TOWARDS SAFER UNDERGROUND GOLD MINING

An investigation commissioned by the National Union of Mineworkers

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PREFACE

The University of the Witwatersrand has a long established relationship with the mining industry. Indeed, its origins go back to the South African School of Mines established in Kimberley in 1896. (1). Since 1917, the Chamber of Mines has given direct grants to the University and its predecessors. In fact, the Chamber remains our largest private donor. Murray has shown in his authoritative study of the early years of the University that there have been occasions in our history when the Chamber has felt that it has not received a satisfactory return upon its massive investment in the University (2). On balance, however, the University can rightly claim to have served the Chamber well over the years.

In recent years, the other side of the industry's history and social structure has been a focus of systematic investigation in this University. Here, van Onselen's Chibaro stands out : a pioneering attempt to create historically the social world of the compound in the early years of the mining industry in Southern Rhodesia. In our own Department, Moodie, Bozzoli, and Innes have all contributed to our knowledge of the social structure of mining.

Moodie's study was commissioned by Anglo-America's Industrial Relations Department and focused on the perceptions and behaviour of black miners. His conclusions are pertinent to Leger's study :

" the major cause of tension underground, apart from the danger of the job itself, is the white miner - who, for the most part of his time underground sits on his box in the company of fellow white miners - most of the genuine supervision is done by the black team leaders".

The studies by Bozzoli and Innes have as their object of investigation, capital rather than labour, but they share with Van Onselen and Moodie a concern to locate mining within the wider structure of South African society. Bozzoli examines the historical origins of managerial strategy and ideology on the mines, while Innes examines the evolution of the structure

of capital, using as his case study the Anglo-American Company. (3).

This study by Jean Leger on safety in underground mining marks a significant departure from past research in at least two respects. Firstly, it is the result of joint collaboration between engineers and sociologists - two disciplines that are, at least in this University, isolated from each other. The project was initiated by the Technical Advice Group (TAG), a group of engineers and scientists who were dissatisfied with the narrow technological approach within the engineering profession. Our department responded positively to their initiative, as we sociologists accept as commonplace the proposition that what happens in the workplace is, in large part, determined by social factors. Indeed, the distinguished American scientist David Noble insists that technology has to be seen as "social production", and the professional engineer as an expert not only in applied science, but in the management of social relations (4).

As a consequence, this study challenges conventional wisdom that accidents are the result of individual employees' negligence or apathy. Put simply, it examines the workplace and shows how pressure put on workers for greater production is an important cause of accidents. For us, the implications are clear. Increasing productivity through an intensification of work is both dangerous to the safety of workers and an unsatisfactory solution to the problems of achieving sustained efficiency (5).

Let me expound on this point. White miners are charged with the responsibility of safety. To this end, the Mines and Works Act and Regulations (MWA 1956) detail the daily production and supervisory tasks of the white miners. With the exception of the Marais Commission in 1960, no commission of Inquiry or research study since has examined the adequacy or appropriateness of these regulations in ensuring adequate safety precautions in S.A. Mines. Significantly, those few studies that have been published tend to assume that accidents are the result

of errors by individual workers or uncontrollable events. No study has examined the way work is organized and the adequacy of safety precautions in the MWA.

In interviews with 90 experienced underground workers from four mines chosen through an expert choice sample, the present-day underground division of labour and problems of safety were investigated by Mr. Leger. The study found that underground mining practice deviated from that envisaged by the Mines and Works Act. Essentially, the informants described a situation underground in which the productive and supervisory tasks of the white miner has been usurped by the team leader.

However, while team leaders have been responsible de facto for safety, they have neither the formal training nor the legitimate authority to take the decisive actions required in the face of hazardous conditions. The decisive power still rests with the white miner, who is able to exercise power in a coercive manner.

This leads to the second and more important sense in which this study marks a departure from previous work. The study was commissioned by and done in conjunction with the largest black mine workers union, the National Union of Mineworkers (NUM). For mine workers, safety is a crucial issue. According to the general secretary of NUM, Cyril Ramaphosa : "In the mines,health and safety is the top priority .... You've got to be alive or uninjured to earn the wages. Therefore to us, health and safety comes first" (6). As a result, we designed the study in such a way that we were able to draw on the extensive experience and knowledge of underground workers. It is their experience that leads Leger to recommend, in the conclusion of this study, that workers must be involved more centrally in safety issues. In particular, he says, safety shaft stewards must be recognized by management.

This is the second report that has emerged from the TAG-Sociology research project. The first was presented last

year to the second Carnegie Inquiry into Poverty and Development at the University of Cape Town. (7). It examined health and safety in the foundry industry. The exciting intellectual possibilities of bridging the divide between the engineering approach to work and technology and that of the sociological approach, has encouraged us to explore the possibilities of widening this project and placing it on a more permanent basis in the University.

It is appropriate, however, that I temper this enthusiasm with a note of caution. The Chamber of Mines Research Organization is the largest privately funded research body in the country, with a budget of R40 million p.a. Directly and through secondments, it employs over 1000 people. Within their vast resources, a low priority is accorded to research into occupational hazards. Mr.Leger has estimated that less than 2% of the Research Organizations overall budget for 1985, has been set aside for direct research on health and safety.

Furthermore, the Research Organization appears to be highly selective in publishing the results of this research. The Research Organization refused to make available for the purpose of this research project 42 unpublished research reports directly or indirectly concerned with safety and health hazards. The titles of these reports and the relevant correspondence are reproduced in Appendix 3. The refusals conflict with the principles of academic research in the pursuit of knowledge and make it impossible to fully evaluate the Chamber's claims that safety standards are high.

We hope that by making our research open to public scrutiny we will encourage others in the industry to do likewise. It is only in this way that safer mining can be achieved.

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HEALTH & SAFETY AS
AN INDUSTRIAL RELATIONS ISSUE.

EW/rlc.

FOOTNOTES

1. B. Murray. Wits. The Early Years. Witwatersrand University Press 1982. Ch. 1.

2. Ibid, p 146

3. C. Van Onselen, Chibaro. African Mine Labour in Rhodesia, 1900 -37. Pluto Press 1976; D. Moodie, "Perceptions and Behaviour of African Mine Workers" Anglo-American Corp, 1976; B. Bozzoli, "Managerialism and the mode of production in S.A." S.A.L.B. Vol. 3 No. 8 Oct. 1977; D. Innes, Anglo American and the rise of Modern South Africa. Ravan 1984.

4. D. Noble, America by Design. A.A. Knopf 1979.

5. Leon Grunberg "Workplace relations in the Economic Crisis". Feb. 1984. Paper presented to the Sociology of Work Session at the American Sociological Association Meetings in San Antario in August, 1984.

6. Cited in Maller and Steinberg. 'Health & Safety in Industrial Relations'. S.A.L.B. Vol 9 No. 7.

7. The results of this research by F. Sitas are summarized in "Health and Safety conditions in Witwatersrand foundries". S.A.L.B. Vol. 9 No. 7, June 1984.

8. For further details see Jean Leger's report.

I would like to take this opportunity of publicly acknowledging the invaluable support and advice we have received from the TAG-Sociology Steering Committee since the project began in January, 1984. The committee consists of S. Caldwell (TAG), Dr. J. Cock (Socio), S. Mare (TAG), F. Sitas (TAG), Prof. G. Schutte (Socio), H. Struthers (TAG).

Two further acknowledgements must be made. Firstly, to the Dept of Sociology and other colleagues in the University and TAG, for the time and resources they have made available for this project. Secondly, to the Fredrich Ebert Stiftung in Bonn, West Germany, for their generous financial assistance. In particular, their S.A. representative, Werner Pushra, for his support and valuable advice.

PART I BACKGROUND

1. INTRODUCTION

"My brother is with me, carrying
His pick and shovel on his shoulder,
And, on his feet, are heavy boots.
He follows me towards the shaft;
The earth will swallow us who burrow
And, if I die there underground,
What does it matter? Who am I?
Dear Lord! all around me, every day,
I see men stumble, fall and die."

("In the Gold Mines", B.W. Vilakazi, 1945)

Accidents in South African gold mines have left more than 46 000 workers dead and hundreds of thousands seriously injured since the turn of this century. The overwhelming majority of these men worked underground, and were black. No estimate can even be attempted of the thousands whose lives were cut short or painfully ruined by occupational diseases.

Every year approximately 600 workers die in gold mine accidents. Although nearly 500 000 people are employed on the gold mines, the fatality rate is amongst the highest in the world. 'Towards Safer Underground Gold Mining' is an investigation of why these accidents occur and the hazards workers are exposed to. Unlike most previous research on safety in South African mines, the starting point of this study was the perceptions and experiences of black underground workers. We decided to interview workers most closely involved in work at the rock face about these issues. Workers' perceptions of hazards were explored in extensive interviews conducted with ninety underground workers from four gold mines. Thereafter local research reports and the international literature were drawn upon to corroborate the evidence of our informants and to develop a broader perspective.

Most studies of safety ignore the day to day experiences of workers and the social relations between workers and management. Our intention in this study is to redress this neglect by bringing to the surface the perceptions of those at the heart of the gold mining labour process. Initially a pilot study was carried out to determine what safety issues were of greatest concern to workers. In depth discussions were also held with union officials about safety grievances workers had raised with them. As a result of the pilot study and these discussions, it was decided that the following issues should be investigated:

(1) Workers personal experiences of accidents and their perceptions of why these accidents had ocurred.

(2) The effect changes in the organisation of underground work have had on safety. The Mines and Works Act of 1956 (MWA) is central to the way mine work should be carried out in the interests of safety. The MWA makes white miners immediately responsible for most safety measures. Since job reservation in the mines is based on the MWA, safety and racial discrimination are interwoven.

Increasingly a large proportion of the duties of white miners are performed by team leaders acting under (or without) exemption. Team leaders have comparatively little training to cope with their changing role. "The end result", it has been argued recently, "is that the man with the training is becoming short on experience and the man with experience lacks in-depth

training. Casualty figures suggest that the blurring of job definitions and responsibility has adversely affected the vigilance demanded of the working environment" (Thompson p163, 1984). We decided to examine in detail the role played by team leaders and team members and the extent to which the MWA affects underground work.

(3) Production bonuses. Bonuses are the "hidden supervisors of production" and are crucial to the way in which miners themselves organise their work. Production bonuses have important consequences for accidents and adherence to safety standards (Clement 1982). Mine management have traditionally paid bonuses to maximise production because of the difficulty of direct supervision underground. However, bonus systems for white and black miners are completely different. A major portion of white miners earnings consists of incentive payments, whereas relatively few black workers receive bonuses. Black workers believe that white miners, motivated by bonuses, press for production without due regard for the safety of black workers. We investigated whether managements' use of production bonuses, in the view of our informants, encouraged the neglect of safety precautions.

(4) The rights of workers to refuse dangerous work and to participate in inquiries and safety inspections. Only minimal worker rights are legislated in the MWA. Unlike in many other countries, black workers do not have the statutory right to refuse work they may consider dangerous. Although black miners' lives are those most at risk, they have played a limited role in safety inspections and accident inquiries in the past. As workers with direct experience of conditions in the working place, our informants had strong views on worker rights and the role workers should play in inquiries and inspections.

(5) The right to negotiate about safety. Safety committees representative of black workers which resolve safety problems with mine management have never existed. An intention of this study was to establish how black miners viewed these rights and whether they believed negotiation with management could reduce hazards.

(6) The adequacy of personal protective equipment and training. Protective equipment does not prevent accidents from taking place, but good equipment can substantially reduce injuries. The provision of suitable protective equipment is generally accepted as the responsibility of management. For example the Machinery and Occupational Safety Act for South African manufacturing industry requires management to supply protective equipment. However this is not the case in the MWA (except for hard hats). We investigated the adequacy of boots, helmets and hearing protection supplied to black miners. Training of black miners is undertaken by mine management. In many recent studies on accident prevention, a lack of training has been singled out as an important cause of accidents (NRC 1982, McAteer and Galloway, 1982). Worker perceptions of the training they receive were investigated.

Black workers perceptions of safety are likely to differ from those of white miners, officials and management. The result of this difference in approach is that recommendations emerge which draw on the unique knowledge and experiences of workers who daily endure working conditions that are amongst the toughest in the world.

2. BACKGROUND

The gold mining industry has and continues to be crucial to the economic, political and social development of South Africa. Gold mining laid the foundations of the present South African economy and shaped the migratory labour system that persists to this day (Webster, 1978).

The significance of gold mining continues to grow. Gold is still the country's most important mineral. Over forty producing gold mines employ almost half a million workers, 90% of whom are black. The total amount of ore milled has risen rapidly in recent years. In 1983 a staggering 100 million tonnes of ore yielded 680 tonnes of gold.

Directly and indirectly gold mining accounts for 15% of the gross domestic product. Sales of gold in 1983 amounted to over ten thousand million rands and contributed 52% of total foreign exchange earnings (GME, 1983). In addition practically all of the 6,8 million kilograms of uranium oxide mined in South Africa are a by-product of gold production. Thus the South African economy is very dependent on gold mining, especially with respect to employment and foreign exchange payments.

South African gold mines are exceptional in that mining takes place at great depths. Gold occurs in thin, tabular reefs inclined to the horizontal. The reef continues to great depths. At present the average working depth is more than 1 600m below the surface, while in the deepest mines stoping is taking place at almost 3 500m (GME, 1983). Working conditions at these depths are extreme. Rock temperatures rise with depth: by 1 600m they are 38 C on average but reach over 50 C in the deeper mines. The stopes are extremely confined. Because the reef is usually only a few centimetres thick, as little rock as possible is excavated, leaving a height of about one meter between the footwall (floor) and the hanging wall (roof). Stopes are steeply inclined at angles of between 10 and 30 degrees to the horizontal. All other factors being equal, the greater the depth of a stope the greater the hazards of working there.

For mine workers safety is a crucial issue. According to the general secretary of the National Union of Mineworkers, Cyril Ramaphosa: "In the mines health and safety is the top priority ... You've got to be alive or uninjured to earn the wages. Therefore to us health and safety comes first" (cited by Maller and Steinberg, 1984).

Safety was the pretext for the first industrial colour bar that was introduced in 1896 (Katz, 1978). White workers, anxious to maintain high wages for skilled work even if this was achieved at the expense of black workers, claimed that safety in the mines could only be assured if certain jobs were done by whites alone. To this day safety and job reservation (entrenched in the MWA) remain entwined. The mining industry is the only industry in which legalised job reservation is still maintained. Although the NUM, the Chamber of Mines and the Government have advocated the abolition of job reservation, it is likely to be an issue of conflict in the future.

In the days of unorganised labour, mass desertions often followed serious accidents (Moroney 1976). Industrial action around dangerous working conditions has continued since unionisation of black miners.

In the wake of the Hlobane disaster - which killed 68 workers - 30 000 workers participated in a half-hour stoppage. This was the first industry wide action mounted by the then newly founded NUM. The evidence that emerged at the joint inquest and inquiry into the explosion vindicated the NUM's claims in the daily press that inadequate safety standards had prevailed at the mine.

At West Driefontein gold mine, seventeen workers were dismissed in November 1983 after they had repeatedly refused to work in conditions they considered unsafe. Despite an inquiry by the mine inspectorate which found the area to be 'objectively safe', the NUM applied to the Industrial Court and was granted temporary reinstatement of their members (NUM vs West Driefontein, 1984). The union argued that the dismissal constituted an unfair labour practice as mine management had not attempted to allay the 'reasonable fears' of the workers. Although the case was eventually withdrawn by the union, the interim court order is likely to restrain management from arbitrarly dismissing workers in the future for refusing to perform dangerous work.

At Rietspruit colliery, a showpiece open-cast colliery which supplies the international coal market, workers have mounted stoppages after fatal accidents occurred there in 1984 and 1985.

Industrial action around dangerous working conditions is likely to grow apace with the development of union organisation, especially as workers have begun to negotiate about long-felt concerns in addition to wages.

3. SOUTH AFRICAN MINE ACCIDENT STATISTICS

Gold mine accident statistics in recent decades do not show unequivocal improvements. The industry has acclaimed the decreasing accident rate, but the fatality rate has not improved significantly since the 1970's.

The reportable accident rate is illustrated in Figure 1. The accident rate has declined from a highest ever value of 64,1 reportable accidents per thousand workers employed per annum in 1968 to 27,1 in 1984. While this is a significant and welcome decrease in the accident rate (see section 5.2), reportable accident statistics cannot be considered a reliable reflection of changes.

Injuries which keep a worker from "his normal or similar occupation for a period totalling 14 days or more" make up the bulk of the figures (R25.1 (e)). (R) refers to a Regulation enacted under the Mines and Works Act of 1956). This is much longer than the comparable period used for reporting accidents in major mining countries. For example in the United States if a worker cannot perform his normal work in the shift scheduled after an accident, an accident must be reported. In Britain the period is three days. The fourteen day period means that improvements in rescue and medical treatment are incorrectly reflected in the statistics as reductions in the accident rate. Furthermore, safety bonuses paid to supervisors provide an inducement to place a worker in a 'similar occupation' before the fourteen days expire. This means that workers tend to return to work before they have recovered properly. Reports of accidents which lay off workers for much shorter periods are in fact already made for compensation purposes. These could form the basis of an improved reporting system.

The decline in the reportable accident rate since 1968 has not been accompanied by a statistically significant decline in the fatality rate. The total number of deaths per year due to accidents are shown in Figure 2. Total fatalities generally declined from 1960 to 1975 but rose again in the late seventies and have remained at about 600 fatalities per year ever since. The average annual fatality rate, shown in Figure 3, has oscillated between 1,2 and 1,5 deaths per thousand workers employed since 1960. Again, incorporated into this rate are improvements in rescue and treatment.

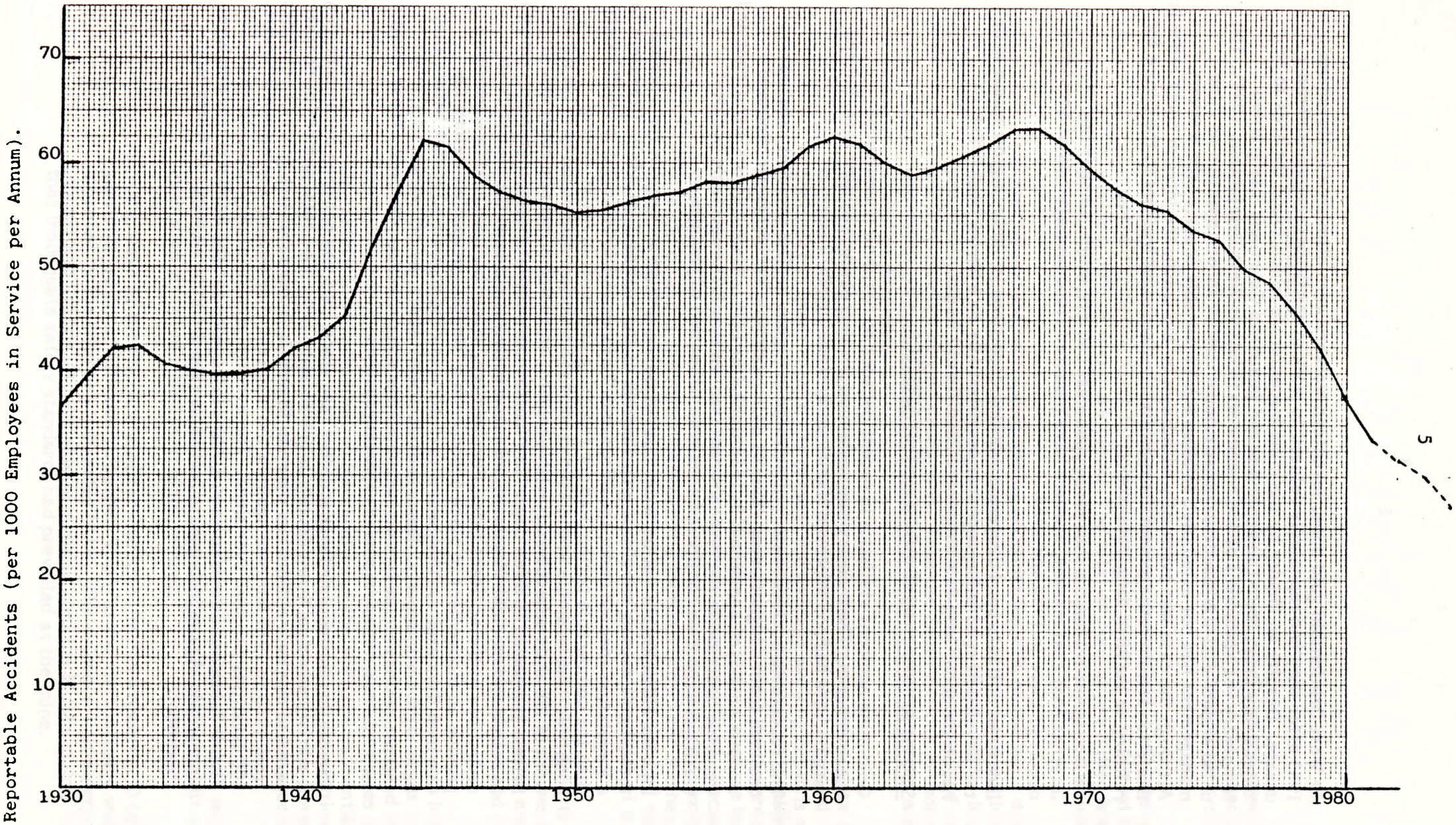


Figure 1: Three year moving average annual accident rate per 1000 employees in service for gold mines.
Source: GME Annual Reports. Note that the definition of reportable accident has only remained the same since 1930

Figure 2: Total Annual Fatalitites on South African Gold Mines

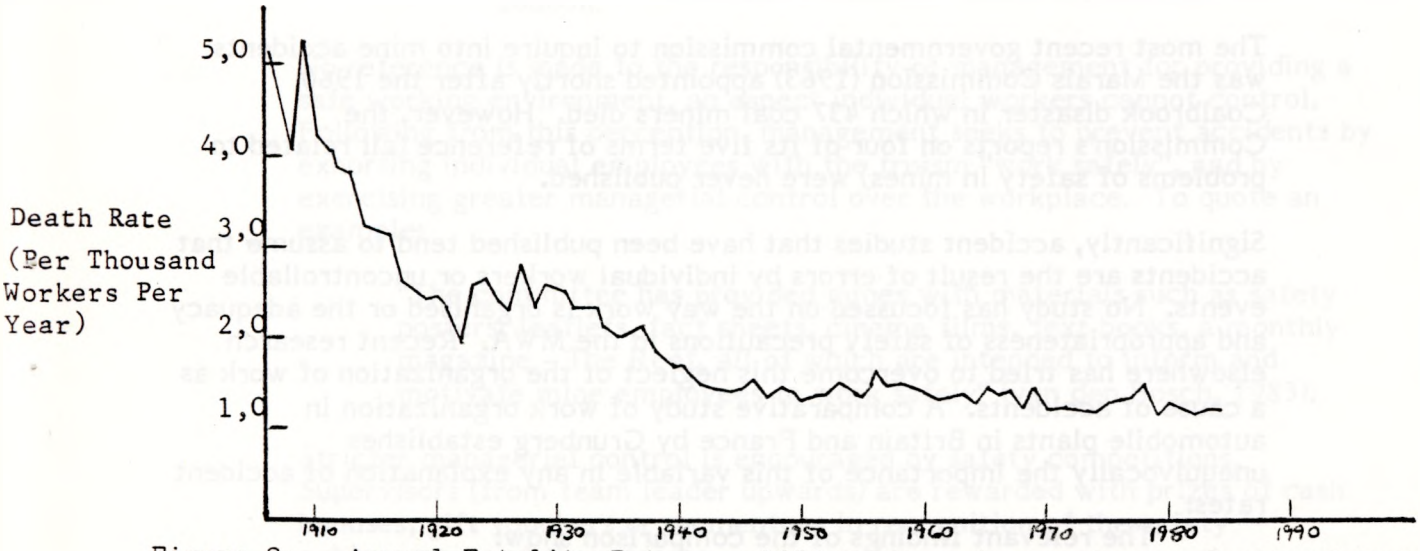


Figure 3: Annual Fatality Rate per 1000 Workers in service on South African Gold Mines

Source: GME Annual Report

4. LITERATURE ON ACCIDENTS IN SOUTH AFRICAN GOLD MINES

Despite the terrible toll in South African gold mines, relatively few studies of gold mine accidents have been published. For example, although a large body of literature exists on such topics as rock mechanics and the problems of rock bursts in local gold mines, occupational accidents caused by rock falls are generally referred to only in passing. The most important collections of accident studies have been included in published symposia on the 'Prevention of Underground Accidents' (SAIMM 1953), 'Gully Stoping' (AMMSA 1976) and 'Underground Transport' (SAMRE 1984).

Accident statistics have been analysed in three studies. Bettencourt and Jensen (1970) found that workers with little work experience, and stope workers, especially drillers, were involved in considerably more accidents than the underground workforce as a whole. In contrast to a commonly held view that accident patterns are not comparable from district to district they found that there were no significant differences. Bettencourt and Jensen also stressed the importance of training and the need for more detailed examination of accident statistics to effect accident prevention measures.

Lawrence (1974) examined human error as a possible contributor to gold mine accidents. In a sample of 405 fatal accidents, 71 % of which were due to rockfalls, Lawrence found that in 99% of these accidents there had been some form of prior warning of the impending accident. Most warnings emanated from the underground environment and consisted of either visual or visual and audible warning signals such as cracks and sounds of movement in the hanging wall. Arising out of this study Blignaut (1979 a,b) experimented under simulated conditions with training methods which were designed to reduce the number of accidents due to rock falls. Blignaut's novel training techniques hold promise for improved training and should be applied and developed further.

Wagner and Tainton (1976) studied 482 fatal fall of ground accidents. More than half (56 %) were found to be related to gullies and 70% of these accidents involved strike gullies. The most important conclusion of their study was that more than half of all stope fatalities due to falls of ground were confined to an area measuring less than 50 square meters, an area the size of a large room. Generally this area was poorly supported. Because of the small area involved, the authors pointed out that it was technically and economically feasible to support this area.

The most recent governmental commission to inquire into mine accidents was the Marais Commission (1963) appointed shortly after the 1960 Coalbrook disaster in which 437 coal miners died. However, the Commission's reports on four of its five terms of reference (all related to problems of safety in mines) were never published.

Significantly, accident studies that have been published tend to assume that accidents are the result of errors by individual workers or uncontrollable events. No study has focussed on the way work is organised or the adequacy and appropriateness of safety precautions in the MWA. Recent research elsewhere has tried to overcome this neglect of the organization of work as a cause of accidents. A comparative study of work organization in automobile plants in Britain and France by Grunberg establishes unequivocally the importance of this variable in any explanation of accident rates:

> "The relevant findings of the comparison show:
>
> 1. the Ryton plant produced a C6 car in 36.42 man hours whereas the Poissy plant produced the same car in 28.98 man hours, a difference of 7.44 man hours; and

2. the Poissy plant had an injury experience, as measured by the severity rate, that was over sixty times higher that for Chrysler UK and was of an even greater order of magnitude when compared to the Ryton plant" (Grunberg, 1983).

Importantly Grunberg dealt with work not simply as a technical process but he also attempted to examine work as a social process by exploring the way tasks are allocated in the workplace. He found this to be the key to explaining the sixty fold difference in accident rates between essentially identical automobile plants producing the same vehicle. His insight provides a conerstone for our investigation.

5. MANAGEMENT'S APPROACH TO SAFETY

5.1 The Unitary Perspective

In 1913 the Chamber of Mines formed the "Safety First Committee" upon the initiative of the Rand Mutual Assurance Company (van den Bosch, 1983). This committee, later renamed the Prevention of Accidents Committee, still operates in conjunction with the Mines Safety Division and is responsible for most management safety efforts.

In the eyes of management the issue of safety has traditionally been seen as a managerial prerogative. When accidents happen, the tendency of management is to attribute them to the fault of individual workers, a perception illustrated by the objectives of the Prevention of Accidents Committee. The primary aim of the committee is to: "Establish and maintain a climate and attitudes within the mining industry conducive to the elimination of accidents." Secondary objectives maintain that the Committee should:

"1. Provide leadership in the industry's drive to eliminate accidents.
2. Actively support the industry's safety efforts and assist in motivating mine employees to adhere to the prescribed safety standard through the organisation of inter-mine safety prize schemes and other competitions." (Prevention of Accidents Committee correspondence to NUM, 30.12.83. Emphasis added).

No reference is made to the responsibility of management for providing a safe working environment, an aspect individual workers cannot control. Following from this perception, management seeks to prevent accidents by exhorting individual employees with the truism "work safely", and by exercising greater managerial control over the workplace. To quote an example:

> "The committee has provided mines with materials such as safety posters, leaflets, fact sheets, cinema films, text books, a monthly magazine - The Reef, all of which are intended to inform and motivate mine employees to work safely" (van den Bosch, 1983).

Stricter managerial control is encouraged by safety competitions. Supervisors (from team leader upwards) are rewarded with prizes of cash bonuses, gift vouchers or mementoes in recognition of the safety achievements of their teams.

South African mine managements' approach to safety is analagous to the view adopted by the 1972 Robens commission of inquiry into safety and health in the United Kingdom. The recommendations of the Robens commission, which led to the enactment of the British Safety and Health at Work Act of 1974, were based on the following three assumptions (Benjamin, 1984a):

"(1) that the most important single reason for accidents at work was apathy. Apathy is the view that accidents happen to other people and not oneself and that there is nothing that can be done to stop them;

(2) that (from an industrial relations perspective) 'there is a greater natural identity between "the two sides" than in most other matters and that consequently there was no need for bargaining on health and safety issues;

(3) that safety is mainly a matter of the 'day-to-day attitudes and the reactions of the individual'."

Blaming the individual and disregarding the nature of work itself is the response most commonly associated with what is known as the 'unitary perspective' which assumes that there exists a common interest between employer and employee in the work situation (Fox, 1969). The fallacy of this approach is that:

> "the way the situations in which accidents take place are structured tends to be presumed, lost sight of, or just ignored. Moreover, at one level analyses of this sort can no more provide adequate accounts of industrial accidents than would highly specific analyses of pedestrian accidents, were these to ignore the massive significance of the motor car for our society and concentrate instead on the design of bumpers and door handles and the state of mind of jay walkers. There have been, in short, very few attempts to locate accidents in their total situation, to see them in the context of the social relations of production: 'forensic' analyses - that is, those which attempt to specify highly particular casual factors - are no substitute for this" (Nicholls and Armstrong, 1973).

5.2 Loss Control : The Cost Benefit Approach to Safety

Management's adoption of a unitary perspective to health and safety problems is underscored by the introduction of 'loss control' almost ten years ago. Adherents of loss control assert that safety is best achieved by the introduction of a loss control program like the "International Mine Safety Rating" (IMSR).

The IMSR program was developed by an American consultant, Frank Bird, in conjunction with the Mine Safety Division. In common with conventional safety programs the IMSR suggests procedures for investigating accidents, carrying out inspections, preventing fires etc. A great deal of "professional management" is also integrated into the scheme. An unusual aspect of the IMSR system is its 'rating' scheme. A one to five index has been devised which rates a mine not according to its accident records, but in relation to the mine's scores for 20 separate management activities or 'programme elements'. While some elements like protective equipment and physical conditions are typical of any conventional safety program, the index is heavily weighted with managerial procedures such as purchasing and engineering controls, general promotion, hiring and placement, personal communications, etc. To simplify matters the scores for all the various

items are added together and then expressed on a scale of one to five. Borrowing from the South African Hotel Board, this final score is given as a number of 'stars'.

Injury statistics are only considered in the IMSR index when a mine applies for 'five stars'. In addition to a minimum score in each of the 20 elements, the total of the injury and fatality rate must be 25% less than the industry average for the class of mine. It appears that the IMSR grading is more a reflection of a mine's managerial procedures than its ability to produce gold without accidents.

Mine management's enthusiasm for loss control is probably a consequence of its seductive promise that loss control increases productivity whilst reducing accidents. However this proposition is not novel. For example, the members of the Safety First Committee noted in 1913:

> "It seems to be palpably obvious that a very large number of accidents are preventable and if by systematic and persistent endeavours the accident rate here could be reduced within the next few years, it is possible that this Company's members might be saved 40 000 pounds per annum in compensation paid direct to white workers alone but the indirect saving of loss of time, the prevention of damage to plant, etc. and other factors could only be expressed in much larger figures" (cited by v.d. Bosch, p.5, 1983).

However claims such as these have limited validity. As Sass notes:

> "Industrial safety is only profitable when the direct and indirect costs associated with accidents (i.e. production shut-downs, damaged equipment and materials, increased workers' compensation assessments, etc.) exceed the final cost of eliminating these accidents. From a solely financial perspective, it is often more economically feasible to allow all but the most blatant dangerous conditions to exist, rather than incur the additional financial outlay necessary to make the workplace safe. In the same light, management has even less of an incentive to moderate the negative health effects flowing from the workplace as very few costs associated with industrial illness are absorbed by the industry that produces them" (cited by Benjamin 1984b).

The rationale behind loss control leads to the following conclusion: To the extent that management is able to quantify the various costs and risks involved in either preventing accidents or allowing them to continue, so will attempts be made to operate at an optimal level of profitability regardless of the rate of accidents. Thus loss control should be termed the cost benefit approach to safety. As Bird himself has noted:

> "The safety professional recognises that it is neither economically feasible nor practical to prevent all accidents. Safety involves accident prevention, loss reduction and risk avoidance. Certain conditions and practices that could result in certain accidents may very well be tolerated consciously after proper risk evaluation" (Bird 1983).

Chamber of Mines spokesmen and the Government Mining Engineer have claimed that the IMSR system has led to a reduction in accident rates (GME 1981, 1982, 1983). These claims are not founded. The death rate since 1978 has not shown any statistically significant improvement.

It is true, as has been pointed out in Section 3 (Figure 1), that reported accident rates have declined steadily since 1968. However the decrease until 1980 cannot be attributed to 'loss control' because loss control and the IMSR were only introduced in 1976 and 1978 respectively. Even then they were not implemented throughout the industry immediately but over a period of two to three years. Thus the improvements ascribed to the IMSR are the continuation of a trend which had already been underway for more than a decade.

The major contributor for any real decrease in accident rates is the policy of internalisation and stabilisation of the labour force actively pursued by the Chamber of Mines after 1974. Since then the black workforce has become increasingly more experienced. Research undertaken both locally and abroad (e.g. Jensen and Bettencourt, 1970) has shown that accident rates decrease dramatically with increasing experience (see Figure 9, Section 17.4). This explanation has also been proposed by a Chamber spokesman (Financial Mail 28.9.84, p.91). The statistics, however, do not reflect the true incidence of improvement because of the inadequacies discussed in Section 3.

Conclusion: Loss control is an extension of the unitary approach to safety adopted by the Prevention of Accidents Committee and the Mine Safety Division. It widens the use of 'cost benefit analysis' to a new sphere, namely safety. The IMSR program requires that management must draw up numerous procedures, many of which have only an indirect bearing on safety. These procedures formalise the supervision and control aspects inherent to previous 'safety campaigns'. The claimed contribution of the IMSR to the decrease in accident rates has not been substantiated.

5.3 Research into Safety by the Chamber of Mines

The Chamber of Mines Research Organisation is the largest privately funded research body in the country. Its budget for research related to gold mining in 1985 is R38 million (total budget for all research is R40 million). Directly and through secondments over 1000 people are employed by the organisation. Research is presently pursued along five broad themes: the distribution and extraction of gold; the environmental problems posed by deep level mining (especially heat); human resources; the problems of rock pressure and rock bursts; and stoping techniques.

The Research Organisation appears to be highly selective in publishing research results, particularly in regard to safety. Only a small proportion of research reports are ever published. Published articles usually contain several citations to unpublished reports. The Chamber refused to make available for purposes of this research project 42 unpublished research reports directly or indirectly concerned with safety and health hazards. The titles of these reports and the relevant correspondence is reproduced in appendix B. This refusal directly contradicts public statements made by Chamber of Mines spokesmen about safety (for example see the 1984 Chamber of Mines Presidential Address, page 13).

Funding of research that is not directly relevant to production has never been a priority in South Africa, whether undertaken by private or state funded bodies. Webster (1981) found that "an analysis of the budget allocation to the HSRC and the Human Resources Laboratory (HRL) of the Chamber of Mines, indicates a very low percentage of total research money spent on social research. What is clear is that the bulk of money went into technical research, in particular, in the case of the Chamber of Mines, in attempts to restructure the labour process through mechanization. 'The largest private research effort in South Africa was trebled in 1974 for the

prime purpose of revolutionising gold mining by means of mechanical devices designed to gouge, hammer or bore out the ore'."

The Research Organisation's Human Resources Laboratory is responsible for research directly concerned with health and safety. The 1985 budget indicates that health and safety is a low priority. An amount of R720 000 has been budgeted, less than two percent of the Research Organisation's projected R40 million expenditure (1985 Programme and Budget on Gold, COM Research Organisation). Most of the R720 000 is earmarked for investigating heat stress and nutrition, leaving only R121 000 to research hazards such as noise, vibration and poor illumination.

The inadequacy of the health and safety research budget is emphasized when it is considered that the sum of R720 000 represents an amount of approximately R2 per underground worker per year. It may be claimed that the rest of the Chambers' research program is related indirectly to health and safety. This is not the case. If all research projects which have a possible bearing on health and safety are taken together, they add up to R7,8 million, that is 20% of the total budget. Furthermore, these projects are chiefly concerned with improving productivity and tackling the unique technical problems posed by mining at depths which will approach 5000m in the future. Unless these technical problems are ameliorated, mining at such depths will not be economically feasible or physically possible.

In the United States by way of comparison, $33,9 million (R67,8 million) has been budgeted for mine health and safety research in 1985. This is equivalent to $80 (R160) per United States miner. The research budget for noise control alone amounts to $1,2 million (R2,4 million, U.S. Department of Labour, personal communication 1985).

The Research Organisation's investigations have usually located the issue of safety as a problem related to the inadequacies of individual workers. For example studies have been carried out on the perception of hazards by workers (Lawrence 1974, and Blignaut 1976 a, b, 1979 a, b), the adequacy of safety signs and the ability of workers to recognise them (Rodenwoldt et al 1975), training techniques (Blignaut 1975) and protective equipment (Scheepers and van Graan, 1978).

Environmental problems that have been studied in general include illumination and noise (van Rensburg et al 1980, Schroder and van der Walt 1981, Kielblock et al 1984), dust (Schroder et al 1981) and heat (Kielblock et al 1981, van der Walt et al 1981). Unfortunately the influence that underground environmental conditions have on accidents has not been studied. Thus the research required to compensate for the unique conditions in South African mines, such as confined space, heat and noise, has not been performed. Only three reports to the author's knowledge have been prepared that relate to these topics (Pace 1979, Pace and Barnes 1979, Barnes 1982). The findings of these studies are cause for concern about the effects of the underground work environment on accidents. They were limited to simulated tasks in artifical environments and should be explored further.

Conclusion: Research into safety has been accorded a low priority despite the extreme and unique conditions in local gold mines. Funds devoted to safety research are limited and crucial problems have not been addressed. Analysis of the research of the Chamber of Mines reinforces the argument that management's approach to safety concentrates on the fallability of individuals rather than on improving the work environment and the way in which production is organised.

Where research has been undertaken, there is evidence to suggest that the results have not always been acted upon. An example is the problem of noise in mining. Although Chamber research has been underway since 1964, noise levels remain extremely hazardous (see Section 15.5).

PART II - RESEARCH STRATEGY AND SAMPLE PROFILE

6. RESEARCH STRATEGY

Three hundred and eight thousand (70 per cent) of a total black labour force of 446 000 are employed underground (GME 1983). To obtain a representative sample of such a large number of workers was beyond the resources available for this study. Moreover it is impossible to carry out a representative study without free access to the industry. So in order to carry out this investigation we collaborated with the most representative black workers' union in the industry, the National Union of Mineworkers. Informants were selected by senior union shaft stewards and office bearers from each mine to ensure that informants would be experienced and have an intimate knowledge of underground working conditions. This is termed 'expert choice sampling' which is a type of strategic informant sampling (see Smith 1975, pp 117-118). Initially a pilot study with 27 workers at one mine was completed. For this study a sample of ninety underground workers with at least one year's underground work experience were interviewed between August, 1984 and January, 1985.

Our sample was drawn from four gold mines. The mines were selected on the basis of four criteria : geographical location, accident and fatality rates, the mining group to which they belonged and ease of access to workers. It was assumed that the variations resulting from these criteria would ensure that any systematic differences within the mining industry would be minimised in our sample.

Geographical location is important because of variations in geology and in the incidence of rockbursts from district to district. Two of the four mines were located on the Far West Rand, the others on the Klerksdorp and Orange Free State gold fields. Rockbursts occur in all three districts included in our sample. Accident and fatality rates at two of the mines were lower and two were higher than their district averages and the national average. The mean injury and fatality rates for each mine and district are presented in Table 1. Ownership of the mines in our sample was in the hands of three mining groups. The mining group that owned two of the mines is the largest employer in the industry. All the mines of our sample started operations after the Second World War. At the time of this research all four mines were operating profitably. Because of the variety of underground occupations, union stewards were requested to select workers preferentially from two categories of workers : day-shift (rock breaking shift) stope team leaders and day-shift stope machine drill operators.

Stoping was selected instead of developing or any other mining operation for the following reasons:

* It is the key underground mining operation
* Over 50 percent of black underground workers are directly involved in stoping activities (estimated from Spandau 1979)
* Stoping is much more hazardous than other mining activities. Bettencourt and Jensen (1970) found that 70% of all injuries occur in production stopes.

Team leaders were chosen because they play a crucial role in:

* Supervising, controlling and co-ordinating production.
* Ensuring that adequate safety precautions are taken.
* Interacting with white miners and officials, for example in reporting progress and problems encountered.

Machine drill operators were selected because:

* As team workers, they are from the bottom rungs of the mining hierarchy.
* It was assumed that they would be familiar with most aspects of stoping operations because of their role in production. For example, drillers have to wait until the face has been searched, misfires removed and the face properly supported before they can start drilling. Drillers often assist workers who charge up the holes and connect explosives.
* Drilling is particularly dangerous because of the ever present threat of rockfalls and rockburts. The injury rate for machine crews is substantially higher than for any other underground occupation. It is more than twice the injury rate of the overall mine average (Bettencourt and Jensen, 1970). Hence it was felt that machine drillers would be aware of any neglect of safety precautions.

Fifty three of our 90 informants (59 %) were employed as stope team leaders or machine drillers on day shift at the time of their interview. The breakdown of their occupations is given in Table 2. The distribution of the occupations of our informants according to mine is presented in Table 3. Four informants were not union members.

All interviews were conducted by the author. Translation was carried out by union shaft stewards from each mine. Two semi-structured interview schedules were used - one for workers with supervisory jobs (team leaders) and another for team workers. The questionaires are included in Appendix A. Each interview lasted from three-quarters to one and a half hours. In addition to the above, four miner's assistants were interviewed (in an open interview) to gain insight into their role in the production process (see Appendix C).

7. WORK EXPERIENCE PROFILE OF SAMPLE

The work experience profile of our informants is important to establish the validity of their statements and perceptions. If our informants have relatively short periods of underground experience, then the choice of the sample of informants is questionable. But if our sample of informants is more experienced than workers in the industry as a whole, then the degree of confidence that may be placed in any conclusions based on their perceptions is increased. The purpose of this section is to compare the work experience of our informants with that of black workers in the industry as a whole so as to assess the degree of confidence that can be placed in our sample's perceptions.

7.1 Total Work Experience

The length of underground experience of underground mining of our sample was much higher than that of black workers in the mining industry on average (1). The average for our informants was 15,7 years. This included a certain proportion of homestays.

FOOTNOTE

(1) Statistics on the age and work experience profiles of workers in the gold mining industry are not published. The only figures available relate to selected samples made during research studies of the Human Resources Laboratory.

TABLE 1 - Mean fatality and injury rates for the mines of our sample, their respective districts and the gold mining industry as a whole for the period 1973 to 1983 (Loss Control Survey, 1973-1983).

Mine no.	1	2	3	4	National Average
Mine fatality rate	1,08	1.66	1,05	2,23	1,32
District fatality rate	1,13	1,66	1,42	1,66	1,32
Mine accident rate	30,43	55,64	40,92	50,59	42,88
District accident rate	33,77	52,51	45,93	52,51	42,88

Source : Loss Control Survey, 1973-1983

TABLE 2 - Occupations of informants

Supervisory workers	No.	Proportion of total (%)
Stope team leaders (18 day shift, 3 night shift	21	23
Development team leaders	1	1
Other team leaders (construction, equipping and locomotive)	7	8
Section and senior team leaders	9	10
Total supervisory workers	38	42
Team workers		
Stope machine drillers	33	37
Development machine drillers	6	7
Winch drivers	4	4
Loco drivers	2	2
Team members	7	8
Total team workers	52	58

TABLE 3 - Occupations of Informants According to Mine

Mine No.	1	2	3	4
Total TL category	13	12	5	9
Total team member category	14	13	13	11
Section and senior TL category	1	5	0	3
Stope team leader (day)	5	4	4	5
Stope machine operator (day)	11	7	8	7
Total interviewed at mine	27	25	18	20

It is more than twice as long as the average for the industry (2). Hall (1982) and Peart (1982) found that the average total time spent in mining (underground and surface) amounted to slightly more than six years in 1981. They do not state whether homestays are included or excluded in arriving at their figure for total experience. Without access to mine records it was unfortunately not possible to take homestays into account for our sample. If homestays of between three and six months a year are assumed, the average length of work experience of our informants is still higher than the overall average. Peart (1982) indicated that in a typical homestay/workstay cycle, 25% of the total time is spent at home and 75% is spent working on the mines.

Differences between the profiles of experience of our sample and the industry as a whole are illustrated in Figure 4. No informant in our study had less than two years and almost two thirds had more than ten years underground experience.

7.2 Length of experience in current job

The total length of experience of our informants in their current jobs was also higher than that for workers in the industry as a whole (Figure 5). The only industry wide data are provided by Peart (1982) for 1979 and 1981.

The average current job experience of our informants was almost ten years, whereas Peart found the industry average was only 2,8 years in 1981. The average length of experience in a particular job may have increased considerably in recent years. Peart found that the mean length of experience increased from 1,6 years in 1979 to 2,8 years in 1981. Even if this rate of increase continued through to 1984 the average of our informants in their current jobs would still be greater than for the industry as a whole.

7.3 Age

As one would expect from the above comparisons, the average age of our informants (35,9 years) was much higher than the industry average for black workers of 30,3 years (Hall, 1982) in 1981. In Figure 6 the age distribution of our informants is plotted together with the data of Hall (1982) and Peart (1982).

FOOTNOTE

(2) This finding is consistent with other studies which have generally noted that the majority of trade union members are drawn from more experienced and more stable groups of workers. This is illustrated by the following note from Papart (1984) on service and matrimonial status:
"In the early 1950's, Mitchell discovered that longer service miners tended both to be union members and married. J.C. Mitchell, Data collected from Nchenga Mine Staff Records, 30 April 1951; Epstein came to similar conclusions in 1954. A.L. Epstein, Politics in an Urban African Community (Manchester, 1958), 112-115; In 1968, Bates discovered that 64,9 per cent of married miners belonged to the union while only 26,4 per cent of the unmarried miners joined. Robert Bates, "Trade Union Membership in the Coppermines of Zambia : A Test of Some Hypotheses," Economic Development and Cultural change, 21 (1972-73), 284-85."

Supervisory workers in our sample were generally older and more experienced than team workers. This is consistent since supervisory jobs are more senior and require more experience than team jobs. The average age of the supervisors in the sample was almost 40 years compared to 33 years for team workers.

Supervisors had an average of 15,7 years total underground experience, 9,8 years of which were in their current jobs. Team workers averaged 12,7 years underground experience of which 9,3 were in their current jobs.

7.4 Accident Experience

It is important to establish that accident victims are not over-represented in our sample. If this is the case it could be argued that our informants' perceptions were biased by unfortunate personal circumstances.

Thirty-six workers (40%) of the sample had experienced 39 reportable accidents. If a mean period of mining employment of 16 years is assumed for our sample, then these 39 accidents represent a reportable injury rate of 27 injuries per 1000 workers per annum. (If homestays are taken into account, the rate may increase by 20 to 50%). This is much less than the industry's mean injury rate of 53,3 reportable injuries per 1000 employed workers per annum for the period 1968 to 1984.

The low accident rate of our informants was probably due to:

* The healthy worker effect, which is the tendency of workers to leave a particular industry on account of injuries or disease.
* The greater than average experience of our sample since experienced workers are involved in proportionately fewer accidents than inexperienced workers (Bettencourt & Jensen, 1970).

7.5 CONCLUSION

It may be concluded that our sample consisted of a group of workers who, when compared to the industry as a whole:

* Had more underground experience
* Had more experience in their current jobs
* Were somewhat older on average
* Had experienced fewer accidents than average

The above are consistent with the criterion of our expert choice sampling strategy that informants should be experienced underground workers.

PART III - WORKER PERCEPTIONS : SAFETY AND THE ORGANISATION OF MINE WORK

8.1 WORKERS' PERSONAL EXPERIENCES OF ACCIDENTS

The accidents that informants were involved in are categorised according to the Government Mining Engineer's classification in Table 4. The proportions of the different types of accidents follow the trends recorded for the industry as a whole. There is a preponderence of injuries due to falls of rock and rock bursts followed by machinery and tramming accidents.

Half of the accident victims felt that their accidents could have been prevented. The reason informants gave most often (24% of preventable accidents) was that officials and white miners had not allowed them to take adequate safety precautions because of production demands:

> "Whilst we were busy loading, the square (hanging) fell off and hit me on the finger. We were being rushed and treated bad. Just because I am afraid to delay work and at the same time I was tired, I could not do anything else but do as I was ordered."

Four workers noted that they had reported dangerous conditions prior to the accident, but were refused permission to undertake the necessary safety precautions.

> "(The hanging) fell where there was not a support. We had reported this matter to the team leader. The team leader went to the white miner. Then the white miner told the team leader to 'tell those people if they do not want to work, they must take their clothes and go on surface', that is to discharge. Because the miner forced us to work there and threatened to discharge us, so we just had to work without putting in packs. There were sticks there, but we told the team leader that they served no purpose because when we started to drill there it started to shake, So we asked the team leader to put in a pack because it was a big place, then the white miner forced the issue.
>
> I do not know if the white miner got into trouble because I was away in hospital."

Other preventable causes of accidents included shortages of support materials, poor work methods, inadequate training and lack of proper signals between fellow works. No worker injured by a rockburst believed that his injury could have been prevented. However, more than half of those hurt by falls of rock said their injuries could have been avoided.

8.2 Perceptions of Risk

Informants were asked to describe three dangerous aspects of their work. All but one informant felt that underground work was dangerous, many emphasizing that they thought it extremely dangerous. Informants mentioned 246 hazards altogether. These hazards have been categorised according to the GME's classification of accidents in Table 5. Rockfalls, rockbursts, machinery, transport, explosives and falling in shafts and excavations were perceived by informants as the most dangerous. The instrumental causes of all fatalities that occurred during the period 1968 to 1981 are also presented in Table 5. The figures are not, strictly speaking, comparable with each other, especially as informants were only requested to mention three hazards. Nevertheless, except for the inclusion of machinery which is responsible for proportionately few fatalities, the hazards described

by informants coincide with the five most important causes of fatalities in mining.

A number of our informants comments are quoted here because they vividly capture the hazards that workers face daily.

(1) Hazards presented by the underground environment, especially rockburts, rockfalls and heat:

"When we are drilling and going forward, behind us there is insufficient support. (I fear) rock bursts because when we are right inside there is no support and when the rock bursts, then the rock falls".

"The heat, it sometimes overpowers and I collapse".

(2) Hazards underground can not be seen in isolation from the use of heavy machinery. Not only is this equipment potentially hazardous, but the high noise and vibration levels are health hazards in themselves and make it difficult to perceive warning signals:

"As I am drilling, the noise made by the machine makes it impossible to hear the sound of the hanging when it is falling. When I am drilling, if the jumper is broken, the machine will fall to one side, and the jumper that has broken may shoot back and injure me anywhere. The (drilling) machine as it is vibrating may cause numerous cracks on the roof of the stope, and the stope may fall at any moment without me realising and injure me".

(3) In describing hazards, informants referred to what can be conceptualised as coercive social relations:

> "Even though you see and you realize this place is dangerous and can fall at any time, you are forced to get in there. In the face where we are working, we still have in mind that the rock can fall at any time."

Conclusion: Over half of our informants injured in reportable accidents believed these accidents could have been prevented. In general the hazards identified by our informants tallied with the causes of fatal accidents given by the mine inspectorate. Workers' personal experiences of accidents provide an introduction to their perceptions of safety standards and practices. These will be thoroughly examined in the sections that follow.

TABLE 4 - Types of accidents that laid off informants for two or more weeks and whether they could have been prevented.

Type of Accident	No. of accidents	% of total accidents	No. that may have been prevented	% that may have been prevented
Rockbursts	7	18	0	0
Falls of rock other than rockbursts	16	41	9	56
Machinery	7	18	5	71
Trucks & tramways	3	8	3	100
Falls of materials	2	5	2	100
Falling in shafts and excavations	2	5	1	50
Others	2	5	1	50
TOTAL	39	100	21	54

TABLE 5 - Categorisation of hazards noted by workers compared to the causes of fatal accidents as reported by the Government Mining Engineer for the period 1968 to 1981

Type of Accident	No of times a particular hazard was described as a risk by informants	Causes of fatal accidents between 1968 - 1981 (1)
	%	%
Rockbursts	9,4	18,0
Falls of ground other than rock bursts	31,3	36,4
Machinery	15,4	1,4
Trucks and Tramways	9,8	15,7
Falls of materials	0,4	4,0
Falling shafts and excavations	4,9	8,1
Explosion of gas (19)	3,2	1,0
Due to handling explosives and blasting operations (29-35)	8,9	3,3
Sundry (27)	16,6*	12,5

*This figure includes occupational health hazards like dust and noise, and a variety of specific problems that could not be simply categorised.
(1) Source: GME Annual Reports.

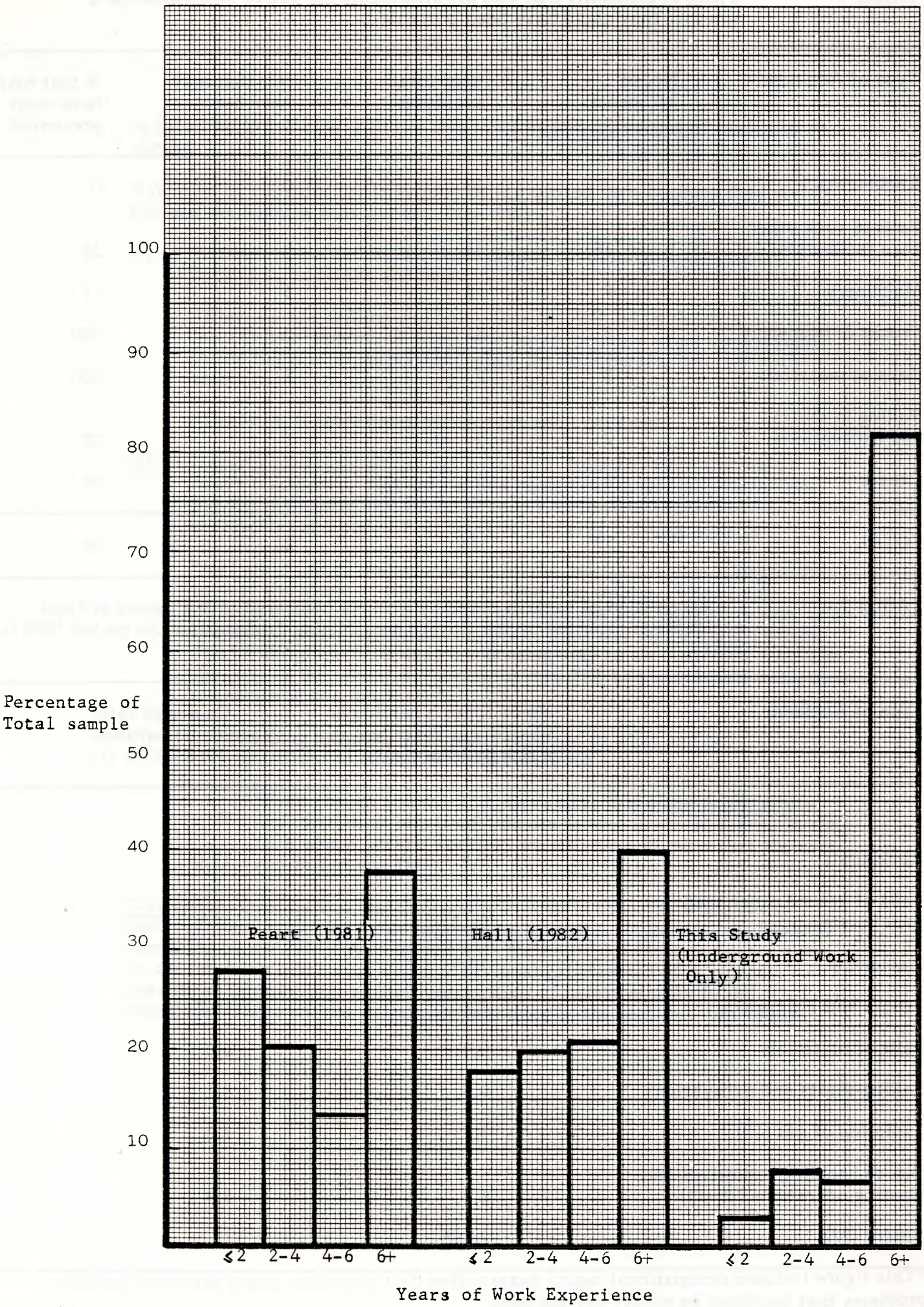


Figure 4: Histograms comparing years of work experience of workers in this study and Chamber studies by Peart (1981) and Hall (1982)

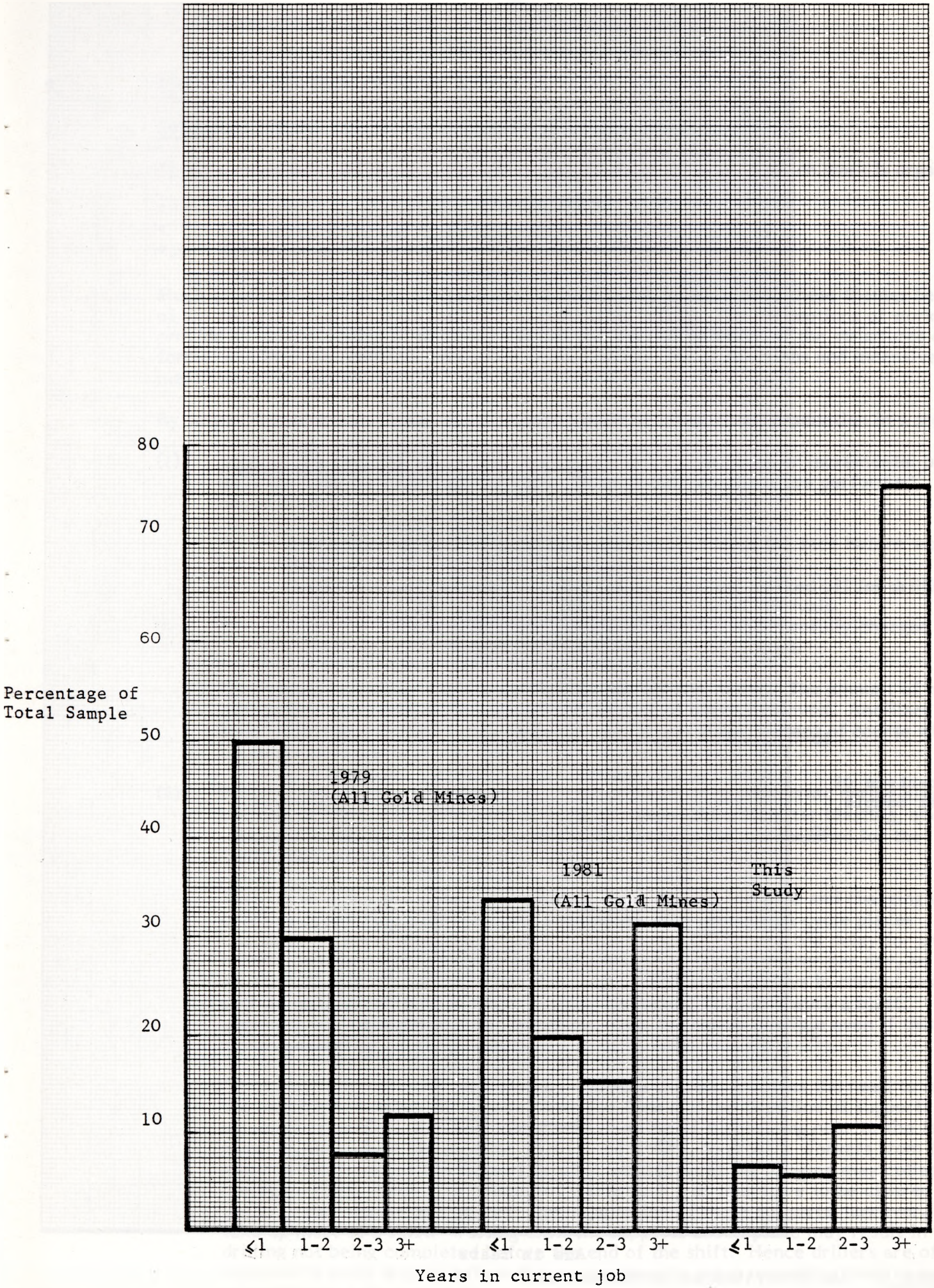


Figure5: Total Length of experience in current job.
Source: Peart (1982)

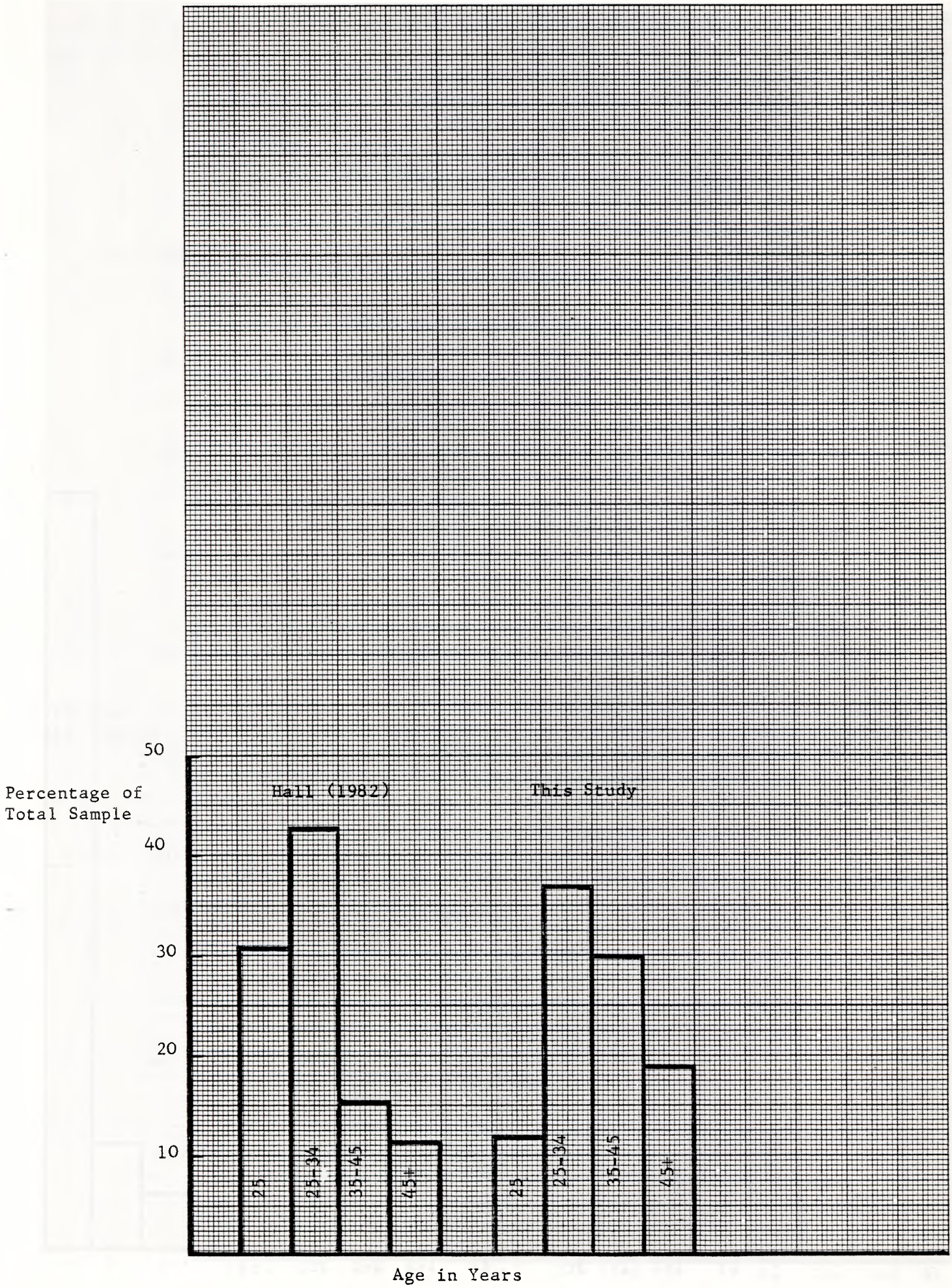


Figure 6: Age distribution of Mineworkers

9. THE ORGANISATION OF MINE WORK

9.1 INTRODUCTION

Three themes were followed in the interviews to grasp the way in which work is organised:

* The daily work activities of informants
* Instruction and supervision of work
* Sanctions and incentives.

Much attention was paid to the provisions of the MWA in relation to these themes because of the central importance of the MWA in regulating safety. The perceptions of workers provide an understanding of what work is carried out and by whom of the structures of formal and informal controls over production; and the role of sanctions and incentives in maximising production.

By way of introduction, three essential points must be made about production in a stope:

(1) Stoping is a cyclical production process and not a continuous or incremental process as is the case for most factory work. Three basic operations are performed sequentially:

* After blasting, broken rock has to be removed from the face before work can start.
* Once the face has been inspected for misfires and marked off for drilling, holes about 1,2m deep are drilled at evenly spaced intervals.
* When the holes are finished they are washed out and carefully charged with explosives. The charges are then connected and ignited.

Every blast 'advances' the face by approximately one metre. The amount of rock excavated is basically dependent on the number of blasts achieved. Ancillary tasks such as putting in support may be performed at any stage, except of course when blasting takes place.

(2) Blasting takes place only once a day. The mine must be evacuated during blasting because of the imminent danger of rockfalls and rockbursts after blasting, and the vast quantities of noxious fumes produced. A few hours are required for the ventilation system to remove the fumes.

With present day technology for clearing rock, drilling the face and charging up, only one production cycle per day is practical. The production cycle places tremendous pressure on workers in individual stopes. If there is a delay for any reason, instead of achieving an optimal advance of say one meter per day, an advance of only one meter in two days will be achieved. Delays in crucial tasks such as drilling can lead to major production losses. Thus to ensure a blast, attempts will be made to complete these tasks as soon as possible even if this means neglecting safety precautions.

An example, frequently mentioned by machine drillers, involves the need to support the hanging wall when the gap between the face and the first line of supports becomes excessive. It is necessary to have a line of supports as near to the face as possible, with due allowance for drilling operations, to protect workers from falls of ground. Moreover, if the support lags behind the face, the hanging may collapse during blasting. Excessive amount of waste rock will then have to be cleared away which in turn delays operations. The installation of these supports, however, may take up most of a shift. Waiting until the supports are in place may result in the drilling not being completed before the end of the shift. Hence drillers are often required to start drilling before the supports are in place, exposing them to an excessive risk of a rock fall.

(3) The ability of management and workers to plan in advance is limited. Unlike production on an assembly line or in a typical factory, workers are constantly faced with unexpected situations underground. Difficulties and bottle-necks tend to be the rule of production, rather than the exception. The reef, for example, is not a continuous body, but has discontinuities such as faults, slips and dykes. These may only reveal themselves as they are negotiated, upsetting preconceived plans in the process. Unexpected contingencies such as misfires, electrical and mechanical breakdowns and rockbursts, create a range of their own difficulties.

Planning difficulties are exacerbated by the logistical problems inherent to gold mines : anything required from surface has to be brought kilometres into the earth in a small cage, then transported perhaps kilometres through a maze of haulages and crosscuts before it eventually reaches the stope. The same problems are experienced in 'reverse' if an item must be taken to the surface for repair.

Problems such as these inevitably delay production. Delays in turn may result in management putting pressure on workers to return production to normal. But because the possible degree of planning is limited, short cuts in the safest ways of negotiating the problems may have to be taken. Thus workers find themselves facing unusual situations for which they have not received adequate training.

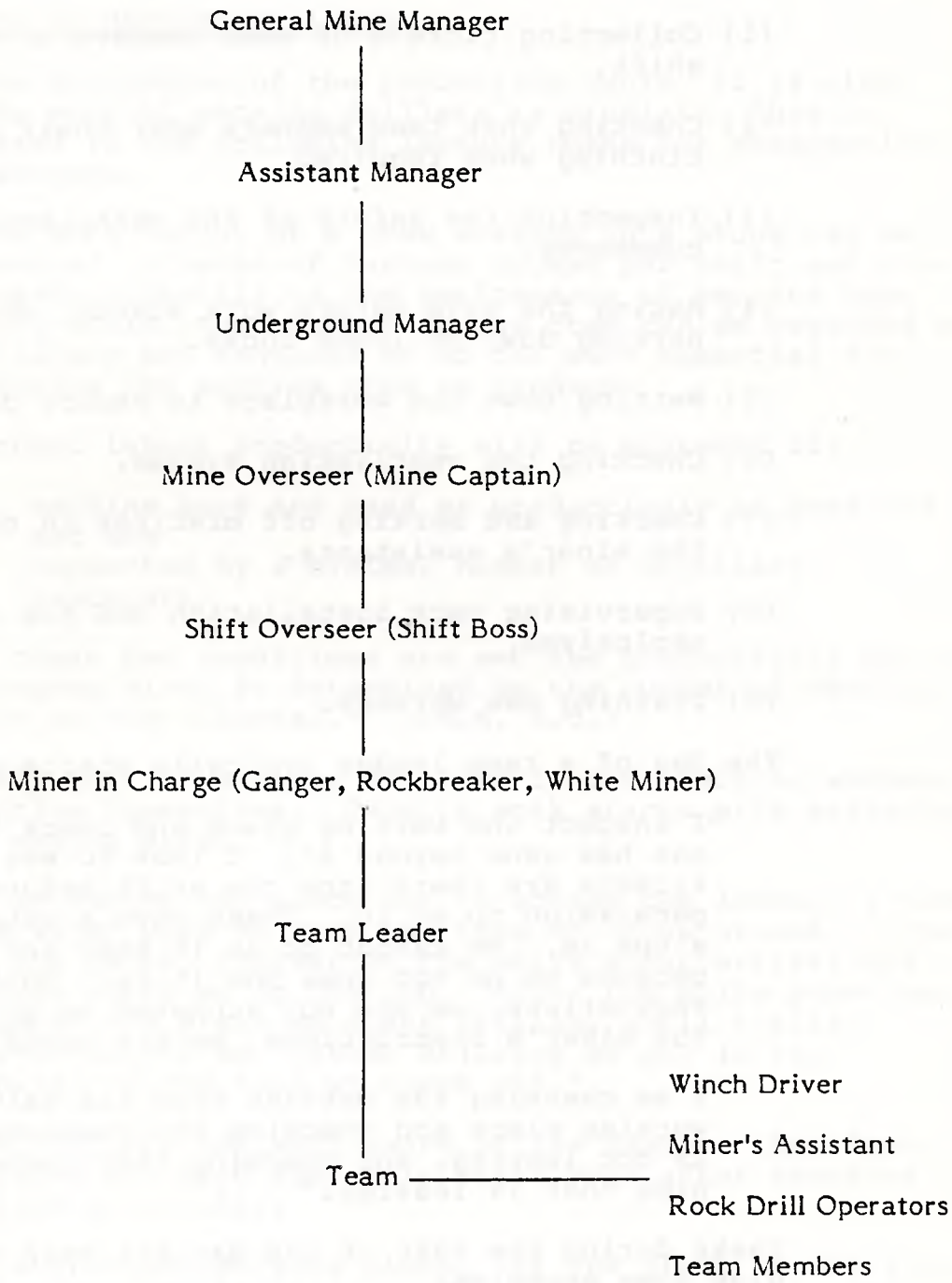
9.2 The Regulation of Safety by the Mines and Works Act

In most countries legislation provides for a wide range of inspections and procedures to ensure safety. In South Africa, the MWA specifies how and when these inspections are to be carried out, as well as a wide range of safety procedures and duties. However, the Act is not simply a safety code. It is also a legislative framework which reserves, on the basis of race, certain tasks and skills through its definition of "scheduled persons".

The Act defines scheduled persons as Europeans, "Cape Coloureds" or "Cape Malays", or the descendants of "Mauritius Creoles or St. Helena persons" (A12(2)(a)). To legally undertake many tasks and standard safety procedures a worker has to be a scheduled person. "A scheduled person in charge of workmen" is defined as a "ganger" or "miner" (1(9)). In this report the colloquial terms 'white miner' will be used for "miner" or "ganger" to avoid confusion with black miners and because only whites have these jobs in deep level gold mines. A schematic diagram of the hierarchy of command in a gold mine from the general mine manager to the stope worker is given in Figure 7 for further information.

The MWA regulations are an unusual, if not unique piece of legislation. In delineating and reserving specific tasks and skills for white miners, they define in detail their labour process. It is not the intention of this report to detail all of these procedures. Rather, a limited number of provisions crucial to the daily activities of the rockbreaking (morning) shift in the stopes will be examined. Similarly, to simplify analysis of our informants responses, only the responses of stope machine drillers and stope team leaders working on day shift will be reported where appropriate.

FIGURE 7: Schematic diagram of the hierachy of command in a gold mine from the general manager to stope workers.



9.3 DAILY WORK ACTIVITIES IN STOPING

9.3.1 The Work of Team Leaders

According to the stope team leaders who we interviewed, they are generally responsible for the following:

(1) Collecting tickets of team members at the start of the shift.

(2) Checking that team members wear their protective clothing when required.

(3) Inspecting the safety of the workplace before work commences.

(4) Making the safe before work starts, which includes the barring down of loose rocks.

(5) Wetting down the workplace to reduce dust.

(6) Checking the ventilation system.

(7) Checking and marking off misfires in conjunction with the miner's assistants.

(8) Supervising pack installation and the charging up of explosives.

(9) Training new workers.

The day of a team leader typically starts with inspections:

> "I inspect the waiting place and check to see that no one has gone beyond it. I look to see if the token tickets are there from the shift before which give me permission to go in. These have a note about how the stope is. We cannot go in if they are not there because we do not know how it is. Following the regulations, we are not supposed to go in. Following the miner's instructions, we are bound to go in.
>
> I am checking the methane from the waiting place to the working place and checking the compressed air to see it is not leaking, and checking that there is no water pipe that is leaking."

Tasks during the rest of the day are many and varied. To give some examples:

> "If there is a shortage of machine operators, I am doing it. If there is a shortage of a loco-driver, I'm driving it - any job."
>
> "My other job is to inspect the gang on this side, and the gang on that side and see how they are working."
>
> "When knocking off every afternoon I have to check

whether there are shortages. If there is something short, I will go to the underground store and requisition it if it is available."

The team leaders answers immediately raise questions related to the themes we have set out to explore. These questions will be considered in the following sections.

9.3.2 The Work of Machine Drillers

From the discussion of the production cycle, it is clear that the work of machine drillers is crucial. This is emphasized in the following lecture notes for prospective mine managers:

> "The work output of a crew working in a stope can be measured in terms of fathoms broken per shift and this depends primarily on the performance of machine boys (sic) while other labour in the crew can be regarded as ancillary and required to do the work essential for allowing the machine crew to produce.
>
> Highest labour productivity will be achieved if:
>
> a. machine boys are used as productively as possible and are
> b. supported by a minimal number of ancillary labourers.
>
> If these two conditions are met the productivity of the European miner is determined by the number of machine boys at his disposal." (SACM, n.d.)

The daily work of machine drillers is best left to workers to describe themselves. Usually work starts with assisting in the making safe:

> "I am taking the pinch bar to scrape the loose. I take the water pipe to wash the face of loose stones. I put up the jacks, thereafter the white miner arrives and paints where we do the job. After the white miner has painted the place we start drilling until tjaila (finishing) time. After drilling we put in the explosives and then we knock off."

Machine drillers are well aware of the dangers they face. Experienced men said they only start work after checking conditions personally:

> "I search the working place. If the place is bad I am going to tell the team leader. I do not believe if somebody is searching for me, that is why daily I must make sure myself.

Hazards other than just rockfalls also threaten drillers:

> "When you start drilling you must start checking the 'jombol yametsi'. You must search for places where water can come out of the rock."

The changing role of white miners and team leaders was also referred to in the descriptions of some drillers:

> "In the morning when I go to work I go to the waiting place. There the team leader reminds us of the 'mteto' (safety rules). When it is time to go in, I will go to my place to fetch my tools and protective clothes.
>
> In the olden days the white miner used to show me where to bore the holes and not to bore the holes, maybe six or seven years ago. Now the white miner does not go, only the team leader who tells me everything.
>
> I am supervised by the team leader, the job that is supposed to be done by the white miner is done by the team leader.
>
> I lash if the night shift has not lashed, then I start with boring. I am the only one who operates that machine.
>
> Whatever job the team leader asks me to do, I do that. So I may help the miners' assistant putting in cartridges into the holes and connecting the wires."

The daily activities of drillers include a number of tasks not specifically associated with drilling, for example making safe, clearing, putting in supports and even assisting with the charging up. When questioned more closely, all the machine drillers confirmed that they were required to assist other team members when there was no drilling to be done.

> "If at all there is no place where we must drill, it is now that I am bound to help the other people, for example with timbering."
>
> "We are ordered to do this (job) by the team leader or white miner ... If you don't do this, you are told 'You have eaten the companies money'. We are told that this is the company rule. We do the fastening of pipes, seeing to it that the ventilation system is working properly."

Assistance provided to team members at times has a direct bearing on the drillers' safety:

> "Usually we help them in the case where we cannot drill because of the space between the face and the last installation of packs (is too big). Then we have got to install the new line of packs in order to make the place safe."

The tasks required of drillers go beyond those that could be considered to be related to drilling activities. For example some informants were required to operate winches:

"I help with driving of the mono rope. I do that following the instructions of the team leader. I have not been trained to do this job."

The reason for doing jobs like winch driving often stemmed from the absence of fellow workers:

"I once drove a winch because the man was absent, so I had to drive it to open that place so that I could drill."

In most cases team leaders were responsible for telling drillers to do these extra tasks. A quarter of the drillers were also instructed by white miners or voluntaily undertook additional tasks.

9.3.3 Discussion

Flexibility in working arrangements was not limited to machine drillers, but applied to many other team workers as well as informants in supervisory jobs. The literature suggests that job flexibility is encouraged by senior management and white miners to raise production levels (Smith 1974, NPI 1982). A productivity survey conducted at four gold mines by the National Productivity Institute (NPI, 1982) notes that:

"Those miners regarded as better performers (they were also the highest money earners) were interviewed very intensively by the NPI survey team and the following labour utilisation techniques were found to be commonly applied:

- Motivation of the Black team members to be cross-trained and to be utilised on different tasks in order to overcome bottlenecks, should these occur.

- The cross-training of all capable operators.

- Using as many of the team members as possible to prepare a face for drilling.

It is interesting that whereas the tendency in factory work is for the division of labour to be increased in mining the division of labour is blurred to facilitate production. This may be welcomed for reducing the monotony and alienation of mine work. However, the conclusions of local and international studies suggest that accident rates are increased. These studies have shown:

(1) Inexperienced workers suffer substantially higher accident rates than experienced workers (Bettencourt and Jensen, 1970, NRC 1982).

(2) Miners who are regularly called upon to do tasks that are not part of their routine work have much higher than average accident rates (Snyder 1983).

9.4 Inspections of the Work Place

9.4.1 Regulations and Exemptions

The first requirement of every shift is for all working places to be examined thoroughly. Thereafter inspections should be carried out at regular intervals. This is important because conditions in a working place can deteriorate within hours.

Inspection usually includes "making safe" all working places before work commences: "All ... stopes and other workings ... shall be made and kept safe for persons in the mine and no person ... shall travel or work, or cause or permit any other person to travel or work, or cause or permit any other person to ravel or work, in any part of such workings until it is made safe" (R.7.1)

A further regulation defines making safe: "The ganger or miner shall remove or cause to be removed all dangerous loose or loosened rock, mineral or ground. He may be assisted in this work by persons working under his personal supervision and control" (R8.8.2). The basic tools used in making stopes safe include a hammer for "sounding" the rock and a 'pinch bar', a type of crowbar used for removing loose rocks from the hanging and side walls.

The white miner's responsibility for ensuring safety continues throughout the shift : "the ganger or miner carrying out the examination and making safe ... shall take all reasonable precautions for the safety of persons present ... and such precautions shall continue as long as he allows any person to remain in the working place" (R8.8.4). For gold mines the regulations do not specify how often a white miner must inspect. In coal mines a white miner must make "at least three inspections of every working place in his section during each shift (R8.9.6).

In the past it was the responsibility of "scheduled" persons to make safe "every stope which has remained idle for more than six hours ... and every underground working place in which blasting has taken place, shall be examined and made safe by a ganger or miner who shall be the holder of a permanent blasting certificate" (R8.8.1).

The above and other duties specified in the Regulations, have been considerably reduced by the "Re-organization of Work" exemptions granted by the GME.

Figure 8 has been prepared to facilitate explaining the exemptions. They allow a "competent and experienced" team leader during the rockbreaking (morning) shift to enter the working place after blasting to make safe. A gang of up to five workers may accompany him. The team leader and his assistants may enter up to two hours before the arrival of the miner in charge, miner A. A second white miner called miner B, is given general responsibility of the working place during this time. Miner B may stand in for no more than four white miners (A's) during this period. Miner B must inspect each working place within an hour of work commencing to satisfy himself by consultation with each team leader ... that the work is proceeding safely." (Exemption 3.2 (d), GME 1976). The white miner in charge of the working place (miner A), has to re-examine it "within 90 minutes after the scheduled time of his arrival." (Exemption 3.2 (f), GME 1976). This means that the miner in charge of a working place is only required to inspect it three and a half hours after work has started.

According to the exemptions, the teamleader has to report "any sources of danger found or observed and the steps he has taken to safeguard the safety and health of persons". (Exemption 3.2 (e), GME 1976). No diminished responsibility is granted to the white miner in charge for ensuring safety during the rest of the shift (see R8.8.4 quoted above). From the above description it is apparent that at least one inspection by a white miner should be carried out within an hour of workers commencing work.

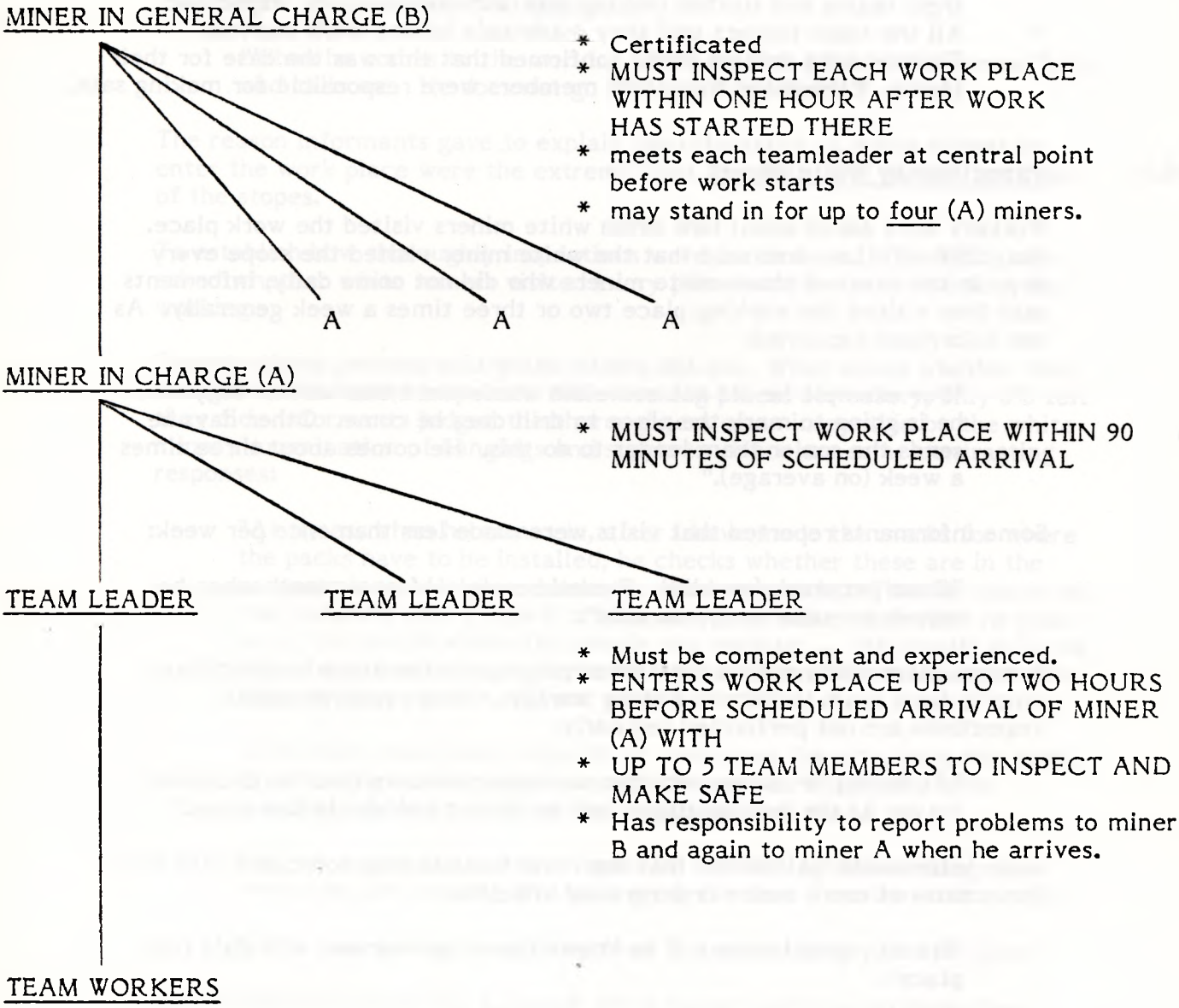


Figure 8 : Simplified diagram showing inspection and making safe procedures envisaged by "Re-organisation of Work" exemptions (GME, 1976).

9.4.2 Worker Perceptions

Informants were questioned about who inspected the work place and who made safe before work started.

* All the stope team leaders said they carried out the initial safety inspection.
* Thirty of the thirty three (91%) machine drillers confirmed that team leaders did the initial inspection. The remaining three drillers said that team leaders simply went into the working place together with the rest of their teams and started making safe without any prior inspection.
* All the team leaders said they made safe before work started.
* Twenty eight drillers (85%) confirmed that this was the case for their teams. Five noted that team members were responsible for making safe.

9.4.3 Inspections by White Miners

Workers were asked about how often white miners visited the work place. Only 39% of informants said that the white miner visited the stope every day. In the cases of those white miners who did not come daily, informants said they visited the working place two or three times a week generally. As one informant explained:

> "For example he did not come the whole week this week. Only when he is going to mark the place to drill does he come. Other days he sends the senior team leader to do this. He comes about three times a week (on average)."

Some informants reported that visits were made less than once per week:

> "Once per week (usually). Sometimes only after a month when he comes to make measurements".

In some cases white miners monitored progress in the stope by soliciting reports from team leaders and other workers. As a result personal inspections are not performed regularly:

> "At times, he comes once per week, at times we hear he is around maybe at the waiting place, but we do not see him in the stope."

Some informants maintained that the miner's visits only coincided with the inspections of more senior underground officials:

> "He only gets in there if he knows the mine overseer will visit the place".

Informants were questioned about what white miners did when they came to inspect. The picture that emerged from our informants was that the overriding concern of white miners was the progress of production in the stope. Safety was a secondary consideration. In the words of a team leader:

> "When he comes he only comes to check if the work is going. If the work is going then he marks the place for the machine operators to drill, thereafter he goes to the box"

Production was usually well underway when the white miner arrived. His inspection established whether work was proceeding smoothly and special instructions would be issued if necessary:

"When he gets there he just simply checks that the work is going and then he goes on".

"There is nothing he is doing in fact. He just comes to check whether the face is going straight, and to tell to do this and that".

In certain cases, informants described the "inspection" as comprising a report made by the team leader to the white miner in the comparative comfort of the less restricted gullies:

"When he comes to the working place, he just goes to the central gully and calls me. He does not go into the stope itself."

The reason informants gave to explain the reluctance of white miners to enter the work place were the extreme heat, humidity and narrow confines of the stopes.

To establish how thoroughly inspections were carried out, informants were asked whether white miners visited every place where a team member was working.

Seventy-three percent said white miners did not. When asked whether they thought white miners inspected their working places for safety, only 8% felt they did. Informants judged the thoroughness of an inspection by the white miner's examination of hangings and supports. Here are some contrasting responses:

"At times, when he comes in, after I have made the marks for where the packs have to be installed, he checks whether these are in the correct place. He also checks for the loose rocks. Then he checks all the problems that I report to him, and if he has enough time he goes to all the places where the people are working ... He usually tells me when he is in a hurry, at times he has not time, he must hurry to the other stopes, then he will not go and check."

"The white miner only inspects by looking at the site, he is not doing it according to the proper way which says you must take some searching tools and search the hanging and all that."

"No, because time and time again he is reaching the working place where we are working and he is using the tape measure where he is."

"He is only asking everything from the team leader, then he goes."

Some informants said that although white miners pointed out hazardous conditions, they did not follow this up:

"What I note is that this white miner is just instructing me that this place is not so much safe, then he is just leaving me, not seeing how I fix up the place."

In some cases safety had been delegated as the responsibility of the team leader:

"Since I have worked with this white miner, he did not even tell me, 'Look, see this place, it is not right'. He has only told me where we are going to work."

"Even if he comes into the working place, he does not inspect anything. He stays in the central gully and calls me. If there is a place that is very dangerous, he does not come to look, he says 'Be a man, maak a plan'."

The answers to three further questions confirm the view of our informants that white miners play a limited role:

* Ninety four percent of the informants said that white miners, on the days when they visited the stopes, spent less than one hour per shift in their working places.
* Eighty two percent reported that on the days white miners came to the stopes, they paid only a single visit.
* White miners usually do not visit working places at the end of the shift to check if the day's work has been completed. Only 12% of informants reported that end of shift checks were carried out.

9.4.4 Conclusion

Our informants perceptions may be summarised as follows:

* White miners no longer contribute to the initial work place inspection and making safe. This is legitimate in terms of the exemptions. However, it means that white miners no longer exercise an important skill which previously was their strict prerogative.
* In a minority of cases (15%), team leaders are not fulfilling their responsibilities of inspection and making safe.
* The primary purpose of the visits of white miners is to monitor progress of production.
* A majority of white miners (61%) do not visit their stopes on a daily basis.
* Only a few white miners (8%) inspect the safety of working places.
* During their visits white miners generally spend less than an hour in the stopes.
* At the end of the shift, most (82%) white miners do not check to see whether the days work has been properly performed.

It may be concluded that in the view of our informants white miners are not fulfilling their inspection responsibilities. Although white miners receive the best training of all stope workers, their knowledge is not being applied for the critical task of inspection. The remaining stipulations of the MWA are generally ignored.

9.5 Tasks Reserved for White Miners - Removing Misfires, Marking Off and Handling Explosives

9.5.1 Introduction

The bulk of the Regulations of concern to white miners in charge of stope teams relate to the following tasks:

* Marking off the position and direction of holes for explosives.
* Checking for and removing misfires.
* Setting and removing supports.
* Handling explosives

These duties have also been considerably reduced by the "Re-organization of Work" exemptions. The legal responsibilities of the white miner that remain are explained below and contrasted with what happens in practice. These tasks are of particular interest because traditionally they have been regarded as more skilled. Only the responses of day shift stope team leaders and drillers are reported.

9.5.2 Examining and Removing Misfires

Regulations: Team leaders, according to the exemptions,

> "may examine a working face, locate, mark and plug misfired holes, and examine and plug sockets ... provided that the miner must, before pointing out or marking a blast hole for drilling, satisfy himself that the examination and washing out has been satisfactorily done. In so satisfying himself, the miner in charge may use visual means but shall in addition -
>
> (a) in stopes examine at least one socket in every 10m of face by means of water under adequate pressure, or compressed air and water ... or by means of a scraper" (Exemption 6, GME 1976).

The white miner is still responsible for removing misfires:

> "No person other than the holder of a blasting certificate ... Shall extract ... explosives from a hole which has been charged" (R9.34.1).

Responses: Eighty six percent of stope informants reported that white miners did not use water or water and compressed air to examine the face for misfires. For example : "He does not check with water. It is only that the miner's assistant must be in front of him, he just comes after to see." Informants were not asked whether scrapers as described in the exemptions (see above) were used for this operation.

Removal of misfires by white miners was reported by 4% of our stope informants and a further 4% said that the miner and his assistant did this task. In most cases misfires were removed by miner's assistants (65%), team leaders (14%) or by team leaders and miner's assistants together (12%). In a small minority of cases (4%), machine drillers assisted in removing misfires.

9.5.3 Marking Off Drill Holes

Regulation: White miners are exempted from marking off all drill holes if a marking off device "is used to fix the exact position and direction of each hole to be drilled from the predetermined direction and position of the first hole marked on the face" (Exemption 7, GME 1976). This first hole must be marked by the white miner after he has checked and removed all misfires from the face.

Responses: This was the only task that an important proportion of informants said white miners carried out:

* Twenty percent of informants reported that only white miners marked off drill holes.
* Sixteen percent said that the white miner together with the team leader, senior team leader or the miner's assistant marked off. Thus, the miner was involved in this task according to 36% of our informants.
* The remaining 64% said the team leader did the marking off on his own.

* No informant reported that the team leader marked off after the white miner had marked the first hole.

9.5.4 Handling Explosives

Regulations: Only "scheduled persons" with blasting certificates may conduct the following operations related to the handling of explosives:

* The white miner is in charge of all explosives, detonators and fuses.
* Explosives must be stored in a locked container at the waiting place until needed at the face.
* The miner must keep the key of the explosives container on his person throughout the shift.
* "No person shall conduct, or cause or permit any other person to conduct, the operations of preparing or firing explosives charges in the workings of a mine or at a works unless he or such other person holds either a provisional or a permanent blasting certificate valid for the class of mine or works to which the mine or works belongs" (R9.28.1).
* Limited assistance is permitted "in the preparation or firing of charges by reliable persons who are not holders of blasting certificates". When preparing charges the persons concerned have to act under the immediate supervision of the miner. The firing of charges has to be done in the sight or hearing of the miner.

The following tasks are expressly excluded from the scope of the above. It is illegal for black workers to:

"(a) cap a fuse with a detonator;
(b) insert a detonator into a blasting cartridge;
(c) press home explosives into a shot hole;
(d) make any connection to bring an electrical detonator into circuit with a firing cable or connect a firing cable to the terminals of a shot exploder..." (R9.28.4).

Exemptions to clauses (b) and (c) permit a black worker to insert detonators into blasting cartridges and press home explosives into shot holes "on condition that ... he carries out such work under the immediate supervision and within sight distance of, and not further away than 30 metres from the miner in charge" (Exemption 1.1 GME 1976).

Responses: The miner's assistant is the team member specifically involved in handling explosives. Although no exemption allows miners' assistants to lock and unlock the explosives case:

* Sixty three percent of informants said that assistants did so when obtaining explosives.
* Twelve percent said that only white miners did this task.
* Six percent said either white miners or their assistants did.

White miners were present during charging of holes according to only 6% of informants. Although it was not an explicit part of the questionnaire, whenever the connecting up of charges was discussed it emerged that team leaders supervise and assist the miner's assistants with charging up. This description by a team leader provides an example:

> "After drilling we are going to take the water pipe and wash them out, put in the explosives. The fuse is put in and connected, then we will pack till the holes are full up. Thereafter we connect this fuse, then I burn it. My job is to see that it is all done in a correct way. If the team leader knows the job, the white miner will not go there. He will go when he knows the bosses will come".

At two of the mines in our sample central electronic blasting systems were used and at two the conventional "lighting up" of slow burning fuses was done. Of the 23 stope informants from the latter two mines, only 13% said the white miner did the lighting up or was present when the fuses were lit. The rest said that the team leader or the miner's assistant was responsible for lighting up. To quote two typical responses:

> "The team leader is doing all of the job (lighting up). At that time the white miner is in the waiting place. After that the team leader is going to tell the white miner he is all finished and then we can all go".

> "The miner's assistant does this. He does this daily. The white miner only gives the assistant the cheesa stick which he has to collect at the box."

It appears to be the rule that our informants saw the miner's assistant as responsible for all aspects related to handling and charging of explosives. The team leader acts as a supervisor and co-ordinator and provides extra assistance when required.

Further evidence of this was provided by an interview held at one mine with four miners' assistants. Their descriptions of their daily work were fully consistent with those of our stope informants. An edited version of the interview is reproduced in Appendix C.

9.5.5 Conclusion:

From the above it may be concluded that in the experience of our informants the MWA regulations (as modified by the GME Exemptions, 1976) relating to misfires, marking off and handling explosives are generally not followed in practice underground.

10. Control Over Production

10.1 Supervision

Stope team leaders in describing their work regularly referred to their supervisory roles. Supervision went well beyond the safety aspects that have just been discussed and extended to most tasks related to production:

> "I have got to supervise whether the centre gully is going straight. I mark the face for the drillers. I also check whether the drillers are drilling according to the standard, that is they are not making short holes. (I am) also looking to it that the winch drivers have got the required rigger chains and eye bolts. I have to make sure that all the equipment and materials needed are available."

Specific questions were put to team leaders to establish how instructions were given to team members and how work was supervised and monitored. All the stope team leaders in our sample said that:

(1) They were responsible for telling team workers what work they were required to do each day.
(2) They supervised team workers to ensure that work was done in the correct way.
(3) At the end of the shift, they were responsible for checking that the team had completed their work.
(4) White miners gave instructions through team leaders rather than directly to team workers.

Similar questions were put to the stope machine drill operators to establish the consistency of the team leaders' assertions. The qualifications of the drillers adds to our picture of the organisation of underground work.

Machine drillers were asked whether white miners gave them instructions directly. According to 94% of the drillers, white miners usually gave their instructions directly to team leaders. The two remaining drillers said that in their teams instructions were relayed to the team leader via the miner's assistants:

> "He gives his instructions mostly to the miner's assistant, sometimes he gives his instructions to me, sometimes he gives instructions through his assistant. The miner's assistant is the most indispensable man. The white miner gives his instructions to the team leader through him."

> "The white miner gives his instructions to his assistant who comes to tell the team leader what he wants to be done."

These answers confirmed that there is little interaction between team members and white miners. Only forty percent of the drillers said they received instructions directly from white miners. However, this only happened

occasionally, or because of force of circumstances:

"Usually the miner finds me already at the place. But if there is a specific job to do the miner will send me to a place. But usually by then you will find that I have been given a job by the team leader. Now I will have to go to the team leader to tell him I have been told to do this. If the miner comes and tells me to do such and such a job, I usually leave the job that I have been told to do by the team leader."

"Sometimes it happens when the white miner comes, the team leaders are at the other side and only the machine operators are there. Then he tells us straight."

While they may supervise production, team leaders also take part in every aspect of production. Every stope team leader interviewed said he assisted team members whenever it was necessary. They assisted with "lashing, fastening packs, doing the water pipes, connecting the blasting cables", etc.

Assistance was required for three reasons.

(1) Training

Team leaders initially teach novice workers the skills required for their new jobs:

"Usually I assist the new employees who are not sure of what they are doing, so I have to assist them physically."

Team leaders also supervised workers directly by assisting with a task to ensure it was done properly:

"Sometimes somebody does not want to work well so I have to show him how to do it"
and
"At times I show people when they are not installing packs in the right way, and I help when we are in a hurry. If somebody is not driving the winch (properly), I help to show him how to do it."

(2) Production Pressures and Shortages of Workers

Often there are too few workers to do a job : enough workers may not have been allocated or team members are absent. Coupled with the pressures for production these factors force team leaders to become involved in production. These statements illustrate this:

"I am lashing, I am working packs also, especially when there is a shortage of labour and we are in a rush for the job to go. I can't wait for the shortage."

"Sometimes the workers are overburdened and we are running short of labour and I have to help out. I do the installation of packs, winch driving and

shovelling."

(3) Neglect of the MWA Regulations

Team leaders are required to do tasks previously performed by white miners:

"(I am) putting the wires for blasting because the whites do not do that. There is a store underground and these whites who do not want to work normally give us papers to requisition things. All the job is done by us."

"I am doing all the job, all the others that according to the law are supposed to be done by the white miner. I am doing them - I cannot say why."

Conclusion

It may be concluded from our informants descriptions that the team leader acts as the front line supervisor of production as well as actively assisting with work in the stope. What then is the role of the white miner? Is he there, as one of our informants remarked, simply to invoke and impose managerial authority?

"The white miner gives instructions directly because sometimes we do not listen to our team leader so the white miner comes to tell us what to do."

Or does the white miner play a co-ordinating and resource role with the team leader relying upon him when problems and crises arise? To assess the extent to which team leaders rely on the white miner's skills and expertise, two aspects of underground work will be examined:

* The manner in which the white miners assist in co-ordinating production.
* Whether team leaders call upon the expertise of white miners when deviations from normal conditions lead to dangerous situations.

10.2 Co-ordination

Co-ordination of production in underground mining involves several functions. Firstly, a sufficient number of workers, equipment and materials must be available in the stope to ensure efficient production. Secondly, when shortages occur, decisions must be made about where the limited resources available will be used. This applies in cases where there are not enough workers to complete a task, or in times of material shortages. Thirdly, the activities of teams working in adjacent areas need to be co-ordinated to maximal advantage. There are further planning and co-ordination functions that are usually located at higher levels in the mine hierarchy, for example deciding on the layout of stopes and how they will be developed before stoping proper begins, what equipment and techniques will be used in production, etc. In view of the fact that white miners and shift overseers were not

interviewed, it is only possible to examine the first aspect of co-ordination mentioned above.

Team leaders were asked who was responsible for ensuring that adequate equipment and supplies were available in the stopes, and what procedures would be followed when further materials had to be acquired.

The response of all the stope team leaders was that they were personally responsible to ensure adequate supplies. This was seen by team leaders as part of their normal job. The actual arrangements for requisitioning the necessary supplies varied from mine to mine and to a certain extent on informal arrangements between team leaders, white miners and shift overseers.

A few team leaders could requisition supplies themselves:

> "When knocking off every afternoon I have to check whether there are shortages. If there is something short, I will go to the underground store and requisition it if it is available. I sign the requisition myself. On our way to the working place next morning we will get the stuff, otherwise if we had to go fetch from the working place there would be a delay. If they are obtainable from the surface store, then if we can carry them I arrange for my members to carry them, if they are too heavy I will arrange for them to come with the cage that carries the jumpers."

> "There is a store underground and those whites who do not want to work normally give us papers to requisition things"

Team leaders usually had to report their requirements at least to white miners:

> "I have to make sure that all the equipment and materials needed are available. If we are running short I have to report to the miner and he requisitions the necessary equipment. The miners make out the requisition forms and I have to - or my team - fetch the equipment."

When the shift overseer was responsible for requisitioning supplies, team leaders generally proceeded through the white miner, although the miner often played little more than a perfunctory role:

> "I tell the white miner we are short of equipment. He tells me I must go to the shift boss to get it. It is the duty of the white miner to check, but he imposes this duty on my shoulder."

One team leader reported that he avoided the white miner altogether as he could not authorise requisitions:

> "I go straight to the shift boss, he gives me the requisition to go and fetch it. The white miner has no authority to go and get stuff, so I go straight to the

shift boss. It is my job to check if all these things are short, not the white miner."

At some mines senior or section team leaders were responsible for requisitions. They organised the necessary supplies directly themselves, or obtained them through a white miner or shift boss:

"If I run short of materials, I am telling the section team leader who is going to tell the white miner or shift boss."

Conclusion

The above replies show that team leaders perform a vital co-ordination function in the stopes. They are responsible for ensuring that adequate supplies and equipment are available. Mine instructions may require team leaders to requisition supplies via white miners, but this was only a procedural requirement and often ignored. It may be concluded that the white miner was generally viewed by our informants as not being involved with co-ordination at this level.

11. Reliance on the White Miner in Hazardous Conditions

This section examines, through an analysis of what happens in situations which our informants consider dangerous, how reliant team leaders are on the skills of white miners.

For workers, dangerous conditions mean their lives are on the line. Human life is extremely vulnerable when sandwiched between two layers of rock, a thousand and more metres underground. Poor environmental conditions may be tolerated because occupational diseases take years to manifest themselves. But, for example, when the poor condition of the hanging wall indicates a possible rockfall, death becomes an imminent possibility. Thus, when conditions deteriorate, workers may be expected to seek the best expertise at hand to secure their safety.

According to the MWA white miners have to make safe if dangerous conditions develop:

"If at any time a working place ... becomes or is found to be unsafe ... the ganger or miner in charge shall take all reasonable measures for making it safe and for safeguarding every person in the working place against such dangers as may have arisen." (R 8.1.3)

If any worker complains of danger the white miner must withdraw all workers and personally inspect the working place:

"If any ... person working under the supervision of a ganger or miner complains that the part of the working place where he is required to work is dangerous, the ganger or miner shall withdraw all workmen therefrom until he has personally, with such assistance as he may

require, made it safe, or until he has had it examined by another person who shall be the holder of a blasting certificate and has obtained the concurrence of such person as to the safety of such part. Until he has complied with this requirement, the ganger or miner shall take all reasonable precautions to prevent the entry of any person to the part complained of ..." (R8.3.2).

During the interviews the assumption was made that informants recognised extraordinary conditions which constituted a threat to life and limb. If this were not the case and minor hazards were exaggerated complaints would be justifiably ignored by supervisors. This assumption is reasonable because of the extensive underground experience of our informants. Its validity was confirmed when, during one of the project's last interviews, a team leader related this experience in reply to the questions in this section:

"About a month ago this happened. I was working day shift, and I told the white miner we should not blast the panel before it was supported. Then the shift overseer said we should not support the panel because he wanted to blast. So we drilled and blasted. That resulted in two fatalities when the night shift went into clean because the space was too wide.

The inspector of mines was down and measured the distance between the line of supports and the face, and they asked me why I had not supported the panel. So the shift overseer said he had instructed me not to support. The gap was wider than mine standards. The (night shift) team leader is still lying in hospital."

Team members and supervisory workers were questioned about what they would do if they perceived dangerous conditions. The responses of the drillers and stope team leaders will be considered below.

11.1 Machine Drillers' Responses to Dangerous Conditions

Machine drillers said they complained to the team leader (85%) or to the senior team leader (6%) when they encountered serious hazards. Nine percent noted that they had never felt a complaint was necessary.

Of those drillers who lodged complaints, ten percent said that their team leaders did not heed their concerns. This group's statements warrant examination. The first driller said:

"The team leader and the white miner talk them two (together) but I don't know about what. The team leader does not want to listen when I complain, so I try to take some precautions like looking for a stick to make that place safe. If I complain before I start working (that is at the start of the shift) then the team leader will take it seriously, but if I complain after I have

started then he does not want to listen."

A second driller also explained that his team leader would not respond if work was already underway:

"The team leader tells me I must work - if I don't want to work I must take my jacket and go, but I need the money, so I work. The team leader does come and check, and then he calls the team member to put in the packs.

What often happens is that we put temporary support, but at times we feel unsafe and we report to the team leader, but then he says we must go and tell the white miner we do not want to work. The team leader is safety conscious when he goes in, but by the time when we are drilling, he wants us to drill, then it ends there. So he does not say we must go out of there."

In the third case, the team leader appeared to fear the white miner and used the latter as a threat to persuade the driller back to work without taking further precautions:

"The team leader says the baas (white miner) says I should work there, and if I do not want to work I should tell him and report to the baas that I do not want to work.

At times the team leader does come to inspect, but there is nothing he does if the place is unsafe."

A common theme suggested by these three cases is that team leaders do not want to interrupt work once it is underway, even if dangerous conditions cause concern. The white miner is seen as a threat by both the team leader and team members. If he is called, it will not be to see to problems, but to ensure that workers continue with production.

Having considered the few negative responses of team leaders to warnings of danger by drillers, let us now examine the more general experiences of workers. In most cases, informants said that the team leader usually dealt with problems himself and called upon team workers to assist if necessary. For example:

"He will support the place if it is the hanging that is bad."

"Usually he comes to us whenever I report a complaint. Then we try to make the place safer. We do not bother ourselves to report to anybody else like the white miner."

Note the discretionary authority of the team leader to stop production in the next example:

"Well, I told the team leader that the place was bad. When the team leader reached there, there were people working there. He told them to come out and he started

to remove the loose rocks. When he was doing this, a rock fell on one of his helpers and broke his wrist."

11.1.1 Reliance on White Miners

According to the majority of the machine operators, white miners are called to assist only when exceptional difficulties arise. Calling the white miner to assist generally results in one of three outcomes discussed below. The number of times each outcome was described is summarised in Table 6.

(1) The request was either ignored or assistance was provided by proxy:

"The team leader calls the white miner. Then the team leader tells us what the white miner said. The white miner does not come, it is only the team leader who is going to fix that place."

The team leader will take some safety measures. If it is dangerous, he may go to the white miner. When he went to call him, the white miner said we must put some 'sprags' (supports) there and told the team leader to tell the workers that he wants the stoff (rock) to go to the tip. We find the place is still too dangerous even with the sprags."

(2) White miners visited the working place but their proposals did not allay the apprehensions of workers. For example their suggestions confirmed what the team leader had already proposed which in the view of the informant was inadequate:

"(When I complain) they rectify the place. They just use sticks and I am afraid that this is still not enough. The team leader does come when we complain. If it is very bad, he calls the white miner and he comes to look. He just instructs the team leader to put in sticks."

In some of these cases, the insistence of the white miner that production should proceed led to confrontations:

"The team leader takes the complaints very seriously. The team leader does not call the white miner, but if he cannot fix it up he calls the white miner. The white miner does not take the complaint seriously, he wants people inside. When he wants people inside, he comes to clash with the team leader till the team leader runs away. Then all the people run away. Then we get charged. It has happened to me twice that I have got charged straight. They said that we did not want to work, that they will give us a stamp and we were demoted. It happened to us, the three machine operators ..."

(3) When the white miner was called, he acted in a manner appropriate to the situation and workers were satisfied with the outcome:

"If the place is very bad, the team leader will report to the miner, then he will come to see the place. When the shift boss arrives, he reports to the shift boss. When the team leader has reported to the miner and he sees it is bad, he will tell the team leader to take the people out and put a notice plate around that place."

"The team leader comes in and looks at the place to see if it is actually worth the fuss, or if it's a small stone, he will bar it himself. If it is a big thing, he will call the white miner. If the white miner feels it is bigger than him, he will call for the bigger guns. They always instruct workers to fix it while they are looking."

11.2 Team Leaders' Responses to Dangerous Conditions

All the stope team leaders said that they complained to the white miner if they encountered dangerous conditions. The responses they received from white miners, as was the case for those reported by the drillers, varied considerably (Table 7).

Forty-four percent of the team leaders indicated that they received useful assistance. Some informants noted they had a good relationship with their miner:

"He often behaves like a gentleman and he always takes my word. He comes and we see what we can do, him and I."

Even when team leaders felt that the action taken by the white miner was appropriate, they noted that production delays were a constant concern of the miner:

"The white miner comes with me to see the place and work out a plan, but he still needs the panel (to be blasted)."

However, 56% of the team leaders felt that the white miner's visit did not lead to a satisfactory solution:

"I complain to the white miner, from there to the shift overseer. (If they are) failing to take the necessary precautions (I complain) to the mine overseer. It is very rare for the white miner to say that this place is unsafe. Sometimes he comes to inspect, sometimes he does not. Usually he is asking me how to make that place safe. On some days he does suggest what I can do."

Forty-four percent of the team leaders said that the white miner would not come:

"He says we should work carefully. He is at the box all the time, he does not come to look. He will only come the following day if he knows the mine captain is going to come."

"When I complain to the white miner, he says 'maak 'n

plan'. He does not come. He says we must make a plan that the machine operators can do their work for the day.
When I get back (to the stope) I tell the team members that we must adjust the place and finish the work for the day. When it is too dangerous, I take the workers out and we work another place. Then when we finish the shift I go and see the shift boss and tell him that it was too dangerous and we did not work there today. The shift boss will then say tomorrow you must go and take some safety measures, and when you are finished, then the team must carry on."

The reason for the white miner not coming in some cases was explained as being related to the miner's role vis-a-vis the team leader and the shift boss. The miner, they said, was only concerned with production, the latter two with safety:

"The white miner is not interested in safety whatsoever, he is only interested in production. So he does not do a damn thing about it. He does not come at all, he says it is up to the team leader to do it, he wants to blast every day."

"The powers invested in the white miner are to check that the blasting happens. The rest of the things is for the shift boss. If I tell the white miner it is dangerous, he tells me to go to the shift boss."

Going to the shift boss, however, did not occur frequently. It may be noted from Table 7 that only a third of the team leaders said they approached more senior line officials.

Confrontations leading to possible assaults were also reported by team leaders. One case is particularly interesting because it hints at the pressures that may be brought to bear on white miners by management officials:

"There was a hanging and those roofbolts were slacking. I called the white miner - he told us we would have to blast those rocks to make them fall. On the next day we had to install the roof bolts.

Then the shift boss came on that day. He told us we were wasting a lot of time, he wanted us to get the stoff. Then the white miner refused and left, then the shift boss instructed me to blast and threatened to charge me. Then the white miner said he must charge him because it was his instruction. Nobody was charged (in the end). On the very day of arguing with the shift boss I was hurt on my thumb. The shift boss threatened to assault us, so I was running away and fell."

TABLE 6 - Analysis of the outcomes of machine drill operators' complaints about dangerous working conditions (n = 33)

Outcome of complaint	No	Proportion of all complaints (n = 30) %
Had never made a complaint	3	-
TL did nothing about problem	3	10
TL took action alone	9	30
When TL called white miner (WM)	18	60
- WM never came to inspect	6	20 (33% of cases where WM called
- WM inspected but workers dissatisfied with solution	5	17 (28)
- Workers satisfied with solution	7	23 (39)
TOTAL OF COMPLAINTS	30	100

TABLE 7 - Experiences of stope team leaders when they complained about dangerous working conditions (n = 18)

Outcome of Complaint	No	Proportion of total responses %
TL approached white miner:	18	100
- WM investigated problem	11	61
- WM ignored request	7	39
TL approached shift or mine overseer in addition to white miner	6	33
TL satisfied with response of WM or SO	8	44
TL dissatisfied with response of WM or SO	10	56

TL - Team leader
WM - White miner
SO - Shift overseer

11.3 Reliance on the White Miner : Assessment and Conclusion

The responses of team leaders and drillers may be summarised as follows:

(1) Team members approached the team leader initially if they were concerned about conditions in the stope.

(2) Team leaders generally examined the problem themselves and took remedial action on their own initiative.

(3) Only when conditions were very serious was the white miner or a more senior official approached for assistance. A proportion of these requests were ignored.

(4) Slightly more than half of the stope workers felt that the assistance provided by white miners was not satisfactory.

(5) Possible delays in production were an important concern.

(6) When white miners investigated and assisted in the stope, they often merely confirmed what the team leader had already suggested.

In the view of our informants team leaders generally do not rely on white miners for assistance when conditions deviate from normal and become exceptionally dangerous. In more than half the cases where problems arose, white miners did not respond to requests or they merely confirmed the approach adopted by the team leader. Our informants suggested that the chief concern of white miners was that production should be maintained. White miners wanted production to return to normal as soon as possible, whether the actions taken to ameliorate the hazards were adequate or not.

12. Sanction and Reward

Management has long realised that the forms of sanction and reward they adopt have a profound influence on the productivity of workers. However, the effects which any system of discipline and reward has on the risks that workers voluntarily take, and in turn on the accident rate, are seldom analysed. The following sections examine how the forms of sanction and reward used by management in the gold mining industry affect work and safety.

The concern of management is to evolve a system of sanctions and rewards that enhances productivity. This is especially the case for underground mining where operations are widely dispersed and close supervision is difficult (Smith, 1974). For example, production in a typical gold mine takes place in 250 stopes. The length of work face of each stope is about 40 metres. If all the stopes were joined end to end, the total face length would add up to 10 kilometres. This would be difficult enough for management

to control and supervise in a well lit, spacious factory or along an assembly line. In the confined space, noise, heat and almost pitch darkness of an underground workplace, the question of control takes on a qualitatively different character.

12.1 Sanctions

There are many situations in which management may discipline workers, and many ways in which this is done, ranging from verbal rebukes to outright dismissal.

Informants were asked about what happened when they or their teams did not finish their work. Their replies were as follows:

* Thirty-nine percent of the machine drillers anticipated disciplinary action would be taken against them.

* Sixty-seven percent of the stope team leaders expected disciplinary procedures (Table 8).

Team leaders said they may make teams work overtime if targets had not been met (note - overtime on the day shift cannot be considered in the conventional way because it is restricted by the blasting time):

> "They do work overtime if they have not finished the work because I will be charged if they do not finish."

> "If at all my workers have not finished, I sometimes get insulted by the white miner and am forced to do overtime. This happens sometimes, maybe two or three times a month. Sometimes we refuse to do overtime, then they promise, 'Next time we will charge'. Every day it happens people do overtime and do not get paid for it."

The disciplinary action that drillers (30%) and team leaders (56%) expected most often was to be 'charged'. This procedure involves an appearance before a mine-managers 'court'. The disciplinary committee is presided over by a line official (for example the mine overseer) of higher rank than the person (for example a white miner or shift overseer) laying the charge. Evidence of an offence will be brought against the defendant and a penalty decided upon by the official appointed to rule over the case. If the charged person feels that the outcome is unjust, an appeal may be made to a more senior mine official.

Team leaders recounted the outcome of charges laid against them:

> "If we do not finish the work of the day, we report to the white miner. If we have not finished, then he instructs me to go to the shift boss' office. He says I am reluctant to do work - he promised to charge but ultimately he charged me by demoting me from team leader to stope team (member) for nine months."

TABLE 8 - Worker's explanations of sanctions that would be applied if work that had to be finished by the end of the shift was not completed

	Machine Drillers		Team Leaders		All Team Workers		All Supervisory Workers	
	No.	%	No.	%	No.	%	No.	%
Always complete set tasks	8	24	-	-	11	21	2	5
Work overtime	6	18	2	11	12	23	3	8
No sanction imposed	6	18	4	22	13	25	11	29
Disciplinary action taken	13	39	12	67	16	31	22	58
Nature of disciplinary action								
- Charged	10	30	10	56	14	27	18	47
- Demoted	-	-	1	6	-	-	1	3
- Disciplinary record	1	3	-	-	1	2		
- Bonus reduced	1	2	-	-	-	-		
- Warning or rebuke	1	3	1	6	1	2	3	8
TOTAL	33		18		52		38	

A demotion like the one described means a drop in wages of about fifty percent.

Work may not be completed as a result of safety problems that arise during the shift. In this situation the team leader has two options. He may risk his life and those of his team and insist that they continue working; or the team may interrupt their work and take the necessary precautions. The team leader then has to convince the miner or shift overseer when he reports to them after the shift that there was a safety problem which delayed work:

"When the work of the day was not finished, then the white miner reported to the shift boss who asked me why it was not done. I told the shift boss that the place

was so dangerous that I had to take safety measures before we could start working. He only gave me a formal warning without a charge."

Team leaders indicated that the outcome depended largely on the discretion of the white miner concerned:

"The white miners differ from one man to another. The other with whom I once worked, even if he understood the reason for not finishing, would charge me. Actually, I cannot say they charged me. There were complaints lodged against me, and I made appeals to the mine overseer, and he would find that the reasons for not doing that thing were reasonable, and they would drop the charge.
The other one I am now working with, he understands and does not charge me."

The exercise of discretion was the reason why some team leaders were not concerned about being charged. Nevertheless, they are still required to give account of themselves:

"I explain why the work is not finished and have never met any problems as a result of that."

"When I am not finished the job I am telling the senior team leader the job is not finished, and I am also going to tell the white miner that I must finish it up tomorrow, I must start tomorrow."

'Charges' were disliked and feared, not only because of the results arising from a charge - like demotion or possibly even dismissal - but because they were seen as extremely arbitrary. What angered informants most was that the charges often arose out of unfortunate circumstances beyond their control. One of many examples, related by a machine driller, illustrates this:

"The team leader reports to the white miner that I have not finished my job, and he charges me.
Yes, I have been charged. It was due to the knocking off time. We were forced to knock off before the time. They were ready to blast so we had to knock off.
I had to go to the labour supervisor to thumbprint that the statement was true. You are being forced to thumbprint even though you do not know what it is. Then you go the disciplinary committee. They will put a record, and may be it is your last record (before being dismissed). At that disciplinary committee, when the worker is trying to ask the questions, the worker will find that the accuser is not there. They will say, here are the papers, you did not want to work. They gave me a record."

Conclusion

The following points have been made:

(1) A minority of drillers (39%) were affected by disciplinary procedures. Such procedures did not arise in the majority of cases because no action was taken (18%), drillers completed their work in time (24%), or worked overtime to complete their work (18%).

(2) Disciplinary procedures posed a threat for the majority of stope team leaders (67%), probably because they were held responsible for the work of the team as a whole.

(3) Penalties ranged from verbal warnings to the possibility of dismissal.

(4) The use of disciplinary procedures was viewed as an arbitrary action on the part of the white miner or officials.

(5) While some workers were able to defend themselves in a mine-manager's court or stave off a charge, others found themselves powerless against the word of an absent 'accuser' whose statement was assumed infallible.

The value and purpose of a sanction lies not so much in its use but in its effectiveness as a deterrent. In gold mining the purpose of the deterrent is to prevent delays in production. When time consuming safety procedures are required to reduce hazards, workers experience a conflict between concern for their own safety and the pressure to continue with production. Informants believed the use of charges was arbitrary and felt powerless to deal with charges. It may be concluded that the sanctions used by management create an atmosphere of insecurity which encourages rather than discourages workers from taking risks. The position is exacerbated by the lack of statutory rights which allow workers to refuse dangerous work (see Section 14 below).

12.2 Rewards : Production Bonuses

Management may attempt to achieve with incentives what cannot be achieved by sanction. In gold mining, management has customarily used production bonuses to increase production. This has two effects:

(1) They increase the intensity of work. Bonuses are the hidden supervisors of production, the 'kom-a-kom'* that 'makes the job go'. To quote a study on productivity in South African gold mines:

> "The mining industry has always been at the forefront in terms of direct individual payments by results to underground workers, such as contract payments to

* 'kom-a-kom' - production bonus, a colloquialism used by workers. Literally - come, come!

European stopers and developers, and drilling bonuses to Bantu machine operators ...
This direct type of payment, based on simple measures of production such as centares (m^2) broken or metres advanced for Europeans, or holes drilled or tons trammed for Bantu, are generally accepted by mining men as quite essential for high productivity." (Smith, 1974)

(2) Bonuses influence the way workers themselves organise work to increase productivity. Smith (1974) has described an example of how this has happened in local gold mines:

"The improvement in productivity of underground Union (white) men is directly connected with incentive payments. Stopers and developers have readily accepted the extra responsibility of supervising more and more labour with more and more equipment because their contract earnings have been increasing dramatically."

Three types of bonuses are paid for underground work:

(1) Direct Individual Bonuses are paid to individuals and based on a measure of the individual's work output, for example the number of holes drilled by a machine driller.

(2) Supervisory Bonuses which may be considered an extension of the direct individual bonus. Supervisors, such as white miners or team leaders, are given a monthly production target, known as a 'call'. The call is based on factors related to the particular working place concerned. Past production records may be used in calculating the call, for example the number of centares broken, or time standards derived from work standards. Bonus payments are then paid pro-rata to the number of calls achieved. The scheme may be open ended, or closed. If open ended there is no ceiling on the total amount earned. If closed, extra bonuses are not paid once production exceeds a specified target.

(3) Team Bonuses may be paid to stoping and development teams. The team is also given a call for the month. The bonus is then shared on a pro rata basis between team members.

12.2.1 Differences Between Black and White Workers' Bonus Payments

It is crucial to grasp two major differences between bonuses paid to white 'rockbreakers' (miners) and black underground workers. The bonuses paid to white miners are open-ended, that is, there is no limit to the total amount that may be earned. But management policy for black workers is that bonuses should be limited to a maximum of one third of the basic rate of pay on average (Rodenwoldt 1982).

Secondly, the bonuses paid to rockbreakers are 'supervisory' bonuses. The contribution of rockbreakers is indirect in that it is a supervisory and co-ordinating role. In some cases, up to a hundred men or more may be supervised by a single miner (Personal communication, 1981).

Bonuses of such an indirect nature are not paid to black miners. Bonuses are limited to individual black workers or teams engaged in production who meet two criteria: They must perform tasks which can be objectively measured and they must be directly involved in production. Arising from these criteria, management at industry level took a decision to limit bonus payment to machine drill operators and their assistants. On some mines, however, team bonuses have continued or have been introduced recently (Rodenwoldt 1982).

These two policy differences result in vast differences in bonus earnings between white and black workers, both proportionately and absolutely. In Table 9 the mean proportion of the basic wage rate earned as a bonus by black workers is given for four bonus schemes. Rates for black workers are generally limited to about 20% of basic wages per month. Bonuses paid to white miners amounted to 80% of basic wages. Taking wages in 1980 as a basis, machine drillers typically earned bonuses of R30 to R40 per month, while white miners received bonuses of over R600 on average. In 1980 some white miners earned bonuses of over R2000 per month. These figures show that the bonus earnings of white miners are fifteen to twenty times those of black workers on average. This is much higher than the ratio between white and black underground wages which in 1980 was between four and five (GME 1980).

TABLE 9 - Average bonuses paid expressed as a percentage of the wage for machine drillers, team leaders and rockbreakers.

Bonus Scheme	Direct Individual	Direct Individual	Team Bonus (Production Call)	Team Bonus (Time Rate)
Team Leaders	None	None	33	8
Machine Drillers	19	20	59	17
White Rock-breakers (all gold mines, 1980)	80			

Source : After Rodenwoldt (1983)

12.2.2 Bonuses and accidents

Considerable debate has centered around whether bonuses contribute to or cause accidents. For example, Morrison (1983), in arguing for the use of incentive systems, dismissed the possible increase in accident rates that may result from production bonuses as insignificant or unverifiable but adduced no evidence for his position.

Clement, in a study of a large hardrock mining corporation in Canada, argued that bonuses were an important contributor to accidents. He cited studies which found that:

(1) Seventy percent of a total of eighty-six fatalities at the corporation over about twenty years were related to bonus payments.

(2) Workers paid on bonus schemes experienced higher injury rates than those on fixed salaries.

To explain how bonuses contribute to accidents Clement quoted a statement made by a trade union official to a governmental commission of inquiry:

> "The incentive or bonus system is another area where the company encourages the employee to ignore safety rules in unsafe and unhealthy conditions. This system is designed to give a miner extra money for working at an increased rate. This of course means that he will ignore rules and take shortcuts to earn a few more dollars a day. I personally have approached drillers about unsafe conditions in their work area and have been told by them 'there is no money in cleaning up or in scaling loose'."

An important difference between the Canadian and South African experience should be considered. The miners who earn production incentives in Canadian mines are involved in productive tasks and are risking their <u>own</u> lives if they neglect safety procedures. In South African gold mines, unlike mines elsewhere, miners are paid production bonuses that depend on the risks other workers take.

12.2.3 Worker Perceptions of Bonuses

The neglect of safety precautions in the pursuit of production bonuses amounts to a calculated risk. To investigate this issue, it is first necessary to establish whether workers have the information at hand to 'calculate' the risk. Informants were asked if they were paid bonuses and if they understood how their bonuses were calculated.

Our informants' replies are presented in Tables 10 and 11. At all four mines machine drillers received bonuses. At three mines stope team leaders received bonuses whereas at one mine they did not (Table 11).

At mines two and three the reasons for some team leaders

saying they did not receive bonuses were:

* Their dissatisfaction with the small amount involved, "They say there is a bonus but we don't see it."

* The bonus appeared to have been discontinued: "I was getting it, but I am not getting it now."

TABLE 10 - Proportions of informants who (1) received bonuses, (2) understood how bonuses were calculated and (3) said they neglected safety measures to increase bonus earnings

Job Category	Percentage who receive Production Bonuses (%)	Proportion of those paid a bonus who understood method of calculation (%)	Proportion of bonus earners who neglected safety precautions (%)
Stope team leader	44	40	0
Stope machine drillers	94	7	15

TABLE 11 - Breakdown by mine of stope team leader responses to bonuses

Mine No	1	2	3	4	Total
Receive bonus					
Yes	3	2	0	5	10
No	2	2	4	0	8
Column sub-total	5	4	4	5	18
Understood how bonus is calculated (%)	0	0	-	80	40

This lack of clarity of team leaders about bonuses is a general feature of the industry. Only at one mine did any of the stope team leaders understand the basis for calculating bonuses (although none of the drillers at the same mine did).

An important reason why informants said they did not understand bonuses, was because the payment scheme had never been explained: "Nobody is telling me how it's being calculated."

Workers' attempts to find out how it was calculated only led to frustration:

> "I once queried one time, I was told that I don't know where the money is coming from, I must just be thankful. I asked the white miner, the shift boss and the PA (personnel assistant)."

Bonuses fluctuated without any explanation, leading to further confusion:

> "The time this bonus was introduced, we used to get R70 for every 700 feet mined, but now we get R30 or R40 and so we don't know how they calculated it."

In general workers had a vague understanding of how the bonus was calculated: "I only know that it is calculated with metres, but further than that I don't know." But informants could not establish in advance the amount of the bonus, or relate it to the amount of work that had been completed in the stope because of their lack of information: "I only see when it's placed on my ticket, I don't know how it's calculated."

The finding that very few informants understood the basis of bonus payments is remarkable, particularly when it is considered that production bonuses are a key element in management's approach to increase work effort. Management policy on the gold mines states that "the method of calculating bonuses should be fully understood by workers" (Rodenwoldt 1982, Smith 1974). For any incentive scheme linked to production to be effective (from a managerial perspective) it must be clearly understood by workers.

Our results confirm the findings of a Chamber study undertaken by Rodenwoldt (1982). Rodenwoldt found that the majority of workers did not know bonuses were paid in relation to work completed. To quote from his conclusions:

> "Questions arise whether provisions for granting bonuses were effective in raising productivity. The policy of rewarding efforts, generally, was not understood by workers. Responses were similar, whether less complex or more complex schemes were used, whether earnings were dependent on individual efforts or on team efforts. "

Extracts from Rodenwoldt's results are reproduced in Table 12. Rodenwoldt's conclusions about grievances related to bonuses are also important. He found that 90 percent of all bonus grievances were never resolved, despite the majority of his respondents having approached management officials for assistance (refer Table 12). Rodenwoldt's conclusions show that poor communications exist between workers and mine officials and personnel assistants, even in the case of a system created by management in its own interests. This reinforces our conclusion in Section 11.2 that poor communications exist between black workers and more senior personnel.

TABLE 12 - Workers' understanding of different bonus schemes used in South African gold mines (After Rodenwoldt (1982)

Bonus scheme No	1	2	3	4
Type of scheme	Piece-rates, awarding a bonus for each output unit	Piece-rates, awarding a bonus for output above a specified level	Production awards	Time Rates
No of informants	86	79	23	104
	%	%	%	%
Knew that bonuses were paid in relation to work done	15	14	35	42
More information required about bonus scheme	91	78	100	80
Able to approach officials for more information	31	15	43	42
Grievances about bonus payments	55	63	43	51
Had approached officials for advice	79 (% of complaints)	52 (% of complaints)	100 (% of complaints)	45 (% of complaints)
Satisfied with outcome	11 (% of complaints)	2 (% of complaints)	40 (% of complaints)	8 (% of complaints)
Proceeded with complaint by approaching another official	21 (% of complaints)	8 (% of complaints)	60 (% of complaints)	8 (% of complaints)

12.2.4 Safety and Production Bonuses Paid to Workers

Workers had strong feelings about neglect of safety precautions whether it was on account of production incentives or for any other reason. Informants generally said that they personally did not neglect safety measures in pursuit of bonuses (Table 10). Their first concern was survival:

> "It is because I think of my life more than money."
>
> "We first count our lives, then money comes thereafter."
>
> "I know that the person who is going to be injured is myself, maybe I am going to die."

For team leaders there was the question of their own survival, and the responsibility they bore towards their team workers:

> "I don't want to get hurt or my members."
>
> "I am thinking about the lives of the people, even if it costs me my bonus."

It has been argued above that the team leader is responsible for production, supervision and co-ordination in the stope, and that team members turn to him when hazardous conditions arise. From the answers team leaders gave to our questions about bonuses, it appears that their responsibility verges on, if in practice has not already become, a legal responsibility for the safety of team members. Two team leaders illustrated this development:

> "Although I know that they are very much interested in great advances, I also know that if there is any accident and they find any mistakes I will be picked up for that and charged."
>
> "Because people die, and if people die I will be the one to be blamed."

A further reason why team leaders are hesitant to risk their lives or the lives of team workers is the relatively small size of their bonuses. Table 9 indicates that team leaders, when they receive bonuses, earn about half the pro rata amount received by drillers. This provides less of an incentive to put lives at risk. As one team leader retorted: "You cannot kill people for a fifty cent."

It is fortunate that productivity bonuses are so poorly understood by workers at present. Basic wages are low and any means of escaping the spiral of poverty may be grasped. This is illustrated by one of the few informants who explained that he at times neglected safety precautions on account of his bonus:

> "Because we are getting so little, that is why we are risking our lives, so that we get a little bit better at

the end of the month."

12.2.5 Supervisory Bonuses

An informant captured the issue of bonuses as follows:

"If there is too much reef in the stope, we are forced by the white miner to work on even though there may be skelms (misfires) in the reef. We ourselves do not neglect safety for bonus, we are forced to because we are promised discharge."

Informants were asked whether they thought white miners neglected safety measures because of supervisory bonuses.

The majority believed white miners did as shown in Table 13. It is important to note that not all miners were said to neglect safety measures. Informants made distinctions between different miners:

"They are not the same. Some do neglect safety measures, others do not. The one I am working with now is very much concerned about safety."

"The first one I worked with used to be like that. But the one I work with now is not like that. He gives us no trouble because he does not want to see anybody in his gang get hurt."

Apart from this minority the situation was seen in a different light by most informants.

"It has been clear that their only interest is the production target in order to make out their bonuses, because that is all you hear them talking about."

TABLE 13 - Informant's views on whether safety measures were neglected by white miners on account of the latters' bonuses (%)

	Stope team leader	Stope machine drillers	All informants
Proportion that said safety measures were neglected	83	91	83

Informants gave a range of reasons to explain why "the white miner is hungry for holes". These have been grouped here to facilitate the argument.

(1) Many informants felt that miners did not accept advice when warned by team leaders or workers that conditions were hazardous:

"To support my statement even if he has been warned by the team leader that there is something that can cause an accident he simply ignores that, he simply instructs us by being very harsh to carry on."

"The miner is after the blast, that is daily you must try and blast in this place. So he is not taking part in safety - everything the team leader is doing. When the team leader is telling the white miner that we are supposed to put the packs here, the miner says no, we ought to blast here, even though the place is not fit to blast."

"If you are telling the miner that this place is dangerous, the white miner is going to tell you about his bonus, that the job is too slow, you must try and do the job so he can get his bonus."

(2) Informants felt that because white miners did not perform adequate searches and inspections, they did not take possible hazards into account and ignored them:

"The white miner wants the feet. Even if the machine operator is supposed to start the job, he is just pointing the place where they are to start. But if you search the place, you are going to find it is unsafe. But he (the miner) is not going to say anything about this - it is myself (team leader or the machine operator that is going to try and make the place safer."

(3) Workers were at times instructed to neglect specific safety measures. These usually involved aspects of support.

"If he is given a certain call, and if he can not get up to the call because of the support, he will neglect it."

"What he does is tell the team leader to support and the machine operator must drill while they are still busy supporting. If now I am drilling there is this vibration which causes the falling of the rocks. Secondly, when the square is long, its imperative the place be supported. He instructs the machine operators to drill without supporting."

Neglect of supports often related to shortfalls in supplies and logistical difficulties:

"At times when they are running short of packs, he forces to blast despite the fact that he is increasing the distance between the packs, meaning there is an open space with unsupported roof (which) hangs on the people."

"It sometimes happens that after advancing there is no support because of transport, and the white miner tells the people to keep on drilling, because he wants

to blast to get his production bonus."

Occasionally the neglect of very specific (but unexpected) safety measures were described:

"(He is making us drill) if we are short of water. The compressed air is pushing out the dust faster, so you can drill faster. If you use water it makes a mud and it is not so fast."
(Note : Drilling without water is strictly illegal because of the silicosis hazard.)

(4) Informants described the neglect of safety measures they had been taught during training:

"They tell you that these safety measures do not work underground, they only work in the school mine. For example, at times it does happen you get a bad hanging, and it's a big rock, and you try to bar it down, and you cannot. So you must put a pack - but the white miner says : 'No, put in a temporary stick support'. That is no good, it will just fall."

(5) Occasional conflicts between white miners and line management were recounted and explained in terms of bonuses. The MWA also accords full responsibility to line managers such as shift overseers to ensure safety procedures are applied.

"Where I work, last month, there was a rockfall. So the shift boss instructed the team leader not to blast for three days and that we must put in roofbolts and supports. But immediately after the shift boss left the white miner told the team leader that tomorrow we must blast this place because the tape* has now stopped."

(Note : * Tape - used for measuring the advance of the face which in turn determines the bonus.

Usually when production is delayed by an untoward event like a rockfall, the white miner receives compensation for the loss of bonus earnings. However, this is unlikely to be as much as the bonus he would earn if production had continued normally.)

The above perceptions show how bonuses come before the white miners' concern for safety. Informants advanced four reasons why this was possible:

(1) Team leaders bear the responsibility both 'de facto' and 'de jure' if anything untoward happens in the stope:

"The white miner knows exactly that I am accountable to the lives of the people I am working with. So he is also making me accountable to look to the safety of those people I am working with. And there is nothing that he is going to be asked in the case of an

accident, it is only me who will be in for it."

(2) White miners no longer play a productive role in the stope so their exposure to hazards is minimal:

"They come in for short intervals and leave the place, leaving us to fend for ourselves if there is any danger."

"He is only after getting the stoff (ore). He is rushing people to do the job. This rushing of the workers is only because the white miner is not the one who is doing the job, the one who is going to get injured."

(3) Informants believed that management in general and white miners in particular were unconcerned about the safety of black workers:

"They do not really care whether the place is safe or not safe. All they do is press on that the place should be blasted so that they get their bonus. Furthermore, they are not the ones that get injured. It is the blacks that get injured."

"Even if the place is too bad we are forced to blast it so we can get the stoff out. They do not care about lives, they are only after money. They are forcing us to do the job, promising us with charges."

(4) White miners claimed to know more about hazards than informants:

"What he is after is production that will make his bonus. Whenever you complain to him about an unsafe place, he will say the place should be just supported with sticks (temporary supports) and that you should go on, because he is the one who knows if there will be a rock burst."

12.2.6 Conclusion

Bonuses paid to workers personally were rarely understood and did not represent a significant proportion of their wages. The majority of those who received bonuses were adamant that their incentive earnings did not encourage them to neglect safety precautions.

Bonuses paid to white miners were seen in a totally different light. Informants eloquently catalogued how production incentives motivated white miners to exert pressure to maintain production, even if this required team members to neglect safety measures or take excessive risks.

From a viewpoint of safety, production bonuses should be avoided or kept to a minimum. They place continuous pressure on individual workers, and create conflict between supervised and supervisory workers.

13. WORKER RESISTANCE TO DANGEROUS CONDITIONS

This section examines the extent to which workers are able to resist coercion to work under dangerous conditions and the consequences of their refusals. Refusals to work were mostly related to informants' fears of rock falls.

A decision by workers to refuse to work in dangerous conditions is not easily taken because intense confrontations between workers and supervisors usually result. This account by a team leader provides one example:

> "I was once forced. When I found it too dangerous, I went to the boss. When I got there, I found the white miner was not there, so I went and took the workers out. Then I went back and waited for the white miner. When he came, he said 'No, go and work there'.
>
> Then I went to the team members and told them the white miner said we must work. They said 'No, call the white miner, he must tell us himself! So when I went back to him, he said 'Who was that one who told you to bring me. Bring him here'.
>
> When I came back to the team members I could not point out a worker. I took them to work in another place. When the shift boss came he inspected and agreed it was dangerous, and said let us wait until the rock falls, and he gave us some other work to do."

Eighty-nine percent of stope team leaders and seventy-nine percent of machine drillers said they had refused to work in dangerous conditions. The outcomes of their refusals are analysed in Table 14. They have been categorised in three ways:

(1) After the refusal to work, negotiation between the worker concerned and the team leader, or between the team leader and the white miner or shift overseer led to a course of action satisfactory to the informant:

> "I complained that the place was bad - it had some cracks, it was in need of packs. So the team leader helped me and then I worked very well".
>
> "I was instructed to work in a bad place but I said no. Now the white miner said I was instructed to work there, now I myself told the white miner that the place was rather bad. The miner told the mine overseer that the team leader was refusing to work there, so the mine overseer came with the white miner to see the place and asked me why I did not want to work there. Now the mine overseer asked me if there is another way of getting in there. Now I told him I'll make a plan to work the place, and so I worked the way I found it was safer".

This outcome represented a small proportion of cases (Table 14).

(2) Informants steadfastly refused to work and no accommodation was reached with their supervisors:

> "I (and a new team) were forced to put supports in a very dangerous place, and the shift boss refused to come and see the place. I worked for the first day. On the next day a shift boss came from the school mine and he told us to leave the place because it was too dangerous.

Then came the very shift boss who had originally told us to work there. He said the team leader (the informant) was very cheeky and refused to obey his instructions. The training shift boss asked me if I had refused. I said yes, because I could not take these people who are still being trained to work in that dangerous place! So there was a squabble between them. The shift boss said I should be removed, the other one said I was training the new members in safety measures. Now we don't communicate any more. In the end they took another team leader and people who knew the work and they installed packs and so on to make it safe to work."

More than half of the informants who refused to work were charged as a result (Table 14). Workers' perceptions of danger were not accepted as sufficient reason for not working:

"When I got into the place it was too dangerous, the place was trembling. I told the team leader - he barred. After this the white miner came and he told him. The white miner told the team leader, 'Put the packs here, the only thing I want here is work'.

I refused completely to drill until the white miner went to get another machine operator and I did the lashing job. When I knocked off I was paraded by the msiza (deputy personnel officer). I was taken to the mine captain who asked me why I refused to work. I told him it was dangerous. He asked me if it was supported, so I said yes it was supported, but it was still dangerous. The mine captain said 'The white miner said you struck'. He said it was a final warning for me."

(3) The most frequent outcome of a refusal was that the worker would return to work at the insistence of the white miner or team leader:

"At times the distance between the packs and the face is too much, and there are cracks on the roof. As I am the person who is working the machine which shakes the roof and causes the stones to fall, I am the one who is going to get injured.

At times I just have to work because there is nobody at my side, or when the team leader reports to the white miner he just forces me to work, and says that the law of the mine is that I must work first and then go on surface and report.

What happens is that the miner, since there are phones, if you refuse to work he phones the shift boss and tells that a certain COY (company number) must be blocked because he does not want to obey instructions. So when you come to the surface they do not ask if it's dangerous, they ask you why do you refuse to obey instructions. So that's why I feel I have to work."

"By the time I got into the stope and started drilling I realized there were some loose rocks. Then I reported to the team leader, but he said I must go on. But when I carried on there was a fall of rock, so I stopped. The team leader said he would make a charge, but he never did."

TABLE 14 - Analysis of refusals by workers to work in dangerous conditions

	Stope Team Leader		Stope Machine Operator	
	No.	%	No.	%
Never refused or forced	2	11	7	21
Refused but satisfactory arrangements made for work to continue	2	11 (13% of total refusals)	5	15 (19% of total refusals)
Steadfastly refused to work	4	22	8	24
(Charged as a result)	(2)	(50% of refusals to work)	(6)	(75% of refusals to work)
(Accident occurred)	-	-	(2)	(25% -ditto-)
Refused initially, but worked thereafter	10	56	13	39
(Accident occurred)	(2)	(20% of refusals where work continued)	(8)	(62% of refusals) where work continued)
Total refusals	16	89	26	79

This account shows that refusals to work may also lead to conflict between team members and team leaders.

Accidents happened to 44% of stope informants who felt they had been coerced to return to work after their initial refusal:

> "In 1983 I was once forced to work in an unsafe place. I told the team leader and he told the white miner. The white miner on his arrival only instructed the team leader to put the sticks there. Then he left to the tunnel where there is fresh air.
>
> I commenced my work and through the instinct of fear I saw there was a trembling of the rock, spattering me with mud. So I left the place and within a second it fell."

Conclusion: The majority of informants had encountered situations sufficiently dangerous that they felt they should refuse to continue working. However the situations were seldom satisfactorily resolved. If workers persist in their refusal to work a disciplinary charge is likely, yet their experiences suggest that if they return to work the risk of death or injury is extraordinarily high. White miners usually play a leading and decisive role in insisting workers return to work. However, this conflict does not only occur between white and black workers. Workers described cases where team leaders had insisted they should continue working despite particular hazards.

The next section explores whether this is a major source of conflict between team members and team leaders.

13.1 Team Leaders and Safety

It has been argued above that team leaders are management's front-line of supervision and control over production. Since workers are required at times to take extraordinary risks in excavating ore, conflict between team leaders and team members may be anticipated. This is especially the case since team leaders are paid substantially more than team members. If teams do not meet production calls then team leaders face demotion (Moodie, 1976).

Team workers were asked if they thought team leaders were concerned about safety to assess the extent of this conflict. Ninety-one percent of the stope machine drillers said team leaders were concerned about safety. It is necessary to consider their responses closely because of the crucial role team leaders already play, and more especially because of possible future changes in the regulations.

Informants, in justifying why they believed team leaders were concerned about safety, explained how they inspected and made safe:

> "The team leader what he does is check the place. If he finds it's dangerous he bars, or if he does not bar he puts in packs and supports before he lets us start work."

A crucial aspect workers noted was that team leaders occasionally instructed workers to keep out of the working place if conditions were severe:

> "The team leader will go inside every morning before the team starts work. So if the place is not safe he will make it safe. If the place is seriously dangerous, he will stop the people to go inside. He will give them a job to do around until the miner comes. When the miner arrives they will see that place with the miner, and they will use some sticks to support it."

Team members generally were confident that if they reported problems, team leaders would deal with them satisfactorily:

> "Whenever there is any place that we feel or see is unsafe, when reporting it to him, he usually sees to it that the place is made safe."

Apart from making safe before the shift, team leaders played a vital role by withdrawing workers from danger. Workers appreciated the importance of this action, especially since it was regarded by white miners as a refusal to work and conflict with white miners could follow:

> "He is used to stop us when we are working in a dangerous place. When the white miner comes, he tells us that we must start without making the place safe. The team leader and the white miner quarrel, and then the white miner tells the team leader he wants 'Amafete. Work!'."

The tendency for the team leader to be held legally responsible for the safety of workers was also described:

> "Yes, because if someone in the team can have an injury he is the first one to be contacted - 'How did that man get an injury? Was that place inspected?'."

> "The team leader searches the working place, and if somebody gets injured he is responsible for that."

Finally, workers noted the importance of the team leader's experience in recognising hazards:

> "He always warns me of any dangers that possibly I may have not seen."

> "Because always he is telling us that this place is unsafe as considered by him, and he is telling us not to work there."

While the majority of workers expressed confidence in their team leaders' attitudes to safety, three drillers did not. Two drillers criticised their team leaders for neglecting their duties:

> "The team leader is not searching."

> "At times I find that the team leader goes out leaving us in that hot spot and goes to sit at the beginning of the tunnel or the entrance of the stope where there is air coming in."

It is significant that the criteria used to judge the conduct of the team leaders are the same as those used when commenting on the attitudes of white miners to safety (see Section 9.4.3).

The third driller noted that his team leader's fear of the white miner was an obstacle:

> "Yes, at times he is concerned about safety. But at times in fear of his white baas he always pushes people to work where it is dangerous to work."

Conclusion: Stope drill operators generally perceived team leaders as making a valued contribution to safety, especially when they:

* Took on the risks involved in the initial inspection and making safe.
* Regularly monitored the work place for hazards.
* Shared the ardours and risks of underground work by taking an active part in production.
* Withdrew workers from hazards, thereby risking the wrath of the white miner and disciplinary action.

Our informants applied the same criteria for judging team leaders as they had used for white miners and were critical of team leaders who shirked their responsibilities.

14. WORKERS' RIGHTS : THE RIGHT TO REFUSE DANGEROUS WORK AND THE RIGHT TO REPRESENTATION

The words of our informants in the last section vividly show how workers resist pressure to continue work in dangerous conditions. Only limited rights are granted in the MWA.

Workers' rights may be considered at two levels:

(1) The right of individual workers to refuse to do dangerous work, and

(2) The right of workers to organise collectively to promote their interests. Both levels of rights are recognised in embryonic form in the MWA. These rights were raised with informants and their views are discussed here.

14.1 The Right to Refuse Dangerous Work

Every informant argued that he should have the right to refuse to do dangerous work. Workers were emphatic this was an inalienable right. If they were not allowed to exercise this right, the consequences were clear:

> "It is my right because when those hangings fall, they will kill me, they will kill nobody else. So when I am dead, there will be nobody to support my family."

In practice informants met with difficulties if they attempted to exercise this right:

> "I have the right but as far as the mine regulations are concerned, I will be striking, I will be doing my own law."

> "I have got the right to refuse but the mine law does differ, you first work and then go 'mangala' (complain) afterwards that you have been forced to work in an unsafe position."

Many informants confirmed that when they faced dangerous conditions they had to 'work first, complain later'. An informant stated in more detail:

> "When you complain before the job, they say you make a strike, you don't want to work. Sometimes they know the places before, but the place changes every now and then due to the blasting of everyday, or sometimes you find it in a bad way that you cannot work.
>
> Sometimes you work in such a bad area that you survive the whole shift. Other times just as you start to work it falls on you. The bad thing is I have to complain at the end of the shift. Either I leave or I die."

The 'mteto', a code of five 'rules' that workers are taught as part of their training, includes a statement that workers should never enter an unsafe place. This was rarely acceptable to officials:

> "At the training centre we are taught that if ever you see a place is not safe, you must not work there. In the true sense this does not happen. From the training centre they will not be there to defend you when you are being charged."

However, some workers were able to use the 'mteto' successfully when under pressure to proceed with dangerous work:

> "According to the regulations of the five mteto, number four says - 'Do not enter when it is dangerous. This has actually worked for me when I have pointed that number four stipulates that."

Conclusion: Our informants statements demonstrate that the right to refuse to do dangerous work is vigorously contested between workers and management. Although the MWA makes provision for a worker to complain to the white miner (R8.3.2), this is the start and climax of any complaint (Benjamin, 1984b). Workers do not have recourse to more senior officials.

Far more extensive rights are legislated in many mining countries. In the United States workers have the right to refuse to work when they believe conditions are unsafe. They may also refuse to follow orders which may violate the Mine Safety and Health Act, safety standards or regulations (Act 105(c)(1), McAteer 1981). Similar provisions apply to miners in Ontario. Both in the USA and in Ontario the law prohibits management reprisals against workers for complaints about hazards or refusals to work. Relevant regulations describing the rights of workers and their organisations in various countries are reproduced in Appendix D because of the importance of this legislation.

14.2 The Right of Worker Representatives to Accompany Inspectors

Introduction: In South Africa workers do not have any right to accompany mine inspectors during their regular inspections. However, the regulations give workers and their representatives the right to attend inspections at the site of an accident:

> "Any person who may be held responsible in any manner for an accident, as well as any representative appointed by him, shall have the right to attend any inspection in loco, but such attendance shall be at their own risk. In case such person is, by reason of death or the severity of his injuries, unable to appoint any representative to attend the inquiry or inspection in loco, the relatives or, in their absence, the fellow workmen of such person may appoint such representative" (R25.5).

In the United States, to give but one example, this right is extended to all inspections. Worker representatives may accompany inspectors on any inspection and attend pre- and post-inspection conferences with management. Since inspector's visits are required to remain unannounced, union representatives may request that they be informed of the arrival of an inspector on their mine (McAteer 1981).

Worker Responses: All informants said that union stewards should accompany inspectors on visits. Workers generally mistrusted management's role during inspections. They believed that management did not present inspectors with a valid assessment of conditions and hazards. The only way to relay problems to inspectors was by accompanying them:

> "People are being forced to get into dangerous conditions. The shaft stewards should go with the inspector of mines because whatever we are being told by management is not right."

"Because the shaft stewards, as the workers themselves, they know how it is underground. They are being forced and threatened. So they will be having the right now to sit, discuss and conclude with the government inspectors on matters relating to safety."

Workers were rarely aware of inspectors' visits except after serious accidents. Thus many responses related to inspections that followed accidents and revolved around two issues:

(1) Informants alleged that conditions in the working place were altered after serious accidents to avoid any single person being blamed for the accident:

> "The union will see that there is a robbing gang in the working places. They will notice that the packs are new, that they are different to the others. Now there is no one noticing that, even if the inspector sees that, he does not say it. It is his own secret and the management."

Another informant elaborated on this point:

> "The shaft stewards have got underground experience, they have seen the place where the death has taken place so this can help to give good information why the accident has happened, and take good witnesses for the deceased.
>
> What happens when the working place is not good, and death takes place - before the inspector goes underground the place is supported according to mine standards.
>
> So when he arrives and checks the place he finds it in good condition, whereas before it was not like that. That is why I say the shaft stewards must even go and check the place before the inspector of mines comes. I have seen it happen several times. It is a matter of one day only, but the inspector of mines may only come after three days after the accident has happened."

(2) Informants said that pressure was brought to bear on individual workers and team leaders to commit perjury at accident inquiries. Informants suggested that this was less likely to occur if proper representation was permitted:

> "By the time somebody gets an accident, they have the white miner who pressurises these black miners that this place was safe, who agree. If the shaft stewards are there, he could not agree with that report, so this would go straight as it was."

Workers do not appear to be informed of their right to representation at inquiries and accident investigations. Nor are workers encouraged by management to exercise this right. The following account of an informant who was a union steward illustrates this:

> "There was an accident, so the miner rushed inside to see, and at the very same time I ran to fetch the stretcher to try and save his life. As I entered the place, I saw there was a lacking of safety, to make sure of that the man passed away..... I saw there was one mat pack... They were rushing the people to go and work, there should have been packs and sticks as well. All

> that came after the man had passed away. The man had the accident on Friday, on Saturday they were busy fixing the place.... They are fixing the place before the government inspector arrives, so he can also believe that this man is dead on his own risk, and that is not true. If I was allowed to act that time as a shaft steward, I could have caught them... They did not call me to the inquiry. I am still waiting for a call. That man belonged to my section, he was a union member."

Conclusion: The right that workers have to inspect the working place after an accident has occurred should be exercised, especially in the light of the many allegations that the scene of an accident is altered before an inspector of mines has an opportunity to make an inspection.

These inspections usually occur at very short notice. Therefore it is necessary in advance to make a firm arrangement with both the management and inspectorate concerned that worker representatives will be informed about every accident and can accompany any inspection that follows.

Rights of accompaniment limited to accident inquiries may assist in unravelling the causes of an accident and in seeing that justice is done, but are unlikely to prevent many accidents. Management officials will usually accompany inspectors on their tours. This right is not granted to worker representatives yet the role of the inspector is specifically to safeguard the safety and health of workers.

The benefits of the experience of worker representatives for pointing out hazards have been described by workers. This has been recognised in many mining countries where workers have these rights enshrined in law. Without this right workers are not in a position to put forward the hazards they face without resorting to requests to the Government Mining Engineer himself for special inquiries. This mechanism, described in Section 14.4 below, cannot be considered suitable or adequate for dealing with more general day-to-day hazards. Until the right for workers to accompany inspectors is established and regularly utilised, workers will not perceive the inspectorate as an impartial body.

14.3 Safety Committees

Safety committees at individual mines are not provided for in the MWA. This is unlike local manufacturing industry where safety committees have been required since the introduction of the Machinery and Occupational Safety Act in 1984. The unionisation of mine workers creates the possibility of structures such as representative safety committees being formed.

This possibility was raised with informants to determine whether they believed union safety committees which negotiated regularly with mine management could provide a useful forum for raising problems and reducing accident rates.

Informants were unanimous that union safety committees could play a useful role. Again a variety of answers were given as to why workers believed this to be the case. The potential for safety committees curbing managerial power to coerce workers into dangerous conditions was seen as a priority:

> "(A committee) can work very well, because as a union it would not allow management to harrass or force people to work at unsafe places and they would be having access to the work places and procedures governing the safety measures and so management will be afraid to let the people work at unsafe places."

"The committee of the union will be having more pressure on management. We people we differ in ideas and management itself imposes some threats on us which might frighten one to go and work in an unsafe place and which may result in his death. So if the committee is there everybody will be free knowing that his case will be heard properly."

"Up to now we only see a place to be unsafe and we can do nothing about it, because to sit with it or voice it out to management does not help at all, because they are not going to do anything about it, instead they will just threaten. So the committee will be a fortress for all of us to go and present our cases."

Informants believed that better communication and co-operation with management and white workers could reduce the number of accidents:

"Each time that we are talking about safety to our white counterparts they do not listen. But if there can be a committee, and some underground workers on that committee, then everything can come up to date."

"Anything we regard as unsafe or wrong, the white miners say its right. They don't have enough time, they don't practise safety. Theoretically we have it (safety), but we don't practise it because of the white miners. So if we have a committee may be we can have that because we can have a say."

"It would help if the union is present. The union is willing to build co-operation, to build unity. Then the management will be able to be responsive if they say this place is dangerous. The safety committee is indispensable because if I (a team leader) and the white miner can let the workers to work without safety measures, then the team can tell the union to put pressure on us to put safety measures, and we can work in a co-operative manner."

No further comment is required. The MWA makes provision for three further rights which will be discussed briefly below.

14.4 Inquiries into Safety and Health Hazards

Trade unions may request the GME to hold an inquiry into any matter affecting the health and safety of workers:

"Where any organization of workers at any mine or works or the head of a State department or the mine safety committee submits a request, in writing, setting out the reasons, for an inquiry to be held into any occurrence or condition at such mine or works affecting or likely to affect the safety or health of persons, the Government Mining Engineer shall cause such occurrence or condition to be investigated and, if he deems it expedient, he may depute any inspector of mines or machinery or any other Government Officer to hold an inquiry into such occurrence or conditions." (MWA 5(4)).

This right should be exercised so that underground hazards, such as those dealt with in this report (for example workers' rights, the effects of production bonuses on safety, noise problems, rock falls and rockbursts, inadequate protective equipment, etc.) may be thoroughly investigated. These inquiries may provide a springboard for the introduction of new regulations.

14.5 Health and Safety Complaints Book

The MWA requires all mine managers to maintain record books at each shafthead or change house. The purpose of this book is for 'scheduled persons' to "enter any complaint in connection with safety or health which they wish to bring to his (the mine manager's) notice" (R4.4.1, see also R4.4.2 - 4.4.6). The mine overseer has to inspect the record book daily and the manager once per month.

The provision of a record book may provide a useful but limited means for workers to communicate hazards to management. However, in the light of the discussion in this report, the limiting of this right to scheduled persons denies its value to the very people it is meant to protect.

14.6 The National Mine Safety Committee

Provision is made by the MWA for the establishment of a 'Mine Safety Committee' at national level. The primary functions of this committee are to advise the GME on his responsibility for supervision over mines and works and on anything that may have a bearing on the safety and health of mineworkers (MWA).

The committee is appointed by the Minister of Mineral and Energy Affairs and is made up of the GME and two of his deputies, three employer representatives, one person representing mine officials and three people nominated by worker organisations. No representatives of black trade unions have been admitted to this committee. This remains the case even though the number of workers represented by the NUM alone is greater than twice the total of all white workers employed in the industry.

PART IV WORKER PERCEPTIONS - PROTECTIVE EQUIPMENT AND TRAINING

15.1 Introduction

The application of safety measures costs time and money. For management there is always a conflict between how much effort and resources should be devoted to improving the working environment and constraints on working costs. This applies particularly to underground mining because an area, once mined, has no further value. Safety measures adopted by mine managements may be divided into three categories:

(1) Engineering controls and safeguards which preferably should be incorporated into original machinery, for example 'intrinsically safe' electrical equipment and mechanical guards around moving parts. Engineering controls may also be used in the mine with the explicit aim of safeguarding life and limb, for example hydraulic and timber supports.

(2) Routine safety and emergency procedures, for instance checks of vehicle brakes before use and procedures adopted in unusual or emergency situations, such as evacuating workers when a fire breaks out. The value of any procedure depends on how familiar workers are with it, which is primarily a function of training.

(3) Personal protective equipment provided to minimise injuries when accidents occur. Examples are boots, hard hats, gloves and hearing protection.

Informants were only asked about protective equipment and training as it is difficult to assess the adequacy of engineering controls without free access to mining operations. Boots, helmets, hearing protection and payment for protective equipment were raised. A section also deals with training.

15.2 Boots and Foot Injuries

Workers are required to pay a nominal fee for boots. All 90 informants reported that they were supplied with boots that did not have steel toe caps.

Discussion

Injuries to the toes, feet and ankles represent a significant proportion of all injuries. A study of Rand Mutual compensation cases found that 12,9% were related to feet and toe injuries, and 17,6% to leg and ankle injuries (Oberholzer, 1973). These accidents incapacitate workers to a greater extent than equivalent hand or arm injuries. Bettencourt and Jensen (1970) found that workers with foot and leg injuries remained in hospital twice as long on average as those with hand or arm injuries of similar severity. An unpublished study found that of 770 hospital admissions for toe, foot and ankle injuries, 29% were related to the toe region, and 53% and 22% to the instep and ankle regions respectively (Barry, 1969). These

and ankle regions respectively (Barry, 1969). These figures, expressed as a total of all accidents, are compared with the figures applicable for United States coal mines in Table 15. Two points emerge from the table:

(1) The high proportion of injuries related to toes (3%). This is much higher proportionately and absolutely than the equivalent experience for United States coal mines. Toe injuries account for less than one percent of all injuries in the United States. The ratio of foot to toe injuries in Barry's study is 3, whereas in the United States coal mines the ratio is 5,6.

(2) The high proportion of foot injuries in local mines compared to the United States.

These figures show that protective boots could be used to good effect in gold mines. Hardened steel toe caps and metatarsal guards could reduce the injury rate appreciably.

TABLE 15 - Leg and foot injuries in South African mines and USA coal mines expressed as a percentage of all injuries

Injury location	Rand Mutual Claims (Oberholzer, 1973)	Gold Mine hospital admissions (Barry, 1969)		All USA coal operations 1981 (MSHA, 1982)	
Thigh				0,6	
Knee				6,7	
Lower leg	17,6			1,0	12,5
Ankle		5		4,2	
Foot		9	17	5,0	
Toes	12,9	3		0,9	5,9
Total	-	30,5		18,5	

14.2.1 Boot Requirements in Other Countries

Boots with toe caps are usually required wherever there is a danger of falling objects. In Britain a National Coal Board directive requires that they be used in all coal mines. In the USA the requirements for boots are covered by regulation (Title 30 Code of Federal Regulation 75.1720(e)). In Ontario mining regulations specify:

"Every worker who is exposed to the hazard of foot injury shall wear protective footwear consisting of a boot or shoe which incorporates a protective box toe that will protect a worker's toes against injury due to impact and which is capable of resisting at least 125 joules of impact energy" (Ontario regulation 569/83 s.4).

Steel toe caps do not present a methane ignition hazard (Eisner 1985). No boot regulations or standards apply in South Africa (GME, personal communication, 1984).

15.2.2 Boot Manufacture and Use in South Africa

The South African Bureau of Standards (SABS) have prepared specifications for the local manufacture of boots. The specifications include toe caps to withstand an impact energy of 200 J (SABS 492 and 1114) but these are optional at the request of the client. Local manufacturers make a wide range of boots with and without toe caps. Optional specifications also apply for penetration-resistant soles made of spring steel which are used to minimise penetration injuries caused, for example, by stepping on a nail. The typical manufactured cost of a pair of mine boots without toe caps or steel mid-soles is R15. The extra cost of incorporating steel toe caps is approximately R2 per pair of boots, an increase in the overall cost of ten to fifteen percent (manufacturer's prices, 1984).

15.2.3 Boot Recommendations

As well as the hazard of toe injuries, a number of other factors related to the design of boots should be considered. All recommendations should be tested by workers before they are used on an industry-wide basis.

(1) Toe caps All boots supplied underground should have protective toe caps.
(2) Metatarsal guards Typically these consist of a hinged metal or plastic plate that protects the foot from impact injuries. Boots with metatarsal guards, the "crash helmets for feet", should be tested because of the high proportion of foot injuries. They have been available on the South African market in the past. Even though they were imported, the cost was only 25 to 30 percent higher than typical mining boots (Stewart 1984). No SABS specification has been developed for boots with metatarsal guards.
(3) Steel mid soles Penetration injuries caused by objects like nails can be prevented by incorporating spring steel mid soles. Puncture wounds as a result of these injuries are difficult to clean and frequently lead to sepsis. SABS specifications have been developed for midsoles.
(4) Socks and laces A significant proportion of ankle injuries relate to sprains, ruptures and tearing of ligaments. The degree of protection provided by boots against these injuries is related to the quality of socks and laces that are used. Mine management do not provide either, although they should be considered as

an essential component of protective footwear. The provision of suitable socks would also eliminate the problem of 'boot rub' and reduce dermatitis.

(5) Non-slip soles and studs The steep slopes encountered in the stopes, together with the wet, rough and rock strewn footwall cause 'slipping and falling' accidents. Accident statistics show that this is a severe hazard. For example in 1981, 62 (10%) of all fatalities were related to slipping and falling. Thus special measures should be investigated to improve the friction characteristics of boot soles. In Britain carbide studs are successfully used for this purpose (Eisner 1985, Ramsay and Senneck, 1970).

15.2.4 Conclusion

Boots are a form of protective equipment accepted by every worker as essential for underground work and are worn as a matter of course. Well designed boots together with suitable socks can significantly reduce or prevent injuries directly and will reduce fatalities and injuries related to slipping and falling, all at relatively little cost.

15.3 Hard Hats

Head injuries are an important cause of death. In a study of 93 fatalities, 24% were due to head injuries (Moir, 1985). Bettencourt and Jensen found that 13% of hospitalizations resulted from injuries to the head (1970). The MWA Regulations require all underground workers to wear hard hats of a design approved by the Government Mining Engineer (R7.7.1). Black workers must be provided with hard hats free of charge (R7.7.3).

Informants were asked whether they thought the hard hats supplied by the mines were adequate. Forty-two of our informants noted one or more of the following problems:

(1) In dangerous situations hard hats were easily dislodged or lost. This was the most frequent complaint.

"These cap helmets are not good enough because when the rocks fall this cap is the first to fall - then the rock finds a bare head and danger appears."

"Even the wind is taking it off."

This problem may be solved by improving the design of hard hats or by providing a chin strap.

"These helmets are good but what I am experiencing is if you are escaping it is falling first, whether you have tightened it or not, so I would prefer a strap for tightening around the chin."

(2) At one mine two designs of hard hats were in use. One design had a brim, whereas the other was

akin to a peak cap without any brim.

> "Most of the helmets being used are cap like, they do not have brims, so even if a small rock comes they can cause a serious injury, like cutting your ear. If they had brims they would be more satisfactory."

The design of hard hats should be more thoroughly investigated as head injuries constitute a significant proportion of injuries. Small design improvements, like the incorporation of chin straps and broader brims, may result in significantly fewer accidents at little cost.

15.4 Noise and Hearing Protection

High noise levels are common to most mining operations. Exposure to excessive levels of noise leads to 'noise deafness', also known as noise induced hearing loss. The risk and extent of noise deafness is related to the intensity of the noise, the frequency composition of the noise (high frequencies are more damaging than low frequencies) and duration and distribution of exposure to noise during the day and throughout a person's life.

Excessive noise damages the delicate hair-like nerves of the cochlea, an organ inside the ear that senses sound and transmits it to the brain. Noise deafness causes sounds to become softer and less clear. Noise deafness is incurable. Hearing aids are of little help because the nerves of the cochlea that sense noise are permanently destroyed (Maas, 1972). Management and medical officers have been aware of the noise hazard for many years. The first studies by the Research Organization started in 1964. In 1970 a mine medical officer estimated that forty percent of mine employees were at risk of noise induced deafness (Solan, 1970). Fifteen years later his published comments still hold true : "I have been informed that noise levels for each noisy occupation on the mines have been monitored, but that the figures are not yet for publication". At the end of 1979 the first industry-wide studies were undertaken by the Chamber's Research Organization (Schroder et al 1980, 1981, 1982).

15.4.1 Noise Levels in South African Gold Mines

Practically all underground workers are exposed to equivalent noise levels (L_{eq}) higher than 85 dBA. At this noise level after only ten years thirty workers per thousand will have impaired hearing (SABS 083-1970). In the context of this report, impaired hearing means an average hearing loss of greater than 25 dBA in the speech frequencies of 500, 1000 and 2000 Hz (SABS 083-1970).

Eighty-five dBA is the maximum noise level permitted in South African manufacturing industry. Above this level the Machinery and Occupational Safety Act (MOSA) requires the employer to "take the best practicable steps to reduce the noise in the environment" (SABS 083 - 1970, 5.2). If

it is not possible to reduce noise levels to below 85 dBA, ear protection devices that provide adequate attenuation (noise reduction) must be used. No similar regulations to limit exposure to noise apply to the mining industry.

The Chamber of Mines noise surveys suggest that the majority of day shift underground workers are exposed to an equivalent noise level of 100 dBA or more (van Rensburg et al, 1980). At this noise level the hearing of 120 workers out of every 1000 will be impaired within five years (SABS 083 - 1970). In manufacturing industry workers may only be exposed to this level for a maximum of 15 minutes a day according to the MOSA regulations.

Machine drillers experience the highest noise levels. Noise levels of greater than 120 dBA are emitted during pneumatic rock drill operation (Schroder et al, 1980). Only forty-five seconds exposure per week is permitted by the MOSA standard at this intensity of noise! Chamber noise surveys have shown that the equivalent noise levels that machine drillers experience are greater than 110 dBA. A quarter of all machine drillers may be expected to have noise impaired hearing loss within five years. Much higher levels, greater than 135 dBA, may be expected in shaft sinking when twenty to thirty drills are operating within the confines of a shaft only a few metres in diameter (cf. van der Sandt, 1970).

15.4.2 Noise and Accidents

Studies have shown that nearly half of all injuries caused by rock falls occur during drilling operations. It should also be borne in mind that the "fog" produced during drilling reduces the operator's visibility. These problems are particularly important in the context of Lawrence's finding that half of the people involved in fatal accidents failed to perceive warnings of the impending accident (1974).

The high noise levels during drilling operation probably contribute to the high accident rate experienced by machine drillers by masking out warning signals like shouts of fellow workers and the sounds of rock movements.

The only Chamber research related to this topic investigated whether noise, heat and light affected the execution of a particular task (Barnes, 1982). Noise had no effect. However, the design of this experiment was inadequate for the following reasons:

(1) The research was done in a simulated environment.

(2) No attempt was made to simulate the warning signals present in the underground environment. Only visual warning signals were simulated.

(3) The high and low noise levels used were not sufficiently different. The noise level used as a high level was 105 dBA. The 'low' noise level was achieved

by operators using wax ear plugs. These are not effective for attenuating noise levels.

(4) The high noise level (105 dBA) was not "high". The level usually encountered during drilling is above 120 dBA. This is thirty times louder.

15.4.3 Provision of Hearing Protection in Gold Mines

Informants were asked about hearing protection. The responses are presented in Table 16. It was found that although the majority of machine drillers recognised the noise hazard they were exposed to, hearing protection was rarely encouraged or supplied.

Only two workers in the whole sample (90) were provided with hearing protection. Both worked in development ends at the same shaft of one mine. Both workers viewed ear protectors as necessary:

"After you have taken them out there will be no sign you have been in a noisy place. They are just comfy."

All informants said that noise was a severe problem, especially for rock drill operators:

"This machine, in fact underground, there is so much noise that after some time you will find somebody, even if still young, cannot hear a damn. Just like mine now, I have been going to the medical station for some treatment. I can't find any."

"Because I am experiencing that sometimes I do not hear properly, sometimes I do. It is a sign they will be damaged in the future."

"Because these machine operators ... when they are through with their job, their ears are ringing."

Workers expressed a need for hearing protection:

"That can be very much effective because the machines are damaging our ears."

"We are using cotton wool. We wish we could get them (hearing protection), especially because we are using cotton wool."

Most workers had no experience of hearing protection devices. Some had been instructed in their use during training:

"I think they must be a protection of the ears because there in the school mine we are getting a lesson about them but when we go underground there is nothing."

Informants noted two more important reasons for the use of ear protection. Drillers complainted of grit entering the ear canal and causing infections:

"There are times when we must drill on our side, and the fine dust is getting right in our ears."

"They would be very good because small pieces of rock get in the ears and irritate them."

Secondly, informants described another manner in which accidents are related to hearing loss. Exposure to noise results in a temporary hearing loss. A few hours are required before hearing returns to normal. Some informants noted that accidents may occur during this period due to the temporary loss of this crucial sense:

"(Hearing protection) should be supplied because we might get injured because we did not hear."

TABLE 16 - Proportion of informants provided with hearing protection and informants' views on the need for hearing protection

	Hearing protection provided (%)	Believed hearing protection should be used (%)
Rock drill operators (n = 39)	5	92
All other informants (n = 51)	0	76

15.4.4 Disadvantages of Hearing Protection

Workers, however, do express a hesitation about wearing ear muffs. Informants were concerned that when wearing hearing protection they might not be able to hear warning sounds from the rock face or from fellow workers. This was also the reason given by all informants who said hearing protection should not be used.

"At times drilling, if the rock falls, I will not hear the rock falling"

"Maybe sometimes there is someone trying to notify you about the fall of grounds, so that those ear protectors will prevent you from hearing, so you will get injured."

Similar concerns are common amongst workers who have to wear hearing protectors in all parts of the world. Usually these concerns have been dismissed by employers because in the past some experiments found slight improvements in signal and speech intelligibility could result from wearing hearing protection (Kryteri, 1946). This view is also expressed in Chamber of Mines reports (Schroder et al, 1980) although no experimental work, to the author's knowledge, has been carried out to establish if it is valid for local conditions.

Recent research has challenged some of the assumptions of this earlier work. Wilkins and Martin (1982) found that wearing hearing protection did not have any large effect on recognition of artificial warning signals such as sirens and alarms. However, the perception of 'environmental' warning sounds was reduced by hearing protection because of other irrelevant signals or high ambient noise levels. In gold mining high ambient noise levels which mask warning sounds prevail (Schroder et al, 1980). Abel et al (1982a) studied speech intelligibility in quiet and in noise, and showed that hearing protection did not have any effect for individuals with normal hearing. However, when individuals suffered from hearing loss, protection reduced the intelligibility of speech considerably. This would be the case in the gold mines where a high proportion of experienced workers (say three years and more) usually suffer some hearing loss (Schroder et al,

From the above it may be concluded that noise is a serious occupational hazard in gold mining, primarily because of its potential for causing noise deafness, but also as a potential contributor to accidents, particularly those involving falls of ground.

15.4.5 Inadequacy of Hearing Protection

Two further points must be made about hearing protection devices. Hearing devices usually only provide half the attenuation in the workplace as that achieved in the laboratory. For example, Abel et al (1982b) have found that attenuation values of between 12 and 20 dB are achieved in practice for ear plugs whereas manufacturers claim attenuations of 30 to 40 dB (Nixon 1981, refer also Savich, 1982). Even if ear plugs were constantly worn by rock drill operators this means they would not provide the required degree of attenuation. The reason for this discrepancy relates to the use of new, properly fitted devices in ideal laboratory conditions which are not repeated in field practice, particularly in underground mining.

Secondly, hearing protection programmes are seldom successful. This is due to a variety of reasons which include poor fit and sizing of protection devices, maintenance difficulties, poor hygiene and inadequate attenuation (Riko and Alberti, 1982). The hazard of accidents in the high noise levels of gold mine working places means that hearing protection is an inadequate and

inappropriate solution. This raises the question of what engineering controls are available to solve the noise problem.

15.4.6 Engineering Controls

The wide variety of machines in use underground call for a range of noise control measures beyond the scope of this study. However one item directly relevant to this study will be considered here, namely the pneumatic rock drill. This is amongst the noisiest of machines used underground. Most of the noise created by a rock drill originates from the air used to power the drill being exhausted to the atmosphere. If a suitable silencer or muffler is fitted the noise level on a drill may be reduced by 8 to 16 dBA, a significant, although insufficient, improvement (Schroder et al, 1980). The reduction in noise level is accompanied at worst by a small loss of efficiency (<3-4%).

Inquiries of local pneumatic drill manufacturers revealed that a standard stope drill fitted with a silencer is available on the South African market (Compair, 1985). The silencer reduces the noise level by approximately 10dB. The manufacturer claims that no maintenance of the silencer is required and the loss in efficiency is less than one percent. The cost of the silencer is marginal to the capital cost of a new drill (R50 extra on R800). This extra capital cost is insignificant when maintenance and running costs of operating a rock drill are considered. Further advantages apart from noise reduction accrue from the silencer. Visibility is improved because no exhaust fog is formed. This means better observation of the hanging is possible which may reduce the risk of accidents (cf Blignaut 1979a,b). Vibration and dust levels are also reduced. Despite all these improvements which have been achieved at a marginal cost, less than 2,5% of new drills of this particular design are sold with silencers.

The Chamber has acclaimed the lower noise levels associated with hydraulic rock drills which the Research Organization has developed over the past few years. These drills have been developed because they can bore holes twice as fast as conventional pneumatic drills, and are four to five times as efficient.

15.4.7 Conclusion

Engineering controls are always the preferred solution to environmental health and safety problems. When responding to critics of high noise levels in the industry, Chamber spokesmen have claimed that hearing protection is provided for workers (Financial Mail 28.9.84). On the contrary, this investigation has found that the provision of hearing protection is limited. This is the case despite the concern workers express about the high noise levels they are exposed to and the need for noise levels to be reduced. It has been argued that hearing protection will prove inadequate to safeguard workers hearing. Furthermore, hearing protection is an inappropriate solution given the

need for workers, especially machine drillers, to detect warning sounds that may provide warning of imminent dangers and to hear warning shouts. In contrast to hearing protection, engineering controls will make it easier to detect warning signals and reduce the hazard to hearing. In the case of rock drills, they are available at low cost.

15.5 Payment for Protective Clothing

Mineworkers are required to pay for certain items of protective clothing, in particular a nominal payment is required for boots (R1.45 per pair) and overalls (± R16). Most informants (94%) felt they should not be required to pay for these items. As one worker expressed his feeling: "It's not good to pay for clothes that help in the production of the mine."

Protective clothing is necessitated by the nature of underground work. The principle that protective equipment be provided free of charge is contained in the MWA with regard to the free supply of hard hats. Charging workers for certain items probably reflects management's concern to minimise working costs and that protective equipment costs will rise significantly if equipment is made freely available. This is no justification for charging workers as other arrangements can be made. For example, in the United States coal operators provide items such as self rescuers, personal ear plugs and safety glasses without charge and a protective clothing allowance ($160 per year in 1985) is paid for overalls, boots, belts and gloves (UMWA 1984).

15.6 Training and Safety

15.6.1 Introduction

Before novice workers start work underground they are taught a limited amount of 'fanakalo', a lingua franca used on the mines for instruction and communication. Thereafter rudimentary job training is carried out in fanakalo. During this period underground workers usually also undergo acclimatisation.

All informants were asked the following questions about training:

(1) Whether they believed new workers received sufficient training before they started to work underground.

(2) If new workers were sufficiently fluent in fanakalo before they started work. This point had been raised by workers in our pilot study.

(3) Where they thought training should take place, either on surface or underground.

15.6.2 Responses

A summary of the replies is contained in Table 17.

Sixty-two percent felt that the training provided was inadequate. The following comment about the adequacy of training captures the bewildering and frightening experience of a new worker's introduction to underground work:

> "They do not understand this fanakalo and become confused. They fear to make the place safe before they start their work. They do not know underground, only the surface."

This led to accidents in the view of some informants:

> "The new workers are being given a very short time (for training) because they go underground before they are conversant with underground implements and how they are used, and before they are conversant with fanakalo. Even if you say 'Pasopè' they just give you a blank look."

In some cases team leaders noted that it would be largely up to themselves to train workers, even after workers had received more specialised training:

> "Take a winch driver who has been sent to the training centre. When he comes underground he does not know how to operate the winch. I am having a trouble of teaching the team members how to properly install packs even if they are from the training centre. The third one is the miner's assistant who has been sent to the training centre, I am having trouble teaching him how to connect the fuses and detonators."

Those that believed training was adequate noted:

> "There are some regulations that are given to them that they must report dangerous conditions to their team leaders."

For most informants, however, the quality of training was not directly related to accidents: "Accidents still happen if we get enough training."

TABLE 17 - Workers' views on the adequacy of training and fanakalo and where training should take place (n = 90)

	Yes (%)	No (%)	Mixed response (%)
New workers receive adequate training	36	62	2
New workers speak sufficient fanakalo when starting work	16	83	1

	Surface only	Underground only	Surface and Underground
Location where training should take place	32	27	41

15.6.3 Fluency in Fanakalo

A common medium of communication is essential to safety in the underground work situation, especially as the environment is dynamic with novel problems constantly arising. Workers in particular recognise this need. A question on fanakalo was asked with this in mind, as well as to have a meaningful criterion to judge the consistency of workers' views on the adequacy of training. A qualification is required in the light of the controversies over the use of fanakalo. The discussion here is not concerned with evaluating the appropriateness or adequacy of fanakalo for mine work. Nor does it suggest that fanakalo is the appropriate language. Rather, the purpose of this discussion is to evaluate whether the training workers receive is adequate, and whether they are able to communicate successfully in a common medium.

In contrast to the question on training in general, far more workers felt that there was not sufficient opportunity for new workers to learn fanakalo. Eighty-three percent of informants stated that new workers could not speak enough fanakalo when they started work underground. Some informants noted that this had consequences for safety.

> "Even if you tell them 'Runaway!' because of say a fall of rocks, he does not hear you because this fanakalo is strange to him."

The lack of fluency in fanakalo throws into question the adequacy of training in general of which fanakalo is an integral part. Mine managers also see fluency in fanakalo as an essential part of training (Thorburn, 1960). Moreover, training usually takes place in the medium of

fanakalo. It is questionable how successful training can be if workers are not adequately familiar with fanakalo by the time they start work underground, which is when they have in fact completed their formal training. Recently published research by Barnes et al (1983) throws light on this problem. They compared the success of two instruction techniques when presented in either a home language or in fanakalo to a sample of novice Xhosa workers. Barnes and his co-workers found that information provided in fanakalo was poorly grasped. This was not the case when Xhosa was used. They concluded that "Fanakalo was a poor medium of communication to use for the induction process when compared to the use of a home language such as Xhosa." Three aspects of their study are pertinent:

(1) The context of Barnes et al's work was the training and induction of novice workers.

(2) The information they conveyed during their experiments, namely the reasons for heat acclimatization, is typical of what is conveyed to workers as part of their initial training.

(3) The group of workers that Barnes et al worked with, namely Xhosa speaking workers, are generally regarded by workers to be amongst those who most easily become fluent in fanakalo. This is a result of the similarity between Xhosa and Zulu and the origin of fanakalo in Natal as a means of communication either between the Zulus and English settlers or Zulus and indentured Indian workers (Ivens- Ferraz 1983).

15.6.4 Training : Further Comments

A number of further points should be added about training in local gold mines. A remark made frequently by informants was that techniques or equipment demonstrated in the training centre were not applied or were not available underground:

> "Somebody is trained on the school mine, but when it comes to do the job underground, then someone comes and says, 'Hey, this is not the school mine'."

Formal training for both black and white workers is brief by international standards. Training for novice black workers, including fanakalo tuition and acclimatisation, is completed in one to three weeks. A team leader remarked: "These people are not given enough time for training, they just want them to go and work underground."

In Britain mine trainees for semi-skilled work have a minimum of 100 days instruction before they begin work underground. After the mine trainee has been assigned a job underground he receives 150 days of special training in selected skills. The full training course continues for three years (McAteer and Galloway, 1980).

Foreign migrant workers in West Germany spend the first 20

days of their training learning German alone. Training continues with thirty to seventy days of practical and classroom instruction. A further twenty days of classroom instruction follow, concerned mainly with safety and health aspects. If a miner changes his job after six months, a minimum of ten days new assignment training is required (McAteer and Galloway, 1980; MSHA 1978).

The United States in contrast to these extensive programmes has minimal training requirements. New miners must receive forty hours of training on over twenty topics. The training course must be submitted by each mine to the Mine Safety and Health Administration for approval. The course must cover every safety and health problem of the mine although this may require more time than the minimum provisions of the regulations (McAteer and Galloway, 1980). The minimal training requirements in the United States have been identified as one of the major reasons why the United States has a much higher fatality rate in coal mining than is the case for West European countries (MSHA 1978, McAteer and Galloway 1980, NRC 1982).

An unpublished study by Rodenwoldt et al (1975) provides evidence for the poor standard of training in local mines. They investigated to what extent workers correctly recognise safety signs (not safety posters). The recognition of safety signs is a pre-requisite for mine work just as a knowledge of road-signs is essential for safe road use. The results of their study are disturbing by any standards. Table 18 is reproduced from Rodenwoldt's report and shows that all safety signs were poorly understood. Some of their comments are worth repeating verbatim:

"'Hazard stripes' This was poorly recognised and interpreted despite the fact that it was used on all the mines surveyed ...

'No entry' This was poorly recognised despite the fact that it was used on all the mines ...

'Methane' The vast majority of workers were unaware of the significance of this sign and its international standard and recommended equivalents of 'methane' were equally inadequate."

The authors add:

> "Considerable variations in response were apparent. These could not have been attributable simply to familiarity (or lack of it) for some signs were frequently misinterpreted even though they are in use on all the mines."

They concluded that although there were some difficulties with the symbols used on certain signs, training given to workers was insufficient or inappropriate. Later research was to verify this conclusion:

> "Experiments were conducted and the research conclusively demonstrated that men new to the industry with little or no schooling could be trained in les than two hours to read, understand and retain the meanings of these signs very well." (Robertson 1980)

The consequences of inadequate training have been highlighted by the work of Bettencourt and Jensen (1970). They found two important trends which may be observed in Figure 9. Firstly, novice workers with less than four months experience suffer far more injuries than experienced workers employed in the same job. In fact novice workers experience accident rates that are twice as high as workers with more than two and a half years experience. Secondly, experienced underground workers who have spent less than four months in a particular job suffered consistently higher accident rates than workers with more than four months of experience in that job. They concluded that special attention should be paid to training and follow-up training of inexperienced workers.

15.6.5 Where Should Training Take Place?

A third of our informants believed training should take place on surface (see Table 17). Most, however, were in favour of training taking place underground in combination with instruction on surface. Some mines do conduct training underground. The reason informants gave for training taking place underground was that new workers would become familiar with their future work and the underground environment while under suitable supervision:

> "So that the new workers can see the dangerous places where they are happening."

> "My reason is because there these people are taught theory <u>and</u> practice."

For some workers, however, the possibility of training taking place underground was met with skepticism: "(Training should take place) only on surface because underground all they are after is this 'feet'." (feet - the distance that the face advances, usually measured once per month)

15.6.6 Conclusion

A majority of informants believed that training for new workers was inadequate. Most noted that novice workers were not even fluent in fanakalo when they started underground work. Local training requirements are brief by international standards. Even straightforward aspects of local training examined by Chamber researchers, such as the recognition of safety signs, has shown standards to be poor. Researchers at the Chamber have suggested that improved training may provide a partial solution to the very high accident rates suffered by inexperienced workers (Bettencourt and Jensen, 1970).

TABLE 18 - Recognition of Safety Signs by Mine Workers : Total Number of Correct Responses

TOTAL NUMBER OF CORRECT RESPONSES (n = 224)

SAFETY CODE SIGN

Sign	1 Hazard stripes	7 Danger tag	8 Danger tag	10 Electricity	9 No entry	11 Methane	18 Fire ext.	17 First aid	12 Stop	13 Stop (hand)	3 Waiting place	5 Working ahead	6 Travel way	4 No travel way	2 No smoking	15 Explosives	14 Poison	16 Switches
F	46	136	121	178	77	22	38	153	157	115	115	44	136	142	169	74	82	62
%	20,54	60,71	54,02	79,46	34,37	9,82	16,69	68,3	70,09	51,34	51,34	19,64	60,71	63,39	75,45	33,04	36,61	27,67

RECOMMENDED SIGNS

Sign	9 Narrow haulage	5 Poison X-bones	6 Electricity	2 High voltage	10 Octagonal stop	12 Stop methane	4 Fire ext.	8 Drinking water	7 No drinking water	1 No long objects	3 No sitting on conveyors
F	50	171	13	20	140	11	29	155	117	65	5
%	22,32	76,34	5,80	8,93	62,5	4,91	12,95	69,19	52,23	29,01	2,23

INTERNATIONAL SIGNS (SABS)

Sign	14 Suspended loads	13 Methane	15 Explosives	12 First aid	9 Helmet	8 Ear muffs	7 Goggles	11 Boots	10 Gloves	2 No drinking water	4 No smoking	6 No water for ext. fire	5 No naked flames	3 No pedestrians	1 No proceeding
F	66	16	23	107	75	37	101	140	178	99	38	6	27	32	55
%	29,47	7,14	10,27	47,77	33,48	16,5	45,09	62,5	79,46	44,2	16,96	2,68	12,05	14,29	24,55

F = Frequency of correct responses.

(Reproduced from Rodenwoldt et al 1975)

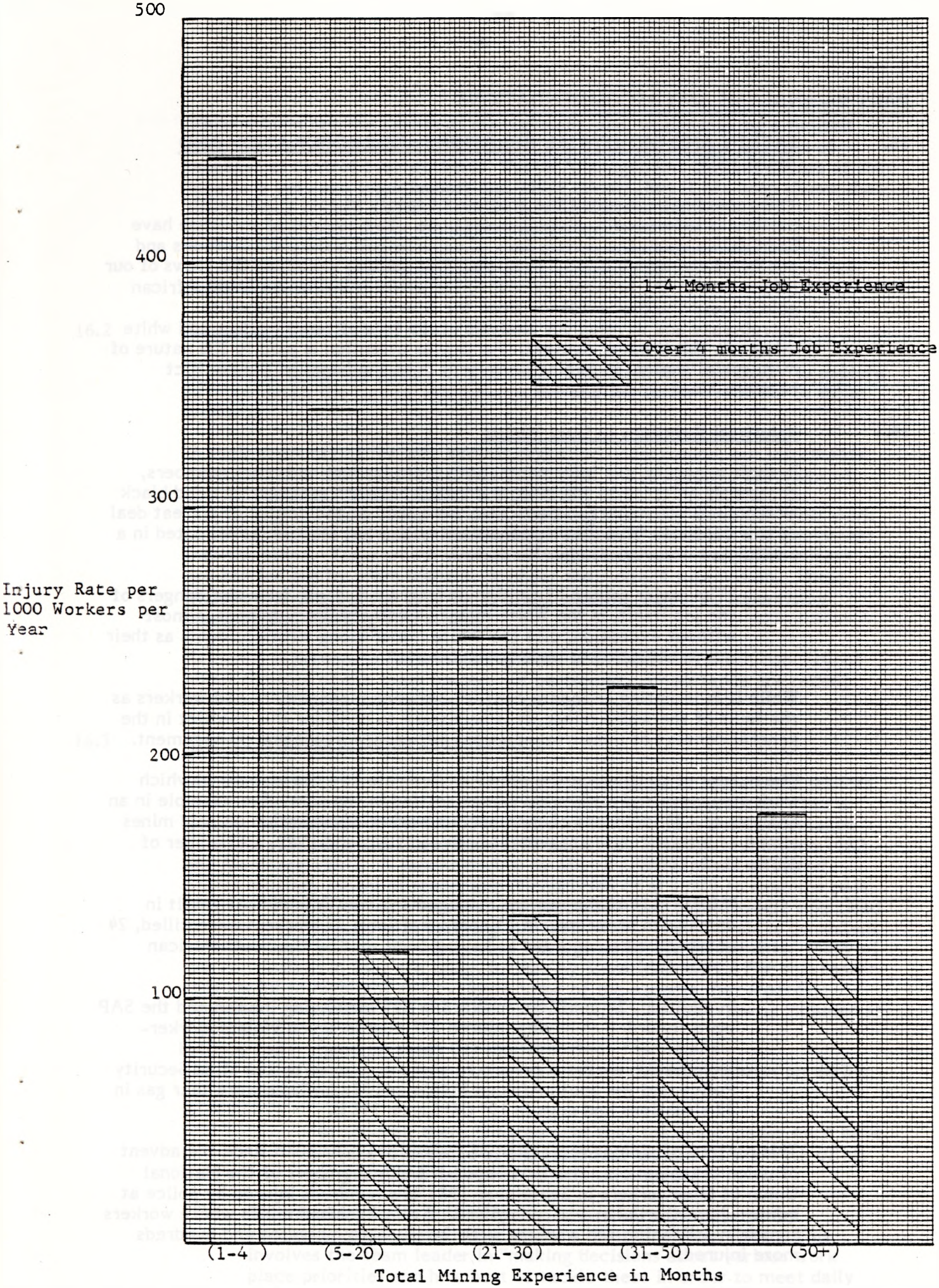


Figure 9 Histogram showing effect of current job and total mining experience on accident rates.
After Bettencourt and Jensen, 1970

PART V - ANALYSIS AND RECOMMENDATIONS

16. SAFETY AND INDUSTRIAL RELATIONS : CORROBORATION AND ANALYSIS

This report has examined the problem of safety in gold mining with particular reference to stoping operations. Two sources of evidence have been drawn upon: the perceptions of experienced underground miners and published and unpublished literature. This section examines the views of our informants in the broader context of industrial relations on South African gold mines. Further evidence from the literature is introduced to corroborate and develop our analysis of the role of team leaders and white miners in this broader context. Particular attention is paid to the nature of managerial control in mining because it is at the heart of the conflict between black workers and white miners.

16.1 Industrial Relations in Gold Mining

In their accounts, our informants, both team leaders and team members, constantly referred to the intense conflict between management and black workers. White miners in particular were seen at the center of a great deal of this conflict. This view is consistent with what Moodie (1976) noted in a participant observer study. He stated:

> "The major source of tension underground, apart from the dangers of the job itself, is the White miner. Ordinary Black miners, almost without exception, cite the White miner along with accidents as their major objection to underground work."

While it is tempting to locate conflict between management and workers as the fault of the white miner, it is necessary to consider this conflict in the general context of industrial relations between workers and management.

The nature of conflict on the mines is illustrated by the manner in which work stoppages and strikes have been settled in the past. For example in an analysis of 158 incidents of spontaneous worker organisation on gold mines aimed at influencing management between 1971 and 1982, a Chamber of Mines study found:

> "Most (111) of the worker-management conflicts did not result in damage to property. In 15 confrontations, 37 workers were killed, 24 of whom were recorded as having been shot by the South African Police (SAP).
>
> In addition, 24 conflicts resulted in 349 men being injured and the SAP were recorded as having injured 127 men in seven violent worker-management confrontations (10 cases missing). The recorded termination methods most commonly employed by the Mine Security Police and the South African Police in 158 conflicts were tear gas in 33 situations and dogs in 19" (McLaren 1983).

This pattern of violent repression of strikes has continued since the advent of union organisation. The first legal strike by members of the National Union of Mineworkers in September 1984 saw hundreds injured by police at mines where the union was recognised. At unorganised mines where workers struck in solidarity, ten workers were fatally shot by police and hundreds more injured.

It is in this general context of conflict that our informants perceptions of white miners should be understood.

White miners are the agents of management who, whilst making a limited contribution to productive activities in the stope, perform a function of managerial control over workers. Worker/management contact occurs at the interface between team leaders and white miners, but it has been shown that this contact is very limited (Section 9.4.3). Communication with line officials and more senior management, it may be surmised, is still more limited. In the underground work situation the conflictual relationships between workers and management are transferred to the relations between black workers and white miners.

16.2 Summary of the Role of Team Leaders

In order to grasp the nature of this control function it is necessary to explore in more detail the role of the team leader and the latter's relation to stope workers.

In their accounts of the way work is organised underground, our informants described how the team leader has taken over the productive functions of the white miner. Team leaders are generally directly responsible for instructing and supervising workers, checking that they complete their work at the end of the day and co-ordinating the flow of materials and equipment into the stope. Tasks which were previously the preserve of white miners are carried out by team leaders, or under their direct supervision. These include marking off the face for drilling, locating supports, supervising charging and blasting operations.

Evidence is presented here to corroborate and illuminate these conclusions about the role of the team leader. Of particular importance are recent Chamber of Mines unpublished research reports.

16.3 The COM Model of Stope Team Leaders

Management has been concerned to upgrade the skills of stope team leaders as a means of improving productivity and reducing working costs. Thus a number of analyses of the job of stope team leaders have been undertaken over the past ten years (Lawrence 1972 and 1976, Moerdyk and Lillico 1982 and Momberg 1981). A recent review by Moerdyk (1983) used a United States military model of leadership (Hendriksen et al 1980) to examine past Chamber studies of team leaders. He concluded that team leaders exercised sixteen broad functions in carrying out their work. His analysis is consistent with the descriptions of underground work given by our informants. Many of our conclusions in fact are taken further by Moerdyk's work. For this reason it is useful to highlight and evaluate some of the aspects that Moerdyk described. A summary of the functions identified in his review is included as Appendix E.

(1) In introducing the role of the team leader, Moerdyk quotes an earlier study by Lawrence (1976):

> "In general, there is agreement that the team leader must have a sound knowledge of the technical aspects of the work of his gang and also a keen safety consciousness."

(2) The team leader is seen to be concerned with the day-to-day execution of pre-determined plans, a 'first-line supervisor'. This involves the team leader in "making decisions about various work place priorities and how best to tackle these in order to meet daily and monthly 'call' figures. Continual replanning is also necessary so as to minimise time and blasts lost for various reasons." (Moerdyk 1983).

To execute their decisions team leaders must re-allocate men and equipment to where they are most needed, particularly when breakdowns and other difficulties arise.

(3) Team leaders are also responsible for the:

> "controlling and evaluating of men, machinery and environment. It includes the inspection of on-going processes and the initiation of corrective steps where necessary. In the case of machinery, this may require the acquisition of new or replacement equipment, whereas with the labour force this may involve training by the team leaders and/or by the training department. It may also require the supervisor (team leader) to take disciplinary steps against the worker where this is necessary" (Moerdyk 1983).

This confirms our analysis of co-ordination and training.

(4) Training is expanded upon further by Moerdyk when he concludes that team leaders must be able to do every task that team workers do and "must be able to teach and train subordinates in their tasks. "This confirms what we noted in Section 9.3.

(5) A crucial assumption of Chamber researchers is that productivity in the stope is best achieved by motivating workers "without the need for sanctions and other coercive measures and without the need for constant supervision by the team leaders."

The following comments suggest management recognises that autocratic forms of discipline and coercion are a problem in the industry at present:

> "It would thus appear that autocratic and arbitrary supervision is likely to give results that are satisfactory in the short term but to be counter productive in the longer term. Given the need to stabilize the work force, particularly at gang level, short-term solutions need to be avoided. This suggests that the team leader (and miner) will have to be taught, where necessary, to avoid arbitrary and punitive behaviour." (Moerdyk 1983).

(6) The relationships between white miners, team leaders, and team members are also discussed. Moerdyk notes conflict between team leaders and white miners but explains this as 'role ambiguity': if the team leader is to win the confidence of workers, the team leader must be able to further the interests of team workers. This entails white miners yielding some of their control. Unfortunately this point is not elaborated further.

(7) Moerdyk notes that team leaders are responsible for solving problems that may lead to delays in production or accidents. "This involves the recognition of some abnormality or deviation in the environment. This abnormality may be the existence of hanging rock, a weak point in an air or hydraulic hose, or changed behaviour patterns indicating stress, intoxication or depression in gang members."

(8) It is the intention of Chamber researchers that in solving problems, management's cost benefit approach to production and safety should be an integral part to the approach adopted by team leaders: "Once the situation has been identified and the nature of the problem recognized, the next stage is to consider various alternative forms of

action and to assess the likely cost/benefit relationship of various actions in terms of both safety and production. Furthermore, it is often necessary that the action be taken rapidly in the underground mining environment...." (Moerdyk 1983).

(9) The unitary perspective of management denies workers a say in "the establishment of long term goals and policies. This kind of strategic decision making is not appropriate for lower levels of workers within the existing South African economy..... Furthermore, these skills are appropriate to lower level workers in other, more worker oriented economies such as West Germany, Japan and Yugoslavia" (Moerdyk 1983).

The review of the role of team leaders by Moerdyk confirms what was found in our investigation. The unpublished Chamber studies show that the changes in the role of the team leader are not simply a matter of neglect on the part of white miners. Mine management is encouraging and fostering the changing role of team leaders to maximise productivity.

Rather than simply supervising, team leaders actively perform productive tasks when and where required. This is one facet of management's attempt to blur the division of labour in stope teams in order to enhance production: workers are required to perform any task so as to reduce bottlenecks (refer section 9.3.2 NPI 1982 and Smith 1974).

It is the hope of management that stope teams will operate autonomously with a minimal need for external control because of the difficulties of supervising dispersed and isolated groups of workers. In order to achieve this goal, potential conflict between team leaders and team workers must be minimised. Strict supervision is seen by the Chamber researchers as counter-productive in the long term and autonomous units are believed to be more productive than strictly controlled units. This analysis suggests that management is attempting to separate the managerial functions of supervision and instruction from control and discipline. Team leaders are responsible for the former, white miners the latter. With this in mind let us now examine the white miner's role in greater depth.

16.4 The Abandonment of Productive Work by White Miners

In discussing the changing role of the white miner, it is necessary to briefly consider developments in the production techniques of hard-rock mining. In particular the change from 'conventional' mining to 'concentrated' mining (with the use of a free breaking bench) has had a profound effect on the traditional skills of miners.

The essential 'skill' required of a miner engaged in conventional mining in the past was not related to 'blasting' as suggested by the legal requirement of a 'blasting certificate'. Rather, it related to the marking off of drill holes so that the maximum amount of rock would be broken with every hole drilled. Only a limited number of holes (approximately 100) could be drilled, charged and blasted in a single shift. The most important production variable in this process was the optimal location of each drill hole. If holes were well located face advance would be rapid, but if poorly placed, explosives would detonate with little effect. Since the shape of the face changed with each blast the miner had to draw on his skill and experience in siting each individual hole to best advantage.

The development of concentrated mining techniques, partly due to improvements in blasting ancillaries and in rock drill jumpers, has eliminated the skill required to locate each hole for maximum breaking. These are now marked according to a standard saw-tooth pattern along the length of the face. Instead of the skill required previously for marking off, the limiting production variable has become the length of face that can be prepared, drilled and charged in a shift.

The skill of the traditional miner having been rendered superfluous, management since the early sixties has set about re-organising the production process. Despite initial resistance to changes in the allocation of work, particularly during the 'experiments' of 1964 (Sitas 1979, Viljoen 1965), white miners have accepted the incipient changes to their productive role over the years and have withdrawn voluntarily from production for two reasons:

* Unlimited production bonus payments have meant that any reduction in responsibility or productive activity could be exploited to their own advantage in the short term by earning increased bonuses. Encouraging team leaders to take over supervisory and productive tasks was an easy way to maximise earnings.
* As part of annual union management negotiations, the (white) Mine Workers Union has conceded control over particular tasks in exchange for improvements in conditions of service. The result of these changes is that white miners supervise increasingly large numbers of workers. The following table drawn from the Wiehan report shows how the ratio of black underground workers to white miners has changed since the 1960's.

TABLE 19 - Ratio of black underground workers to rockbreakers (stopers and developers) and general miners

Year	1966	1968	1970	1972	1974	1976	1978	1979
Underground workers per certificated miner	26	31	35	37	39	41	53	56
Index	100	119	135	142	150	158	±204	215

(Source:Wiehan 1981)

These changes provide an explanation for the limited productive role played by white mines as described by our informants. Conclusions in line with ours were drawn by the members of the Wiehan Commission and the NPI investigators:

> "The effect of this extending span of supervision cannot be pinpointed with accuracy. Bearing in mind, however, that it also involves an increase in the geographical area which has to be supervised, it is clear that there are physical limits to the number of workers that can be effectively supervised in the mining situation. It is therefore natural to expect that some tasks now allocated by law to certificated workers must increasingly be performed by people who are currently not so qualified" (Wiehan 1981).

The NPI (1982) report comments:

> "Many miners, because of the number of work places they supervise are, in addition, physically unable to comply with their statutory job requirements. Current capital projects as they reach completion, will exacerbate the present position as the demand for miners over the next two years increases."

These conclusions and the statistics used by Wiehan, taken together with the views of our informants, confirm that the position of the white miner in the productive process has changed dramatically. Certainly it bears little resemblance to that envisaged by the MWA enacted nearly thirty years ago.

The corollary of the withdrawal of white miners from productive tasks is that the basis of the bargaining power of white miners has been eroded. This has been in the long term interest of management. They are now in a far stronger position to re-organize the role of white miners in the production process should they wish to do so in the future.

If white miners perform only a limited productive role, what is their present function? Why are mine managements prepared to pay what appear to be very generous wages to miners if they do not perform productive functions? In describing the role of the white miner in relation to safety, our informants have thrown light on the nature of the white miner's present role in production. In the next section it will be argued that while team leaders act as the first line of supervision over production, white miners are management's front line of coercion.

16.5 Management Control in Mining

Mine managements are faced with two problems of managerial control specific to underground work, especially in deep level gold mines:

* The supervision, control and co-ordination of production which takes place in dispersed but discrete units.
* To maintain production at a steady pace despite the extremely hazardous conditions encountered. This is particularly important if conditions in a stope deteriorate drastically, because the costs involved in developing a stope are very high.

Supervision, co-ordination and control in the stope is exercised by team leaders. However, the extent to which team leaders can co-ordinate production between individual stopes must be limited, more especially since they take an active part in production. Co-ordination between stopes is therefore a function of white miners, more senior officials and perhaps senior team leaders.

Coupled to this co-ordination is the second requirement of mine management: to ensure production is maintained despite any hazardous conditions that may be encountered. To achieve this management has exploited the production bonuses paid to white miners and the racial divisions between workers. Unlimited bonuses, which make up a substantial portion of the earnings of white miners, provide an incentive for white miners to ensure that production continues at as fast a pace as possible. If work stops for any reason, from the perspective of a white miner it is not merely a matter that delays constitute production losses, but it means that his own earnings have 'stopped'. Thus he may be expected to use whatever means are at his disposal to ensure production continues. The end result is pressure on workers to continue operations despite hazards and to neglect standard safety precautions. This pressure is intensified because mining is a cyclical process. Time required to carry out safety precautions or to await the arrival of necessary materials such as supports leads to the possibility of losing 'blasts', and consequently, losses in production and bonus earnings.

The conclusion that safety measures were neglected is supported by our informants' explanation that white miners coerced workers with threats of disciplinary procedures. Although a 'charge' is apparently a fair and neutral procedure, when workers' were charged their claims that working places were hazardous were not accepted against white miners assertions that they had 'struck'.

16.6 Ratio of Fatal Accidents of Black to White Miners

Our informants contended that white miners could expose black workers to hazards because they did not incur personal risk in insisting that workers continued with production without the necessary safety precautions. This view is evaluated here in the light of published accident statistics.

The Chamber of Mines publish accident fatality rates for black and white underground workers. In Table 20 these rates have been averaged for ten year periods. The figures show that fatality rates for white workers were higher than those for black workers until the early 1930's, but thereafter have become substantially lower. In the 1980's the fatality rate for black workers has risen to a figure 67% worse than for white miners.

Greater differences between black and white fatality rates may be observed for rockfalls. As shown in Table 21, black underground workers suffer approximately three times as many fatal fall of ground accidents as white workers at present. As for the case for all underground accidents, the ratio of black to white fatalities due to rock falls has increased steadily. During the period 1911 to 1919 black workers were 1,7 times more likely to be killed by a rockfall. Between 1970 and 1979 the risk for black workers of a fatal accident due to a fall of ground was 3,1 times greater than the risk faced by white employees.

These fatality figures are consistent with the perception of our informants that white miners are not exposed to the same risks as black workers. Unfortunately the statistics maintained in South Africa do not differentiate between specific underground occupations or working places. Such statistics might allow us to draw more definite conclusions.

16.7 Production, Bonuses and Accidents

There is some evidence to corroborate the assertion that production bonuses result in the neglect of safety precautions. This question, however, does not appear to have received much attention locally, particularly in recent times. Simons (1961) in a paper on accidents on mines cited an early inspector of mines:

> "The pressure is felt throughout the mine. The officials who work possibly on the bonus system must be biased in their judgements when the question arises of the advisability of cutting pillars, building stalls and packs, or allowing a doubtful stope to remain idle. They are probably aware that Natives start work before the arrival of the gangers, who are therefore unable to inspect their working places. Of course, the officials will not confess that working under high pressure is answerable for scamped or even neglected work, and consequently the death rate' (Germiston Inspector of Mines 1911)."

Table 20 : Mean fatality rates of underground workers per thousand workers at work for Transvaal and Orange Free State gold mines that were members of the Chamber of Mines.

Period	Whites	Blacks	Ratio of black to white fatality rates
1911-1919	4,93	4,03	0,82
1920-1929	3,20	3,04	0,95
1930-1939	2,69	2,73	1,01
1940-1949	1,75	1,92	1,10
1950-1959	1,89	2,11	1,12
1960-1969	1,36	1,80	1,32
1970-1979	0,97	1,72	1,77
1980-1982	1,02	1,70	1,67

(Source : COM 1982)

Table 21: Estimated mean falls of ground fatality rates for underground workers per thousand workers at work for South African gold mines.

Period	Whites	Blacks	Ratio of black to white fatality rates
1911-1919	0,63	1,09	1,7
1920-1929	0,47	0,97	2,1
1930-1939	0,47	0,86	1,8
1940-1949	0,30	0,76	2,5
1950-1955	0,31	0,74	2,4
1960-1969	0,28	0,80	2,9
1970-1979	0,25	0,78	3,1

(Sources : GME Annual Reports and COM 1982. Numbers of black and white underground workers estimated from COM 1982, p98).

More recently the NPI (1982) study concluded:

> "After interviews with several miners, shift bosses and mine overseers, it was evident that miners were primarily motivated by financial earnings. The more successful miners were not interested in becoming mining officials because of a possible reduction in earnings."

Rondenwoldt (1982) in reviewing production bonuses is more revealing. Drawing from the minutes of the Technical Advisory Committee (TAC) of the Chamber, he shows that management is of the opinion that safety regulations are ignored in pursuit of bonuses:

> "The miner, in order to secure maximum face advance which will guarantee high earnings, is under pressure to organize and motivate his work force. His aims may not necessarily coincide with those of the mine; scant respect is often paid to regulations and policies (TAC, 10/9/1981)."

Management and the white miner share a joint culpability in the neglect of safety precautions and coercion of workers on account of production bonuses. While the white miner no longer performs a productive and only a limited co-ordination function his role is nevertheless crucial to management. The generalized conflict between management and workers is played out daily between the team leader and the white miner. The latter no longer has to act as a sentry or watchman who patrols the stope every few hours, for the team leader exercises this day-to-day supervision. But when production is delayed for one reason or another, it is only a matter of time before the white miner will be informed or become aware of the situation. It is then that he acts decisively. As management's front-line of coercion, he will take whatever measures lie at his disposal to ensure that production starts once more, particularly as every moment of delay threatens his earnings.

In the view of the majority of our informants, rather than undertaking the necessary safety precautions, workers will be forced to take a course of action that threatens their personal well-being in the interests of production:

> "The accident can be prevented. Only one thing - only the white miners. When we are applying this safety, the white miners are saying we are wasting time. Only that thing - they are in a rush for production."

17. RECOMMENDATIONS TOWARDS SAFER UNDERGROUND GOLD MINING

The evidence gathered in this study suggests that the time has arrived for management to establish a new form of social control in the work place. In essence management needs to abandon the coercive control of the white miner in favour of a more democratic system based on the recognition of black worker rights.

Throughout this report it has been illustrated how acutely aware workers are of the dangers they face daily. Management generally realises the consequences of the hazards that workers face although there are important gaps in their research. Safety is thus ultimately not a problem of lack of knowledge, but a question of rights and resources : workers' rights to refuse work in dangerous conditions; workers' rights to negotiate with management about safety and health problems to ensure adequate resources are allocated to safeguard workers' lives and health. This investigation has thrown up

issues of crucial importance, namely the MWA, production bonuses, the rights of workers, training and protective equipment. Recommendations on these issues are made below.

17.1 The Mines and Works Act : Changes in the Definition of 'Scheduled Persons'

To be effective, legislation regulating safety and health in mining must be related to the reality of everyday practice. Because of the changes that have taken place in mining since the MWA was passed in 1956, most parties agree that the Act is in need of major revisions. Following the publication of the Wiehan Commission's report on the mining industry (Part 6) in 1981, the Government accepted the Commission's recommendation that the definition of a 'scheduled person' in the MWA be replaced with a "non differentiating definition of 'competent person'." (White Paper 1981). However, the government chose to leave the implementation of the recommendation to negotiation between the Chamber and the white unions concerned.

In the light of this study the definition of scheduled persons presents an obstacle to safe mining. White miners wield all the arbitrary powers given to them in terms of the act to ensure production continues, yet are no longer accountable for their actions, nor do they risk the hazards faced by the workers they control. The specific responsibility for safety in the stope has been foisted on the team leader. While team leaders are in fact responsible for safety, they have neither the formal training nor the legitimate authority to take the decisive actions required in the face of hazardous conditions. In particular they cannot legitimately stop production and withdraw workers until the working place has been made safe.

This study has also indicated that the results of any changes which allow team leaders to become 'scheduled persons' may be ambiguous. On the one hand changes may give the team leader the necessary authority to tackle hazards in an appropriate way. On the other, the divide between team leaders and workers may increase as a result of changes in training, earnings and authority. It has been shown that the differences that already exist between team leaders and team members lead to a conflict of interest in respect of safety in a small but important proportion of cases. We conclude that for as long as team leaders share in the risks of production through active participation in the work of the team they will be concerned about safety. If this role diminishes, as has occurred for white miners, then safety precautions and standards will be threatened by the dictates of production. With these constraints in mind it is recommended that the change in the definition of 'scheduled persons' should be pursued as a necessary step to securing better safety standards and practices.

17.2 Production Bonuses

Production bonuses have been identified as a major obstacle to safety in mines. Bonus payments inevitably lead to workers taking risks, but in gold mining two aspects exacerbate this problem: bonus payments form a substantial portion of total earnings, and payments are related to the risks that other men are required to take.

It is recommended that the whole question of bonuses should be given careful consideration, and that bonuses paid to supervisory workers be reconsidered and replaced by fixed monthly salaries.

17.3 Workers' Rights

Workers' rights are the key to safer mining. As mining operations proceed to greater depths they become intrinsically more hazardous. In the face of hazardous conditions coercion will continue to be a feature of management in the gold mines because of the costs and production delays that follow from taking safety precuations. In particular, the unwritten law, 'work first, report later', is the antithesis of safe practice.

The following rights have been identified as crucial for miners to ensure they work under safer conditions.

(1) The right for shaft stewards to negotiate about safety and health at mine level.

(2) The right to accompany inspectors on routine inspections and during accident investigations.

(3) The right of union representatives to conduct investigations of hazardous conditions and accidents independently of mine management.

(4) The right to refuse to do dangerous work. The present clause in the MWA (R8.3.2) needs to be altered to allow complaints to be pursued at higher levels than merely the ganger or miner. Further clauses are required to prohibit reprisals against workers who refuse dangerous work and lodge complaints.

(5) The right of black mine workers to be represented on the national Safety Committee.

(6) The right of workers to make use of the statutory complaints book.

17.4 Training

By international standards training on South African gold mines is inadequate. The problem of an adequate 'lingua franca' has also to be addressed. Once a suitable language has been decided upon, it is essential that workers become fluent in this language before they start underground work.

The NUM should consider reviewing the training courses that workers receive. Particular attention should be paid to training in the detection of fall of ground hazards and support techniques because rockfalls and rockbursts are the single most important cause of death and injury.

Consideration should be given to legislation that requires minimum standards of training and re-training to be provided for all workers.

17.5 General Precautions and Personal Protective Equipment

Whenever general safety and health precautions were investigated the inadequacy of present mine standards were apparent. The resources devoted to research are minimal. Where this research has been carried out, or the technology is available, it is often not applied. Our investigation of boots, noise control and hearing protection were illustrative of this. Precautions were found to be wholly inadequate, yet the costs of providing equipment of a reasonable standard are small.

Recommendations on certain aspects of personal protective equipment, particularly boots, hard hats, hearing protection and payment for protective clothing are contained in Section 15. In the longer term each aspect of mine practice related to safety and health must be scrutinised. While many problems will be immediately identified and articulated by workers, other problems may require technical expertise. In some cases, as has been noted in relation to hearing protection against noise hazards, the perceptions of workers will challenge assumptions held by management and scientists. This may be especially important in relation to the tacit knowledge or 'tacit know how' experienced workers have about rockfalls.

18. CONCLUSION

To conclude this report it is appropriate to contrast our investigation with a prediction made ten years ago. Shortly after an article entitled "Human Error as a Cause of Accidents in Gold Mining" had been published (Lawrence 1974), the president of the Chamber of Mines predicted in his annual address:

> "This year the Prevention of Accidents Committee is actively pursuing a new line of attack based upon results of research undertaken by the Chamber of Mines Research Organization which indicated that over half of the fatal accidents which occur can be avoided if dangers are promptly detected so that appropriate action can be taken. This approach together with other new activities and the strongly increased support given to accident prevention within the industry will, I am confident, lead to the industry achieving important advances in safety within a very short space of time."

A decade later the annual fatality rate remains as a tragic testimony to the inadequacy of managerial safety compaigns and any approach which limits the explanation of accidents to individual error. Our informants, many of them survivors of accidents that had taken them close to death, would agree that most accidents can be avoided. Their perceptions substantiate our argument that accidents are not simply a result of great depths and the inadequacies of individual workers, but also a consequence of the way work is organised to maximise production. To this end:

* Scant regard is paid to the requirements of the MWA
* Production bonuses are paid to supervisory workers who do not face the risks involved in production. Bonuses encourage supervisors to pressure workers to maintain production levels despite the hazards that may be encountered.
* Workers directly involved in production are denied the right to stop working in dangerous conditions until the necessary safety precautions have been taken.

If gold mining in South Africa is to be pursued more safely in the future, management has to recognise the rights of workers to act and negotiate for their personal safety and health to be placed above the dictates of production and profitability. The conflict between safety and production is part of a broader conflict between workers and management. The difference is that it is entered into each day as miners desend to their work underground. These words of a senior team leader, who was describing his day-to-day tasks, capture an aspect of the conflict that hopefully this report has shed light upon:

> "First, I must make sure that the team leaders that are working under me are working with safety. I am telling my team leaders that they must not go into places that are not safe, but the white miners are overpowering me and saying the job must go.

I used to report to the authorities that the white miner has forced work in an unsafe condition, but the authorities say no that is still alright, so long as no one has been hurt. If there is an accident they do not remind me about what I have reported - they just squeeze it. When this accident has occurred no one sees that I have reported this."

19. ACKNOWLEDGEMENTS

This research has been conducted in collaboration with and on behalf of the National Union of Mineworkers. The ready assistance that was received from C Ramaphosa, M Maluka, L Sigela, P Hantla and M Nchwe is gratefully acknowledged. The research would not have been possible without the time-consuming efforts and assistance of the many shaft stewards and union committee members who made all the arrangements for the interviews conducted at each mine. Unfortunately they must remain anonymous.

I also wish to sincerely thank the following people who provided their generous assistance: Dr M Barry, P Benjamin, S Cauldwell, O Chesed, Dr J Cock, J Curtis, P de Vries, M Elf, E Engelbrecht, G Faller, M Ford, R King, A Levy, S Mare, M Martinson, M O'Donovan, W Puschra, E Rodenwoldt, Prof G Schutte, Prof H S Sichel, F Sitas, H Struthers, C Thompson and Prof E Webster.

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APPENDIX B - CORRESPONDENCE WITH THE CHAMBER OF MINES REQUESTING UNPUBLISHED RESEARCH REPORTS

A formal request for copies of unpublished research reports related to safety was made to the Chamber of Mines Research Organisation after a meeting attended by representatives of the National Union of Mineworkers, the Research Organisation and the author. The correspondence is reproduced here.

A subsequent meeting of the Chamber of Mines and the NUM was held on February 1, 1985, at the request of the Chamber who were represented by Mr. J. Liebenberg and Mr. M. Steen (Industrial Relations Department). They explained that the requested research reports were sensitive and that the Chamber would not release the reports but would prefer to perform the research jointly with the NUM. The NUM informed the meeting that the investigation had been completed and a joint project at that late stage was not feasible, and that the reports were required as background to the research which was to be published later in the year. The Chamber representatives responded by informing the NUM that the research reports would not be made available. No further correspondence has been received.

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6 December 1984

Professor M D G Salamon
Chamber of Mines Research Organisation
Chamber of Mines
P O Box 61809
MARSHALLTOWN
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Dear Professor Salamon

You will recall that during our conversation on 27 November we discussed the underground safety project presently being undertaken by our union.

The aim of this project is to obtain worker perceptions on occupational hazards, especially accidents. The following themes are being studied specifically:

1. The adequacy of supervision of work by team leaders and contrators or gangers with respect to sagety.

2. Workers' personal experiences of accidents.

3. Workers' perceptions of underground hazards.

4. The relationship between bonuses and safety.

5. Workers' perceptions of protective clothing and training.

6. Workers' perceptions of how mining could be made safer.

7. Workers' perceptions of the role of the National Union of Mineworkers in terms of safety.

We believe that the research reports on the enclosed list would provide important background information for our project and request that these should be made available.

We have noted this year's presidential address by Mr C T Fonton that in respect of safety "Ours is a very open industry"

Professor M D G Salamon
Chamber of Mines Research Organisation 6 December 1984

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and trust that the reports listed will be made available to us timeously as our project is to be completed during the first half of next year.

Yours faithfully

M C Ramaphosa
GENERAL SECRETARY

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APPENDIX C - THE DAILY WORK OF THE MINER'S ASSISTANT

This is an edited version of an interview held with four miner's assistants. To make it more readable, it has been edited to appear as though it was held with one person only. Each point raised was checked with all four assistants to ensure that it was a common experience. The workload of each assistant consisted of one or two panels.

"The first thing I do is washing the square. After that, then I take the paint and I have to look for the skelms (misfires).

"From there we help the machine operators to clean the panel. After cleaning the panel, we are watering them and removing them, although that job belongs to the white miner. We are removing all the misfires. The team leader is always helping as well, and he does help mark.

"Now we have to go look at the electric wire for the explosives to see that it is not cut. After that I have to go to the boxes in the tunnels, where I will get the fuses and the explosives. The box is a steel box about like so (1m x 1m x 1m). It has a padlock.

"What should be done whenever I go and take the explosives, the white miner is supposed to be there, but he is usually not there. I am always carrying those keys, and I can prove it now (producing the key). The white miner takes the key only when I go on leave.

"It is the white miner who is supposed to lock and unlock. A week goes without us seeing the white miner at the boxes. He is usually at the station.

"At the station he is getting fresh air. There is more fresh air at the station than at the box. Although we are working with different miners, this is our usual experience.

"The fuses I am taking with me from the surface stores, and the doppies have their own box nearer the explosives. They are also locked with the same key. Even if the explosives boxes are maybe ten or more, but all will have the same key.

"After unlocking and taking them all out, I connect the doppies and fuses. I take them to the gully where I will make preparations. Here I will make a hole in the gelatine and connect the doppie.

"Now I take all those things connected together and put them into a sack and take them where the machine operators are drilling.

"It is my job to clean out the holes after drilling but I am making the machine operators do this because I am doing the white man's job connecting all the fuses and detonators.

"When I come to the face and prepare the explosives, the white miner is supposed to be there, but usually he is not there.

"Usually we get there when the machine operators are finished cleaning the grit from the holes. Then we put in the explosives and connect up the fuses to the electric wire. We put in a block behind the explosives. It's made harder by pushing it with a

charging stick.

"The team leader trusts us. Usually he is there, but if he is not there he will not worry because he knows the job will go.

"The white miner's presence is not necessary. His presence hinders the job because he is shouting, threatening to assault even if you are making a little mistake or doing nothing wrong.

"When I am finished I clean all the waste surrounding me like the cardboard boxes. I am putting these into the tip because they may cause fire. Now I take the bag where I had the explosives to the box, lock it into the box and knock off. I do not have to report to anybody (at the end of my shift) because all this (charging up) happens in the presence of the team leader who will report to the shift overseer or mine overseer (on surface).

"Some days I find the miner at the box, other days I arrive there to find he has left and knocked off to surface. On arrival (on surface) he will tell the mine overseer that has blasted (charged up) even though he was not there.

"There is no person who is specifically staying with (accompanying) the white miner. That may be theoretically true, but practically not, because the white miner usually arrives two to three hours after we have started working, so we are already doing that job he is supposed to be doing. There are some days we don't even see him at all. But even if we don't see him we blast.

"If he should see anybody from his gang he will just call him to go to the stope and to report to him what is going on.

"I have to do other work like installing packs whenever the machine operators are not drilling, that is when there is to be no blast. The team leader tells us what work to do."

<u>Question</u> : Who is responsible for seeing that there are enough explosives?

"That is the white miner's job, but he is doing it by asking us if there are enough, so it is our job. If we are running short we will tell him because if we run out, we will be the ones to suffer. He will send us to another station from where we will be carrying them with our own bodies.

"If I am absent, the team leader will have to send somebody to fetch all the explosives and so on. He will probably instruct somebody like a machine operator to put in the explosives, but he will connect them to the wires himself.

"If the team leader is sick, the winch driver will usually do his job, because he is second in command. We have got respect for the winch driver, because we know one day he may be our team leader.

"If I don't blast (i.e. the charges do not explode), the white miner will come in earlier than his usual time. He will come straight to ask me why I didn't blast, threatening to assault me so that I can not answer. Then he will warn me not to do it again, and he will give me a lesson on how to do it."

APPENDIX D. - STATUTORY RIGHTS OF MINE WORKERS IN VARIOUS COUNTRIES.

UNITED STATES.

* Right to "Representative of Miners" for safety and health purposes.
* Right to protection from discrimination for exercising statutory rights.
* Right to exercise rights on behalf of others' safety and health.
* Right to refuse to work under conditions or practices believed to be unsafe, unhealthy, or illegal.
* Right to report a suspected violation or danger to the operator, representative, or MSHA
* Right to institute and to testify in proceedings without interference or retaliation.
* Right to request a special MSHA inspection of suspected violations and imminent dangers.
* Right to notify an MSHA inspector on the mine premises of suspected violations and imminent danger
* Right to informal review of MSHA failure to conduct inspections or to issue citations for reported violations and imminent dangers
* Right to accompany MSHA inspector during inspection without loss of pay ("walkaround" rights)
* Right to participate in pre-and post-inspection conference
* Right to compensation when idled by federal citations or when required by the operator to work in violation of federal citations
* Right to adequate health and safety training
* Right to participate in the development and implementation of mandatory training programs
* Right to a copy of one's training certificate
* Right to withdrawal by MSHA if untrained without loss of pay or other benefits
* Right to participate in the development of roof control, ventilation and dust control plans
* Right to sanitary bathing and toilet facilities, to a self-rescuer, and to drinking water
* Right to respiratory devices
* Right to free Black Lung examinations and tests
* Right to transfer to a less dusty job if you develop Black Lung
* Right to receive Black Lung benefits
* Right to warnings, medical examinations, and transfer under safety and health standards
* Right to audiograms and personal protective ear devices
* Right to federal health and safety evaluations of mine conditions and practices
* Right to be informed and right of access to information
* Right to participate in formal administrative and judicial proceedings

The following further details of the Federal Act are extracted from a MSHA guide booklet, A Guide to miners' rights and responsibilities under the Federal Mine Safety and Health Act 1977. Note that 'operator' means mine management.

LEGAL RIGHTS OF MINERS.

The Act gives certain rights to a "representative of miners," a term which is defined by MSHA to mean a person who has been chosen by two or more miners to represent the miners in safety and health matters at their mine.

PROTECTION AGAINST DISCRIMINATION : SECTION 105 (c).

A miner who uses any of the rights the Act gives to him or her cannot be discriminated against for doing so. It is illegal for a miner to be fired, transferred to a lower paying job, not hired, harassed, or to otherwise lose job benefits for :

*Filing or making a complaint under the Act of an alleged danger or safety or health violation
*Instituting, testifying or assisting in any proceeding conducted under the Act
*Being a subject of medical evaluations leading to a possible transfer to another job location
*Being withdrawn from the mine for not having the mandatory safety and health training.

Congress intended that the Act be broadly interpreted and clearly meant to protect from discrimination any miners who refuse to work in conditions that they believe are not safe or healthful. Miners are also protected if they refuse to follow orders to do work which they, in good faith, believe to be in violation of the Act or its regulations.

ENFORCEMENT OF THE ACT.

PARTICIPATING IN FEDERAL INSPECTIONS: SECTION 103 (f).

The Act gives representatives of miners an opportunity to participate in Federal mine inspections. Congress and MSHA feel that miners, with their knowledge of the individual worksite, can provide the inspector with a great deal of useful information. Also, by watching an inspection, miners will better understand the Act's safety and health requirements and become more safety and health conscious. The Act allows the representative to participate in the inspection of the mine,and in conferences before and after the inspection.

Representatives of miners will be able to accompany Federal Inspectors during inspections involving enforcement of safety and health standards. On the other hand, the right of participation does not include technical consultations, equipment demonstrations, discussions on research or anything else not directly involving the enforcement of safety and health requirements. The right of participation does not normally include MSHA's investigation of alleged discrimination or of criminal violations of the Act.

A representative of miners who is also an employee of the operator is entitled not only to participate in the inspections,but also to suffer no loss of pay while participating.*

REQUESTING FEDERAL INSPECTIONS : IN GENERAL AND UNDER SECTION 103 (g).

At any time any person may, and is encouraged to, notify MSHA of any violation of the Act or safety or health standards, or of an imminent danger. Notice may be given by telephone, letter, or word of mouth to any MSHA inspector or office. If circumstances warrant, MSHA will then inspect the mine to see whether or not the violation or danger actually exists.

If the notice of the violation or imminent danger is in writing, signed by the representative or miner, and describes the nature and location of the violation or imminent danger, an inspection will be made as soon as possible by MSHA to see if the violation or danger actually exists, unless it is clear from the facts stated in the notice that the condition described would not be a violation or imminent danger. If the notice states that a violation of the Act or a safety or health standard exists, a copy of the written notice, with the names of the representative or miner and other named miners deleted, will

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be given to the operator before or at the time of the inspection. If the notice states that an imminent danger exists, the operator will be told immediately of the danger but not the identity of the representative or miner giving the notice, or of any other named miner. If the inspector finds that a violation or imminent danger exists, a citation or withdrawal order will be issued.

COMPENSATION OF MINERS IDLED BY WITHDRAWAL ORDERS: SECTION 111

Miners who are idled because of withdrawl orders issued under the Act are entitled to compensation. Miners working on the shift when the withdrawal order is issued, if idled by withdrawal order, are entitled to full regular pay for the time lost, but only for the balance of their shift. If the order is not terminated before the next shift, all miners on the next shift who are idled by the order must be paid at their regular rate of pay for the time they are idled, up to four hours.

If miners are ordered withdrawn from a mine or part of a mine because the operator does not comply with any health or safety standard, all miners who are idled because of the order will be paid for lost time at their regular rate of pay for the time they are idled up to one week.

ACCESS TO INFORMATION.

GENERAL : Section 103 (c) and (h)

Miners or their representatives can look at or get copies from MSHA or the Secretary of Health, Education and Welfare of most records. Information, reports, findings, citations, notices, orders, and decisions that the Act calls for. Records of each miner's exposure to potentially toxic materials and harmful physical agents are available to the miner or former miner from the operator.

POSTING DOCUMENTS ON MINE BULLETIN BOARD : Section 109.

Any order, citation, notice or decision required by this Act to be given to an operator shall be delivered to the mine office and a copy must be immediately posted on the mine bulletin board by the operator or his agent. In addition, MSHA shall immediately mail, or otherwise deliver, a copy of the order, citation, notice or decision to the representative of miners.

RECORDS OF EXAMINATIONS AND REPORTS FOR UNDERGROUND COAL MINES:
Section 303 (d), (f), (g), and (w).

Coal miners and their representatives have the right to inspect the recorded results of the following examinations, tests, and reports made in underground coal mines :

*Pre-shift examinations - Section 303 (d)
*Weekly examinations for hazardous conditions - Section 303 (f).
*Weekly ventilation examinations - Section 303 (g), and
*Daily reports of the mine foremen and assistant mine foremen - Section 303 (w).

NOTIFICATION PROPOSING CIVIL PENALTY : Section 105 (a).

Whenever an operator receives a notice of proposed civil penalties for a safety or health violation cited by Federal Inspectors, a copy of the notice shall also be sent by MSHA to the representative of miners.

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OPERATOR'S RECORDS OF ACCIDENTS AND ACCIDENT INVESTIGATIONS : Section 103 (d)

The operator is required to investigate all accidents to determine the cause and the means to prevent a recurrence. The operator's records of accidents and accident investigations are open for inspection by "interested persons", which includes miners and representatives of miners.

MONITORING AND RECORDING EXPOSURE TO TOXIC MATERIALS OR HARMFUL PHYSICAL AGENTS: Section 103 (c).

When regulations are issued which deal with miners' exposure to potentially toxic materials or harmful physical agents, and which deal with the operators' monitoring or measuring of such materials or agents, the regulations shall also provide the miners and their representatives with an opportunity to observe the monitoring or measuring and to have access to all monitoring or measuring records. Each miner or former miner will have access to his or her own exposure records. The operator must promptly notify any miner of his or her overexposure and the action being taken to correct the condition.

UNDERGROUND COAL MINE MAPS : Section 312(b).

Coal miners or their representatives may inspect maps of the underground coal mine at which the miners work.

ROOF CONTROL PLANS FOR UNDERGROUND COAL MINES : Section 302 (a)

A copy of the approved roof control plan for every underground coal mine shall be available for inspection by miners employed in the mine and by their representatives.

ONTARIO, CANADA.

The following excerpts are taken from the Occupational Health and Safety Act that applies to mines in Ontario, Canada (Revised Statutes of Ontario, 1980, Chapter 321).

PART II

ADMINISTRATION.

8 (2) . The employer shall cause a joint health and safety committee to be established and maintained at the work place unless the Minister is satisfied that a committee of like nature or an arrangement, program or system in which the workers participate is, on the date this Act comes into force,established and maintained pursuant to a collective agreement or other agreement or arrangement and that such committee, arrangement, program or system provides benefits for the health and safety of the workers equal to, or greater than, the benefits to be derived under a committee established under this section.

A committee shall consist of at least two persons of whom half shall be workers who do not exercise managerial functions to be selected by the workers they are to represent or, where there is a trade union or trade unions representing such workers, by trade union or trade unions.

(6) It is the function of a committee and it has power to,
(a) Identify situations that may be a source of danger or hazard to workers ;
(b) make recommendations to the contructor or employer and the workers for the improvement of the health and safety of workers.

(c) recommend to constructor or employer and the workers the establishment, maintenance and the monitoring of programs, measures and procedures respecting the health or safety of workers: and

(d) obtain information from the constructor or employer respecting.

(i) the identification of potential or existing hazards of materials, processes or equipment, and

(ii) health and safety experience and work practices and standards in similar or other industries of which the constructor or employer has knowledge.

(7) A committee shall maintain and keep minutes of its proceedings and make the same available for examination and review by an inspector.

(8) The members of a committee who represent workers shall designate one of the members representing workers to inspect the physical condition of the work place, not more often than once a month or at such intervals as a Director may direct, and it is the duty of the employer and the workers to afford that member such information and assistance as may be required for the purpose of carrying out the inspection.

(9) The members of a committee who represent workers shall designate one or more such members to investigate cases where a worker is killed or critically injured at a work place from any cause and one of those members may, subject to subsection 25(2) inspect the place where the accident occurred and any machine, device or thing, and shall report his findings to a Director and to the Committee.

(10) A constructor or an employer required to establish a committee under this section shall post and keep posted at the work place the names and work locations of the committee members in a conspicuous place or places where they are most likely to come to the attention of workers.

(11) A committee shall meet at least once every three months at the work place and may be required to meet by order of the Minister.

(12) A member of a committee is entitled to such time from his work as is necessary to attend meetings of the committee and to carry out his duties under subsections (8) and (9) and the time so spent shall be deemed to be work time for which he shall be paid by his employer at his regular or premium rate as may be proper.

9- 1. For work places to which the Workmen's Compensation Act applies, the Workmen's Compensation Board, upon the request of an employer, a worker committee health and safety representative or trade union, shall send to the employer, and to the worker committee, health and safety representative or trade union requesting the information an annual summary of data relating to the employer in respect of the number of work accident fatalities, the number of lost workday cases, the number of lost workdays, the number of non-fatal cases that required medical aid without lost workdays, the incidents of occupational illnesses, the number of occupational injuries, and such other data as the Board may consider necessary or advisable.

3) A Director shall, in accordance with the objects and purposes of this Act, ensure that persons and organizations concerned with the purposes of this Act are provided with information and advice pertaining to its administration and to the protection of the occupational health and occupational safety of workers generally.

10 There shall be a council to be known as the Advisory Council on Occupational Safety composed of not fewer than twelve and not more than twenty members appointed by the Lieutenant Governor in Council on the recommendation of the Minister.

(2) The members of the Advisory Council shall be appointed for such terms as the Lieutenant Governor in Council determines and shall be representative of management, labour and technical or professional persons and the public who are concerned with and have knowledge of occupational health and occupational safety.

(7) The function of the Advisory Council is and it has power,
(a) to make recommendations to the Minister relating to programs of the Ministry in occupational health and occupational safety; and
(b) to advise the Minister on matters relating to occupational health and occupational safety which may be brought to its attention or be referred to it.

PART V.
REFUSAL TO WORK WHERE HEALTH OR SAFETY IN DANGER.

(3) A worker may refuse to work or do particular work where he has reason to believe that

(a) any equipment, machine, device or thing he is to use or operate is likely to endanger himself or another worker;
(b) the physical condition of the work place or the part thereof in which he works or is to work is likely to endanger himself; or
(c) any equipment, machine, device or thing he is to use or operate or the physical condition of the work place or the part thereof in which he works or is to work is in contravention of this Act or the regulations and such contravention is likely to endanger himself or another worker.

(4) Upon refusing to work to do particular work, the worker shall promptly report the circumstances of his refusal to his employer or supervisor who shall forthwith investigate the report in the presence of the worker and, if there is such, in the presence of one of,
(a) a committee member who represents workers, if any;
(b) a health and safety representative, if any; or
(c) a worker who because of his knowledge, experience and training is selected by a trade union that represents the worker, or if there is no trade union, is selected by the workers to represent them,

who shall be made available and who shall attend without delay.

5. Until the investigation is completed, the worker shall remain in a safe place near his work station.
6. Where, following the investigation or any steps taken to deal with the circumstances that caused the worker to refuse to work or do particular work, the worker has reasonable grounds to believe that,

(a) the equipment, machine, device or thing that was the cause of his refusal to work or do particular work continues to be likely to endanger himself or another worker ;
(b) the physical condition of the work place or the part thereof in which he works continues to be likely to endanger himself; or
(c) any equipment, machine, device or thing he is to use or operate or the physical condition of the work place or the part thereof in which he works or is to work is in contravention of this Act or the regulations and such contravention continues to be likely to endanger himself or another worker,

the worker may refuse to work or do the particular work and the employer of the worker or a person on behalf of the employer or worker shall cause an inspector to be notified thereof.

7. An inspector shall investigate the refusal to work in the presence of the employer or a person representing the employer, the worker, and if there is such, the person mentioned in clause (4)(a),(b), or (c).

8. The inspector shall, following the investigation referred to in subsection

(7) decide whether the machine, device, thing or the work place or part thereof is likely to endanger the worker or another person.

(9) The inspector shall give his decision, in writing, as soon as is practicable, to the employer, the worker, and if there is such, the person mentioned in clause (4) (a) (b) or (c).

(11) Pending the investigation and decision of the inspector, no worker shall be assigned to use or operate the equipment, machine, device or thing or to work in the workplace or the part thereof which is being investigated unless the worker to be so assigned has been advised of the refusal by another worker and the reason therefor.

REPRISALS BY EMPLOYER PROHIBITED.

(1) No employer or person acting on behalf of an employer shall,

(a) dismiss or threaten to dismiss a worker;

(b) discipline or suspend or threaten to discipline or suspend a worker ;

(c) impose any penalty upon a worker ; or

(d) intimidate or coerce a worker,

because the worker has acted in compliance with this Act or the regulations or an order made thereunder or has sought the enforcement of this Act or the regulations.

APPENDIX E - MODEL OF FUNCTIONS PERFORMED BY TEAM LEADERS

Reproduced here is the summary of the 'model of leadership behaviour' of stope team leaders proposed by Moerdyk (1983).

I. MANAGING

1. Planning/Coordinating

(a) Setting goals and objectives
(b) Defining tasks needed to accomplish goals
(c) Coordinating activity of subs to keep work going smoothly
(d) Development of "crises management" plan
(e) Developing more efficient systems

2. Organizing

(a) Assigning tasks to personnel
(b) Scheduling work, timetables
(c) Ensuring materials and equipment available

3. Controlling and evaluating

(a) Inspection of individual workers
(b) Walking around and checking - touring
(c) Correction of poor workers
(d) Disciplining

4. Motivating

(a) Allocating formal reward eg recommend for promotion
(b) Setting high standards
(c) Giving praise, appreciation, contingent approval
(d) Giving positive feedback
(e) Appealing to pride in group
(f) Use of threats and sanctions
(g) Arbitary demand for conformity

5. Developing/training

(a) Induction of novices
(b) Initial close supervision, followed by relaxation of control
(c) Analysis of common mistakes - correction
(d) Training during slow periods
(e) Knowledge of all job components
(f) Promotion on ability not seniority, friendship or ethnicity
(g) Helping subordinates with personal problems

6. Group Maintenance

(a) Control of intergroup conflict
(b) Stabilization of subgroups
(c) Transfer newest and/or lowest skilled
(d) Correct balance between maintenance and task functions
(e) Team building
(f) Individual support
(g) Sharing of production bonuses

II. COMMUNICATION

7. Information gathering

(a) Regular enquiry about working conditions
(b) Listening skills
(c) Regular enquiry about individual conditions
(d) Reportage system so that problems are brought to him
(e) Getting information from above
- line
- staff
- unions

8. Understanding the information

(a) Recognition of environmental hazards
- environment
- equipment

(b) Recognition of personnel problems:
- intoxication
- injury
- depressed mood
- illness
- psychological stress
- physical stress
- aggression

9. Transferring information

(a) Fluency in Fanakalo
(b) Fluency in other languages
(c) Ability to give instructions
(d) Reprimand in private
(e) Praise in public
(f) Use of non-emotive, non-threatening language
(g) Calling meetings
(h) Ability to read
(i) Ability to write
(j) Numeracy

III INTERPERSONAL

10. Downward influencing

(a) Acceptance by workers of Team Leaders
(b) Nature of power-base used:
- coercive; force
- structural; position
- charismatic; personality

11. Upward influencing

(a) Knowledge of miner's language (English, Afrikaans)
(b) Good relationship with miner
(c) Good relationship with other superordinates
(d) Recommendations and suggestions accepted by superordinates
(e) Use of threats and sanctions:
- by miner
- by team leader

11. Upward influencing

(a) Knowledge of miner's language (English, Afrikaans)
(b) Good relationship with miner
(c) Good relationship with other superordinates
(d) Recommendations and suggestions accepted by superordinates
(e) Use of threats and sanctions: - by miner
- by team leader

IV PROBLEM SOLVING

12. Identification

(a) Search and scan techniques
(b) Recognition of environmental problems
(c) Recognition of mechanical problems
(d) Recognition of electrical problems
(e) Recognition of hydraulic problems
(f) Recognition of human problems

13. Interpretation

(a) Recognition of implications of problems or deviations
- for safety
- for production
(b) Takes unnecessary risks
(c) Seeks confirmatory evidence

14. Weighing Alternatives

(a) Knowing what alternatives exist
(b) Knowing the likely outcome of each alternative
- for safety
- for production
(c) Inhibitions of immediate response while alternatives are considered
(d) Ability to reach decision in shortest possible time
(e) Consultation with others

15. Taking Action

(a) Having decided on action, instituting it efficiently
(b) Delegation of tasks

16. Prevention/Anticipation

(a) Decision analysis
(b) Situational analysis
(c) Restructuring to prevent further mishaps
(d) Further training if necessary
(e) Disciplinary action if needed
(f) Replenishment of stocks
(g) Check equipment, upgrade

17. Tactical/strategic

(a) Decision making:
- not appropriate to first level supervisors