- checking of the working area and terrain (this could vary between fixed or mobile machinery and / or type of mobile machinery). However, most will include:
  - roof;
  - road (floor);
  - ventilation; and
  - loading / unloading / tipping area where applicable.

(ii) Hazard awareness (those aspects of the machinery which have a history of causing accidents and other aspects identified during the risk assessment of the machines on site). The following list may be used as a guide but should not be considered complete as it is generic.

Trailers:

- brake failures when going up or down steep inclines;
- transporting of other persons;
- draw bars;
- operating widths and heights;
- cold start procedures; and
- pedestrians.

Front-end loaders (EIMCO's):

- brake failures when going up or down steep inclines;
- operating widths and heights;
- vision (restrictions);
- fire; and
- signalling and communications problems.

Scoops

- operating widths and heights;
- vision restrictions;
- pedestrians;
- fire;
- signalling and communications problems; and
- loading and tipping of mineral.

Shuttle Cars

- cable control;
- operating widths and height;
- vision restrictions;
- pedestrians;
- fire;
- wheel changing;
- signalling and communications problems; and
- loading and tipping of mineral.

Coal Cutters

- roof and ribside safety;
- scooping;
- tow bar usage;
- filtering;
- cable control;
- gas leaking;
- pick replacement; and
- ventilation.

Loaders

- roof and ribside safety;
- gas testing;
- cable control;
- cable handling;
- where loaders are not fitted with cabs, the correct cleaning sequence is required to avoid the operators being crushed against ribside; and
- ventilation.

CMs and Road Headers

- roof and ribside safety;
- gas testing;
- cable control;
- ventilation; and
- dust control.

Roof Bolters

- roof and ribside safety;
- gas testing;
- colouring; and
- support and use of temporary support.

Feed Breakers

- roof and ribside safety;
- lockouts;
- guards;
- access control; and
- communication.

Conveyors

- roof conditions;
- lockouts;
- guards;
- signalling clearances; and
- communication.

(iii) Once proficient in the foregoing, practical training as a cable handler can start. Initially this work should take place under the direct instruction of the training instructor and should involve building an understanding of the work situation.

(iv) Once familiar with the work situation*, training in the actual operation of a machine can start, initially under the direct supervision of a training instructor. A 'back to basics' approach must be taken so that the operator fully understands 'why' as well as 'how' the task is done.

(v) Operation of the machine according to laid down procedures which must have been reviewed as part of the risk assessment.

(vi) End of shift procedures.

5.4 RECOMMENDED PROCESS TO CREATE A TRAINING PROGRAMME

The following are the recommended steps to create a training programme:

(i) Obtain a copy of the Code of Practice for the safe operating of the machinery in question.

* Work situation means everything except the actual operations.

(ii) Obtain a copy of the manufacturer's training manual for the machinery.

(iii) Obtain a copy of a risk assessment of the type of machinery to be used. (This will normally exist where there is a Code of Practice or can be obtained from the manufacturer under his duties under Section 21 of the Mine Health and Safety Act 1996.)

(iv) Obtain a copy of a risk assessment of the machine in the environment it will operate in. (This will normally exist where there is Code of Practice under Section 9 of the Mine Health and Safety Act 1996. This should follow the SIMRAC Guide [13].)

(v) Obtain copies of all relevant statutory requirements.

(vi) With the assistance of knowledgeable persons representing :

- operating supervision;
- operating workers;
- maintenance staff;
- safety officials and representatives;
- manufacturer's representative,

design a course with the following modules:

- theoretical training and examination requirements (See 5.2); and
- practical training and examination requirements (See 5.3).

6. COMPETENCE CRITERIA

The following are the guidelines on competence criteria.

6.1 EXAMINATION FOR LEARNER'S LICENCE

(i) Before being accepted for examination, proof of the following must be provided:

- compliance with selection criteria (as per Section 4.1);
- satisfactory completion of theoretical training course elements.

(ii) Trainee's must pass an examination at the training centre. Such an examination, oral or written, should be approved by the responsible engineer.

(iii) After passing the examination, the trainee is now available as an Assistant Operator and may be appointed as such by the Mine Overseer. (Possession of a learner's licence does not guarantee appointment as an Assistant Operator).

(iv) Once appointed as an Assistant Operator it does not mean that appointment as an operator will follow after a period of time.

6.2 EXAMINATION FOR OPERATOR'S LICENCE

(i) The Assistant Operator will become eligible for testing as an operator when:

- the mine overseer is satisfied that he has acquired the necessary skills and proficiency;
- **a minimum period of actual machine operation has been achieved;**
- the theoretical examination has been passed again (Depending on time lapsed).

(ii) The final test should be conducted by a test panel consisting of:

- a training official;
- an engineer or his deputized representative (mechanical foreman);
- an operator or driver selected from the workforce operating a particular machine of similar type.

(iii) The examination should be conducted according to a specified format and a certificate of competency then awarded to successful candidates; and

(iv) Appointments/authorisations should be the responsibility of the Mine Overseer after proof of passing the examination (machine/unit specific) is available.

6.3 PERIODIC EXAMINATION

If a candidate is not appointed as an operator within three months of obtaining his certificate, he must be re-tested before appointment.

6.4 ACTIVE OPERATORS

Upon returning from annual leave, the operator must go through refresher training. He should repeat the complete examination and testing procedure before being re-authorised as an operator.

6.5 MULTI-AUTHORISED OPERATOR

The 180 days requirement applies (Regulations 18.1.7 and 18.1.2 of the Minerals Act refers). However, if such an operator has not operated a particular machine for which he has been authorised for a period in excess of 60 days, he should not be permitted to operate such a machine unless he is re-tested by the Mine Overseer. A record shall be kept of such re-testing.

7. CONVEYOR BELT OPERATORS

During visits to the coal mines it was found that because of automation and remote control, the post of conveyor belt operator was being phased out. Should a mine wish to continue employing conveyor belt operators the same training criteria as for mobile machine operators is recommended.

8. MINING QUALIFICATIONS AUTHORITY

Provision is made in the Mine Health and Safety Act for a mining qualification authority (MQA) which sets education and training standards or qualifications in the mining industry.

It is recommended that the guidelines regarding selection and training criteria, contained in this report, be taken as a basis for referral to the MQA for eventual registration with the South African Qualification's Authority (SAQA) as a national standard and qualification for underground machine operators.

Should this be done, it would result in a single set of accredited selection and training criteria for the mining industry.

9.0 PERTINENT RELATED ISSUES

During the course of the visits by the research team to the mines, the Inspectorate, and the suppliers of machinery, the following issues surfaced which need to be addressed.

(i) It was found that, although selection criteria existed, these were not enforced, especially in cases of favouritism.

(ii) The perception exists that the work of underground operators is not as dangerous or important as that in opencast mines. Hence the lack of attention which is given to selection. This takes place in spite of the underground environment which is dark, confined and hazardous. Operator training on opencast mines was not investigated as part of this project.

(iii) Training departments need more credibility, recognition and authority. Often training arrangements are overruled by line management to suit their own needs.

(iv) Training is often seen as a waste of time and results in confusion of the trainee because training standards tend to be ignored by supervisors in favour of what is thought to be the right thing on the job.

(v) When modifications and alterations are done to equipment or new machines purchased, additional training is not normally provided.

(vi) Standardisation of the controls of machines is very important. For example, similar levers control different motions on similar machines.

(vii) Training is not always considered during the investigation of accidents, neither is the outcome of such investigations (where applicable) considered in future training or retraining programmes.

(viii) Existing theoretical training tends to be related only to actual operations. It is necessary that this training provides the operator with a holistic view of his duties, responsibilities and the company goals. Training should explain the 'WHY' factor.

(ix) It is also necessary that present operators have the broader theoretical training when being retrained. Literacy should not be an issue.

(x) Standardisation in the use of pictograms on pre-use checklists would overcome many misunderstandings on different mines.

(xi) A complete lack of understanding of the concept of pre-use inspections and related checklists prevailed amongst the majority of operators interviewed.

(xii) It was also found that supervisors do not understand and appreciate the purpose and importance of pre-use inspections.

(xiii) Although selection criteria exist for operators, no selection criteria are used to appoint trainers and instructors. In practice it was found that training departments are often used as a protected job environment.

(xiv) A policy regarding operator participation in maintenance work and other practical engineering matters regarding machinery should be clearly defined.

(xv) When machines are purchased, ergonomics are rarely considered. Operator comfort and visibility can significantly improve safety and productivity.

(xvi) The overruling of standard practices, procedures and, particularly, rules by supervisors to keep production going and meet targets, tends to be a common practice.

(xvii) Numerous operators complained about the long hours of work without an adequate food intake. Steps to improve blood sugar levels, especially toward the end of a shift, will help control stress and fatigue.

(xviii) It was found that a total lack of recognition of the importance of the operator's status as a key person in the production hierarchy existed.

(xix) It was also found that no attention is given to the effect of long term occupational health hazards to operators. There would appear to be some evidence that operators of underground mobile machinery suffer higher than expected levels of injury to internal body organs such as the spleen, kidneys, liver and spinal cord. This may be related to vibration and poor ergonomic design.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

The primary recommendation of this research is that the guidelines regarding selection and training criteria contained in this report should become part of a national standard for the qualification of underground machine operators. It is believed that this report should be referred to the new Mining Qualifications Authority for eventual registration with the South African Qualifications Authority. This should result in a single set of criteria for use in the mining industry for these operations.

It is also concluded that the Australian model should be adopted, which separates licensing from authorisation. Specifically, the granting of a license should allow an operator to seek employment in any mine. Training and then licensing could either be conducted at a central, approved facility such as the Central Training College or on a mine which has been accredited by the South African Qualifications Authority. Licenses would therefore become fully transferable.

The development of a matrix showing specific guidance on the elements of the system proposed for different machines, has been considered. An example (without detail) is shown in Figure 10.1. However, this is not a simple task and would require specialist input. Some guidance is given in Sections 4 and 5 of this report.

However, before allowing an operator to work on a mine, the mine must also provide mine specific training on mine specific hazards and standards. This, following testing, would lead to authorisation of that operator to operate that machine, on that mine. In other words, licensing and authorisation would become two distinct and separate phases in the training process.

While the primary duty for the provision of training falls upon the employer under the new Mine Health and Safety Act, the Department of Mineral and Energy Affairs, Mining Division also has an important role in the area of training. The proactive stance of the UK Health and Safety Executive and the various Departments of Mines and Departments of Mineral and Energy in Australia have been observed. In both cases, the government department is actively involved in the promotion of safe working practices by disseminating advice and information to industry and employees. At an operational level, Western Australia for example, produces a large number of information pamphlets, three of which may be found in Figures 10.2, 10.3 and 10.4.

10.2 RECOMMENDATIONS FOR FURTHER RESEARCH

As discussed in Section 9, this research project has revealed many other related issues which, ultimately, need investigation and resolution. There are three major areas where we believe that SIMRAC should consider specific research efforts.

10.2.1 Blood Sugar Levels and Performance

It has been suggested that the blood sugar levels of operators directly influence their awareness and capability, including being able to remain fully alert when in control of a machine. For this reason, research should be instituted to investigate the influence of blood sugar levels on alertness, particularly late in a shift, and the practicality and cost effectiveness of adopting means of dealing with this.

10.2.2 Internal Body Organ Damage

Incidental to this study, it has been found that there is an apparent high level of occurrence of internal organ damage in mobile machinery operators. However, there is little previous research in this area and no comprehensive review of data is currently available for South Africa. It is therefore strongly recommended that an epidemiological survey is instituted reviewing the extent of kidney, liver, spleen and spine injuries in mobile machinery operators. This may be drawn from the results of similar studies in other countries and could consider the current ergonomic design of workstations, seating etc. for machinery currently being sold into the South African coal mining industry.

10.2.3 Above Ground Machinery

While this study concentrated on underground mobile machinery, there are a proportionally greater number of accidents occurring above ground on mobile and fixed equipment. This study has provided a protocol and approach for reviewing the training needs for all machinery on coal mines and, accordingly, it is recommended that it would be cost effective to extend this research initiative. This point, and the limited nature of this project, was repeatedly pointed out by the mines that were visited.

STAGE	CONVEYOR	TRACTOR TRAILER	SHUTTLE CARS	COAL WINNING MACHINES
Selection Criteria				
Learners Licence				
Theoretical Training				
Practical Training				

FIGURE 10.1 Example Matrix

Does a record book need to be kept for the results of testing and analysis of diesel engines?

Yes Records of tests and analysis must be kept at the mine in a Record Book A copy of the permit for each diesel engine also has to be kept

Is it necessary to have ventilation breakdown warning devices installed?

Yes In every mine, or part of a mine where diesels are used underground, warning devices must be installed. Details of the requirements are listed in Regulation 14 12

Can I fuel and service a diesel engine at an underground storage place?

Diesel engines can be fuelled and serviced only at an underground service station. You should be familiar with Reg 14 14 if fuelling and servicing is part of your job

Do the Regulations cover matters such as fire extinguishers, fuel transport and storage?

Yes they do You will find this information in Regs 14 14 and 14 16.

This pamphlet is a guideline and does not replace the Act or Regulations The Act, and particularly the Regulations, do not stand still You need to be aware of amendments that take place You can do this by keeping in touch with your representative or your supervisor. If still in doubt, contact the inspectors.

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Produced by Research and Technical Services Branch

UNDERGROUND DIESELS

(METALLIFEROUS)

Are diesel engines safe for underground mining?

Yes, however special provisions for refuelling,preventing fires and conditioning and diluting of the exhaust are required

Why are petrol engines not allowed?

There are two good reasons:

1. Petrol is far more of a fire hazard than diesel fuel, and

2 Diesel engines do not generate nearly as much toxic gas as petrol engines, e g carbon monoxide or nitrogen dioxide,

Do you need a permit for a diesel engine to operate underground?

Yes, you need to have written permission from the Senior Inspector in your district You will find the details in Regulations 14 3 and 14 4

Are there any conditions attached to a diesel engine permit?

Yes, and you should be familiar with both the permit conditions and the regulations applicable to the diesel engine you operate The Inspector can cancel the permit if you do not comply with the regulations

Is a driving licence required to operate diesel equipment underground?

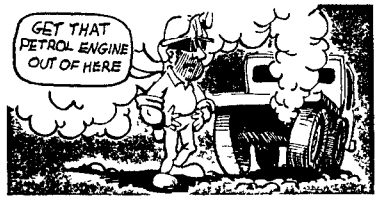
No but you need a certificate The regulations require that an employee is examined by a competent person in a practical trial in underground conditions The certificate is issued by the Manager

Does one certificate cover all vehicles?

Yes, but like a driving licence it has to be signed by the operator, and the types of vehicles you are competent to drive are all listed on the certificate

Is there a demerit point system on certificates?

No An Inspector can suspend a certificate for up to 1 month, and this can only be changed with the approval of the Senior Inspector The Senior Inspector has the power to cancel a certificate or suspend the certificate for as long as he thinks fit



What about ventilation requirements underground when diesels are used?

Ventilation must be of a very high standard in terms of both volume and minimal contaminants. The regulations are strict, and you must become familiar with them (Reg 14 5)

For what reasons can a certificate be suspended or cancelled?

Usually suspensions are given for driving an unsafe vehicle, or for driving in a dangerous or reckless manner However, suspension can also occur for speeding, or not using the gear lockout system fitted to some vehicles

Who is responsible for ensuring exhaust atmosphere testing is carried out?

The Manager Testing must be done everyday and conform to the stand ards set out in Regulation 14 8

Does this also apply to undiluted exhaust gas sampling?

Undiluted exhaust gas sampling must be carried out at least once a week or more often if the inspector requires Reg 14 9 and 14 10 explain

FIGURE 10.2 Example of a leaflet on Underground Diesels

WORK PRACTICES SERIES
No 3

Do not lift or convey access walkways, stairs or cats

Do not touch moving belts or rollers

Do not walk under a loaded moving conveyor that does not have a covered access

Do not forget to place warning signs and fence off the area if you are working overhead

Do not enter the counterweight area.

OBSERVE THE SAFETY RULES !
YOUR LIFE MAY DEPEND ON IT

The advice provided in this pamphlet is basic safety information. Please ensure that you are familiar with your site procedures and that you discuss this information with your supervisor.

INSPECTORATE ADDRESSES:

Perth Inspectorate
100 Plain Street
EAST PERTH WA 6004
Tel (09) 222 3132
Fax (09) 325 2280

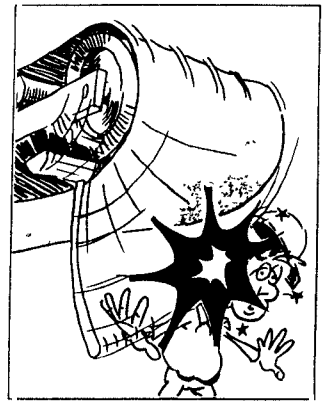
Kalgoorlie Inspectorate
Brookman Street
KALGOORLIE WA 6430
Tel (090) 219 411
Fax (090) 213 612

Karratha Inspectorate
Hedland place
KARRATHA WA 6714
Tel (091) 868 243
Fax (091) 868 251

Collie Inspectorate
66 Wittenoom Street
COLLIE WA 6225
Tel (097) 341 222
Fax (097) 341 686

Produced by Research and Technical Services Branch in conjunction with Reprographic Services Surveys and Mapping Division

Conveyor safety



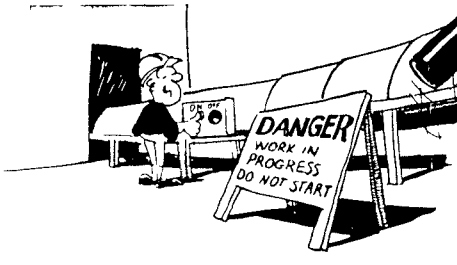
DEPARTMENT OF MINES
WESTERN AUSTRALIA
MINING ENGINEERING DIVISION

Conveyors are an efficient method of transporting ore. They can also be one of the most dangerous items of plant on a minesite if safe operating practices are not maintained

Starting the conveyor:

Before you start a conveyor, Check :

- Are there any danger tags in place?
- Are all the guards fitted?
- Are lanyards fitted and connected to switches?
- Is the warning siren working?
- Are fire fighting devices in place ready for use?
- Are all the lights working and clean?

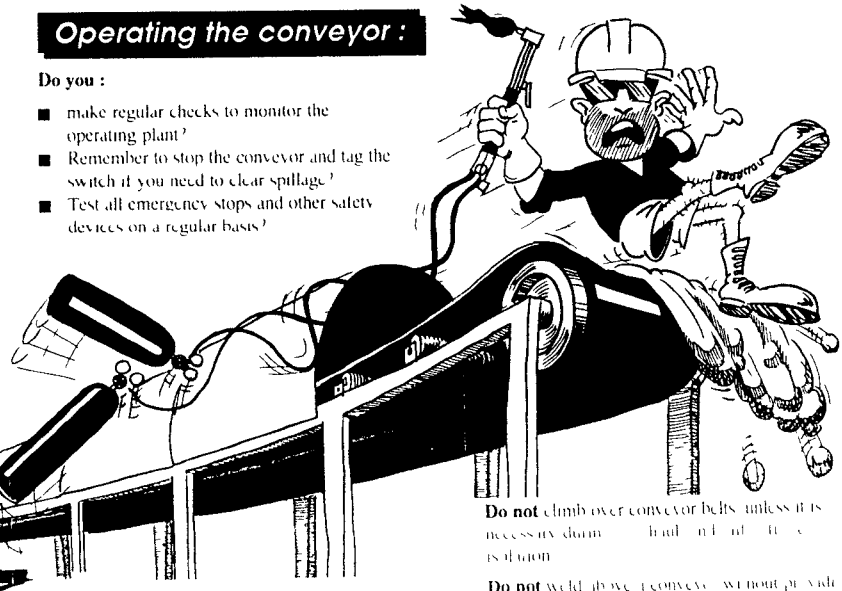


ARE YOU SURE NOBODY IS WORKING ON THE CONVEYOR AND ACCESS PLATFORMS ARE CLEAR

Operating the conveyor :

Do you :

- make regular checks to monitor the operating plant?
- Remember to stop the conveyor and tag the switch if you need to clear spillage?
- Test all emergency stops and other safety devices on a regular basis?



Preventing accidents:

Every conveyor accident is a potential fatality.

Do not remove guards while the conveyor is running.

Do not [illegible] belts

Do not climb over conveyor belts unless it is necessary during [illegible] and [illegible] is absent

Do not weld above a conveyor without providing adequate fire blanket protection. Fire watch should be maintained

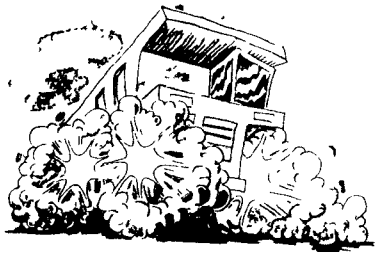
Do not weld or oxy cut around a conveyor if welding leads or gas lines cannot be kept clear of moving parts

Do not enter bins to bypass conveyor feeder/feed chutes while the conveyor is running

FIGURE 10.3 Example of a leaflet on Conveyor Safety

SAFETY:

- Do not try to DEFLATE suspect tyres. Flat tyres can still explode
- Monitor the vehicle from the recommended distance
- Operators leaving the vehicle should avoid alighting in front of tyres. Step across onto another vehicle which should approach from the front
- Be aware that more than one tyre may explode



- After the 24 hour stand down, all affected tyres should be removed and inspected internally by a competent person.

UNDERSTAND THE DANGER - IT'S YOUR BEST PROTECTION

The advice provided in this pamphlet is basic safety information. Please ensure that you are familiar with your site procedures and that you discuss this information with your supervisor.

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Collie Inspectorate
66 Wittenoom Street
COLLIE WA 6225
Tel (097) 341 222
Fax (097) 341 606

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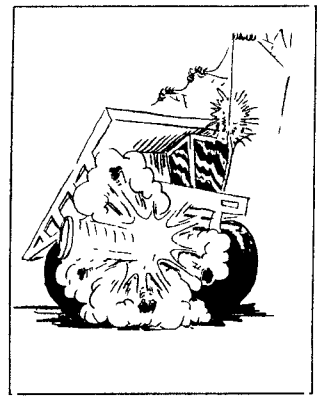
WORK PRACTICES SERIES No. 10

Tyre fires and explosions



DEPARTMENT OF MINERALS AND ENERGY WESTERN AUSTRALIA
MINING ENGINEERING DIVISION

TYRE FIRES AND EXPLOSIONS

Tyre fires and explosions are a major hazard. When excess heat is developed in or applied to a tyre, a chemical reaction may occur and cause a buildup of flammable gases. Should internal gas concentrations exceed a critical level, the tyre will explode if parts of the tyre remain hot enough.

Common causes of tyre explosions:

- Vehicle contact with powerlines
- Overheating brakes
- Wheel motor fires
- Welding wheel rims
- "Oxyheating" wheel nutsor rims
- Tyre defects
- Gross under inflation
- Gross overloading and high operating speeds
- Fire spreading from engines
- Lightning strikes

The timing of a tyre explosion is not predictable. Explosions can either be immediate or be delayed for up to 24 hours.

Managing a Potential Explosion:

- Remove all personnel from the area
- Park the vehicle in an isolated area
- Impose a minimum 300 metre radius isolation zone around the vehicle

- Do not allow anyone to enter the isolation zone for at least 24 hours
- Alert the Fire Crew

Tyre fires can be either the cause or the result of explosions. Dealing with them is a job for the Fire Crew

REMEMBER:

- Burning tyres emit toxic fumes
- Burning tyres are extremely difficult to extinguish.

DO NOT ATTEMPT TO FIGHT A TYRE FIRE WITH A HAND HELD EXTINGUISHER OR ORDINARY WATER HOSE.

WORK SAFE! *Be Aware*

FIGURE 10.4 Example of a leaflet on Tyre Fires and Explosions

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APPENDIX I

DISCUSSION QUESTIONNAIRE FOR MOBILE MACHINES IN COAL MINES

DISCUSSION QUESTIONNAIRE/CHECKLIST FOR MOBILE MACHINES IN COAL MINES

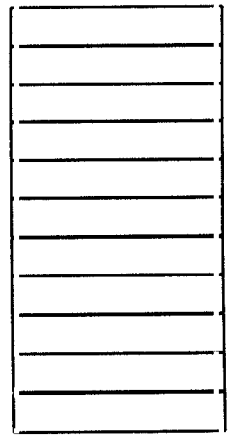
(MINE SAFETY RESEARCH PROJECT COL 341)

Thank you for participating in this project and assisting in completing this questionnaire. It will assist in reducing the risk to all involved in the use of mobile machines at collieries through the development of training systems.

All information will be treated in confidence and no-one will be penalised in any way since this is an information gathering exercise and not an evaluation.

1. WORK ACTIVITIES

1.1 Shuttle Cars
1.2 Scoops
1.3 Continuous Miners
1.4 Coal Cutters
1.5 Mechanical Loaders
1.6 Face Drills
1.7 Roof Bolters
1.8 Locomotives
1.9 Tractors/buses/multipurpose vehicles
1.10 Feeder Breakers
1.11 Conveyor belt systems



Comments

_____
_____
_____

2. Obtain a copy of Mine's training programme for underground personnel operating Mobile Machines.
Response:

_____
_____
_____

3. How was the training programme for underground Mobile Machines compiled?
a) in general b) specific
Response:

_____
_____

4. Were technical manuals used in the compilation of these training programmes? Name them.
Response:

5. Were operating manuals supplied by the manufacturer which were used to compile training programmes? Name them.
Response:

6. Did anyone make an analysis of the operator's tasks? Supply them.
Response:

7. If so were the tasks broken down into steps and associated dangers? Name them.
Response:

8. In doing the analysis were the environmental factors considered? Name them.
Response:

9. Are the responsibilities of the operator, the responsible person, the supervisor and management included in the training programme?

9.1 If so what are they?
Response:

10. Is the operator trained in what is expected of him should he note a dangerous defect on his machine?
Response: state how.

_____
_____
_____

11. Does the training programme inform the operator that he has a "right to know" and thus has access to information such as standards/regulations.
Response: state what.

_____
_____
_____

12. Does the operator training stress the "right to refuse" unlawful instructions.
Response: state.

_____
_____
_____

13. Certain regulations in the act relate to mobile underground machinery. Are they included in the operator training programme? Name them.
Response:

_____
_____
_____

14. Are codes of practice included in the underground Mobile machine operator training programme? Name them.
Response:

_____
_____
_____

15. How are mobile machine operators trained to do inspections with special reference to:

15.1 Observing something being wrong, damaged or not to standard. What specific training does the operator receive to address the above? State.
Response:

_____
_____
_____

15.2 What training does the operator get to know, understand and classify A, B and C-class hazards according to mine standard? State.
Response:

15.3 What training does the operator receive regarding the results of such an inspection?
Response:

15.4 What safety devices are involved and how are they included in the training programme? State them.

15.5 Should something be wrong with a safety device what does the training tell him what should he do? State what.
Response:

16. What review training does a mobile machine operator receive to ensure and confirm that his competence is consistent to, or better than the mine standard? Supply information.
Response:

17. Does the training programme include:

17.1 Performance standards? State.
Response:

17.2 Performance measurements?
Response:

_____
_____
_____

17.3 How the above is evaluated?
Response:

_____
_____
_____

18. How often is a mobile machine operator:

18.1 Tested:

_____
_____
_____

19. Regarding the loss history of these mobile machines - can you provide the following information:

19.1 When and how employees were injured and how this information is included in the training programme? State.
Response:

_____
_____
_____

19.2 How the above experience and lessons learnt are pointed out to other operators being trained? Explain.
Response:

_____
_____
_____

19.3 When and how property damage involved in collisions is addressed in the training programme? Explain.
Response:

_____
_____
_____

19.4 When and how "near misses" which have occurred are addressed in the training programme? Explain.
Response:

_____

_____

_____

20. When and how is the training programme for mobile machines changed or modified to address new or modified equipment? State.
Response:

_____

_____

_____

21. What lessons have been learnt regarding the operation of mobile machines which are believed to be absolutely critical to the establishment/maintenance of a good training programme? State.
Response:

_____

_____

_____

22. Do selection criteria exist for mobile machine operators? State.
Response:

_____

_____

_____

23. If so what are these criteria? State.
Response:

_____

_____

_____

24. Is each prospective mobile machine operator assessed to determine his strengths and weaknesses in order to plan his training programmes? State.
Response:

_____

_____

_____

25. Does the training curricular of a mobile machine operator also include:

25.1 Legal aspects? State.
Response:

25.2 Standards/codes of practice? State.
Response:

25.3 Knowledge of technical factors? State.
Response:

25.4 Operating factors? State.
Response:

25.5 Environmental factors? State.
Response:

25.6 Other factors? State.
Response:

26. Does the practical training of a mobile machine operator also include:

26.1 Simulated training? State.
Response:

26.2 On-the-job training? State.
Response:

26.3 Operating on his own? State.
Response:

26.4 Pre-use check of mobile machine / filling in checklist / reporting of substandard conditions, hazards etc.? State.
Response:

26.5 How is the operator licensed? State.
Response:

26.6 Are other criteria used in the mobile machine operator's training programme?
Response:

27. Is there anything that mine personnel wish to add to this list? State.
Response:

APPENDIX II

UNDERGROUND CHECKLIST/QUESTIONNAIRE FOR MOBILE MACHINES IN COAL MINES

UNDERGROUND CHECKLIST/QUESTIONNAIRE FOR MOBILE MACHINES IN COAL MINES (MINE SAFETY RESEARCH PROJECT COL 341)

1. Colliery: _____

2. Date: _____

3. Type of machinery: _____

4. Preshift inspection: _____

   4.1 Machine _____

   4.2 Safety devices _____

   4.3 Cable _____

_____
_____
_____
_____

5. Handling of Unit _____

   5.1 Assistant/Other _____

   5.2 Self _____

   5.3 Signals _____

_____
_____
_____
_____

6. Visibility _____

   6.1 Operator _____

6.2 Of unit to passers by _____

_____
_____
_____
_____

7. Lights _____

7.1 Clean _____

7.2 In working condition _____

7.3 Effective _____

_____
_____
_____

8. Communication Signals _____

_____
_____
_____
_____

9. Operations Sequence _____

9.1 Handling (Full/Empty - Forward/Backward) _____

_____
_____
_____
_____

9.2 Points to be noted and checked _____

a) Cornering _____

_____
_____
_____

b) Tipping _____

c) Stopping _____

d) Starting _____

e) Parking (what special precautions/rules apply?) _____

10. Ergonomics _____

11. Other _____

APPENDIX III

TRAINING NEEDS ANALYSIS

TRAINING NEEDS ANALYSIS

Training to do a task/job safely should not be separated from doing it efficiently and to an acceptable level of quality. Doing a task properly includes doing it without loss.

To ensure that the necessary training is made available to underground mobile machine operators, a formal and systematic approach is required. This would include the following aspects to identify the training needs:

a) Review of mobile machine operator work activities and responsibilities. Each task should be reviewed to provide insights into the type of work the operator is expected to perform which requires formal or structured training;

b) Review of critical task analysis and procedures. As critical task analyses and procedures are written, reviewed or changed, they should be studied to make sure the information developed from them is integrated into the formal training programme of mobile machine operators;

c) Review of hazard analysis. Hazard analyses which may identify training needs for the operator include:

   (i) emergency response;
   (ii) hazard identification and evaluation;
   (iii) risk assessment;
   (iv) project review and change management; and
   (v) operational and work process controls.

d) Review of inspection reports and then performing an analysis may identify training needs for the mobile machine operator;

e) Review of accident/incident analysis which can provide the trainer with a wealth of information. This can be used to identify training requirements for operators and to update existing training programmes;

f) Review of task observation reports which can substantiate the effectiveness of the existing training programmes and also identify areas which need more attention. For example, basic causes relating to a lack of, or inadequate training, having been identified;

g) Review of changes: more often than not changes in operating procedures may result in training needs;

h) A formal review of applicable regulations, codes and standards applicable to mobile machines and their operators to determine the training required;

i) Review of mobile machine operator training programme evaluation reports, using the information found during the training system evaluation and follow-up, to update the training needs;

j) Surveys of mobile machine operators, their supervisors and managers, artisans and engineers to identify the types of training they believe operators need to properly perform their work - to use the mobile equipment effectively and efficiently.

APPENDIX IV

CANNABIS

CANNABIS

In the pre-placement medical examination a cannabis test is listed as forming part of the examinations. Rejection criteria for users of cannabis must be decided by individual mine managers. Whether rejections based on cannabis usage can be justified in terms of the new constitution is debatable. Regulation 4.7.1 (Chapter 4 of the Minerals Act and Regulations of 1992) states that:

> No person in a state of intoxication or in any other condition which may render or be likely to render him incapable of taking care of himself or of persons under his charge, shall be allowed to enter the workings of a mine.

Abuse of cannabis may therefore be regarded as covered by the foregoing regulation.

APPENDIX V

UK VISIT

1. INTRODUCTION

The UK was visited in February 1996 to gather information from the Mines and Quarries Inspectorate of the Health and Safety Executive (HSE) and from the coal mining industry on their approach to training.

With the demise of the UK coal mining industry, the operations of the HSE in this area have been significantly scaled down. Most of the published material is now out of date and there appears to be a great reliance on 'self-regulation'.

A visit was paid to RJB Mining (UK) Limited, the private company which has bought the residue of British Coal and now operates the remaining small number of pits. John Davies, the group training and development manager, was interviewed and he and his colleagues provided much information about how RJB now conduct training.

2. COMPETENCY BASED TRAINING

The approach to training in RJB is sophisticated and advanced. For many years, British Coal undertook a form of competency based training, which they called Standards Based Training (SBT), which:

- was made up of individual programmes of work, each designed to give the trainee the opportunity to perform one or more tasks or actions;
- concentrated on trainees working towards demonstrating their ability to perform a particular task or action to a minimum standard; and
- was not dependent on time, but on whether the trainees attained the necessary skills and knowledge which, together with the necessary experience and personal aptitude, made them competent.

As an example of this, mechanical and electrical apprentices were subjected to a scheme of training comprising four phases. The apprentice had to demonstrate a certain level of skill which would be passed on to the next phase and this had to be demonstrated to the person training the apprentice and to an independent assessor. These assessments were documented. The apprenticeship training would ideally take no longer than five years to complete.

The training objectives for the course were defined as Skill Specifications and the actual content of the training was defined as Training Specifications. For example, a skill specification would be that:

> *"Apprentices should be capable of using measuring and marking out equipment as outlined in the training specification in metric or imperial units."*

The Training Specification would support the Skill Specifications and define what training had to be undertaken. It required the training assessment to be established so that the apprentices could learn, practice and demonstrate skills in the areas of training required.

Under SBT, Control Sheets were used to document and monitor the actual training and assessment given on a day-to-day basis. An example is shown in Figure V.1. These were used by the apprentice's trainer to document jobs which provide training, practice or assessment. They include a list of the skills and knowledge required to be covered by training assessment along with the relevant objectives. The trainer also lists the jobs undertaken by the apprentice and indicates which skills and knowledge are covered in a particular job. When the apprentice has demonstrated competence in a particular area, a shaded-in circle or 'dot' is put on the sheet. Open circles identify those skill and training elements which are identified for each job on a pre-planned basis.

As part of the SBT scheme, several key people have roles. These include:

Unit Training Officer. He is responsible for the administration of training, record-keeping and the execution of training plans and the scheme;

Link-man. He plans the training in conjunction with the unit training officer and selects jobs to suit the training needs and skills required. He also nominates a Supervising Workman and periodically makes personal assessments and monitors the training and assessments given by supervising workman; and

Supervising Workman. These individuals actually train the apprentices, making a continuous assessment of jobs done, checking that skills are demonstrated and practised to the required standard. They also certify that jobs have been done to the required standard by endorsing the control sheet and then reporting to the Link-man on progress.

An important part of the SBT approach is the continual assessment of whoever is providing the actual training, be it the Supervising Workman, the lecturer or the instructor. Ideally, the apprentice should demonstrate his competence three times in each skill and knowledge element and this should be conducted on three separate jobs.

The second assessment of the apprentice's work is normally done by an independent assessor which could be the Link-man or another Supervising Workman or a college lecturer. This should ideally be any authorised person other than the person who performed the initial training and assessment. Periodically, the Link-man, the Training Officer or the Engineer, should observe the quality of the training and of the assessment given by the Supervising Workman; they should therefore assess the

assessments. Also periodically, the entire scheme is subjected to totally independent assessment by a representative nominated by the company.

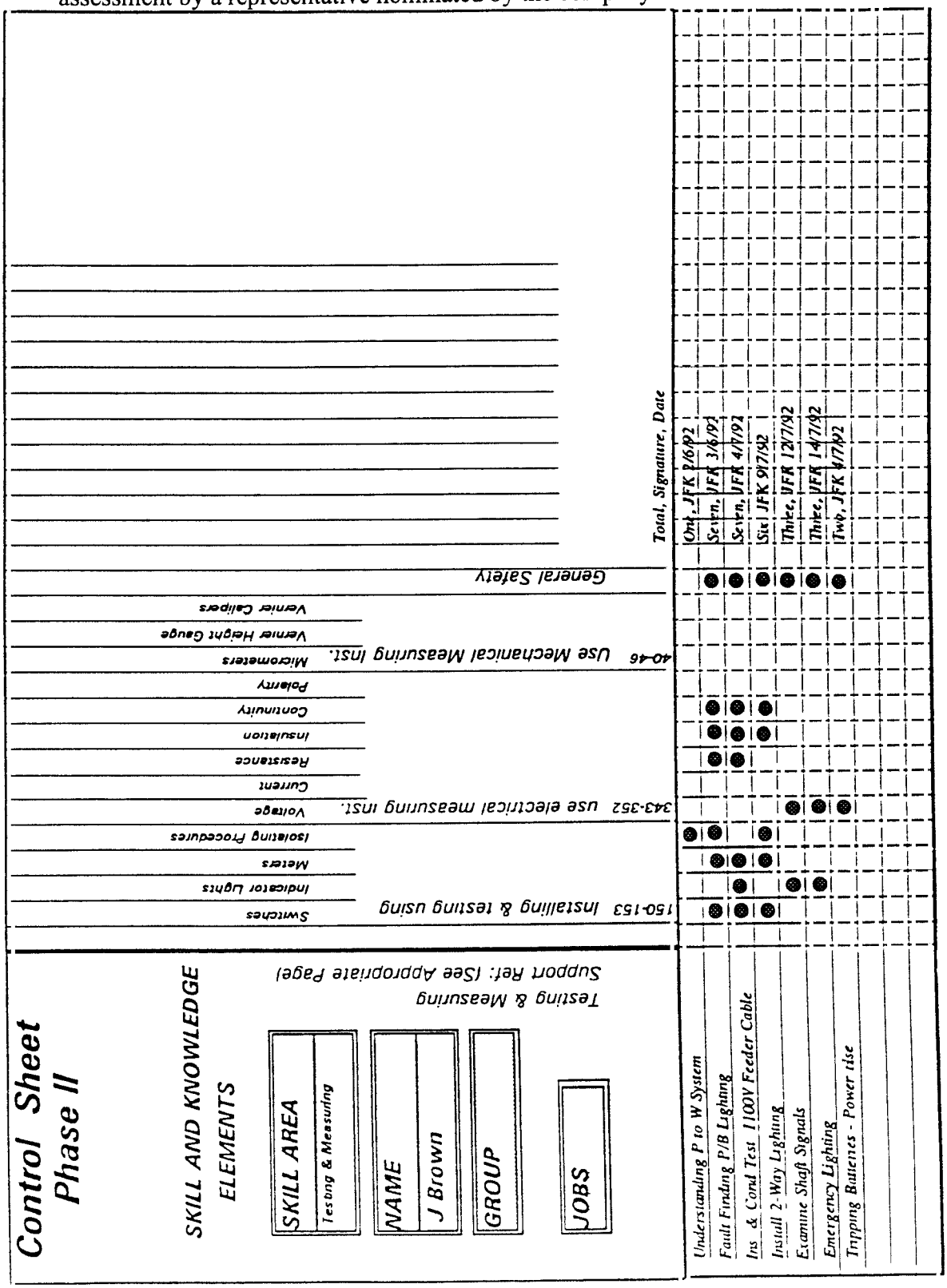


FIGURE V.1 Example of Control Sheet

3. NATIONAL VOCATIONAL QUALIFICATIONS

There is a national scheme within the UK to establish vocational qualifications based on national standards. These standards are developed by various bodies with the authority and credibility to undertake detailed research and consultation and to express best practice on behalf of each employment sector. These bodies are called Industrial Lead Bodies. The standards themselves are statements of best practice in the UK. They are derived by identifying the key purpose of the area of work and then identifying the functions that need to be carried out to achieve that purpose. The standards, therefore, do not necessarily relate directly to existing job roles. However, they do represent best practice and every individual can, by comparing their current job to the standards, potentially identify areas for improvement in the development for themselves and for the employing organisation.

A fundamental part of the NVQ system lies in the undertaking of Assessments. This is the assessment of a person's competence, which is the ability of the person to work to recognised national standards and not just the assessment of theory or knowledge in isolation. The NVQ approach involves the setting up of a process to:

- Plan;
- Observe;
- Measure;
- Decide,

in terms of assessing competence of each unit of each standard.

The NVQ approach is highly structured with national standards, not only in terms of competencies, but also in terms of the assessment of a candidate's performance. Those who carry out the assessment themselves have to be trained and assessed before they are judged to be competent as assessors.

An important part of the assessor's role is to draw up an assessment plan with the candidate before the assessment takes place. This includes agreeing on which elements of the work being undertaken, need to be assessed. The assessor then collects and judges performance evidence against performance criteria. Knowledge evidence is also collected and judged by careful questioning to probe the candidate's underpinning knowledge and understanding.

From the information gathered, the assessor has to make his decision and provide feedback to the candidate. All the details of the process have to be recorded so that the record can be used for the certification process of the candidate.

4. INDUCTION TRAINING AS AN EXAMPLE

RJB Mining have now adopted the standards based programme and developed induction training for their new employees. The programme of training follows SBT principles to cater for individual ability and consists of three stages, each lasting a minimum of twenty days. In other words, the minimum induction training in the British coal mining industry varies between twenty and sixty days depending on where the work is situated. For surface workers, a twenty day minimum period is mandatory and for ordinary underground workers a mandatory forty day training period is required. Craft apprentices and surveyors have to undertake a mandatory sixty days training.

The Record of Achievement is used to follow the trainee's attendance on each module of the scheme and requires the instructor's and trainee's signature for completion. There is also a separate training course report prepared on each candidate which looks at performance aspects like attitude, safety commitment, time keeping and attendance.

5. SPECIFIC TRAINING PACKAGES

All trainees receive general training on machinery in the mines but there are specific training packages for specific machinery. For example, we were able to scrutinise a training scheme for a particular type of monorail conveyance system.

For the monorail in question, the objectives of the training were to permit a learner miner to acquire full knowledge of the equipment and how to operate it, including the performing of daily maintenance. The safety requirements and safety features are stressed throughout the training process.

Performance on such training schemes is measured by the verbal explanation by the trainees, the observation of their work on the equipment and by testing their knowledge and understanding by questioning. The training standards include a checklist on which performance can be assessed, and another one which contains questions with which the knowledge of the trainee can be tested. In all, the document represents a total system for the training and measurement of performance and competency on the machinery in question. On the completion of the entire scheme, the candidates are certified as competent to operate that type of machinery.

6. SUMMARY

In essence, the UK approach to training in the coal mining industry can be summarised as consisting of three phases:

1. Instruction, where the employee is shown how to undertake tasks together with background understanding including legal requirements. For

machinery, great attention is paid to the trainee understanding how the machine works and why it works that way;

2. Observation of performance. The trainees have to demonstrate that they have understood and can perform the tasks which they have been trained for;

3. Testing of knowledge and understanding. It is recognised that a vital part of the learning process is to ensure that the trainees appreciate the reasons behind doing what may, without such comprehension, seem irrelevant or unimportant tasks.

The trainee's performance is measured in each of the three stages both by his immediate trainer and by an independent assessor who also has the role of planning the training of the trainee. Periodically, both the trainer and the assessor are assessed to determine their competence. The entire training scheme is periodically assessed for its effectiveness.

APPENDIX VI

AUSTRALIAN VISIT

SUMMARY OF THE INVESTIGATION INTO OPERATOR SKILLS TRAINING ON AUSTRALIAN UNDERGROUND COAL MINES: 24 MARCH TO 14 APRIL 1996

1. OVERVIEW

Although the approach to operator skill training was found to be far more systematic in Australia than in South Africa, this was not the primary cause for their safer, more effective operation. The primary causes for the safer, more effective operations were identified and prioritised in the following order:

a) Operators are recognised as key personnel and show tremendous job pride. This became obvious from the way they were addressed, the standard of their performance and the cleanliness and condition of their machinery. It could also be added that top operators received top wages;

b) Safety Stewards are elected per shift from the ranks of the operators. They are given joint responsibility with mine officials to ensure the safe, effective operation of the machinery with the power to discipline if, after advice, machinery is not operated in a safe, effective manner;

c) The general attitude found across Australia is that laws and rules were made to be obeyed and not to be broken. No operator or official would contemplate the use of a machine which had a faulty light or warning device. (This was probably best highlighted by the fact that in Australia there were only 22 road deaths over the Easter weekend and that there were less than 200 prosecutions for speeding during this period.);

d) The state authorities are perceived by the mine management and worker organisations as being there to advise them and to assist them with problems. They are not seen as prosecutors, although it is recognised that they have the right to enforce; and

e) Safety is managed jointly by mine management and worker organisations and the freedom of information law is strictly applied. (It was noted that even on a mine which was experiencing a major confrontation between management and worker organisations, extreme care was being taken by both groups to ensure that safety of personnel and property was not affected.)

Although the above points fell outside the direct scope of the investigation - their impact on the primary output of Col. 341, which is improved operator safety in coal mines, cannot be ignored if the South African coal mining industry and worker organisations wish to achieve the same level of safe, effective operation.

2. OPERATOR TRAINING

All operator training in the four states visited (Western Australia, Victoria, New South Wales and Queensland) is seen to have two distinct components. In fact, the Dean of the Faculty of Mining at New South Wales University in Sydney, made the point that there are two distinct components involved in the learning required to perform a job, no matter what occupation is involved.

The two components are:

A	*B*
The training to obtain a qualification that allows a person to perform a task i.e. licensing, certification.	The specific training and experience a person requires to be able to perform the task safely (site specific) i.e. mine rules, mine particularities and hazards which when completed allow for his appointment.

3. QUALIFICATIONS

It was noted that although not legislated as such, safety agreements between mine and worker organisations required particular qualifications for particular occupations. A shuttle car driver required a shuttle car licence, a loader driver required a loader driver's licence. It was also noted that the training to obtain these licences was not done by the mine but by training companies or organisations (mainly private, but some semi-private) whose qualifications were recognised by the mine and the appropriate worker organisations. In Western Australia C.I.R. was visited. They are the largest training organisation in mining and are a private enterprise. The basic curriculum for licensing was shown. (However they courteously refused to allow copies to be made as it was felt they had a marketable product.) In principle however, all licences have the same basic outline as that for a motor vehicle driver's licence, with the difficulty of the content varying with the degree of difficulty of operating the machine.

The step by step process can be generalised as follows:

- **Learner's Licence**

  To obtain a learner's licence a test must be passed, either written or oral, depending on the type of machine to be operated. (Significantly, medical testing is also a prerequisite for writing such a test.) This learner's licence test deals with the basics such as signs, conditions in which the machine operates, etc.

- **Theoretical and Technical Training**

  After obtaining a learner's licence, technical training is done. In all cases this included basic maintenance, unit or sub-component changing and other minor repairs. Advanced licensing courses also went as far as stripping, fault finding, replacing and assembling.

- **Operational Training**

  Actual operational training in 'driving' takes place on a nearby facility under actual working conditions. Operators are trained by experienced operators (now working for C.I.R.) in operational techniques until they are sufficiently qualified to be able to meet a production target level and perform basic maintenance.

- **Licensing**

  Licensing is conducted by an approved panel and consists of both theoretical and practical skills tests. On passing, the candidate receives a provisional licence for a 2 year period.

- **Review**

  After a reviewed test, this licence is made permanent and only requires further review after a 5 year period.

  As C.I.R. licences are recognised by the State, all the major mining houses and worker organisations, the licensing is highly prized by both operators and mines as it ensures a defined standard of knowledge and performance. The advantages of this to both operators and mine management cannot be underestimated as it allows persons to seek employment elsewhere without re-training and puts mines in a position where they can sign on trained staff at any level.

  The most outstanding schools of this nature visited were the Indigenous Peoples' training centres. Here totally illiterate people are taken to a level where they are the most highly sought-after operators of mobile machinery, both in the mines and civil engineering works. A visit to these institutes is a must to all persons interested in education, safety and training in a third world context.

4. MINING TRAINING

The training operators received on the mine has two distinct components:

MINE GENERAL	MINE SPECIFIC
Rules (general) Particularities (general) Hazards (general) Done by mine officials, Training Officer, Safety Officer or Personnel Officer depending on the size of the mine.	Rules (area specific) Particularities (machine specific) Hazards (area specific) Done by the Safety Steward and Shiftboss or Foreman.

After being signed-on in the case of a new operator, or on return to the mine in the case of an employee who was sent by the mine for training, the operator is given orientation induction in the general rules, particulars and hazards likely to be encountered on the mine. He is then handed over to the shiftboss/foreman and safety steward responsible for the area or activity where he will be working. It was noted that the safety steward played a significant role in this site specific induction, which dealt with the rules for the area. After this familiarisation, a test was performed by a person designated by the manager and the safety steward. This test has to be passed before the person can be appointed as an operator.

5. CONTROL OF MOBILE MACHINE OPERATORS

Although the control and management of mobile machine drivers is not specifically part of Col. 341 it is felt one or two general points were obviously so effective and important to the safe use of mobile machinery that they should be highlighted.

a) A strict rule enforced on all mines visited was the '0.00 blood alcohol level'. No person may operate any machine or vehicle, on the surface or underground, or on a public highway if there is any alcohol in his bloodstream. The penalty for a first offence is a 3 month suspension of licence. For a second offence it is a 6 month suspension, while a third offence constitutes a suspension until such a person can prove rehabilitation. (As this rule is not a mining regulation but forms part of the national law, mines and worker organisations have no problem enforcing it.)

b) Most mines practised a points penalty system based on the national road regulations. This means that where an operator is found to be operating outside the standards, he is penalised with points. When the points

exceed a number agreed to between management and worker organisations, an automatic suspension, normally for a two week period with no pay, comes into effect. The third such suspension normally leads to the cancellation of a licence and therefore dismissal.

It was significant to note the elected safety steward's role in this. As safety steward he has the responsibility to advise and discipline where necessary. These stewards take this role seriously and operators are far more concerned with the safety steward than with mine officials.

6. CONCLUSION

There are many facets of skill training in the Australian mines which can be used as models for the direction training of such operators in South Africa should take. However, unless the importance of mobile machine operators is recognised and the necessary job pride developed, little will come from improved training.

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APPENDIX VII

RESULTS OF INFORMATION GATHERING VISITS

RECORD OF INFORMATION GATHERED FROM SIX MINES VISITED

1. Work activities.	
Mine 1	• Locomotives
Mine 2	• Shuttle cars • Continuous miners
Mine 3	• Shuttle cars • Scoops battery • Continuous miners • Face drills • Roof bolters • Tractors • Feederbreaker • Conveyor belts
Mine 4	• Scoop • Coal cutter (Joy) • Tractors
Mine 5	• Tractors - feederbreaker
Mine 6	• Shuttle cars • Continuous finers • Feederbreakers

2. Obtain a copy of Mine's training programme for underground personnel operating Mobile Machines. Response:	
Mine 1	• Obtained training manual
Mine 2	• Obtained training manual
Mine 3	• Obtained training manuals specific for each machine
Mine 4	• A, B coal cutter • Load haul dumpers • Tractors
Mine 5	• Training manuals
Mine 6	• Shuttle cars • Mechanical loaders • Feederbreakers

3. How was the training programme for underground Mobile Machines compiled? a) in general b) specific Response:	
Mine 1	• Developed & compiled by a project team. Made up of representatives from the following disciplines: engineering artisans, foremen and engineering, operating staff. Engineering training officer and instructor as well as original equipment manufacturer.
Mine 5	• Both - general and specific.
Mine 2	• Suppliers and their instructors - Standards committee to keep manuals up to date. All (mgt) contributed.
Mine 4	• General - from manuals in USA • Specific - to units.
Mine 3	• Specific for each machine's operator
Mine 6	• Specific - two types of measures 1) Operating 2) Engineering • General - Policy - Safety - Steps Very good technical manuals.

4. Were technical manuals used in the compilation of these training programmes? Name them. Response:	
Mine 1	• O E M was involved for technical information and on site assistance (Supplied the trainer).
Mine 5	• Technical manuals kept at mine training centre - for all units - example Schroeder face drill.
Mine 2	• Yes - from suppliers.
Mine 4	• Yes - A.B. coal cutter (Anderson Mallor) for standards how to operate / layout and specifications.
Mine 3	• Joy Manufacturers - very valuable information. • Production people know little about technical manuals. • Joy - Eimco.
Mine 6	• Engineering Handling - compiled manuals. • Drew up technical manuals from manuals from manufacturers.

5. Were operating manuals supplied by the manufacturer which were used to compile training programmes? Name them. **Response:**	
Mine 1	• Yes - O E M manuals. • No - production people don't know these manuals.
Mine 5	• On mine and in training centre. • Joy licences.
Mine 2	• Yes - as in No. 3 as well as operating manuals.
Mine 3	• JOY/EIMCO. Instructors from Joy bring their manuals. • R.B. Ingersol Rand.
Mine 4	• Joy Coal Cutter was supplied for operations / training.
Mine 6	• Yes - got information from operator - spares - technical manuals. • No - engineering manual only, not operator one. • Very useful document from manufacturer.

6. Did anyone make analysis of the operator's tasks? Supply them. **Response:**	
Mine 1	• No analysis done. Studies all procedures and recorded them for reference whilst compiling the training programmes.
Mine 5	• Long ago M.S.M.S. task analysis and procedures and critical task inventory. Also job hazard analysis based on JCI "HAZWISE".
Mine 2	• No - only listed a task.
Mine 4	• No - done partly.
Mine 3	• No - only critical task list / Part of MSMS. • MSMS requires this.
Mine 6	• Standard task procedures book used - use task analysis for PTO's. • No shuttle car operator manual : starting / tramming / reversing not formalised. • Yes.

7.	**If so were the tasks broken down into steps and associated dangers? Name them.** **Response:**
Mine 1	• No task analysis was done
Mine 5	• NB see Job Hazard Analysis - NOSA MBO and CoM - MSMS. • Very good use made of HAZWISE. • Operators train new operators. Put them on a shuttle car and tell them what to do. • Done informally.
Mine 2	• Not done.
Mine 4	• Not done. • Team effect in the office by mine overseer and general foreman.
Mine 3	• No (did not do actual task analysis) • Only critical task inventory. • Yes - It is done.
Mine 6	• Not done. • Standard procedures.

8.	**In doing the analysis were the environmental factors considered? Name them.** **Response:**
Mine 1	• No. No P.T.A
Mine 5	• Do cyclic mining - avoids dust and fumes.
Mine 2	• No
Mine 4	• Not done. • Yes - dust and gas.
Mine 6	• Training department - not done. • Operators - Where applicable - PPE. • Dust and ventilation.

9. Are the responsibilities of the operator, the responsible person, the supervisor and management included in the training programme? Response:	
Mine 1	• Operator only. (Pre-use inspection informal).
Mine 5	• Training stops at supervisor level - open door policy, basic mine training, other modules spell out individual's responsible.
Mine 2	• No - busy with programme to devolve all responsibilities to one single person.
Mine 4	• No, not in training manual in writing. • Yes - broken responsibilities.
Mine 3	• Have centralised and decentralised training. • No - informal. • Is a must - not in training manual / program but in standard procedures. • Yes - through on-the-job training . Drivers are taught.
Mine 6	• Training Sections responses - train drivers not shiftbosses or supervisors. • Production officials - their responses - No one will overrule the driver's decision. • Driver has sole responsibility. • It is felt that operators do not accept ownership, special courses are given to supervisors. Management feels it is very important to accept ownership.

9.1 If so what are they? Response:	
Mine 1	• Responsibilities for all concerned are not spelled out - nor are they formalised.
Mine 5	• Spell out each individual's responsibilities at induction inspection - but trainers are not.
Mine 2	• No - looking at it.
Mine 4	• No • No response.

Continued

Mine 3	• Each event / job has it's responsibilities; have no job descriptions and task description not included in training programme. • Operator fills in checklist - pre-use. • Checklist is then checked by miner / fitter / electrician. • Problems are rectified. • Over inspection is done by foreman / shiftboss senior foreman / mineoverseer / managers / engineer. • On-the-job training.
Mine 6	• Training Sections responses - no response. • Production officials - their responses - artisan determines whether the unit can be used or not e.g. oil spill/leak etc.

10. Is the operator trained in what is expected of him should he note a dangerous defect on his machine? Response: state how:	
Mine 1	• Operator is not trained to act according to a Hazard classification. (Illiteracy excuse).
Mine 4	• Done informally.
Mine 5	• Vague - on the job training (operations). • Training - exactly what he should do & take precaution.
Mine 2	• Yes - Not formalised in training manual. No hazard classification.
Mine 3	• Yes - must stop unit (look out) - report immediately to relevant person. Dangerous - stop! Use safety rep to reach bosses. • Yes, on-the-job training informal.
Mine 6	• Production officials - their responses - stop and report immediately to supervisor should something be wrong.

11. Does the training programme include the operator's "the right to know", the access to information such as standards/regulations. Response: State what.	
Mine 6	• Yes regarding standards and regulations.
Mine 4	• Production officials - their responses - on- the-job training includes it. • Training Section's responses - not included in the training programme and not stressed.
Mine 2	• No not spelled out. Not done until operators can read and write. Made available at induction.
Mine 3	• No - not in training programme people know about it.
Mine 5	• Based on I.L.O. At induction are told dangers to health and safety. However Production say not in training programme.
Mine 6	• Production officials - their responses - communicated verbally - not documented. Not part of forms. • Training Sections responses - don't tell him he has a "right", tell him the dangers. Not formal at this stage.

12. Does the operator training stress the "right to refuse" unlawful instructions. Response: State	
Mine 1	• Not formalised.
Mine 2	• No - not specific. Spelt out in philosophy.
Mine 4	• Not in training programme (vague). • Yes - as they of overall job.
Mine 3	• No - not in training programme. • Yes - he may refuse if he feels it is dangerous.
Mine 5	• Not stated in training programme, part of safety and health agreement given at induction.
Mine 6	• Training Section's response - not specifically. • Production officials - their responses - on the job informally accepted - can refuse (afterthought).

13. Are codes of practice included in the underground mobile machine operator training programme? Name them **Response:**	
Mine 1	• No.
Mine 4	• Don't know about these. • Not known.
Mine 2	• Yes - covered in codes of practice for the operation of individual machines.
Mine 3	• At present converting standards to codes; • Environmental code - gas testing; • Roof support practice.
Mine 5	• Training Section's responses - set of examples, videos, exercises - Production - yes - codes are included. Good formal training programme.
Mine 6	• Production Officials - their responses - yes, where applicable - relevant; • Training Section's responses - only vent code - dust control and emergency procedures, but not as a code of operators. What is a code of practice?

14. How are mobile machine operators trained to do inspections with special reference to: **14.1 Observing something being wrong, damaged or not to standard. What specific training does the operator receive to address the above? State Response:**	
Mine 1	• Yes - trained by instructors to identify problems.
Mine 4	• Covered in manual. • No place on checklist to cover hydraulics - shovel down all the time/speak about but don't fix it. • Technical training would be an improvement, pre-shift examinations do not function anymore.
Mine 2	• Yes - part of training programme - go through checklist and report defects on machine.
Mine 3	• Every operator - yes! How to use checklist training provided. • Yes - and drivers are trained on the job.

Continued

Mine 5	• Pre-use checklist. • Have no models for training in full production situation. • Mostly on-the-job training (actual work). • Get training in how to use equipment. • Get additional training in gas testing. • Nothing regarding maintenance work.
Mine 6	• Production Officials - their responses - yes. • Training Sections responses - yes. • Pre-shift checklist and on the job. • No theoretical training at all on the job.

14.2 What training does the operator get to know, understand and classify A B C class hazards "according to mine standard? State Response:	
Mine 1	• Not done.
Mine 2	• No - not specified.
Mine 4	• No training and no guidelines • Not formally - pre-shift checklist does not differentiate.
Mine 3	• Done yes - distinguish A, B, C. Brakes/steering not used. • Training done informally. Will formalise. • Have first class lock-out system. • Some production people do not know.
Mine 5	• Training responses - trained to stop unit at once if something goes wrong. Also knows A is dangerous. • Training responses - in work situation use the A B C haz. classification to apply on pre-use checklist.
Mine 6	• Training responses - not part of training programme. Differs from area to area. • Production officials - their responses - not really - its a good idea! Illiteracy a problem.

14.3 What training does the operator receive regarding the results of such an inspection? Response:	
Mine 1	• Not done.
Mine 4	• Nothing • Hazard classification system not formalised.
Mine 2	• No - not specified. Training in engineering aspects of job - giving assistance and doing repairs during maintenance.
Mine 3	• No - done by Safety Officer. Not part of training programme. Done informally production people - some don't know.
Mine 5	• Training responses - part of basic mining training course. Example check for gas. Finds gas. Switches off the unit.
Mine 6	• Training responses - none. • Production officials - their responses - do not communicate "Why fors" to drivers. Safety Officers do spot checks. • Get it through safety representative meetings • Training responses - not part of training programme. Not trained to understand why some things are not repaired immediately.

14.4 What safety devices are involved and how are they included in the training programme? State them:	
Mine 1	• Locomotives - yes.
Mine 4	• Emergency stop/emergency brakes/lock out device/lock out/gas monitoring device/cap lamp included in practical training.
Mine 2	• Yes - shuttle cars/cont. miners.
Mine 3	• Prestart alarm / reverse alarm / - in training manual - done on the job. • Emergency brakes - flashing lights - sirens - lock-out.
Mine 5	• Training Sections responses - brakes - lights - brakes - etc. • Production officials - their responses - none.

Continued

Mine 6	• Training Sections responses - brakes - emergency brakes / silences / lights / flashing lights / lockouts / limit switch on cable drum / interlock on continuous miners. • Production Officials - their responses - same as above. It is done.

14.5 Should something be wrong with a safety device what does the training tell him what should he do? State what: **Response:**	
Mine 1	• If is an "A" class hazard. Stop/report.
Mine 4	• Drop bucket / do not use machine / emergency brakes are used sometimes.
Mine 2	• Stop - Switch off - report.
Mine 3	• Training manual = stop - lock-out - immediately report (all issued with belt - lock & key) • Stop - lock-out - notify artisan/miner.
Mine 5	• Part of training programme. Stop and reports.
Mine 6	• Training - stops machine - calls artisan. • Operations - stops machine - calls the artisan.

15. What review training does a mobile machine operator receive to ensure and confirm that his competence is consistent with or better than the mine standards? **Supply information:** **Response :**	
Mine 1	• None - instructors use PTO's for that purpose
Mine 4	• Day after leave - goes through the whole course.
Mine 2	• Induction - after leave - induction - on the job follow up.
Mine 3	• Matambo - ongoing review training on the job information, and every 6 months licence renewal training. • Follow up training every 6 months.
Mine 5	• Every 6 months goes through 9 day re-induction - retraining every job - every 2 weeks on the job and relicensing every 6 months. Re-tested after an accident.
Mine 6	• Production Officials - their responses - done. • Training Section - Not done.

16. Does the training programme include : **16.1 Performance standards? State:** **Response :**	
Mine 1	• No
Mine 4	• Not spelled out. • No performance measurement.
Mine 2	• No
Mine 3	• No - have minimum job requirement; - not in the same language; - no job description.
Mine 5	• Performance : whole training programme contains performance standards? • Not specific = very basic training programme. • No standards for kidney belts. • Training : feederbreaker attendant is solely responsible for allowing people to enter the tipping area / operating it is part of tractor training.
Mine 6	• Training Section - some operating procedures. • Operations official - ditto. • Have not. • An industrial engineer does time and motion studies.

16.2 Performance measurements? Pre-use inspections do not work. **Response :**	
Mine 1	• No - have no standard to measure to use P.T.O's.
Mine 4	• Not done
Mine 2	• No
Mine 3	• No - not in induction / training (monitoring). • Why, operators do not use. • NB no one explains the reason for doing pre-use inspections) Why?
Mine 5	• Planned task observations and analysis not done. • Training - checks random sampling = reports.
Mine 6	• Training - not done - monitoring not done. • Gets tested before he is appointed.

16.3 How are the above evaluated? **Response :**	
Mine 1	• No - PTO . Results are passed on to training. Only a few samples. Do not record poor performance.
Mine 4	• No - not done.
Mine 2	• No
Mine 3	• No
Mine 5	• Not done - Do not monitor - no trend analysis / instructors do on the job evaluations. No system / no analysis.
Mine 6	• Training - on-the-job checks not monitoring not formal work. • Planned task observations are done on a random basis.

17. How often is a mobile machine operator :	
17.1 Tested :	
Mine 1	• Training instructor's testing ongoing.
Mine 4	• Passes out after training. • Only for the first time - gets re-tested and appointed after leave.
Mine 2	• Yes per regulation - every 180 shifts re-test at annual induction.
Mine 3	• Operator is trained by training department and tested by production and passed by production department. • 6 monthly - licence by (Safety Dept.) also checked by training instructor on a monthly basis on job. • Every 6 months.
Mine 5	• When considered competent by inspector / every 6 months.
Mine 6	• Training Section - only trained when requested by supervisor then appointed. • Operators - tested before appointment. Re-tested after annual leave.

17.2 Re tested :	
Mine 1	• Every 6 months.
Mine 4	• After leave.
Mine 2	• Yes - must pass everything in training programme.
Mine 3	• 6 months for licence purposes.
Mine 5	• 6 monthly 6 months.
Mine 6	• Training Section - after leave. • Production officials - their response - after leave.

18. Regarding the loss history of these mobile machines - can you provide the following information :

18.1 When and how employees were injured and how this information is included in the training programme? State:
Response :

Mine 1	• Pool information. Use it in campaigns and safety topics and safety day.
Mine 4	• Done informally. • Good system when in plan during the day.
Mine 5	• No formal system - reported to training department - no formal training needs analysis done - at present not done - Training gets all the accident reports. • No basic causes. Training participates in site investigation.
Mine 2	• Not - only available in Safety Department. Addressed at safety meetings.
Mine 3	• All accidents report land up in Training Department. Anything to do with training is automatically addressed. • Ingwe accidents are informally discussed at waiting place and safety meetings. Ingwe accidents passed on to Mine 3. • Green area communication - accident report. • Safety Officer - green areas communication.
Mine 6	• Training Section - flash reports. • Production officials - their responses - vague. • Passed on to training department.

18.2 How are the above experience and lessons learnt pointed out to other operator being trained? Explain: **Response :**	
Mine 1	• Not done
Mine 4	• Not done
Mine 2	• Not done
Mine 3	• Serious accidents yes. At waiting place. • Production does not communicate lessons learnt to training. • Green area communications - see report.
Mine 5	• Hazwise - nothing formal at this stage.
Mine 6	• Training Section - vague • Production officials - their responses - do. • Training manual.

18.3 When and how is the property damage accidents addressed in the training programme? Explain: **Response :**	
Mine 1	• Not done.
Mine 4	• Do not get to hear of it - should get information report same as accident report.
Mine 2	• Not done.
Mine 3	• High potential incidents. • Repeaters. • Communicate to training department what production does about property damage accidents. • Green area communications - see report.
Mine 5	• Hazwise - not addressed at this stage.
Mine 6	• Training Section - yes. • Production officials - their responses - vague. • Treated as an accident.

18.4 When and how "near misses" which have occurred are addressed in the training programme? Explain: Response :	
Mine 1	• Not done.
Mine 4	• Never heard about it - not at training department. • Alpha stay Beta.
Mine 2	• Not in training manual - briefed downwards about safety meeting.
Mine 3	• Production does not know what is in training programme. • Training lies high potential ones. • Matambo deals with near-misses highlighted sections e.g. falls of ground etc. on the job. Only big ones not small ones. • Green area communication - see report.
Mine 5	• Being implemented / planned.
Mine 6	• Training Section - vague. • Production officials - their responses - do - communication is being improved to get them reported.

19. When and how is the training programme for mobile machines changed or modified to address new or modified equipment? Explain: Response :	
Mine 1	• Not formalised. Done by supervisors in the section. No record kept.
Mine 4	• New/modified equipment - training manual is adapted and changed. Manuals not changed.
Mine 2	• As and when it happens the Training Section is notified. Is a standard on mine also when moving from one machine to another operator are reporting • i.e. H.M. (Joy continuous miner).
Mine 3	• Training manual is not changed - but covered in appendices. Not in manual. • Done informally.
Mine 5	• Not done yet. Good idea to do this. Project changes are discussed at meetings.
Mine 6	• Training Section hear of it by accident. • Changes - no formal communication system • Production officials - their responses - Ditto.

20. What lessons have been learnt regarding the operation of mobile machines which are believed to be absolutely critical to the establishment /maintenance of a good training programme? State: Response :	
Mine 1	• Scrubber boxes checked by artisans operators need education to appreciate the importance of a scrubber boy safety system. • An onerous job to do every shift - time consuming.
Mine 4	• Training - nothing / OPS accidents at tips - roof conditions when part of training. Information loss.
Mine 2	• No response.
Mine 3	• Mostly economic - changes has been made. • The centre does mostly theory training NB : why are seats provided for shuttle cars in Botswana but not here?
Mine 5	• Not done.
Mine 6	• OPS STP's changed accordingly. • Training Section - not when understood. Vague. Advised on random basis.

21. Do selection criteria exist for mobile machine operators? State: Response:	
Mine 1	• No - only medically fit and co-ordination tests.
Mine 4	• Stopped - supervisors do that.
Mine 2	• Vienna testing system is used. • Medical - (Grand father clause).
Mine 3	• No physical capacity tests. • Yes. Hearing / sight / colour blindness / co-ordination testing / depth perception / potential index battery test. • Age - medical fitness - sex.
Mine 5	• Training manual. Men. • Physical capability test not done.
Mine 6	• Training - yes no physical capability assessment is done.

22. If so what are these criteria? State: **Response:**	
Mine 1	• No
Mine 4	• Eye sight / physical abilities. • Mine overseer does the selection criteria. • Mine overseer waves the rules.
Mine 2	• Yes - Vienna test 50% literacy.
Mine 3	• Hearing/sight/colour blindness/co-ordinations tests/depth perception/potential index battery.
Mine 5	• In manual.
Mine 6	• Training Section - yes . • Production officials - their responses - yes.

23. Is each prospective mobile machine operator assessed to determine his strengths and weaknesses in order to plan his training programme? State: **Response :**	
Mine 1	• Only experience counts
Mine 4	• No spare people - should have them. • Must have a pool. • Due to shortage of labour not possible.
Mine 2	• Yes - through Vienna test.
Mine 3	• And follow the same training programme . • Before evaluation check & test people on the job informally. • Test according to miner's point of view. • NB A career path must be done.
Mine 5	• No, not every person.
Mine 6	• Training - only physical medical examination. • Have nothing on the individual side.

24. Does the training curricular of a mobile machine operator also include: **24.1 Legal aspects? State:** **Response:**	
Mine 1	• No - literacy levels are a problem. Trainees are told about the regulations. Majority can't read nor write.
Mine 4	• No - almost non-existent.
Mine 2	• Yes
Mine 3	• Not each one personally but in general and relevant regulations are discussed. • Covered by basic conditions of employment • New Act will make us face it.

24.5 Environmental factors? State: Response:	
Mine 1	• No - do get training in use of oil cans for oil, gas testing, not allowing machines to stand and idle.
Mine 4	• Dust suppression and oil spillage's.
Mine 2	• Noise - roof conditions (barring not part of that covered). Question the lack of the "Why Factor".
Mine 3	• Since medical staff goes underground this work is done in depth. • Ventilation dept. only measures - gives no feedback. • Not done a lot of work on noise abatement. • Cater for hearing protection.
Mine 5	• Dust/noise not all included.
Mine 6	• Training Sections responses - noise/dust and oil spillage's. • Production officials - their responses - ventilation/dust.

24.6 Other factors? State: Response:	
Mine 1	• Dust control. Wedging of machines in cages, ventilation and self monitoring systems.
Mine 4	• Safety factors underground - should have families on mines. Contract labour a draw back.
Mine 2	• None - barring is a big issue.
Mine 3	• None
Mine 5	• Doctor does screening test. • Psychological (or open cast only not yet for underground).
Mine 6	• Training Sections responses - No. • Production officials - their responses - • No comments.

25. Does the practical training of a mobile machine operator also include:

25.1 Simulated training? State:
Response:

Mine 1	• Yes - only continuous miner.
Mine 4	• No - used to
Mine 2	• Not done - thinking of it.
Mine 3	• Some yes - certain component or shuttle cars. continuous miners - TV /HM for levers it is not the answer! • Very expensive.
Mine 5	• No
Mine 6	• Training Sections responses - no • Production officials - their responses - no • No.

25.2 On-the-job training? State:
Response:

Mine 1	• Yes - formal and informal where spaces can accommodate two persons.
Mine 4	• Yes - 95%. • Yes - 90%
Mine 2	• Yes ± 90% is on-the-job training.
Mine 3	• Yes - important. • Finally on the job.
Mine 5	• Yes - theory in training centre, practical on the job.
Mine 6	• Production officials - their responses - yes • Training Sections responses - No.

25.3 Operating on his own? State
Response:

Mine 1	• Yes - but under supervision
Mine 4	• No other way
Mine 2	• Yes under supervision
Mine 3	• Yes - under supervision until he is competent. • Yes - after he has been licensed.
Mine 5	• Yes - Shuttle car / coal / trailer / etc. • No facilities for 2 persons.
Mine 6	• Production officials - their responses - yes. • Training Sections responses - yes. • Yes.

25.4 Pre-use check of mobile machine / filling in checklist / reporting of substandard conditions, hazards etc.? State: Response:	
Mine 1	• Yes - have a system that does not work.
Mine 2	• Checklist is cumbersome and too long containing too many points. • Operators do not understand the different factors. • Should look at standardisation in industry.
Mine 3	• Yes
Mine 4	• Pre-use checks done informally / verbally / should be written down.
Mine 5	• Done? Effectively filled in/checked/filed!
Mine 6	• Production officials - their responses - yes . • Training Sections responses - logistics - collects uses / no formal system. All people don't know. • Don't really do analysis etc.

25.5 How is the operator licensed? State: Response:	
Mine 1	• Tested by competent people.
Mine 2	• Passed out by shiftboss/foreman.
Mine 3	• Is tested - qualifies - is then tested again by engineering staff and production personnel. • By an appointed instructor. • By testing on the job.
Mine 5	• Verbal /practical examiner uses test sheet to record. Theory is questioned/practical is tested on the job. On getting full score in test the man is passed.
Mine 6	• Production officials - their responses - trained and tested. Passed test is appointed then licensed.

25.6 Are other criteria used in the mobile machine operator's training programme? Response:	
Mine 1	• None
Mine 4	• No positive responses. • No
Mine 2	• Yes - safety videos.
Mine 3	• Depends on the specific type of mobile machinery. • Production - do not know.

Continued

Mine 5	• Hearing tests. • Additional training - Randfontein Estates - AECI - JOY - belts.
Mine 6	• Production officials - their responses - diesel machine operators - one week in the training centre with mechanic.

26. Is there anything that mine personnel wishes to add to this list? State: **Response:**	
Mine 1	• Issues - Standardisation of machines should be done. Ergonomics should be considered.
Mine 4	• Language problem / incorrect understanding / kidney belts for scoop operators / *Try to pass the buck to team leaders. Training Section should be put under pressure to not release trainees prematurely.*
Mine 2	• Nil
Mine 3	• Signalling. Whistle/light not specific enough. Need better ways. • Signalling should become a code of practice not just whistling any how.
Mine 5	• Operators to have more training into the mechanics of the machines. Should know the theory of it all.
Mine 6	• Production officials - their responses - safety training/engineering training including people who have no perception of danger. Only pick up training on the mines. Artisans have to be trained as operators/drivers.

APPENDIX VIII

RESULTS OF HAZARD IDENTIFICATION EXERCISE

TABLE VIII.1 Hazard Identification for Conveyors

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Fires	Friction	Fatal; Reportable; Lost shifts.	Seized rollers; Mis-alignment; Duff build ups.	Inspection/super/vision; Maintenance; Training.
Pulled into drive and return rollers.	Cleaning repair.	Fatal; Reportable; Lost shifts.	Unlawful removal of guards; Lack of guards; Failure to lock out.	Supervision; Discipline; Training; Design/communications.
Struck by material	Travelling along side; Cleaning along side.	Reportable; Lost shifts.	Inadequate guarding of high places; Inadequate space; Poor alignment.	Design ; Ergonomics; Training.
Cut by belt	Travelling along side; Cleaning along side.	Reportable; Lost shifts.	Wire sticking outside the edge of the belt, as the result of worn belt or poor jointing.	Inspection/supervision; Training; Maintenance.
Cut repairing belt	Doing belt repairs.	Reportable; Lost shifts.	Cut by belt knife while doing repairs (many home made knives involved in such accidents).	Supervision; Tools and equipment; Training.
Struck repairing belt	Doing belt repairs.	Fatal; Reportable; Lost shifts.	Sling or other equipment used failed under stress.	Supervision; Tools and equipment; Training.

TABLE VIII. 2 Hazard Identification for Shuttle Cars

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Pedestrian accidents	Other employees travelling, working or sitting in road ways.	Fatal; Reportable; Lost shifts.	Inadequate warning devices; Inadequate travelling ways; Poor job planning; Lack of visibility.	Mine design; Mine standards; Discipline; Training.
Driver struck by	Protuberances from roof or rib side.	Fatal; Reportable; Lost shifts.	Inadequate inspection of roadways for hazards; Not standard controlling height in which a machine may operator; Hazards not identified as such.	Inadequate standard of safety management; Inadequate mine standards. Inadequate training.
Tyre accidents	Tyre rims "exploding" off wheel during repairs.	Fatal; Reportable; Lost shifts.	Inadequate tools; Faulty equipment; Poor workmanship.	Training; Inadequate standard.
Fires	Cable induction; Cable joints; Flame proofing; Brakes.	Fatal; Reportable; Lost shifts.	Power being left on, on coiled cable; Faulty joints as a result of poor workmanship or wear against rib sides; Poor workmanship in terms of maintenance and flameproofing; Inadequate or no inspection.	Training; Quality control; Inadequate safety management standard.
Towing	Persons crushed between machines while getting ready to tow or slings snapping and striking persons during towing.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment; Wrong equipment; Wrong application; Lack of visibility; Inadequate communication.	Inadequate mine standard; Training.

TABLE VIII.3 Hazard Identification for Scoops

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Pedestrian accidents	Other employees travelling, working or sitting in road-ways	Fatal; Reportable; Lost shifts.	Inadequate warning devices; Inadequate travelling ways; Poor job planning; Lack of visibility.	Mine design; Mine standards; Discipline; Training.
Driver struck by	Protuberances from roof or rib side	Fatal; Reportable; Lost shifts.	Inadequate inspection of roadways for hazards; No standard controlling height in which a machine may operate; Hazards not identified as such; Lack of visibility.	Inadequate standard of safety management; Inadequate mine standards; Inadequate training.
Tyre accidents	Tyre rims "exploding" off wheel during repairs.	Fatal; Reportable; Lost shifts.	Inadequate tools; Faulty equipment; Poor workmanship.	Training; Inadequate standard.
Towing accidents	Persons crushed between machines while getting ready to tow or slings snapping and striking persons during towing.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment; Wrong equipment; Wrong application; Unauthorised usage; Inadequate communications; Lack of visibility.	Inadequate mine standard; Training.
Fires	Flame proofing; Brakes; Batteries	Fatal; Reportable; Lost shifts.	Poor workmanship in terms of maintenance and flameproofing; Inadequate or no inspection.	Training; Quality control; Inadequate safety management standard.
Battery accident	Serious hand injuries during battery changing operations.	Reportable; Lost shifts.	Incorrect alignment; Faulty equipment.	Inadequate inspection; Training.

TABLE VIII.4 Hazard Identification for LHD's

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Pedestrian accidents	Other employees travelling, working or sitting in road-ways	Fatal; Reportable; Lost shifts.	Inadequate warning devices; Inadequate travelling ways; Poor job planning; Lack of visibility.	Mine design; Mine standards; Discipline; Training.
Driver struck by	Protuberances from roof or rib side	Fatal; Reportable; Lost shifts.	Inadequate inspection of roadways for hazards; No standard controlling height in which a machine may operate; Hazards not identified as such; Lack of visibility.	Inadequate standard of safety management; Inadequate mine standards; Inadequate training.
Tyre accidents	Tyre rims "exploding" off wheel during repairs.	Fatal; Reportable; Lost shifts.	Inadequate tools; Faulty equipment; Poor workmanship.	Training; Inadequate standard.
Towing accidents	Persons crushed between machines while getting ready to tow or slings snapping and striking persons during towing.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment; Wrong equipment; Wrong application; Lack of visibility.	Inadequate mine standard; Training.
Fires	Flame proofing; Brakes; Batteries	Fatal; Reportable; Lost shifts.	Poor workmanship in terms of maintenance and flameproofing; Inadequate or no inspection; Unauthorised usage.	Training; Training; Quality control; Inadequate safety management standard.
Bucket accidents	Persons injured while using bucket as a platform while doing work at height.	Reportable; Lost shifts.	Inadequate driver skills; Inadequate communications; Incorrect application.	Inadequate standards; Inadequate equipment; Training.
Run away	Brake failures while going up or down steep inclines under load.	Fatal; Reportable; Lost shifts	Overheated engine cut out; Emergency brake failed to operate; Operator panicked and jumped.	Engineering design standard; Training.

TABLE VIII.5 Hazard Identification for Tractor Trailers

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Pedestrian accidents	Other employees travelling, working or sitting in road- ways	Fatal; Reportable; Lost shifts.	Inadequate warning devices; Inadequate travelling ways; Poor job planning.	Mine design; Mine standards; Discipline; Training.
Driver struck by	Protuberances from roof or rib side	Fatal; Reportable; Lost shifts.	Inadequate inspection of roadways for hazards; No standard controlling height in which a machine may operate; Hazards not identified as such.	Inadequate standard of safety management; Inadequate mine standards; Inadequate training.
Towing accidents	Persons crushed between machines while getting ready to tow or slings snapping and striking persons during towing.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment.	Inadequate mine standard; Training.
Fires	Flame proofing; Brakes; Batteries.	Fatal; Reportable; Lost shifts.	Poor workmanship in terms of maintenance and flameproofing; Inadequate or no inspection; Unauthorised usage.	Training; Quality control; Inadequate safety management standard.
Run-away and overturning vehicles	Turned over on steep incline; Hit rib side on steep incline; Hit rib side on corner.	Fatal; Reportable; Lost shifts	Driver lost control on incline; Driver lost control going around corner; Unauthorised usage.	Engineering design standard; Training; Inadequate safety management standard.
Passenger accidents	Unlawful riding	Fatal; Reportable; Lost shifts.	Unlawful riding either next to driver or behind the vehicle.	Inadequate supervision; Lax or misdirected supervision; Training.
Tow bar accidents (always either hands or feet)	Hitching or unhitching tow bar.	Reportable; Lost shifts	Faulty mechanisms; No safety devices; Inadequate standard or lack of standard.	Training; Lack of inspection; Lack of standard.

TABLE VIII.6 Hazard Identification for Loaders

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Jib accidents	No 2 crushed between jib and rib side.	Fatal; Reportable; Lost shifts.	Incorrect position taken; Inadequate or no reverse warning signal; Caught while machine was being slued.	Training; Engineering design.
Driver crushed accidents. (Found only where the machine is operated from next to the machine, no cab.)	Caught between machine and rib side.	Fatal; Reportable; Lost shifts.	Incorrect position taken during loading; Machine slipped on sloped floor; Driver's foot caught under tracks.	Training; Mining standards.
Towing accidents	Persons crushed between machines while getting ready to tow or slings snapping and striking persons during towing.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment; Wrong equipment; Wrong application.	Inadequate mine standard; Training.
Fires	Flame proofing; Electrical connections; Cables.	Fatal; Reportable; Lost shifts.	Poor workmanship in terms of maintenance and flameproofing; Inadequate or no inspection; Induction in coiled cables left live; Faulty cable joints; Cables damaged by other equipment.	Training; Quality control; Inadequate safety management standard.

TABLE VIII.7 Hazard Identification for Coal Cutters

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Driver crushed accidents	Caught between machine and rib side	Fatal; Reportable; Lost shifts.	Incorrect position taken during cutting; Machine slipped on sloped floor; Drivers foot caught under tracks (normally during fitting); Stelling bar incorrectly used.	Training; Mining standards.
Jib accidents	The jib, which is extremely dangerous, remains the highest risk factor on this machine.	No accidents recorded during past 10 years.		
Fires	Flame proofing; Electrical connections; Cables.	No recorded incidents	Poor workmanship in terms of maintenance and flameproofing; Inadequate or no inspection; Induction in coiled cables left live; Faulty cable joints; Cables damaged by other equipment.	Training; Quality control; Inadequate safety management standard.
Towing accidents	Persons crushed between machines while getting ready to tow or slings snapping and striking persons.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment; Wrong equipment; Wrong application.	Inadequate mine standard; Training.

TABLE VIII.8 Hazard Identification for CMs and Roadheaders

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Assistant crushed	Caught between machine and rib side; Feet caught by machines tracks.	Fatal; Reportable; Lost shifts.	Incorrect position taken during operation; Machine slipped on sloped floor; No reverse warning or inadequate reverse warning.	Training; Mining standards.
Cable handling accidents	No 2 either struck by cable or caught by cable.	Reportable; Lost shifts.	Injured while hanging cable; Injured by falling cable; Caught by cable being pulled.	Mine standards; Training.
Towing accidents	Persons crushed between machines while getting ready to tow or slings snapping and striking persons.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment; Wrong equipment; Wrong application.	Inadequate mine standard; Training.
Fires	Flame proofing; Electrical connections; Cables; Cutting head ignitions.	Fatal; Reportable; Lost shifts.	Inadequate or no inspection; Inadequate or no inspection; Induction in coiled cables left live; Faulty cable joints; Cables damaged by other equipment.	Training; Quality control; Inadequate safety management standard.

TABLE VIII.9 Hazard Identification for Drills

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Driver crushed accidents	Caught between machine and rib side.	Fatal; Reportable; Lost shifts.	Operator or assistant caught between machine or rib side; Operator or assistant injured during fitting.	Training; Mining standards.
Caught by rotating steel	Loose clothing or glove caught causing serious hand and arm injuries	Reportable; Lost shifts.	Incorrect position; Incorrect PPE; Inadvertent operation.	PPE standards; Training.
Towing accidents	Persons crushed between machines while getting ready to tow or slings snapping and striking persons.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment; Wrong equipment; Wrong application.	Inadequate mine standard; Training.
Fires	Flame proofing; Electrical connections; Cables.	Fatal; Reportable; Lost shifts.	Poor workmanship in terms of maintenance and flameproofing; Inadequate or no inspection; Induction in coiled cables left live; Faulty cable joints; Cables damaged by other equipment.	Training; Quality control; Inadequate safety management standard.
Cable handling accidents	No 2 either struck by cable or caught by cable.	Reportable; Lost shifts.	Injured while hanging cable; Injured by falling cable; Caught by cable being pulled.	Mine standards; Training.

TABLE VIII.10 Hazard Identification for Feederbreakers

Hazard	Primary Cause	Consequence	Detailed Causes	Controls/System Failure
Operator crushed	Caught between coal transported and feederbreaker.	Fatal; Reportable; Lost shifts.	Lack of or inadequate warning device; Lack of visibility; High noise levels.	Mining standards; Engineering standards; PPE standards; Training.
Operator caught by jaw crusher	Crushed by feederbreaker	Fatal; Reportable; Lost shifts.	Caught by rotating drum or chain conveyor while cleaning or doing repairs; Failure to lock out.	Training; Mining standards; Engineering standards.
Fires	Flame proofing; Electrical connections; Cables.	No recorded incidents.	Poor workmanship in terms of maintenance and flameproofing; Inadequate or no inspection; Induction in coiled cables left live; Faulty cable joints; Cables damaged by other equipment.	Training; Quality control; Inadequate safety management standard.
Towing accidents	Persons crushed between machines while getting ready to tow or slings snapping and striking persons.	Fatal; Reportable; Lost shifts.	Inadequate standard; Faulty equipment; Wrong equipment; Wrong application.	Inadequate mine standard; Training.

APPENDIX IX

GRAPHICAL RESULTS OF INCIDENT DATA CAUSAL ANALYSIS

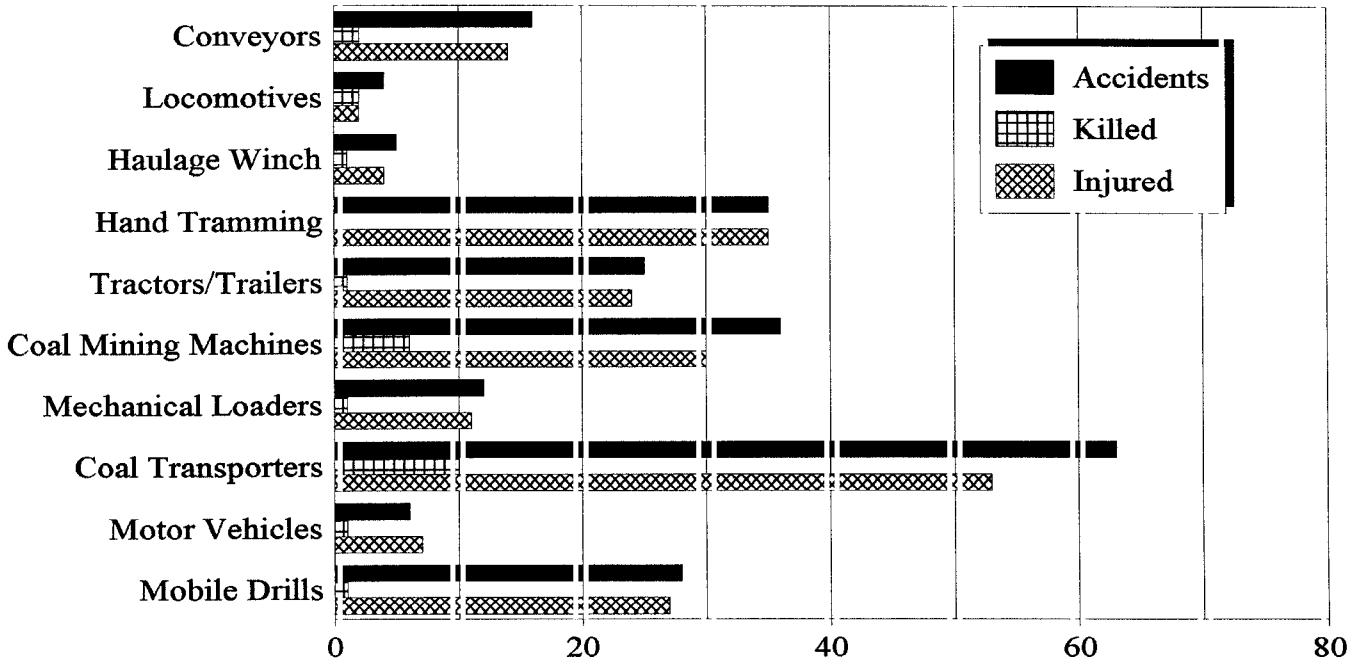


FIGURE IX.1 Analysis of Accidents 1992-1994, Accidents Numbers

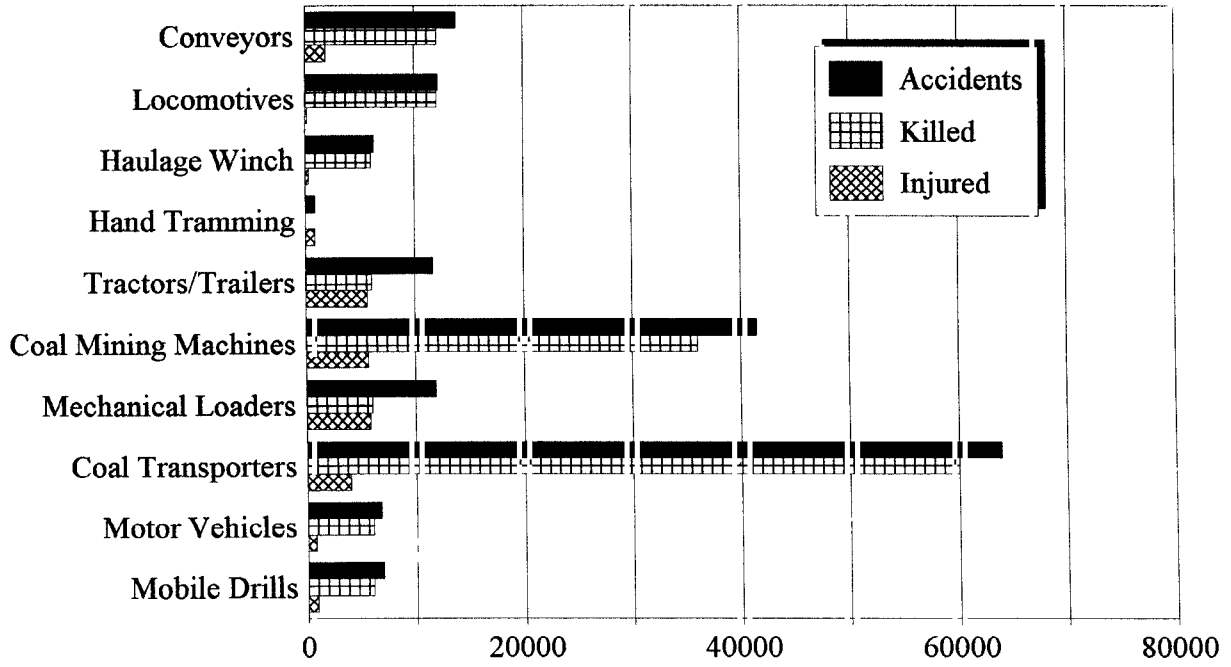


FIGURE IX.2 Analysis of Accidents 1992-1994, Expressed as Penalty Shifts

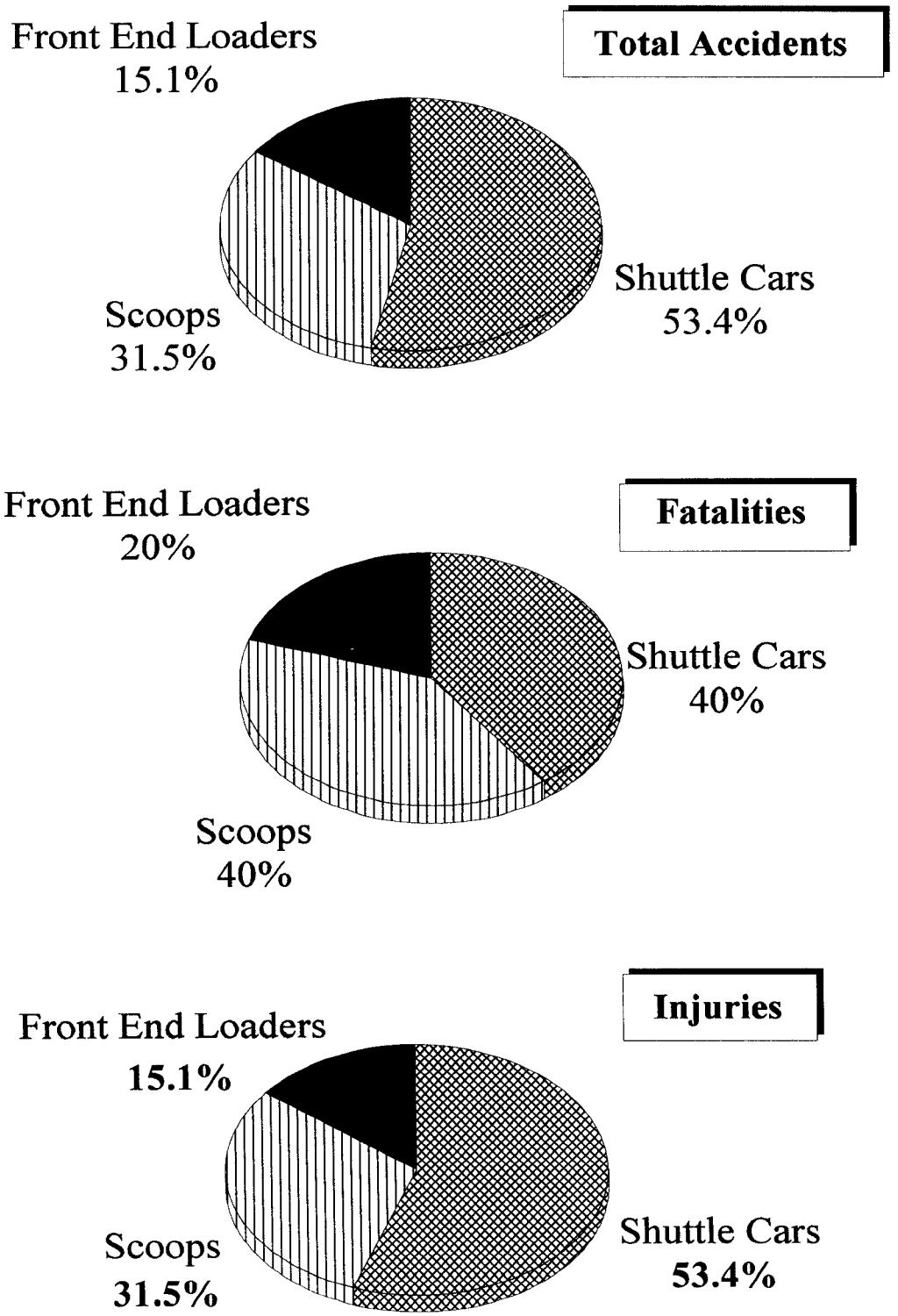


FIGURE 3(A) **Analysis of Coal Transporter Accidents 1992-1994, Per Machine Type**

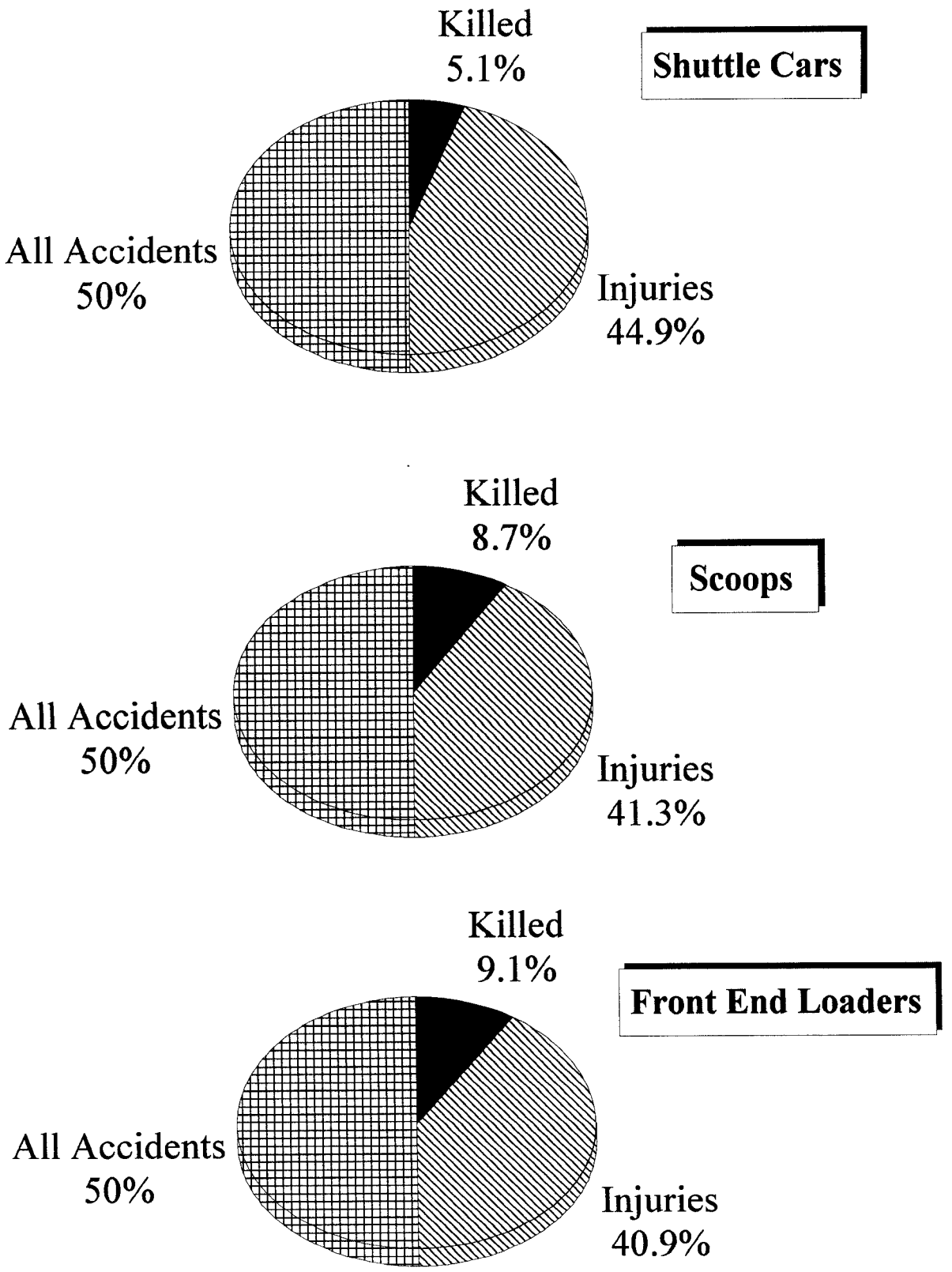
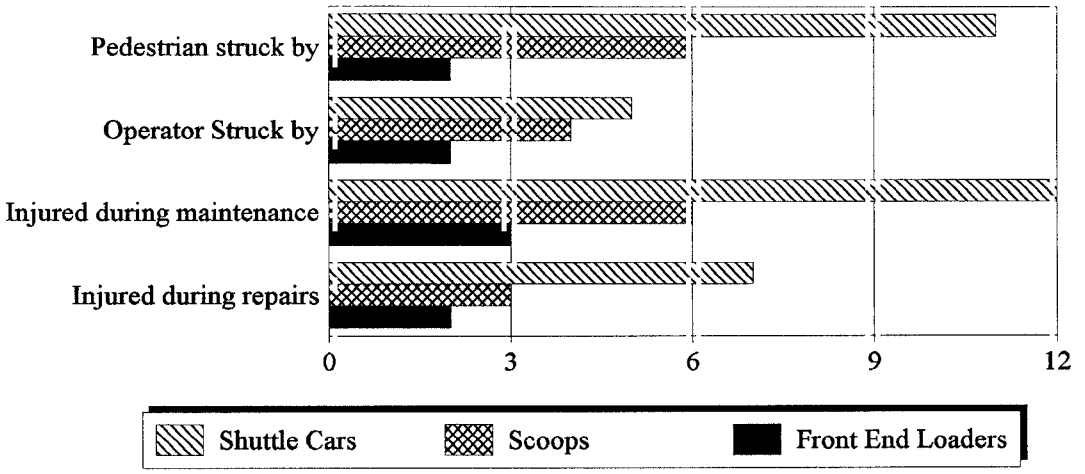
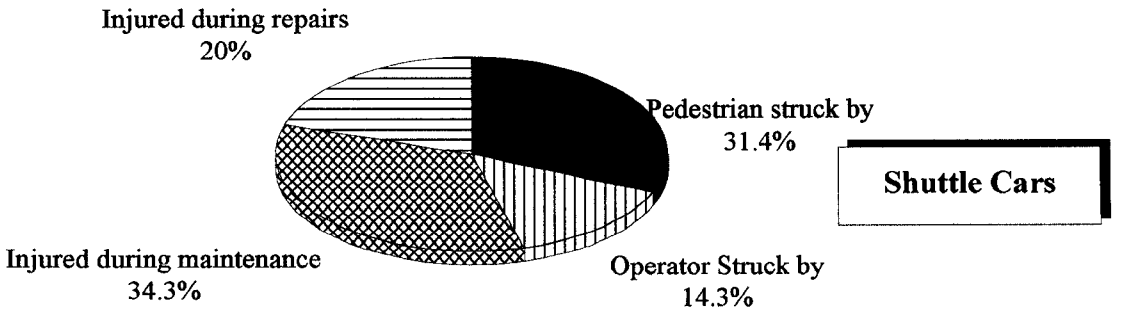
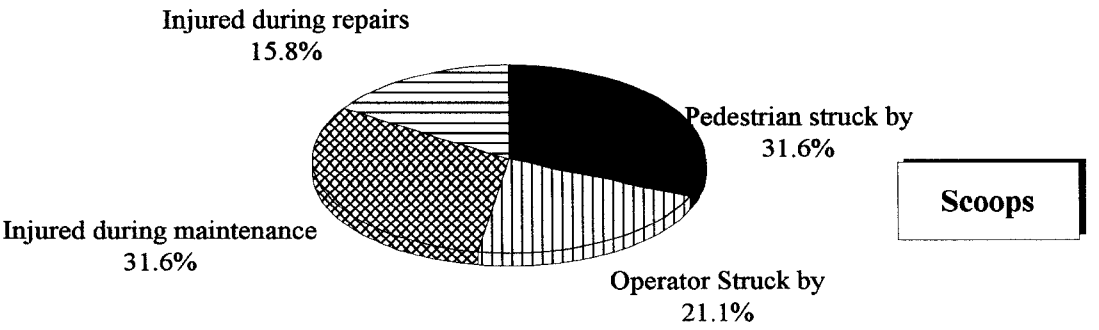


FIGURE IX.3(B) Analysis of Coal Transporter Accidents 1992-1994, Per Severity







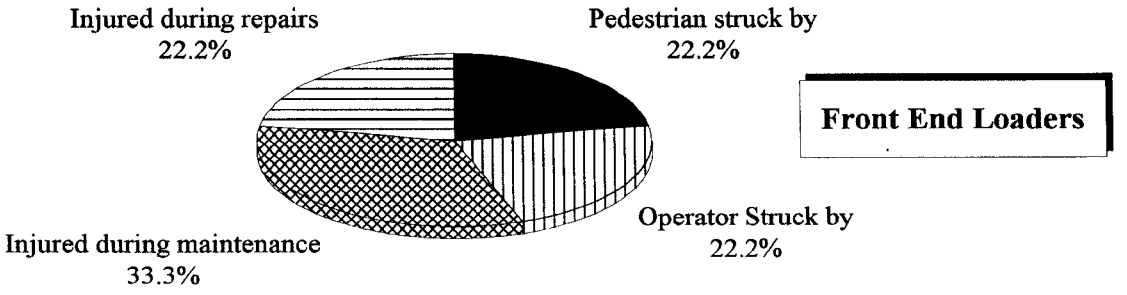


FIGURE IX.4 Analysis of Coal Transporter Accidents 1992-1994, By Cause

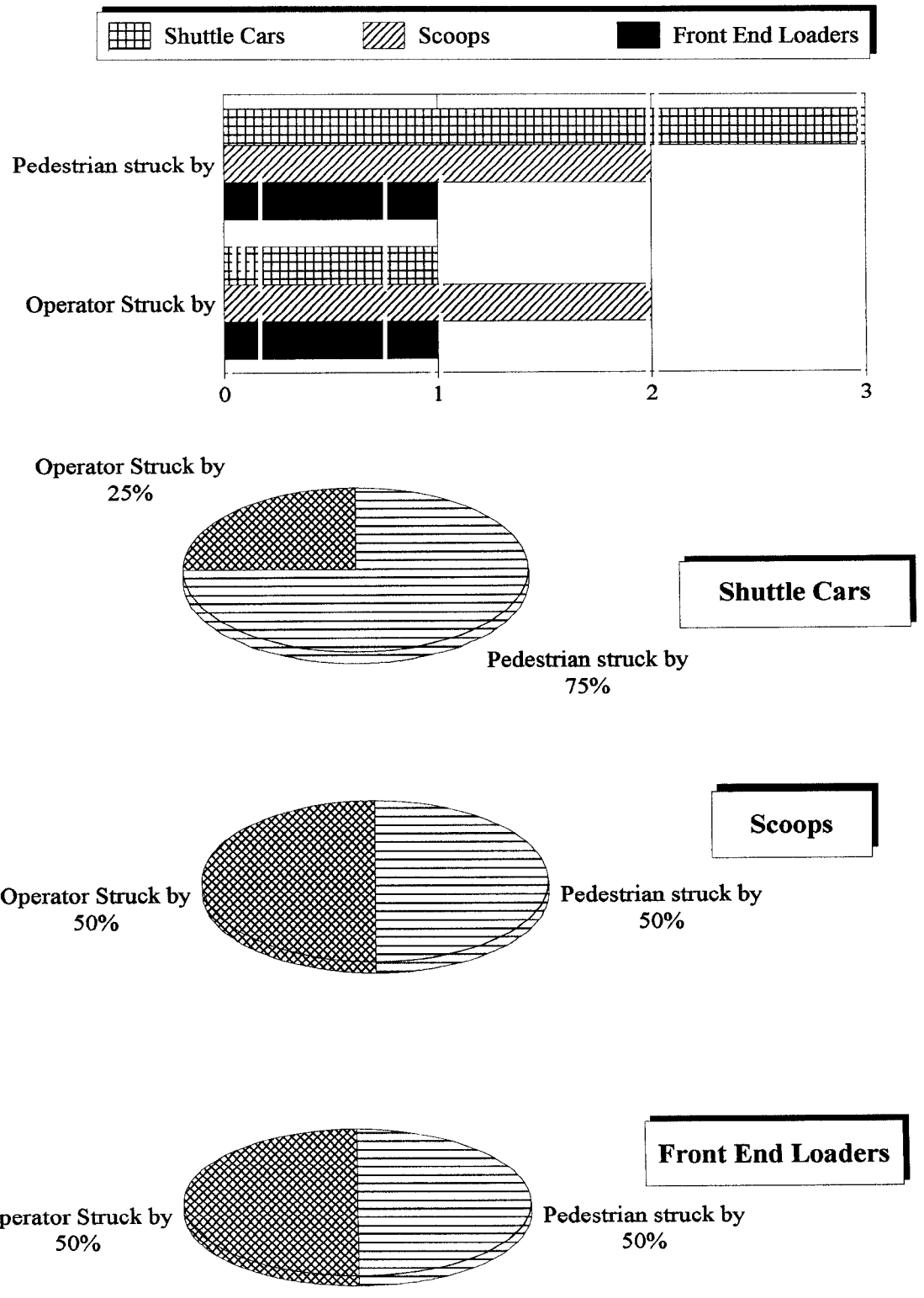


FIGURE IX.5 **Analysis of Coal Transporter Accidents 1992-1994, Fatals, By Cause**

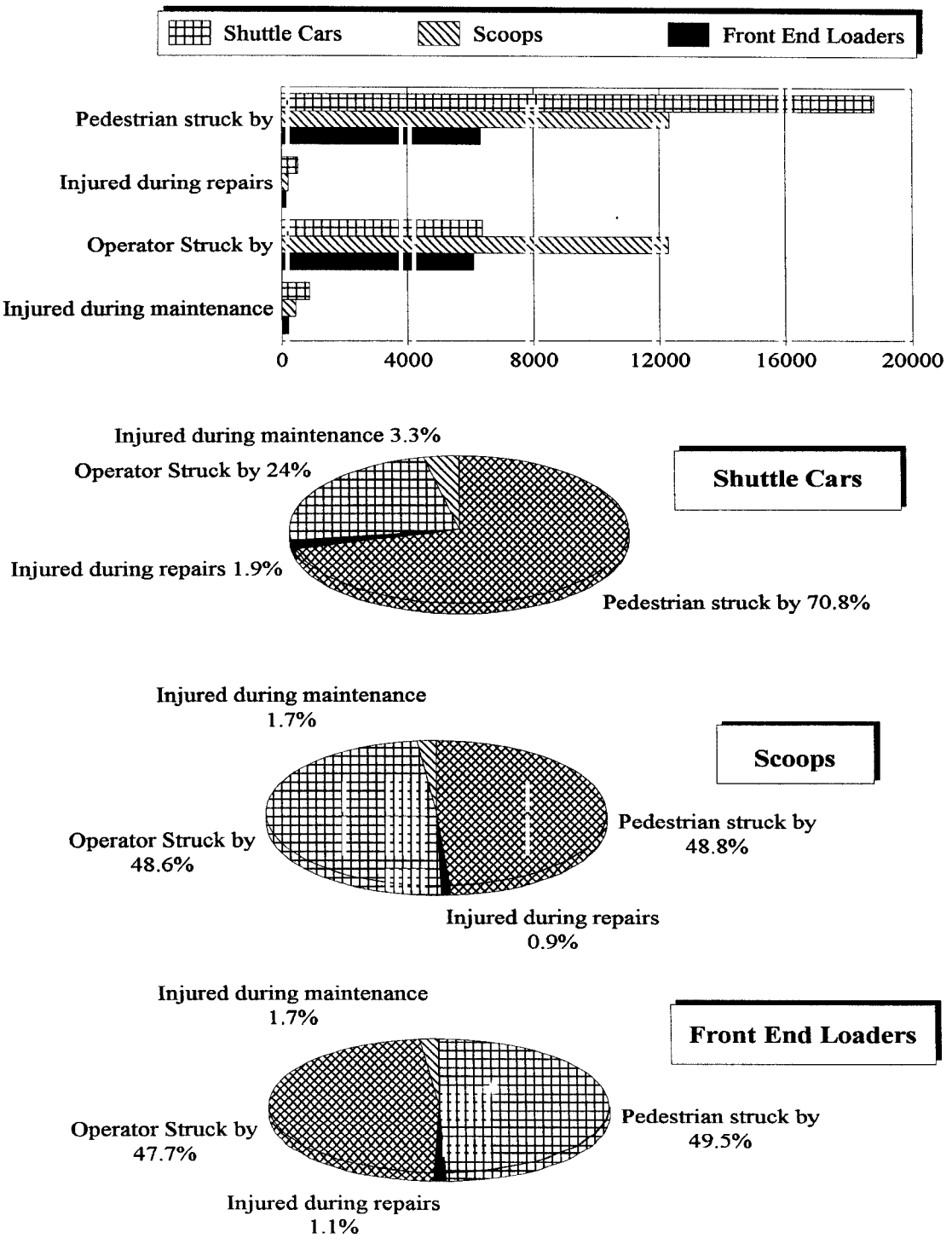


FIGURE IX.6 **Analysis of Coal Transporter Accidents 1992-1994, Penalty Shifts, By Cause**

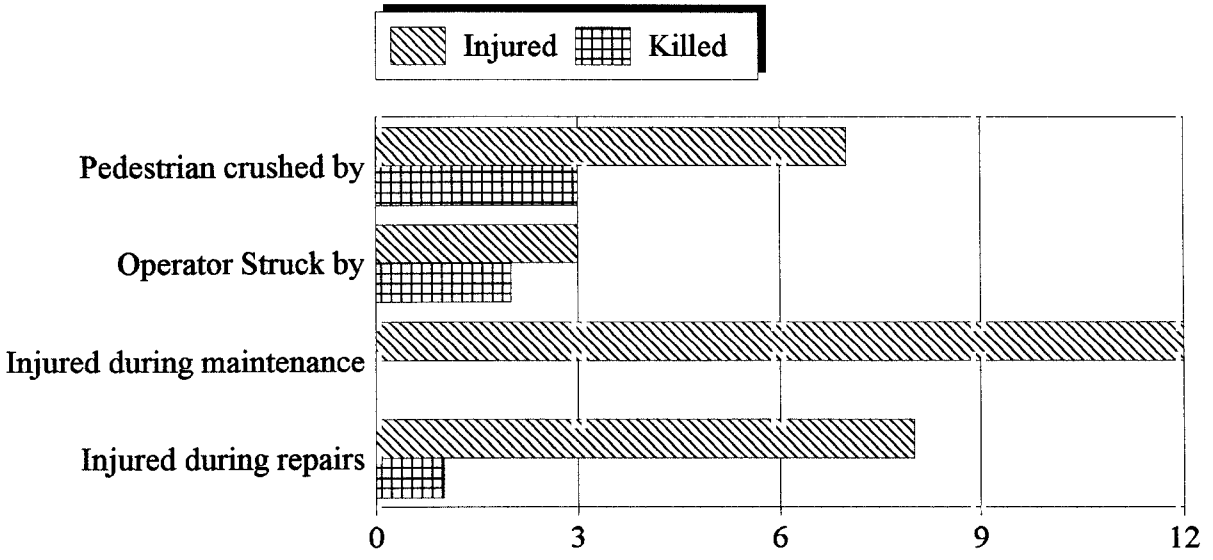


FIGURE IX.7 Analysis of Coal Mining Machine Accidents 1992-1994, All Accidents

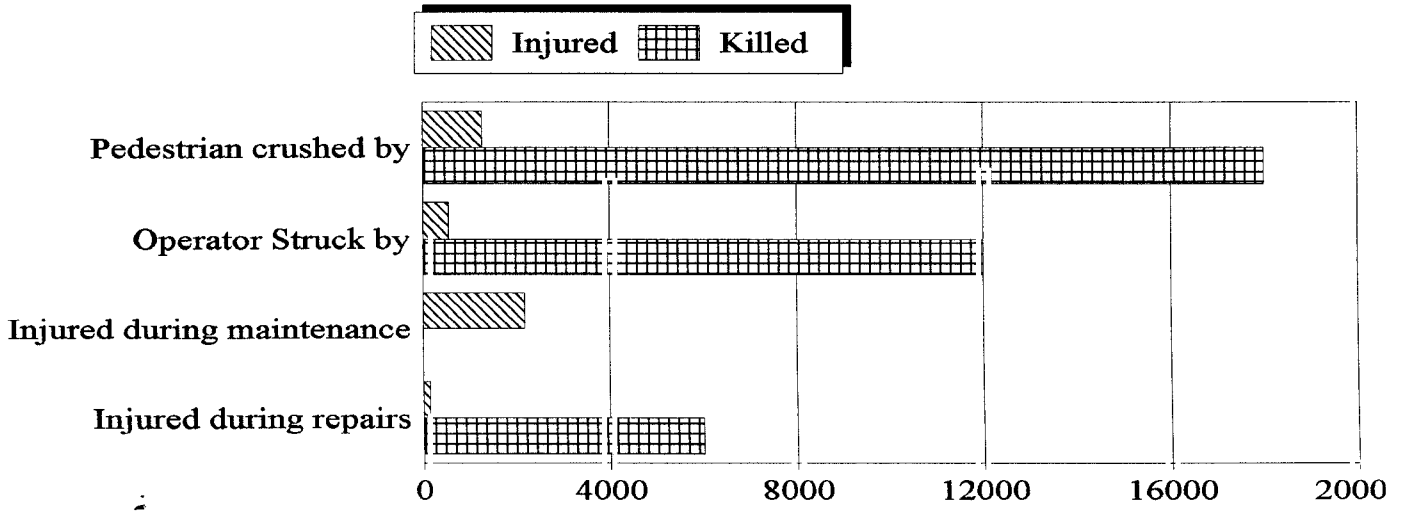


FIGURE IX.8 Analysis of Coal Mining Machine Accidents 1992-1994, Penalty Shifts

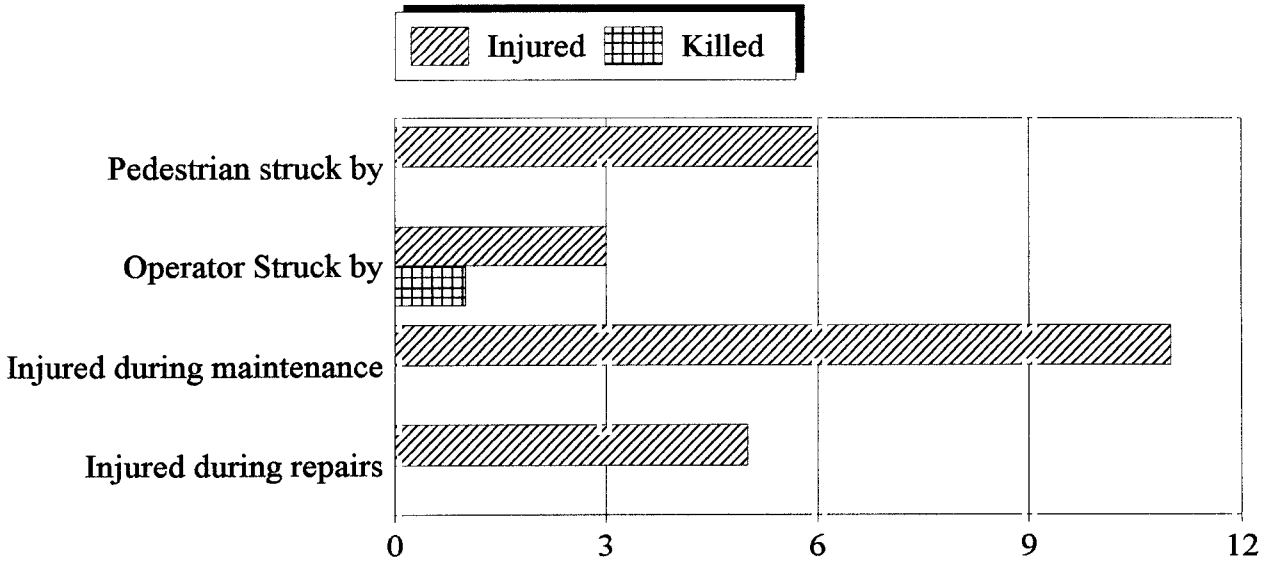


FIGURE IX.9 Analysis of Tractor Trailer Accidents 1992-1994, All Accidents

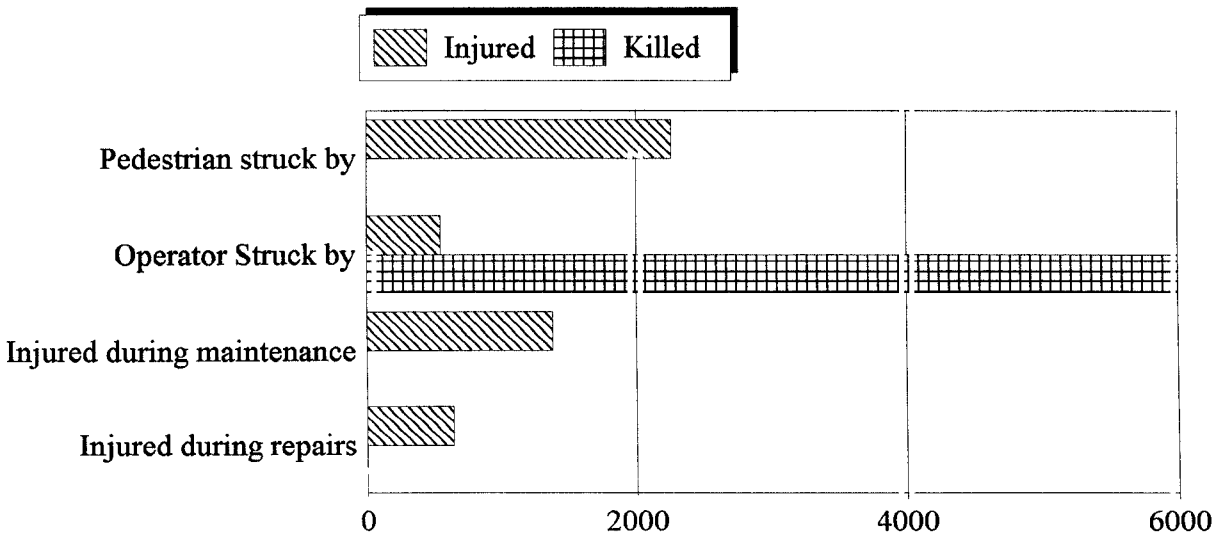


FIGURE IX.10 Analysis of Tractor Trailer Accidents 1992-1994, Penalty Shifts

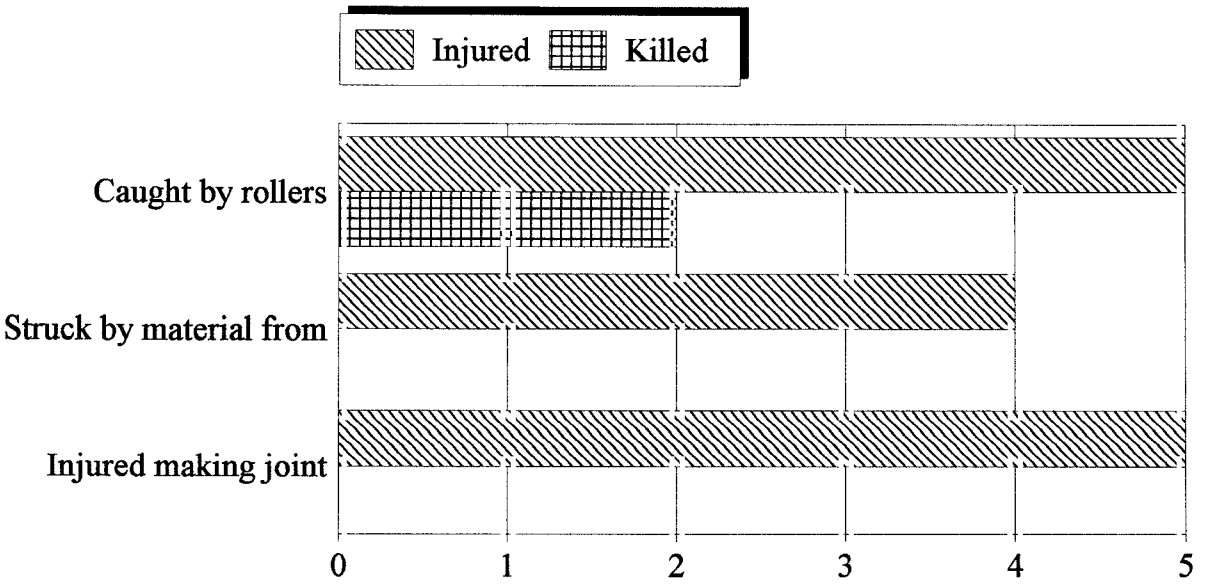


FIGURE IX.11 Analysis of Conveyor Accidents 1992-1994, All Accidents

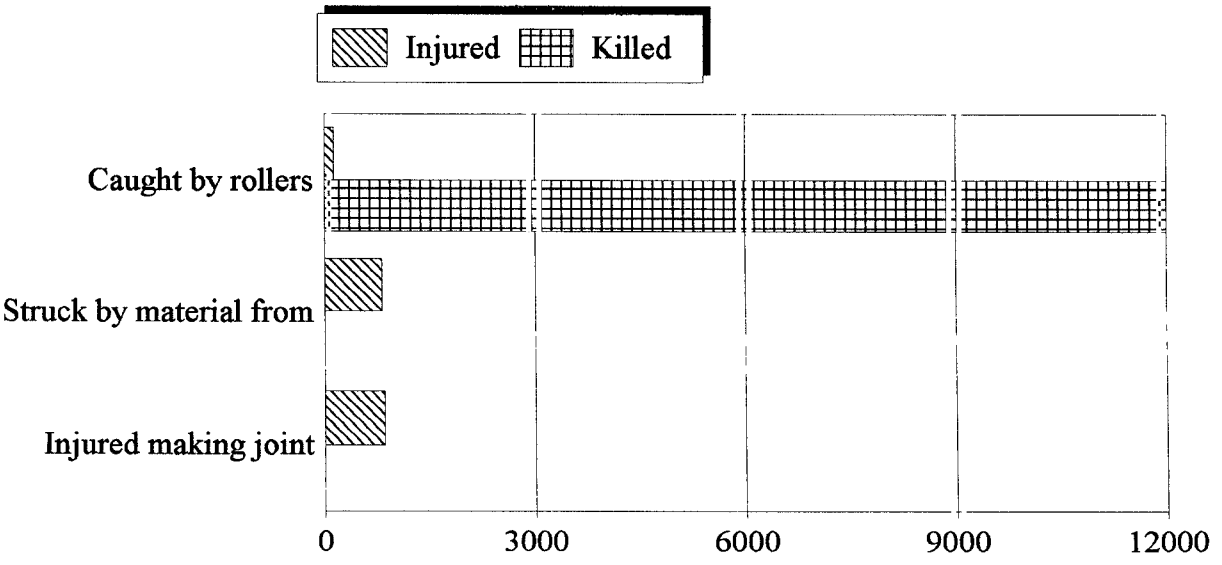


FIGURE IX.12 Analysis of Conveyor Accidents 1992-1994, Penalty Shifts