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FINAL REPORT:
REVIEW OF BEST PRACTICES FOR ESCAPE AND RESCUE FROM UNDERGROUND COAL MINES IN SOUTH AFRICA

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EXECUTIVE SUMMARY

NIOSH has formed a task force to explore the critical area of escape and rescue in coal mines. As part of their brief they have been charged with identifying the world's best escape and rescue practices. Because South Africa is a major producer of underground coal, and has devoted considerable time and resources into research on escape and rescue, it is essential that their systems be well understood. BBE Consulting has been requested to assist the NIOSH task force in providing such information.

Firstly a comprehensive information search for all the available documentation on escape and rescue strategies, practices and regulations currently used by South Africa's underground coal mining industry was conducted. The report describes in some detail how South Africa has derived at its current risk based and outcomes driven legislation pertaining to Escape Preparedness and Rescue, how this is enforced by government, and how mines comply.

No reliable documentation could be found describing the effectiveness of the application of the new legislation in practice during emergencies. Accident statistics do however show an improvement since the introduction of the "new" risk and outcomes based legislation. However, statistical data is not available which would allow for the direct interpretation as to what is the direct impact of the implementation of the emergency preparedness and escape legislation.

As far as could be ascertained, after the publishing of a Guideline for a Mandatory Code of Practice for Escape and Rescue by the Chief Inspector of Mines, no further legislation on this topic is expected in the near future.

An assessment was done on issues relating specifically to personnel/human behavior, leadership, escape behavior, interface with local community emergency responders, traumatic incident stress and physical limitations. It was found that these issues are comprehensively addressed at Mine Rescue Service level [brigadesmen], and to a lesser extent at general mine level, where mainly management is exposed to this type of training.

It was found that underground coal mines use technologies for communication/ tracking, air monitoring, rapid drilling, etc. that are generally available and proven. Each mine house has its own preferred strategy and equipment selection. This ranges from off- the-shelf-equipment usage to specialist equipment and systems development [both in-house and external development]. Due to the risk based nature of the legislation, committees are required to review the strategies and technologies and to make recommendations based on current industry best practices.

Post incident equipment requirements are based on a risk based approach. Equipment used must not adversely increase the risk associated with the prevailing situation. The

equipment used during an emergency response is authorized by the manager in charge of the incident with specialist input from Mine Rescue Services.

Command Center and Control Room procedures are addressed comprehensively in the Guideline for a Mandatory Codes of Practice for Escape and Rescue. This guideline document stipulates the minimum requirements of a control room. It was developed in a tripartite forum using the experience of people involved in actual emergency and response scenarios.

All mine Rescue Team brigadesmen are currently trained by the same service provider. This means that all brigadesmen in South Africa use the same equipment and protocols when responding to an emergency. By having a single service provider in South Africa the statistics on South African brigadesmen is comprehensive and is reflected in the report.

The training requirements for brigadesmen are rigorous with re-training every quarter. This includes training in mock situations, e.g. the building of vent walls, construction and use of spray pipes, working in foam, working is smoke, etc, fitness evaluations, as well as annual heat tolerance screening. Specialised training e.g. ambulance assistance training, rope training, etc. is also conducted. Formalised training is also required for management as part of their minimum required training to qualify as a mine manager, but is much less intensive. Mines Rescue Service also provide a course on Control Room Procedures which they are encouraged to attend. On the job training also forms part of the “training” of management in emergency preparedness and rescue. Training of supervisors and workers generally takes the form of annual compulsory induction courses. The content of these courses is not standardized, and vary in quality and content. Some mining houses send their miners on specialized emergency preparedness courses to the Kloppersbos Explosion testing facility. Here they are exposed to the causes of fires and explosions, and also witness a large scale coal dust explosion.

Although there have been some severe explosion and fire incidents in the history of the South African coal mining industry, no reliable investigation reports could be sourced. Inquiries into the incidents were held, but public domain detailed records could not be found for the purposes of this study.

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LIST OF ABBREVIATIONS

CoP	Code of Practice
COMRO	Chamber of Mines Research Organisation
DME	Department of Minerals and Energy
EAP	Employee Assistance Program
EPR	Emergency Preparedness and Response
FAB	Fresh Air Base
HIRA	Hazard Identification and Risk Assessment
HEG	Homogenous Exposure Groups
OEM	Original Equipment Manufacturer
OHS	Occupational Health and Safety
ILO	International Labour Organization
MHSA	Mine Health and Safety Act
MHSC	Mine Health and Safety Council
MHSI	Mine Health and Safety Inspectorate
MOHAC	Mine Occupational Health Advisory Committee
MQA	Mine Qualifications Authority
MRAC	Mine Research Advisory Committee
MRS	Mines Rescue Services
NUM	National Union of Mine Workers
OFS	Orange Free State
SABS	South African Bureau of Standards
SANS	South African National Standard
SAQA	South African Qualifications Authority
SCSR	Self Contained Self Rescuer
SETA	Sector Education and Training Authority
SGB	Standards Generating Body
SIMRAC	Safety in Mines Advisory Committee
SMS	Short Message Service
TPLD	Trapped Person Location Device
TRUGAS	Transportable Underground Gas Analysis System
US	United States [of America]

1 Background to Study

NIOSH has formed a task force to explore this critical area and recommend improvements to the escape and rescue systems currently being used by US coal mines. This task force has been charged with identifying the world's best escape and rescue practices and developing guidelines for optimizing the chances of successful escape and rescue for US underground coal mines. Because South Africa is a major producer of underground coal, and has devoted considerable time and resources into research on escape and rescue, it is essential that their systems be well understood by US researchers. BBE Consulting has therefore been requested to assist the task force in providing such information.

2 Scope of Work

BBE Consulting scope of work consisted of the following three main focus areas:

2.1 Current South African Practices

Perform a comprehensive search of all the available documentation on escape and rescue strategies, practices and regulations currently used by South Africa's underground coal mining industry.

Collate this information specifically focusing on

- Current strategies and practices, including any reliable evidence regarding their effectiveness and limitations;
- Comment on anticipated or considered changes to current practices, and the possible reasons for the changes; and
- Record the participants involved, and the procedures under which changes are accomplished and the time frames required doing so.

Topics addressed must at least include:

- Personnel/human behavior issues including leadership, escape behavior, interface with local community emergency responders, traumatic incident stress and physical limitations;
- Current and anticipated technologies for communicating/tracking, air monitoring, rapid drilling etc;
- Command centre and control room issues including procedures, interpersonal dynamics and training requirements;
- Mine rescue team and first responder's issues including current protocols and methods, training and technologies. Also, any available data concerning rescue team members age, experience and turn over should be included;
- Training requirements. Describe training procedures and standards for coal miners, supervisory personnel and mine rescue teams;

- Standardization. Describe the extent to which mine emergency language, symbols, training, practices etc, have been standardized throughout South Africa; and
- Logistics. Describe who has responsibility for procuring resources needed by the responders, warehousing of supplies, support for rescuers, families and media and co-ordination of all responding organizations.

2.2 History of South African Incidents

Identify copies of reports on incidents in which coal miners in South Africa either escaped or were rescued from a life-threatening situation caused by underground fires or explosions since 1990. Include historical information about coal mining disasters in South Africa over a period of time long enough to see the effect of changes in Escape and Rescue practices at underground coal mines.

2.3 South African Mines Rescue Services

Gather and collate information about mine rescue teams including at least the following:

- Number of teams;
- Number of times the teams have been called into help;
- The number and types of incidents prompting call outs [e.g. fires, explosions, inundations, ground falls]; and the outcome of their efforts, i.e. number of miners rescued.

3 Current South African Practices

3.1 Legislative Drivers

3.1.1 Background to the Mine Health and Safety Act

South Africa has long since prided itself as being an advanced mining country with regard to the development of innovative technologies for exploiting mineral resources. In the past, the same cannot be said about safety and occupational health issues in the mining industry. Continuous pressure from the National Union of Mineworkers [NUM] resulted in the government and employers agreeing to the formation of a commission to investigate these conditions. The Leon Commission of Inquiry was the first investigate Occupational Safety and Health in the South African mining industry for more than 30 years.

The Leon Commission held hearings from August to September 1994, and published its report in April 1995. It concluded that the incumbent regulatory framework for health and safety in mines was inadequate and that existing laws had been inadequately enforced.

Based on the findings of the Leon Commission a number of recommendations were made to improve safety and health at South African mines. One of the

recommendations that were made was to draft a new Mine Health and Safety Act which would provide a comprehensive legal framework for creating a healthy and safe working environment. Other pertinent recommendations made were that the enforcement agency, research institutions and health information systems be restructured, as well as that appropriate training and certification of all workers in the industry be carried out.

This led to drastic changes in South African legislation. Prior to the Mine Health and Safety Act Number 29 of 1996 [MHSA], mining legislation was of a prescriptive type, whereas MHSA places the responsibility on the operator to identify all the risks and implement measures to eliminate the risk.

In terms of MHSA the employer is ultimately responsible for the health and safety on a mine. MHSA allows the employer to appoint a manager but this does not relieve the employer of any duty imposed on employers by the MHSA.

Furthermore MHSA requires the employer to identify all hazards in the workplace, assess the health and safety risks to which employees may be exposed while they are at work, and record the significant hazards identified and risk assessed.

The employer must determine how the significant risks identified in the risk assessment must be dealt with. As far as possible an attempt should be made to firstly eliminate the risk, thereafter be controlled at source or at least minimized and lastly personal protective equipment be issued and a monitoring programme instituted.

To assist the employer with the risk assessment process all possible relevant information such as accident statistics, locality of mine and emergency services, ergonomic studies, research reports, manufacturers' specifications, approvals, design criteria and performance figures for all relevant equipment, should be considered.

3.1.2 Emergency Preparedness and Response Legislation

Previous legislation on Emergency Preparedness and Response [EPR] stated that the manager of a mine should draw up a Code of Practice [CoP] for rescue operations ensuring that:

- Every person who goes underground is adequately trained in the use of self-rescuing devices; and
- Every person who goes underground is adequately trained in the escape procedure to ensure his survival as far as possible, in the event of an explosion, fire or other emergency.

Although this legislation required that a CoP be developed for rescue operations, there were no stipulated provisions to which the CoP should comply.

Although the EPR under the new MHSA is still under review, new regulations pertaining to this issue have been promulgated into law [via a Government gazette, dated 1 February 2008, reference number 30697].

The MHSA of 1996, Chapter 16 of the Regulations contains the responsibilities of employers with regard to “First Aid and Emergency Preparedness and Response”.

The regulations focus on three main areas namely:

- The appointment of a competent person to report to the employer on the risks of explosions, fires and floods and the alleviation thereof;
- The issuing and monitoring of belt worn self-contained-self-rescuers; and
- Emergency preparedness and response minimum requirements.

The main focus of the emergency and preparedness and response section is related to the requirements and functioning of Mine Rescue Services [MRS] at a mine in case of an emergency.

A copy of Chapter 16 of the Act is reflected in Appendix B.

3.1.3 Explosion Protection of Underground Equipment

Mines where explosive gas, vapour or dust atmospheres may form must be equipped with explosion protected electrical, electronic and mechanical equipment, i.e. equipment that has an acceptable low risk of creating an ignition source.

As methane gas is considered to inherent to coal seams, all underground coal mines need to comply with explosion protection legislation.

Since 1950, testing of explosion protected apparatus has been conducted in South Africa by independent laboratories as required by law.

Typical aspects to be are considered in underground collieries include:

- Classification of potentially hazardous locations [determining the risk of creating an explosive atmosphere];
- Selection of appropriate explosion protected equipment [balancing the above risk with the risk of causing an ignition and therefore an explosion]; and
- Inspection, maintenance and repair of explosion protected apparatus [keeping equipment in a condition that will not increase the ignition risk].

Requirements for explosion protection in underground mines are found in the Mine Health and Safety Act as shown below.

Table 3.1 Explosion Protection Regulations

Regulation	Aspect Relevant	National Standard	Responsible Person
R2[1], R21.17.1	Area classification	SANS 10108	Mine Management [except compulsory hazardous locations]
R21.17.2	Selection of Ex equipment	SANS 10108	Mine Management
R21.17.2	Certification of Ex equipment and systems	SANS 10108	Approved Inspection Authority
R21.1.1.1	Ex installations	SANS 10086-2	Engineer or other Responsible Person
R21.1.1.1, 21.14.3,21.15 etc	Use, inspection and maintenance of Ex equipment	SANS 10086-2	Mine Management
R21.17.5	Repair of Ex equipment	SANS 10086-3	Accredited Repairer, or re-test

3.1.4 Mechanisms Assisting and Ensuring Compliance with Legislation

In the South African mining environment there are various mechanisms that are used to ensure compliance with legislation. The mechanisms include guidelines for mandatory CoP, Chief Inspectors Instructions and Directives, Guidance notes, responsibilities for ensuring compliance with legislation, and the role of the inspectorate, employers and employees respectively.

For more detail pertaining to these aspects refer to the BBE report, titled “Review of best practices regarding the use of refuge chambers in South Africa, BBE Report No. 5207 dated September 2007. A summary is given in Appendix C.

3.1.5 Guidelines for Mandatory Codes of Practice

In terms of Section 9.1 of the MHSA, employers are required to prepare and implement CoP on any matter affecting the health and safety of employees.

A new “Guideline for the Compilation of a Mandatory Code of Practice for Emergency Preparedness and Response” has been developed and has been approved by the tripartite structures of the Mine Health and Safety Council [MHSC] in January 2007. This Guideline still has to be authorised by the Chief Inspector of Mines before it comes into effect.

The scope of the guideline relates to measures or procedures that need to be established to prepare for, respond to, and recover from the impact of emergencies but do not address any emergency prevention aspects.

This guideline will address issues relating to hazard identification and risk assessment, detection and early warning systems, communication systems, first aid equipment and facilities, mine evacuation and escape strategy, rescue and response capabilities, management of emergencies and education, training and awareness.

The guideline will also contain information on refuge chambers; emergency control centre structure and procedures, and duties and responsibilities; and additional references that can be used in the drawing up of the CoP.

In order for any mine specific CoP to be developed or revised, employee organisations are required to participate. Should an urgent need arise for revisions to be made to these documents it could be accomplished in a short time period if all parties agree on the required change.

It is required by law that the CoP be reviewed periodically. In addition to the periodic review it is also required that the CoP be reviewed and updated after every emergency, altered circumstances at the mine, or if significant changes are introduced to procedures, mining and ventilation layouts, mining methods, plant or equipment and material.

3.1.6 Chief Inspectors Instructions and Directives

No Chief Inspectors instructions and directives in force with regards to Escape and Rescue could be sourced.

3.1.7 Guidance Notes

No current guidance notes related to Escape and Rescue could be sourced.

3.1.8 Mining Qualifications Authority

The Mining Qualifications Authority [MQA] is a statutory body consisting of the State, Employer and Employee organizations in the mining industry. It was established in terms of the MHSA and is a registered Sector Education and Training Authority [SETA] for the Mining and Minerals Sector in terms of the Skills Development Act No 97 of 1998.

Under this framework a unit-standard referring specifically to emergency preparedness and response exists. The standard is as follows:

- SAQA Unit standard 116533: Demonstrate basic knowledge and understanding of emergency preparedness and response.

Appendix D reflects the levels of proficiency that students have to demonstrate.

3.2 In Practice

3.2.1 Explosion and Fires Competent Person Appointment

The regulations of the MHSA requires that the employer must ensure that a competent person reports to the employer, at appropriate intervals determined in accordance with the mine's risk assessment, on the adequacy of escape and rescue procedures at the mine relating to explosions, fires and flooding. The competent person must be trained in risk assessment techniques.

3.2.2 Issuing and Monitoring of Belt Worn Self-Contained-Self-Rescuers

The MHSA requires that employers ensure that no person goes underground at any coal mine without a body-worn self contained self rescuer [SCSR], which complies with the South African Bureau of Standards specification SANS 1737. This standard requires that batches of newly developed SCSR be tested against oxygen generation capacity, carbon dioxide scrubbing, breathing resistance and air temperature. The operational duration until the unit 'fails' against one of these parameters is taken as the operational duration of the tested unit. Legislation does not specify a minimum duration. The units are however rated for duration by the OEM following receipt of SABS test results. In South Africa chemical based SCSRs are used and have tested operational durations varying from 15 minutes to 30 minutes. Mines will ensure that their refuge bays are situated within the rated limits of the capacity of the SCSR in use. There are three major suppliers of chemical based body-worn SCSRs in South Africa i.e. Afrox, Dräger and MSA.

In addition, regulations of the MHSA require that any body-worn SCSR supplied to any full time employee at the mine be allocated for the employee's sole use, for the duration of the operation of that SCSR, until that SCSR becomes defective and the employee is issued with another SCSR.

Furthermore the employer must ensure that no defective SCSR is issued for use to any employee at the mine. To ensure this the employer must annually have a representative sample of the SCSRs at the mine tested by an organization accredited to do so in terms of the South African National Accreditation System. The assessment must include the structural integrity and functional performance testing of the units. Such representative sample must not be less than 1% of the SCSRs at the mine and must be representative of the age and deployment of the SCSRs.

The employer is also required to keep records of the following information on SCSRs at the mine, for the preceding 24 months:

- Total number and makes of SCSR in service at the mine;
- Number and make of SCSR purchased by the mine in that period;
- Number and make of SCSR withdrawn from use by the mine in that period;
- The number of shifts worked per day [1 , 2 or 3];
- Number of SCSR in daily use [average for each month];

- Number of employees underground [average per shift];
- Number of spare SCSR available [average per month];
- A tabulation of the type of defects found;
- Number of SCSR repaired/refurbished; and
- Number of SCSR tested in terms of regulation.

3.2.3 Codes of Practice Contents

As stated previously an approved MHSC Guideline for a Mandatory CoP which has been developed by an industry tripartite committee will be issued in due course by the Chief Inspector of Mines [Department of Minerals and Energy].

The coal mining industry was represented on this committee and hence its members have had an insight into the contents of this Guideline. Due to the imminent release of this document into law, collieries have started to develop mine specific CoP based on the requirements thereof.

Furthermore to this, the Mine Ventilation Society of South Africa's Collieries Branch holds periodic workshops where new legislative issues are discussed, the content of the proposed regulations are scrutinized and disseminated, and best practices is discussed openly between the various mining houses.

Once the Guideline document is issued, the CoP for EPR requires that the Employer sets out how the significant risks are identified and assessed. Unless there is no significant risks the following must be included in the CoP:

Timeous Detection of Emergencies
In order to ensure that emergencies are detected as early as possible and persons are warned timeously of such emergencies, the following aspects need to be addressed:

- Types and position of fixed detectors/early warning systems [localised alarms, stench gas, etc.] for the timeous detection and early warning of all identified possible emergencies e.g., fires, flooding/mud rushes, seismicity, gases, chemical/toxic/biological releases, lightning, power failures, etc.;
- Types and quantity, including back-up units, of personalised detectors/early warning systems e.g. flammable gas measuring instruments, flammable gas warning devices, Carbon Monoxide detectors, pagers, radios, etc;
- Detailed procedures for the issue of detectors/early warning systems to personnel [Generally it is recommended that the lamp room guidance note issued by the Chief Inspector of Mines be consulted, OH-11-2003 dated 30-06-2003];
- Procedures to ensure that actual settings of alarm levels remain effective; and
- Frequency of maintenance, calibration and testing procedures.

Various types of monitoring systems are used, either in-house designed or constructed or designed and constructed by sub contractors/suppliers. All typical systems use fixed line communication networks that reports into a central control room. Of the more

advanced systems use cell phone Short Message Service [SMS] to inform responsible person/s of trigger events that has occurred. They also allow remote login of responsible persons to the central control room to enable them to monitor the mine environmental conditions.

There is no legislation that requires mine wide monitoring systems to remain either functioning or be isolated after an incident. The outcome of the risk assessment process would dictate the requirement for each specific mine.

Communication Systems
In order to ensure that appropriate communication systems are in place to deal with an emergency at least the following aspects need to be addressed:

- Type and position of a system for communication at the mine to enable effective communication to deal with an emergency, including arrangements for a back-up system;
- Arrangements for communications from the mine to outside parties; and
- The testing of the effectiveness of the communication systems on a frequent basis.

Typical communication systems in underground coal mines is fixed line communication systems [different manufacturers] from typically production sections and refuge bays to a central control room on surface.

There is no legislation that requires communication systems to remain either functioning or be isolated after an incident. The outcome of the risk assessment process would dictate the requirement for each specific mine.

Medical Care and Facilities
In order to ensure that appropriate emergency medical care and facilities are readily available to deal with any emergency at least the following aspects need to be addressed:

- Arrangements for the provision of emergency medical care, including the locality of facilities, provision of suitably trained medical persons, response times, capabilities to treat and evacuate multiple injured persons, etc.; and
- Availability, location, quantity and variety of emergency medical equipment.

Mine Evacuation and Escape Strategy
In order to ensure the safe evacuation and escape of affected persons to a place of safety at least the following aspects need to be addressed:

- Procedures for the escape and/or rescue of persons from e.g. single and multiple entry working places, surface working places, confined spaces, elevated places, etc.; and

- Provision of places of safety, including the locality, quantity, distance in relation to working places and the provision of life sustaining facilities, such as food, potable water, breathable air, etc. [When body-worn Self-Contained Self-Rescuers are issued it is recommend that the document issued by the Chamber of Mines Research Organization [COMRO] 'ResQpacs; How to calculate safe travelling distances', be consulted]. Refer to Appendix F.

Training and Awareness

In order to ensure that all potentially affected persons are educated, trained and made aware on how to deal with emergencies at least the following needs to be addressed:

- The content and frequency of such training [Section 10[2][d] of MHSA needs to be referred to];
- The procedures and appropriate actions to be taken in the event of an emergency, including simulated exercises;
- The correct procedures and applications on the use of emergency equipment;
- The actions required relating to the location and description of shutdown controls/lock out devices;
- Instructions in the use of belt-worn SCSR; and
- The location of copies of the emergency procedures and instructions.

Rescue and Response

In order to ensure that emergencies are reacted to timeously with adequate rescue and response capabilities the CoP must detail and describe at least the following:

- The requirement, necessity and access to rescue and response capabilities, e.g. number of rescue personnel, arrangement for mobilisation, variety and access to specialised rescue equipment, remoteness of the mine, response times, etc;
- The arrangements with a mines rescue service provider, as contemplated in regulation 16.5.[1][c] and/or with any other rescue service provider; and
- Additional instrumentation and equipment available to maintain rescue brigades, e.g. a means to detect carbon monoxide, carbon dioxide, flammable gas and oxygen, ancillary rescue equipment, etc.

Emergency Management
In order to ensure that emergencies can be managed and dealt with effectively the CoP must cover at least the following:

- Procedures for the updating of emergency manuals, contact details of neighbouring mines, contact details of emergency services, internal and external telephone directory;
- Establishment of emergency control centre/s including location, size, equipment required, plans, communication, etc;
- The duties and responsibilities of persons required during an emergency ; and
- Procedures to deal with adverse environmental conditions, which could be encountered during an emergency, e.g. flooding, gases, heat, etc.

Maintenance and Reporting
In order to ensure that the EPR measures and procedures remain effective, the CoP must cover at least the following:

- The procedure for the inspection, testing and maintenance of all equipment and facilities that may be used in an emergency, at appropriate intervals, and by persons designated by the employer for this purpose; and
- The reporting, recording and archiving, at appropriate intervals, of those measures and procedures and the person/s responsible to do so.

The CoP must also be cross-referenced using the following:

- Procedures for the updating of emergency manuals;
- Contact details of neighbouring mines;
- Contact details of emergency services;
- Internal and external telephone directory;
- Establishment of emergency control centre/s;
- The duties and responsibilities of persons required during an emergency; and
- Procedures to deal with adverse environmental conditions, which could be encountered during an emergency, e.g. flooding, gases, heat, etc.

3.2.4 Emergency Control Centre Requirements

A well-designed and efficient control centre is the key to success in controlling an emergency operation.

In the Guideline for a CoP for EPR, clear guidelines are given as to what the minimum requirements for an emergency control centre are, as well as the persons involved and their respective responsibilities.

The objective of the guideline is to ensure an orderly and efficient transition from routine operations to effective mine emergency response.

Physical Features and Equipment of a Control Room

Size

There is no prescribed minimum size of a control room, however dimensions of 35 m^2 are generally considered to be adequate. A large room encourages convergence of unnecessary personnel who hinder the efficient running of the control room/centre. It is advantageous to separate the control room from the rescue team briefing room. The briefing room could also house the gas chromatograph, radios, batteries and battery chargers as well as the mine ventilation and rescue plan and location plan. The mines rescue service provider representative should have a separate office with outside communication facilities.

Plans

In addition to the Mine Ventilation and Rescue plan, as required by the MHSA regulation 17[19], adequate up to date copies thereof must be available for every rescue team proceeding underground.

Location plans - Large-scale locality plans and small scale plans of area should be available.

The master working plan, laid flat on a table must be continuously updated during the emergency with the following information:

- Position of Fresh Air Base [FAB] with required telephone numbers;
- Exact location of all seals and stoppings completed and under construction;
- Position of rescue teams, whether at FAB or performing a task [use detachable adhesive decals];
- Demarcation of numbered monitoring points with the latest results [Detachable labels showing time of measurement and result];
- Airflow directions and quantities;
- Escape routes;
- Position of explosive boxes;
- Sub-stations and electrical gear;
- First aid stations;
- Telephone positions and numbers;
- Refuge bays;
- Water and air valves;
- Ventilation doors and regulators [opened or closed];
- Fire doors; and
- Identified risks e.g. open ore passes, fall of ground, gas emissions, water accumulations, etc.

Other plans should be available indicating:

- Water reticulation; and
- Compressed air reticulation.

It must be stressed that the plan issued to rescue teams must be identical to the master plan to avoid any confusion.

The numbering of stoppings, gas monitoring points and any other relevant information must be entered on all plans [coding of these points must correspond with rescue teams reports].

Telephone and Communication
No emergency operation can function efficiently without a good communication system.

To achieve this, it is management's responsibility to ensure the following systems are immediately established:

- A fixed line unrestricted by area dialling, to facilitate calls for example to emergency equipment suppliers and the requisitioning of rescue teams by mines rescue service provider;
- Internal [PABX type] telephone system for mine calls;
- Telephone communication with the FAB; and
- A dedicated line or an interface from the control room/centre down the mine to the FAB to facilitate communications between the sub-strata radios and telemetering systems.

Furniture and Fittings
Adequate table space must be available for work on plans.

The person responsible for keeping the records of all procedures [scribe] should be separated from the desk of the manager in control, to prevent distractions by other activities.

If a separate rescue team briefing area cannot be provided, then sufficient space and table layout should be made available to accommodate at least 2 teams concurrently.

A small stationery cupboard, kept locked when not in use, containing coloured pens, writing materials, graph paper, detachable labels, team briefing, instruction sheets and a copy of the CoP of EPR should be provided.

Plan covers, available from the mines rescue service provider should also be available in order to protect plans taken underground.

Pin boards, fixed to the wall should be of sufficient size to accommodate plans of all the mine workings mentioned in the section under Plans.

Lighting must, for obvious reasons adequate. Make provision for standby lighting in case of a power failure.

Seating facilities in the control room must be limited to prevent the natural tendency of well-intentioned people, with no specific function, to distract control management with unimportant matters.

A rescue team control board showing the times and movement of teams should be a permanent fixture.

All colliery control rooms should be equipped with a barometer and a graph for plotting the result of gas samples.

Provide for easy access/facilities to monitor gas detector trends and major ventilation equipment status.

General Organisational Structure of a Control Room

Personnel Requirements

During the immediate post disaster period, control efficiency is reduced for 3 main reasons.

(a) Lack of accurate information regarding the severity, extent and the exact location of the incident;
(b) The summoning of key personnel not fully utilised; and
(c) From [a] and [b] above - no clear plan of action having been formulated.

During this period, unauthorised personnel attempting to establish emergency procedures and systems, hamper management's decision making. These persons should not have access to the control room. Once the initial stage is resolved and a strategic plan has been adopted, the control room should be manned by the following personnel:

Manager in Charge

This person, usually of senior status, takes overall charge and responsibility during their shift in the control room.

Consequently all decision-making revolves around the person who should be the only to brief rescue teams, give instructions and communicate with rescue teams.

All special instructions given, known hazards and hazards reported by teams during the incident should be clearly and fully recorded in a situation log that is kept on a 24-hour clock system.

It is imperative that shift changeovers be performed thoroughly, and that the incumbent personnel in control is completely au fait with:

- The overall strategy;
- Progress thus far achieved;
- Available resources, both human and material;
- Ventilation flows and gas sampling records and trends;
- Temperatures, visibility and any other relevant information;
- Location of operating, back-up and standby rescue team; and
- Oxygen pressures of the teams breathing apparatus.

Only once the above has been communicated to the incoming manager, may the outgoing manager take leave of the control room.

The manager in charge should strive to avoid deviating from the pre-planned strategy. Changes of instructions lead to confusion and time wastage and also portray a lack of leadership and credibility.

The Manager in control must impart an attitude of urgency, efficiency, calmness, friendliness and discipline. [Be in control of the incident]

NB: Avoid placing a person in charge that has insufficient knowledge and experience of the area, fire fighting or rescue operations.

The manager must be receptive to accepting advice and not be dogmatic about their personal views. Back-up documentation and the identified checklist must be continuously referred back to.

Before any rescue team is deployed, the possibility of other risks associated with the emergency must be considered and assessed.

Decisions should be recorded and be based on:

- State of the ventilation;
- State of the atmosphere in the mine [in or near explosive range];
- Source of ignition. Great care should be exercised if spontaneous combustion is suspected;
- Presence of gas due to walls of sealed areas being damaged; and
- Likelihood of survivors.

Media Relations
Any emergency, particularly those that involve multiple fatalities, or missing employees are likely to be of public interest and liable to warrant the attention of the media.

Handling the media can be a sensitive matter. An early, open and technically accurate interview or statement with regular updates can result in fair and sympathetic reporting under what can be adverse circumstances.

It is well known that some media reporting can be emotive, speculative or inaccurate. This fact should be kept in mind when dealing with the media.

All statements issued by the mine to the media should be officially issued by the owners, mine manager or designated media liaison officer. No impromptu interviews and ad-hoc comments should be given by other officials.

Any media queries should be referred to the above mentioned persons and reporting of unsubstantiated positive developments should be avoided.

Ventilation Control
An experienced senior environmental official plays an invaluable role in fire emergency situations. Their knowledge and advice on airflow, quantities and expertise in identifying sealing sites for the construction of stoppings makes this individual an integral member of the control room team. [It may be necessary to call upon expertise of previous officials with knowledge of historical incidents].

By interpretation of gas samples and temperatures trends, coupled with knowledge of air movement across a fire, the ventilation specialist can, with a fair amount of accuracy, interpret the possible behaviour of the fire and effectiveness of the total strategy.

This ventilation department should be consulted in the following matters:

- Planning of reconnaissance patrols;
- Locating the incident using their up to date and comprehensively detailed mine ventilation and rescue plans;
- Giving advice on whether normal work can continue or be restarted in other areas.
- Provide gas detection instruments and ventilation staff to assist underground;
- The stopping and starting of any fans; and
- Checking of all matters relating to the environmental systems affected by the fire.

The Scribe
This should be a person well versed in mining operations, with experience on how to record the sequence of events.

The scribe's function is to maintain accurate comprehensive records of all proceedings, instructions and reports during the incident. These records can be in either a formal minute book or on prescribed forms, which are kept on file.

The Scribe's duties include recording the following:

- All special instructions from the manager in control and hazards reported or known;
- All information reported from the FAB or team captains via sub-strata radios or speakerphone;
- Material requirements for underground use and materials delivered underground;
- Maintenance of the rescue team control board;
- Safekeeping of rescue team pre-operational medical examination forms;
- A separate book for task progress to be maintained in collaboration with the manager in control;
- Maintaining a list or documentation regarding contact numbers, gas analysis monitoring forms, rescue team oxygen pressure etc.; and
- Gathering of duty rosters from discipline heads and display thereof in a conspicuous place.

Mines rescue service provider official

This official will automatically be present throughout the deployment of visiting rescue teams. They should also be available whenever requested by management. These officials have vast experience in various disasters and incidents and this experience can be effectively utilised in the formulation of a strategic plan and the ensuing control of operations.

This official's functions at an incident include but are not limited to:

- Advice and recommendations on options of fire control methods including types of equipment and materials available;
- Arranging for the supply of this equipment/material;
- Advice on rescue team modus operandi;
- Rescue team protection;
- Radio communication;
- Advice on working in hot and humid atmospheres;
- Assistance with continuous gas monitors;
- Identification of potential hazards to teams operating in or entering the area for the first time [risk assessment];
- Obtaining of other specialist's knowledge;
- Information around current technology available;
- The control and requisitioning of additional rescue teams;
- Repairs and maintenance to breathing apparatus as well as spot checks on leakage tests/systems checks;

- Meeting teams prior to deployment and informing them of strategies in progress and history of the emergency;
- Ensuring rescue team members compliance to code of practice with respect to inter alia:
    - Modus Operandi;
    - Ancillary and safety equipment;
    - Medical examinations;
    - Leakage/Systems checks on breathing apparatus; and
    - Competency levels to special tasks.

The aforementioned persons are the only personnel required to remain permanently in the control room. However, other skills and expertise are required frequently, and these people should be available if required, depending on the incident.

Runner
Usually of supervisor status. This person is required to ensure material called for is loaded and transported down the mine, deliver messages and perform general tasks which would otherwise compromise the duties of the control room team.

Engineering Department
A senior member of this department must be on immediate call for breakdowns or stoppages e.g. fans, pumps etc. It is also this persons duty to ensure continuous communication systems and an adequate water supply to the affected area, as well as alert ESKOM or other Electricity Suppliers to ensure uninterrupted electricity supply to the mine.

Arrange for 24-hour back up from the engineering workshop.

Survey Department
Personnel should be on call for the supply of plans and other related matters. i.e. to supply relevant telephone numbers or information regarding potential hazards [dykes, fissures, faults, new holings, open ore passes etc.]

Human Resources Department
Their responsibility includes:

- Compiling duty rosters to ensure continuity of service;
- Change-house facilities for visiting teams;
- Arrange guides and bearers for rescue teams;
- Arrange food and beverages;
- Press/news media control;
- Ensure tight security at mine entrances; and
- Arrange transport and accommodation for teams if required.

Stores
Required for the issuing and control of material and equipment.

Medical Staff
Required for the examination of the mines rescue teams if necessary and to provide coverage for any emergency during the operation.

Gas Monitoring/Analysis Personnel
Analysis of gas samples can be done by making use of for example, the Gas Chromatograph and the Mobile Gas Analysing Laboratory [MOGAL] on collieries.

Fresh Air Base Official
Where possible each FAB must be manned around the clock by an official. There is no job category for this official, but senior supervisor level is preferable.

Cognisance should be taken of persons with an intimate knowledge of the history of the affected area e.g. previous fires/ventilation breakdowns etc.

The functions of this person includes control of labour at the FAB, ensuring efficient off-loading of materials and equipment and the removal of empty material cars, preventing unauthorised entry past the FAB, manning the radio, ensuring communication with management in control.

Local knowledge of the area is of great importance to rescue teams and it is obviously advantageous if this official has this local knowledge.

It must be stressed however, that the line of communication between team captain and manager in control is direct, and no instructions to the teams should be given by the FAB official.

Shifts of the FAB official ought to be of 8-hour [12 hours bank to bank] duration and rosters must be timeously drawn up and displayed.

Security Department
Personnel are required to ensure crowd control and no unauthorised entry onto the mine. In addition they would be utilised for asset protection.

Duty Checklists for Emergency Control Room Personnel

Tables 3.1 to 3.7 lists the typical minimum duties that the key personnel in the control room need to perform as part of their duties and responsibilities during an emergency.

Table 3.2 Manager in Charge of Control Room Minimum Duties

No.	ACTION	RESPONSIBLE PERSON	COMPLETED	SIGNATURE
1	Only one legal technical qualified manager take control.			
2	Establish a Record Logbook and arrange for a Scribe.			
3	Notify Rescue Manager to arrange for two own rescue teams to report to control.			
4	Notify mines rescue service provider regarding rescue team utilisation and assistance.			
5	Notify Department of Minerals & Energy.			
6	Notify police in event of any fatalities.			
7	Arrange for press liaison personnel if applicable.			
8	Gather information from responsible persons and ask relevant questions.			
9	Identify affected areas. Evacuate employees from affected areas and clear shift.			
10	Identify critical equipment needed and delegate arrangement thereof			
11	Identify services needs and ensure availability.			
12	Brief all responsible persons accordingly [include contractors].			
13	Ensure all applicable persons sign a declaration of non-disclosure of information			
14	Barricade areas and plot these areas on plans.			
15	Decide on strategies in conjunction with management team.			
16	Set objectives. [Minimise loss or exposure of men, material, environment, costs]			
17	Draw up a duty roster. [Be flexible – the situation will determine the need. Ideal is to have two managers on twelve hour shifts continually]			
18	Set times for progress report meetings and to re-assess strategies. Update pin board accordingly.			
19	Measure effectiveness of strategy plan to set objectives. Modify plan if initial objectives cannot be met.			
20	Any changes to set objectives or entry to affected area must be approved by the manager in control.			
21	Determine labour requirements for the incident.			

No.	ACTION	RESPONSIBLE PERSON	COMPLETED	SIGNATURE
22	Re-deploy other production labour.			
23	Notify other shafts or mines that may be affected.			
24	Brief and issue instructions to rescue teams.			
25	Ensure rescue teams documentation is in order.			
26	Record findings of teams in Record Logbook			
27	Debrief rescue teams.			
28	Brief management, service departments, DME, Union, Health and Safety Representatives on situation, planned objectives, progress and strategy.			
29	Ensure rescue teams sign a non-disclosure of information document.			
30	Brief medical personnel on potential assistance needed [possible number of casualties].			
31	Issue rescue teams with a body recovery document if applicable.			
32	Issue rescue teams with a “Rescue from Refuge Chamber” document – if applicable			
33	Obtain fire/incident cost code from Accounting Department.			

Table 3.3 Engineer in Charge Minimum Duties in Control Room

No.	ACTION	RESPONSIBLE PERSON	COMPLETED	SIGNATURE
1	Report to Control Centre frequently.			
2	Ensure preferential treatment from power supplier [ESKOM].			
3	Supply control room personnel with telephone number of affected area.			
4	Notify other shafts/mines regarding power supply problems.			
5	Prepare contingency plan in event of loosing a fan.			
6	Ensure availability of hoists.			
7	Re-arrange scheduled shaft times if applicable			
8	Brief all responsible persons accordingly.			
9	Maintain dam level [plus 80% if possible].			
10	Be aware that pH of water will change.			
11	Notify other affected shafts of Point. 10.			
12	Ensure clearance of stations at affected levels.			
13	Ensure availability of transport where applicable.			
14	Ensure availability of equipment operators [Locus, Incline winches & Surface trucks].			
15	Arrange for applicable artisans to be placed on standby.			
16	Ensure availability of communication lines to Fresh Air Base.			
17	Ensure isolation of applicable services to affected area.			
18	Utilise and arrange necessary equipment/material from other shafts/mines.			
19	Arrange frequent inspections of fan blades in affected areas [tar accumulation].			
20	Ensure continuity of power supply to control room.			
21	Establish duty roster of applicable engineering personnel with sound knowledge of affected areas, detector heads where applicable and mine.			

Table 3.4 Ventilation Officer in Charge Minimum Duties in Control Room

No.	ACTION		RESPONSIBLE PERSON	COMPLETED	SIGNATURE
1	From detector heads available, define the probable location of the fire [affected area].				
2	Identify affected areas and affected shift workers.				
3	Locate fire vent districts.				
4	Plan reconnaissance patrols if applicable.				
5	Identify safest routes to evacuate affected shift.				
6	Warn adjoining shafts/mines.				
7	If available, supply previous master fire plans of affected area.				
8	Identify dedicated chimney [borne risk in mine, consider as high risk area all the time].				
9	Schedule duty roster [shifts to overlap with manager in control. Does not change shift the same time as the manager].				
10	Provide/supply gas detectors, monitors, gas tubes.				
11	Interpret the fire behaviour and effectiveness of the total strategy. What effect will any changes have on the strategy?				
12	Advise management where work can continue without putting any employee at risk.				
13	Monitor	Status of main and booster fans			
		Pressure of sealed off area			
		Fire chimney conditions			
		Gas detector trends			

Table 3.5 Responsible Surveyor Minimum Duties in Control Room

No.	ACTION	RESPONSIBLE PERSON	COMPLETED	SIGNATURE
1	Supply control centre with plans and always have at least 3 complete sets of plans available.			
2	Ensure plans are updated accordingly after monthly planning sessions.			
3	Supply updated locality plans as required of affected area for rescue team's usage.			
4	Update rescue plans and colour as per master plan.			
5	Identify and mark current workings on plans. Add "self-stick notes" on plans with work group names and number of employees in the area.			
6	Highlight fire districts on plans.			
7	Highlight natural barriers on plans.			
8	Highlight faults on plans.			
9	Highlight boundary pillars and any holings through them.			
10	Supply section plans for suspect areas.			
11	Identify reference pegs on plans.			
12	Schedule duty roster survey personnel conversant with affected area.			
13	Ensure access to survey office after hours.			

Table 3.6 Human Resources Representative Minimum Duties in Control Room

No.	ACTION	RESPONSIBLE PERSON	COMPLETED	SIGNATURE
1	Ensure clearing of shift, report missing person[s].			
2	Supply updated telephone list of all related control personnel.			
3	Parade required employees needed for assistance.			
4	Ensure affected area personnel crush control.			
5	Arrange union and safety representatives.			
6	Arrange meetings when requested.			
7	Arrange update/progress meetings unions.			
8	Arrange/control media.			
9	Arrange security personnel when/where required [access control].			
10	Receive rescue teams and arrange change house accommodation.			
11	Supply meals and beverages to control personnel.			
12	Supply meals and beverages to rescue teams as required.			
13	Notify family member in cases of disaster.			
14	Arrange transport for family members when required.			
15	Arrange accommodation for family members when required.			
16	Arrange briefing times and area with family members.			
17	Arrange designated area for press releases if/when required [refreshment].			
18	Arrange necessary documentation in case of accidents or fatalities.			
19	Arrange guides/bearers for rescue teams if available.			
20	Arrange posttraumatic treatment for rescue teams if necessary.			
21	Arrange posttraumatic treatment for applicable employees involved with disaster if necessary.			

No.	ACTION	RESPONSIBLE PERSON	COMPLETED	SIGNATURE
22	Arrange medical observation for employees and rescue teams being in contact with body fluids			
23	Arrange correspondence to management of assisting mines [thank you letters].			
24	Arrange parking and security for vehicles of rescue teams.			
25	Schedule duty roster to ensure continuity of service departments.			

Table 3.7 Designated Security Department Representatives Minimum Duties in Control Room

No.	ACTION	RESPONSIBLE PERSON	COMPLETED	SIGNATURE
1	Arrange access for mines rescue service provider and equipment.			
2	Arrange access for rescue teams, equipment and parking.			
3	Ensure access control of public.			
4	Ensure access control of press/media.			
5	Direct press/media to predetermine designated area [liase with the Human Resource Department].			
6	Direct public to predetermined designated area [liase with the Human Resource Department].			
7	Notify manager in control of press/public/media attendance.			
8	Barricade area around shaft to ensure access for ambulance if applicable.			
9	Ensure crowd control.			
10	Ensure traffic control.			
11	Escort people into and out of mining area.			
12	Arrange investigation teams, if applicable [arson].			
13	Ensure equipment control from stores to underground.			

Table 3.8 Medical Representative Minimum Duties in Control Room

No.	ACTION	RESPONSIBLE PERSON	COMPLETED	SIGNATURE
1	Be available to conduct medical examination of mine rescue teams if required and enter findings on appropriate documents.			
2	Notify hospital[s] and other emergency medical personnel of incident magnitude, possible number of casualties, and type of injuries.			
3	Prepare medical facilities to be in state of readiness.			
4	Notify ambulance personnel to be on standby.			
5	Ensure readiness to proceed underground when required.			
6	Schedule medical staff for duration of incident.			
7	Supply manager in control with emergency telephone number of other emergency services available, if requested.			
8	Inform hospital[s] personnel in the event of rescue team members being in contact with body fluids.			

3.3 Training

Section 10 of the MHSA requires employers to provide employees with any information, instruction, training or supervision that is necessary to enable them to perform their work safely and without risk to health. No specific mention however is made of required training specifically relating to escape and rescue in the MHSA regulations, guidelines, directives or notes. Should a risk of underground explosions and fires be identified, the employer must provide employees with appropriate training regarding emergency response.

Mine Manager
For a person to be appointed a Mine Manager the candidate has to pass the Mine Manager's Certificate of Competency. These exams are set under the auspices of the DME Commission of Examiners and they form a formal part of the educational qualification of candidate Mine Managers.

As part of the syllabus for mine managers there is a specific requirement for candidate mine managers to be familiar with emergency preparedness and escape requirements [Part B of Mining II: Mining Technical Services [Coal] Section C: Risk Management - Part 2 and 3].

Supervisors, Miners and Labourers
External training forms part of the requirements for individuals to qualify as underground mine workers. Under the National Qualifications network, the MQA has developed outcomes based unit standards that underground miners must demonstrate competence in. In the unit standard titled “Demonstrate basic knowledge and understanding of emergency preparedness and response” learners are required to demonstrate the required actions in case of an emergency. This includes the donning of SCSR and in some cases entering a place of safety [which could include a refuge chamber] and following the prescribed procedures. Assessment criterion 4 requires learners to demonstrate the importance of adhering to the symbolic signs in terms of the consequences to health, safety and production.

3.4 Training in Practice

During induction training, either upon returning from annual leave, or for newly appointed underground employees, all aspects of mine health and safety are covered. This includes emergency preparedness and escape strategies, which encompass the escape from work areas to places of safety [inclusive of responsibilities, escape routes, symbolic signs, identification of alarm systems, guidance devices etc].

The induction course content and quality is not regulated, and it was found that the content and quality varies between mining houses, and even between shafts in the same mining house. Further to the induction training, underground miners walk the escape route from the workplace to the rescue bay. The intervals between these mock escapes vary between the mines [ranging from monthly to quarterly]. Some mines also require that the escape route be walked immediately after a section has moved. In very few cases the miners were required to walk the route in low to zero visibility conditions. Discussions with the mines revealed that generally each mine had different criteria for escape routes and procedures.

Some mining houses send their miners on specialized emergency preparedness courses to the Kloppersbos Explosion testing facility. Here they are exposed to the causes of fires

and explosions, and also witness a coal dust explosion first hand in a 200 m coal dust explosion tunnel.

South Africa has 11 official languages and numerous cultural groupings. Most of the underground work force originates from rural areas which result in a general cross cut of cultural groupings. In discussion with the mines it was reported that language and cultural backgrounds does complicate the training of the workforce. Various approaches apart from the lecture type training have been developed. These include outcomes based training using graphics and personal computers with touch screens, to awareness training in mock-up sections etc. No definitive common preferred training method could be identified within the scope of this study.

4 History of Coal Mine Explosions and Other Incidents in South Africa

4.1 Coal Mining in South Africa

Throughout coal mining history, flammable gas and coal dust explosions have been recognized as the most feared disasters in an underground coal mine. South Africa is rich in mineral resources and has a large, well established mining industry employing in excess of 400 000 people. The coal industry employs a workforce of about 60 000 which produces in the order of 245 Mt run of mine coal per annum.

South Africa's coal is obtained from approximately 64 collieries that range from among the largest in the world to small-scale producers. Of these collieries, a relatively small number of large-scale producers supply coal primarily to electricity and synthetic fuel producers.

The coal-mining industry is highly concentrated with five companies accounting for approximately 85 %of saleable coal production. These companies are:

- Ingwe Collieries Limited, a BHP Billiton subsidiary;
- Anglo Coal;
- Sasol;
- Eyesizwe; and
- Kumba Resources Limited.

Production is concentrated in large mines, with 11 mines accounting for 70 percent of the output.

The major coal deposits are in the Mpumalanga region and in KwaZulu Natal. The majority of the current major coal producers in South Africa are based in the Mpumalanga coal fields. In general the mined coal seams are thick [1.8 m to up 8.0m], flat [no significant dip], shallow lying [nominally 80 m to 450 m below surface] and undisturbed stretching over a considerable area. These conditions allow for a mixture of surface and underground mining and, of the total run of mine production, about 105 Mt per annum or 43 % is obtained from underground mining. The majority of underground mining operations are of the bord-and-pillar type utilizing continuous miners or road headers and shuttle cars. Currently in SA there are three wall mining sections.

Figure 4.1 depicts the total employment figures on South African coal mines for the period 1997 to 2006. No information could be obtained as to the average age of underground coal mine workers.

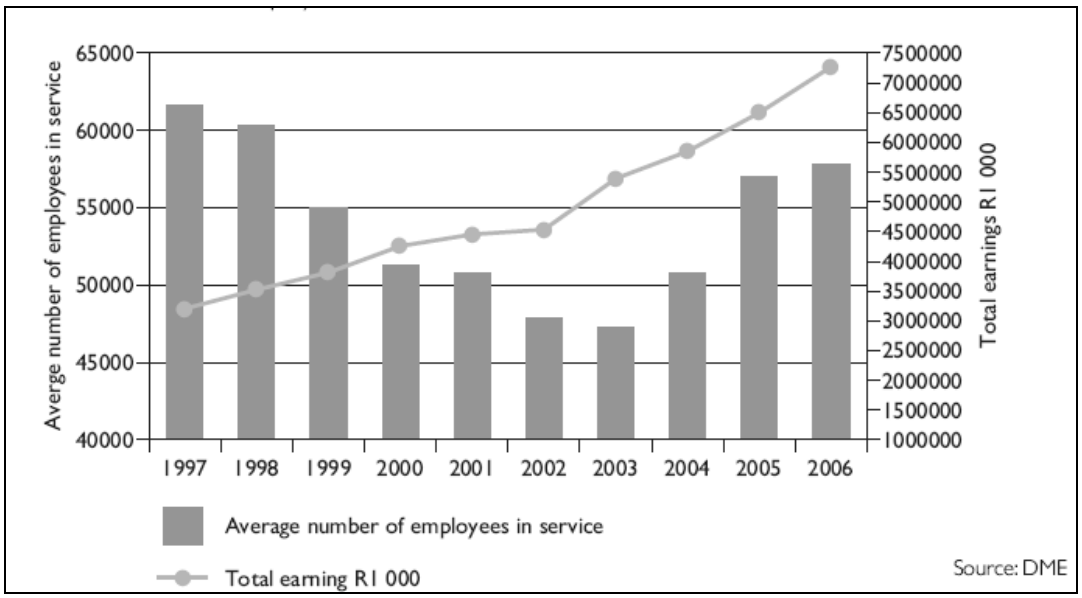


Figure 4.1: Employment on South African Coal Mines 1997 to 2006

4.2 Coal mine explosions in South Africa

Although methane and coal dust explosions in the South African coal industry are fortunately not frequent events, the consequences of an explosion are so severe that the Leon Commission of inquiry identified it as an aspect which required urgent attention.

The first recorded coal mine explosion in South Africa, occurred in 1891 at Elandslaagte in KwaZulu Natal. Since then more than 342 explosions have caused the death of some 1 037 coal miners and injury to 550 more. The number of colliery fires and explosions since 1981 is shown in Figures 4.1 and 4.2

As can be seen from the graphs there has been a decrease in the number of fires and explosions since the mid to late 1990's. The reason for this decrease is most likely a combination of reasons including the introduction of new risk based legislation, increased research and development, increased awareness and new technologies. Figure 4.3 indicates that the last fatalities that occurred due to fires and explosions in South African collieries were recorded in 1996. Although there has been fire and explosion incidents since 1996 [three explosions and 20 fires] no fatalities were recorded. It is difficult to contribute this fact solely to improved strategies on emergency preparedness and response and on general awareness of the risks of fires and explosions, but it has to be recognized that it could have had an impact.

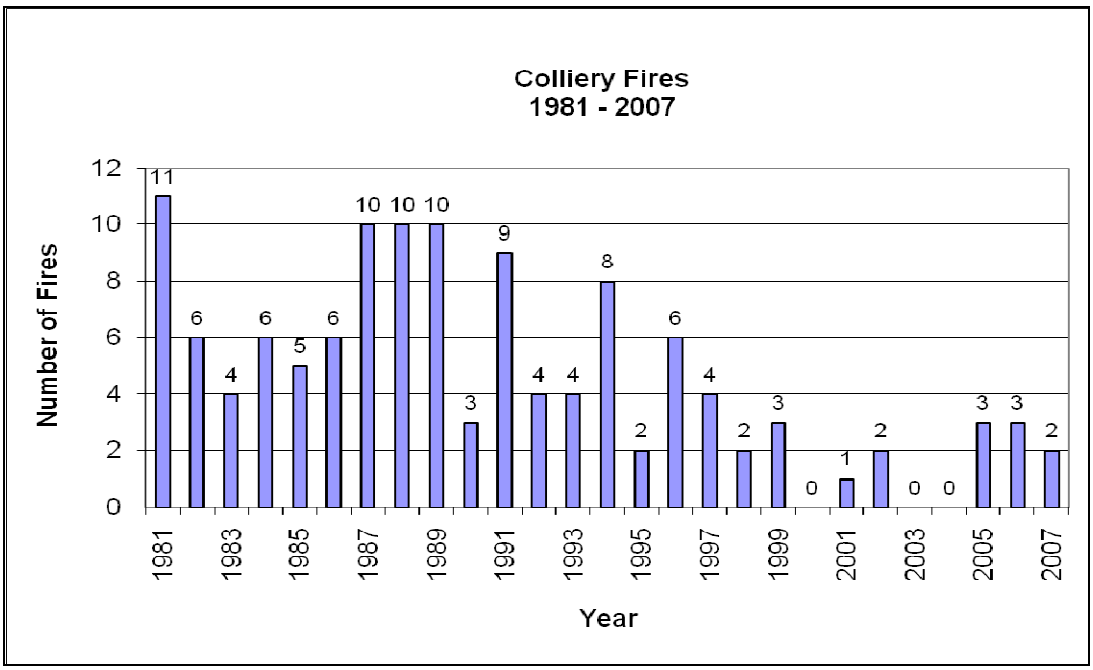


Figure 4.2: Colliery Fires between 1981 and 2007

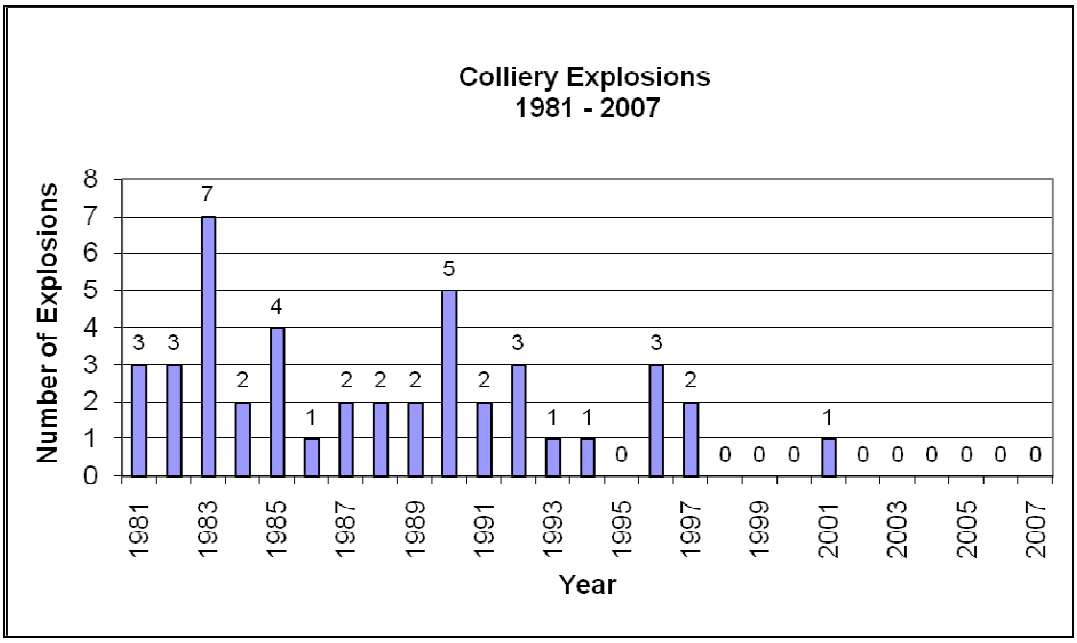


Figure 4.3: Colliery Explosions between 1981 and 2007

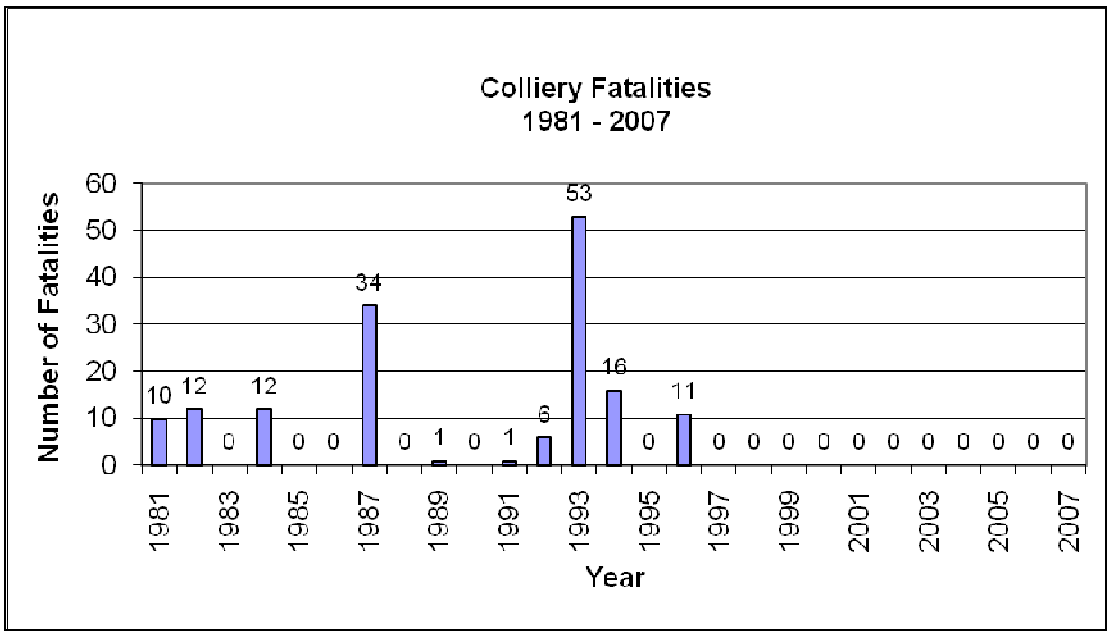


Figure 4.4: Colliery Fatalities due to Fires and Explosions between 1981 and 2007

The most significant coal mine explosions in South African history have been identified from the available data and are listed in Table 4.1.

Table 4.1: Ten Worst Coal Mine Explosions in South African History

Colliery	Date	Killed	Injured
Durban Navigation Collieries	08/10/1926	125	0
Natal Navigation Collieries	16/05/1923	78	4
New Marsfield Collieries	31/07/1935	78	0
Hlobane Colliery	12/09/1938	68	8
Hlobane Colliery	12/09/1944	56	13
Middelbult Colliery	13/05/1993	53	0
Glencoe Colliery	13/02/1908	50	5
Burnside Colliery	20/05/1930	38	0
Ermelo Mine Services	09/04/1987	35	11
Middelbult Colliery	12/08/1985	34	7

5 Mines Rescue Services

5.1 Mine Rescue Strategy for South African Underground Mines

The MHSA requires employers at underground mines to provide, maintain and have mine rescue teams readily available at their mines. These teams should consist of at least five competent persons [brigadesmen] per mine rescue team. The number of teams required per mine is also prescribed and is as follows:

i) where there could be between 100 and 1 100 persons underground, at least 1 mine rescue team;
ii) where there could be between 1 101 and 3 600 persons underground at least 2 mine rescue teams;
iii) where there could be between 3 601 and 8 100 persons underground at least 3 mine rescue teams; and
iv) where there could be more than 8100 persons underground at least 3 mine rescue teams and at least 1 additional mine rescue team for every additional 6300 persons who could be underground;

The MHSA also requires that the employer enter into a contract with a mines rescue service provider to coordinate and facilitate the provision of mines rescue teams and other services, relating to an emergency, on a cooperative basis.

Furthermore the MHSA requires that when an emergency is identified on the mine the employer must immediately notify their mines rescue service provider that they may require the use of rescue team members.

The Mines Rescue Services [MRS] is currently the only such registered service provider in South Africa. MRS is responsible for training rescue brigadesmen for rescue work and administers a rescue service scheme, providing rescue and recovery services as well as resources and expertise for an effective emergency service, primarily for the South African mining industry.

To achieve a professional, cost effective rescue service, the following issues are addressed by MRS:

- Physiological protection and psychological testing of rescue brigadesmen;
- Specialised training;
- Breathing apparatus;
- Fire fighting strategies;
- Monitoring of mine fires; and
- Legislation.

5.2 History of MRS

In 1924 the Rand Mines Group established a Central Rescue Training Station for the purpose of training selected employees of the mines of that Group in the use of prototype ["Proto"] and other apparatus for fire fighting and rescue operations underground.

This Station and its facilities were gradually made use of by nearly all the mines on the Witwatersrand, collieries elsewhere, diamond mines, fire departments and others. Inevitably the Rescue Training Station was approached to train employees of mines of other groups.

In 1946 the station was taken over by the Transvaal and Orange Free State [OFS] Chamber of Mines and placed under the direction of a Committee of Management. The post world war expansion of the South African mining industry, especially precious metals and coal, led to the decentralisation of the Rescue Training Service.

In 1961 the Welkom Station was opened and served the OFS and the Klerksdorp gold fields, including the base metal mines in the North West Cape. During 1964 another branch was created with the establishment of a station in Witbank, covering the expanding Eastern Transvaal coal fields and metal mines. This station was relocated to Evander during 1982, which is the nucleus of the future expansion in coal mining.

In 1975 the Chamber of Mines took over from the Natal Coal Owners Society, as well as the control of the Mines Rescue Service in Natal, where a new station was commissioned in Dundee, serving the Northern Natal coal fields.

In 1980 the Johannesburg Station was removed to new and modern premises outside Carletonville on East Driefontein Gold Mine Property.

In August 1996 in line with the Chamber of Mines policy of unbundling, the Rescue Training Service was transformed into a standalone company. The new company is a private sector non-profit organization and is known as Mines Rescue Services [Pty] Limited [MRS] and is a wholly owned subsidiary of the Chamber of Mines Services [Pty] Ltd. MRS is managed by a Board of Directors, who are responsible for strategic policy and major financial decisions, including budgetary approval following recommendations by the Committee of Management.

5.3 Structure

The staff complement of MRS is 35 full time personnel. The organizational structure is reflected in Figure 5.1.

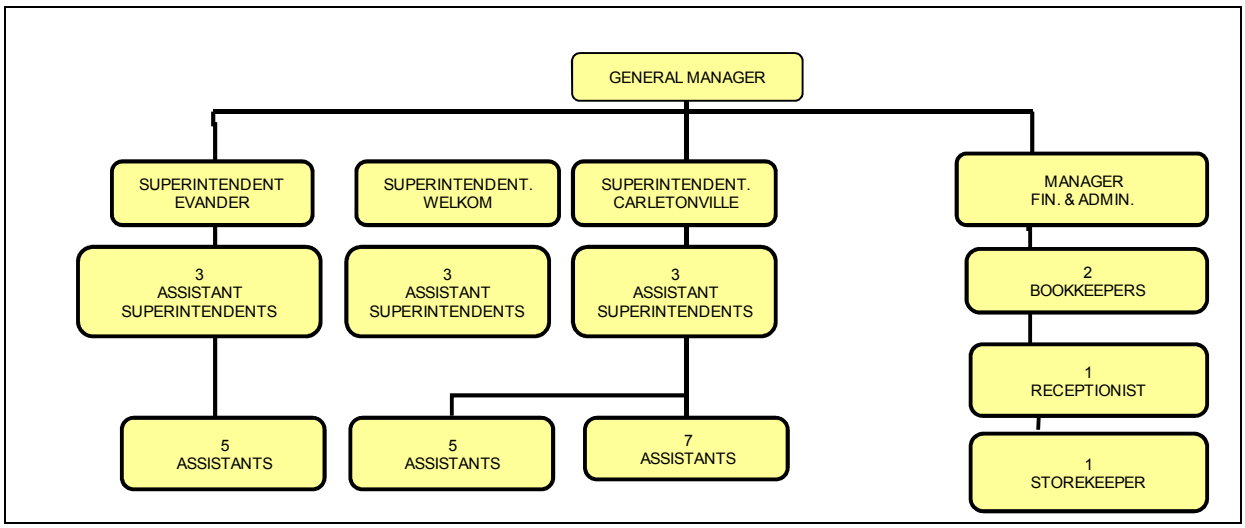


Figure 5.1: Subdivision of Staff Compliment of MRS

To service the South African mining industry effectively MRS divided South Africa into three regions which are serviced by an MRS station in each of these zones. The stations in the regions are centered in areas where the majority of mining actives are taking place within that region. The three areas are Carltonville, Evander and Welkom. The various stations serves the commodities mined in the region with the Evander station hosting all the coal mining brigadesmen.

Underground mines that have their own rescue teams are classified as Class “A” mines and underground mines that do not have their own rescue teams are classified as Class “B” mines. At the end of December 2007 there were 75 “A” Class and 40 “B” Class member mines. The relationship between Class “A” and “B” mines over the past 20 years is shown in Figure 5.2.

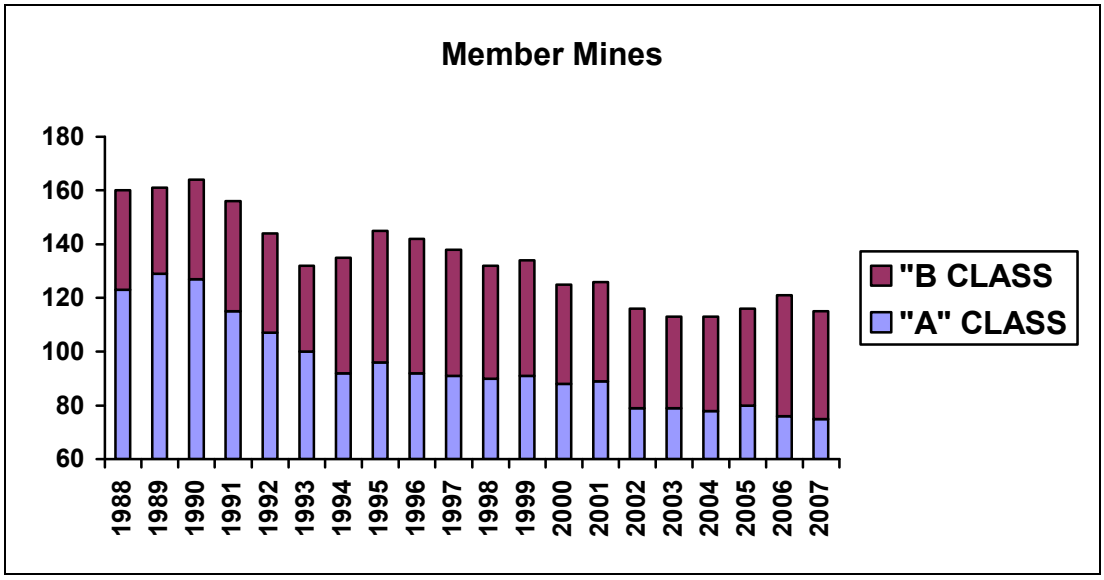


Figure 5.2: "A" & "B" Class Member Mines between 1988 and 2007

The breakdown of Class “A” and “B” members of MRS per region is shown in Table 5.1.

Table 5.1: Breakdown of "A" & "B" Class Members of Mine Rescue Services

	TOTAL 2006	TOTAL 2007
GOLD “A” CLASS	**29**	**29**
GOLD “B” CLASS	**7**	**4**
COAL “A” CLASS	**26**	**22**
COAL “B” CLASS	**20**	**18**
OTHER “A” CLASS	**21**	**24**
OTHER “B” CLASS	**18**	**18**
TOTAL	**121**	**115**

5.4 Funding

The MRS is a non-profit organization that requires funds to cover salary and overhead costs. Funding for the MRS is obtained through employer contributions of member mines. The annual subsidy required from employers is made up of the number of employees and the tons mined. The break down is shown graphically in Figure 5.3.

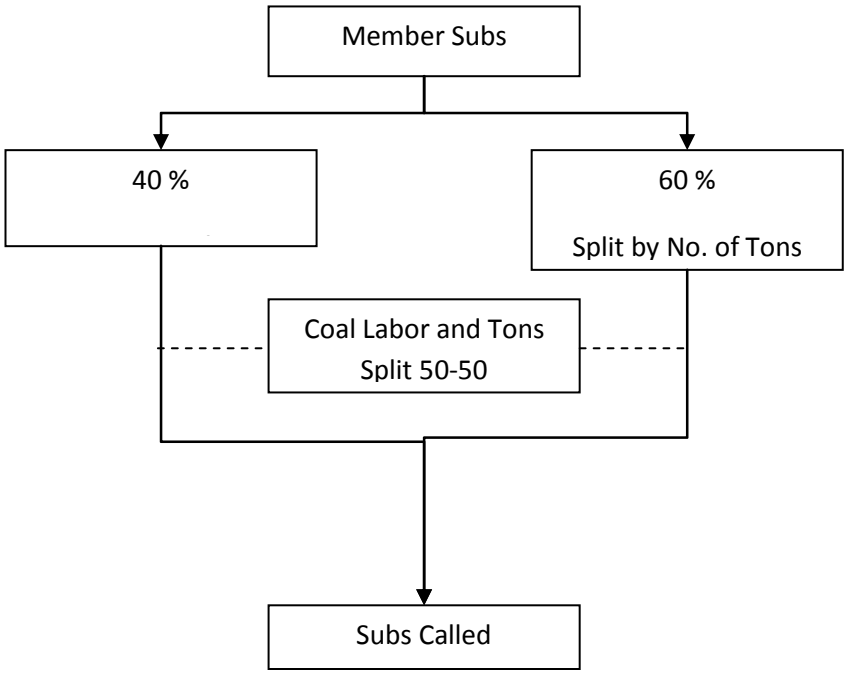


Figure 5.3: Funding of Mine Rescue Services through Employer Contributions

5.5 Rescue Brigadesmen

Employees may "volunteer" to become Brigadesmen at the mine they work at. Selected personnel undergo medical examinations together with a selection process prior to being accepted as a brigadesman candidate

Initially all recruits are medically examined by their own doctor. This is followed by an examination conducted by the mine medical practitioner who will certify the candidate is medically fit to undergo a Heat Tolerance Test as well as the initial one week training course. Appendix E gives the procedures followed for the Heat Tolerance Test conducted by the MRS.

Candidate brigadesmen should possess certain appropriate qualities prior to training. These are:

- A calm temperament;
- Responsible;
- Used to discipline
- Experienced in underground work;
- Aged between 21 and 46;
- Pass a five day initial training course;
- Pass Medical Examinations;
    - Initial;

  - Periodically; and
  - Pre-operational.
- Pass Heat Tolerance Test; and
- Pass Work Load Test

After successful completion of the training course brigadesmen sign a contract with the mines they represent. This contract ensures that the brigadesman fulfils his duties with regard to call out procedures, maintenance procedures, payment for duties, medical requirements and general behavior requirements.

Mine rescue brigadesman training includes initial and subsequent quarterly training. This training is conducted under supervision at surface mock ups of underground infrastructure where the fire fighting environment is artificially simulated [smoke and heat]. During this training typical work that could be expected to be performed is carried out, e.g., laying of spray columns, building walls etc.

Subsequently all brigadesman undergo a six monthly medical. Prior to proceeding underground for any emergency work, all brigadesman undergo a pre-operational medical examination.

Table 5.2 reflects the average age of brigadesmen for the three regions.

Table5.2: Average Age and Years Served in the Brigade for Each Satellite Station in 2007

Region	Age of Brigadesmen	Years in the Brigade
Carltonville	34.4	5.1
Evander	34.1	5.2
Welkom	33.9	4.9

The average years served in the Brigade is almost five years. A more detailed examination by team member is shown in Table 5.3.

Table 5.3: Number of Years in the Brigade per Position for 2007

Team position	Carltonville	Evander	Welkom
Team Captain	11.2	9.7	10.3
Vice Captain	6.9	7.0	6.9
Ordinary Member	3.7	4.2	4.1
Team Rookie	1.7	1.9	1.1

Reasons on why Brigadesmen leave the Brigade are being recorded. It cannot be verified whether the brigadesmen leaving the service divulge the teal reason, but it is the view of MRS that thus far the reasons are fairly accurate and honest.

Table 5.4 show the reasons given by the 335 Brigadesman interviewed. Data could not be obtained on how many of these brigadesmen were involved in actual rescues operations nor the nature of the rescues.

Table 5.4: Reasons for Turnover given by Brigadesmen Interviewed for 2007

Reason for Leaving Brigade	Percentage
Left the mine	42
Resigned - No reason given	19
Work related pressure	9
Failed work load	1
Requested to leave the team	9
Left due to medical reasons	5
Reached 46 years age limit	5
Lost interest	1
Number of teams reduced	2
Deceased	-
Promoted	3
Other	4

5.6 Number of Rescue Brigades

There has been a steady decrease in the number of brigade teams and brigadesmen since the late 1980's. This is mainly due to the closure of many of the KwaZulu Natal mines and the general down scaling of mining operations. Figures 5.4 and 5.5 reflect the statistics.

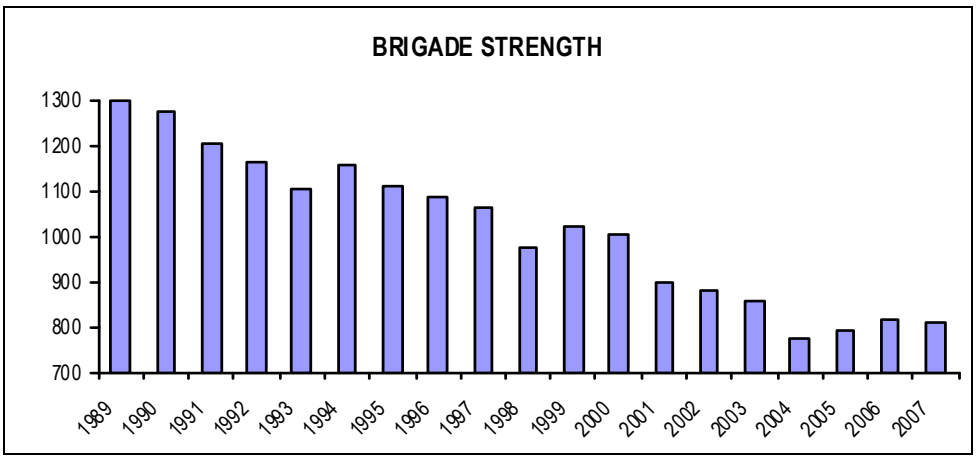


Figure 5.4: Decrease in Strengths of Brigadesmen

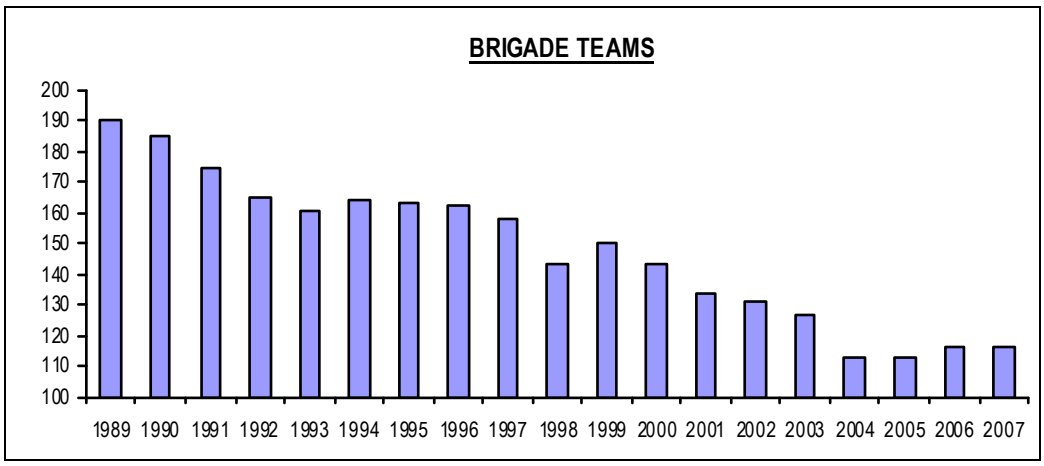


Figure 5.5: Decrease in Brigade Teams

The present make up of teams per commodity is shown in Table 5.5 below for each of the rescue stations.

Table 5.5: Present Make-Up of Brigades Teams per Commodity

	Totals	
	Men	**Teams**
Gold	347	50
Coal	204	30
Diamond	17	2
Manganese	13	2
Asbestos	-	-
Copper	17	3
Antimony	4	-
Chrome	12	1
Platinum	166	24
Uranium	8	1
Titanium	-	-
Nickel	13	2
Iron	-	-
Lead	9	1
TOTAL 2007	**810**	**116**
TOTAL 2006	**815**	**116**

From Table 5.5 it can be seen that there are approximately 200 Brigadesmen out of a force of 815 [25 %] that serve the coal mining industry.

5.7 Incidents Attended

During 2007 there was a decrease in the number of fires reported as well as in the number of teams utilized to bring these fires under control. Of the 329 incidents reported, 58 were call outs to fires that required the use of 384 rescue teams.

Furthermore, during the year there were 271 other incidents that required 1 226 rope rescues, 44 mines rescue medics services and 419 rescue teams. These rescues resulted in the rescue of 28 persons and the recovery of 20 bodies.

These figures include all commodities mined in South Africa which include underground coal mines.

Table 5.6 below shows the breakdown of required services and indicates when MRS personnel were required to attend an incident.

Table 5.6: Summary of Incidents Responded to and No. of Teams Used

Category	MRS trips/attend			Team Usage		
	Yes	No	Total	Home	Outside	Total
Fires	38	20	58	132	252	384
Specialized incidents	28	169	197	296	39	335
Reconnoiters	20	12	32	70	15	85
TOTALS 2007	86	201	287	498	306	804
TOTALS 2006	67	158	225	534	380	914

The following graphs depict the history of fires reported together with the use of rescue teams during fires, for the period 1998 to 2007.

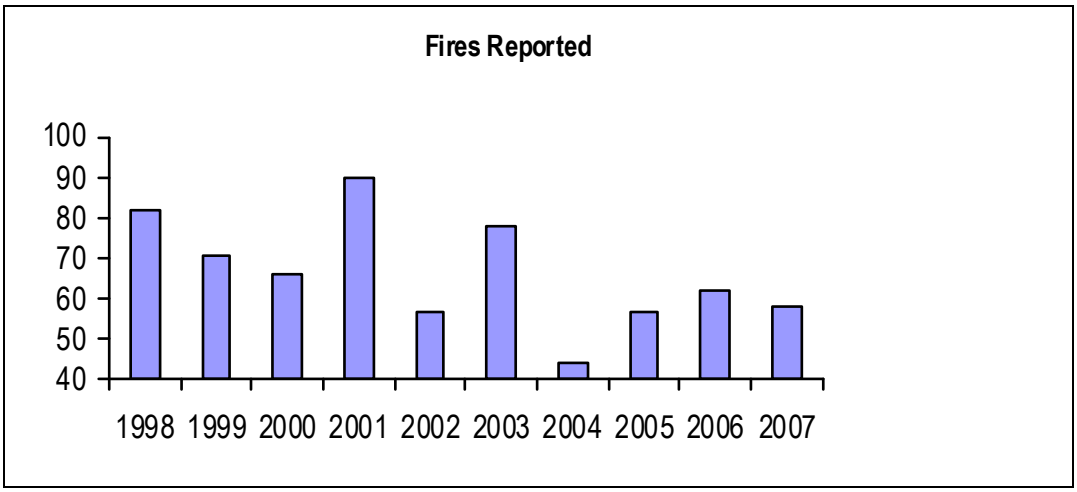


Figure 5.6: Graph Depicting History of Fires Reported for the Period 1998 and 2007

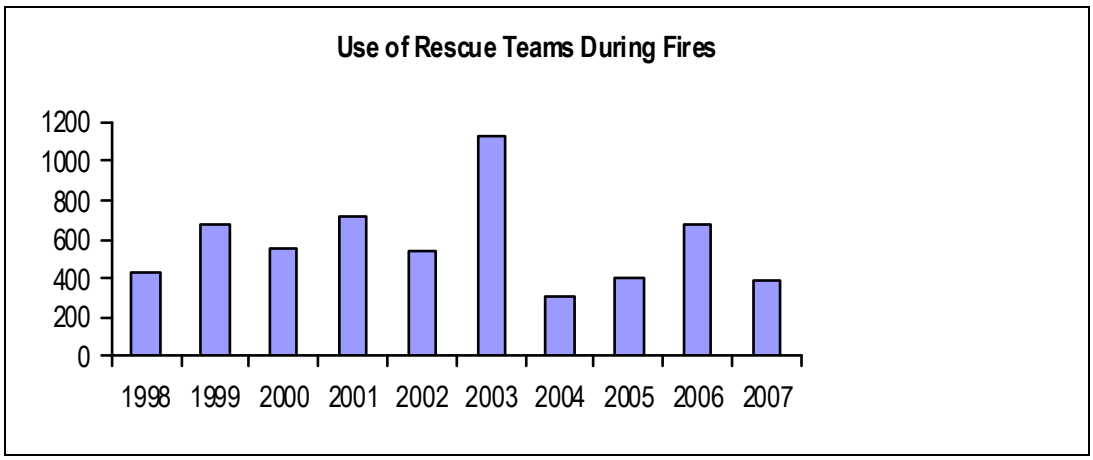


Figure 5.7: Graph Depicting History of Fires Reported for the Period 1998 and 2007

It has to be noted that comparing the number of fires attended to by rescue teams compared to the number of fires reported for coal mines per annum, it is clear that the majority of fires are on the hard rock mines. In general the ventilation and mining layouts in deep narrow tabular deposit hard rock mines is more complex than that of flat seam coal mines. This has the effect of causing fire fighting to be more complex in hard rock mines. MRS training is predominantly on hard rock mine fire fighting techniques. There is migration of personnel between the hard rock mining and the coal mining industry, with the result that most brigadesmen have been exposed to real fire and rescue situations.

This fact is supported by the average number of incidents that rescue team members attend per year. Figure 5.8 reflects these numbers.

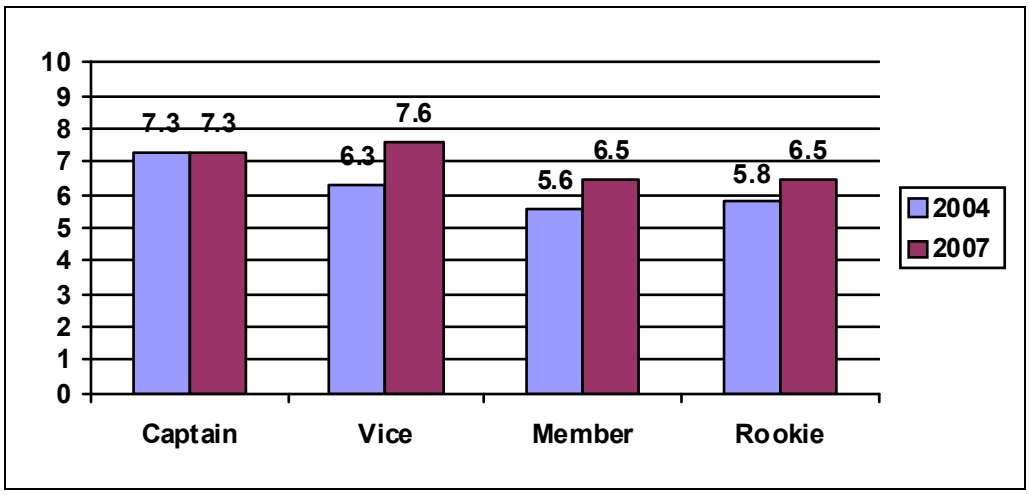


Figure 5.8: Total Number of Incidents Attended per Year for 2004 and 2007

5.8 Rescue Brigadesmen Training

5.8.1 Initial Course

The initial course consists of a 5 day practical and theoretical course on the use of breathing apparatus and fire fighting techniques. Candidates must successfully complete theory and practical training requirements together with the Work Load Test by end the of the course. The Work Load Test required is shown in Appendix F.

5.8.2 Quarterly Training

During the first and fourth quarters practical training is conducted in the simulated mine. Each alternate year during the second quarter, Heat Tolerance Testing is conducted. The brigadesmen undergo the Work Load Test in the third quarter.

The summary of the design criteria for the Heat Tolerance Test is as follows:

- 24 Steps per minute;
- 31,7 ºC W/B;
- 33,2 ºC D/B;
- One hour duration;
- Rectal temperature;
    - $\leq$ 39.0ºC heat tolerant; and
    - $\geq$ 39.1ºC not heat tolerant.

Breathing apparatus and equipment used by rescue teams are inspected and serviced whenever the teams attend training. MRS schedules and performs preventative maintenance of all breathing apparatus. Supplies of saleable firefighting equipment and breathing apparatus spare parts are maintained by certified MRS personnel. This is done to be able to supplement the mines equipment requirements during emergencies and to be able to repair and maintain breathing apparatus.

5.8.3 Advanced Course

The Mines Rescue Services holds a three day course, for selected brigadesmen who have been selected as prospective captains/vice captains of teams. This course focuses on risk assessment and management principles.

5.8.4 Specialized Training

Basic Ambulance Assistants Course [BAA]
This is a specially designed four week course where brigadesmen are taught advanced life support techniques, aimed at coping with injuries related specifically to mining accidents.

During 2007, a total of 210 brigadesman were registered with the Health Professions Council of South Africa.

Three initial courses were held during the year at the Mines Rescue Services' accredited college and 17 candidates passed. A total of 141 persons attended refresher courses during the year. Reports have been received of 44 BAA's utilised during emergencies but the number of BAA's utilised during non bona-fide calls are not known.

Mines Rope Technician's Course
Selected brigadesmen undergo a four day course where they are taught different rope techniques which are used to retrieve persons who have fallen into voids. The training concentrates on the development of basic skills in the application of various rope techniques, e.g.:

- Griptech;
- Skyjack; and
- Rescue Winders.

Trapped Person Location Device [TPLD]
During 2007 all brigadesmen received training in the use of the TPLD. This equipment has been acquired to locate persons trapped during a fall of ground whilst employed underground. The instrument uses sophisticated seismic sensors which are placed at strategic positions to determine the proximity of the person trapped.

Command Centre and Control Room Practices
The MRS will be present throughout any emergency involving the call out of brigadesmen. MRS will also make themselves available in other circumstances when ever requested by management.

At any emergency situation the Mine Manager assumes responsibility, however extensive use is made of the MRS staff whose experience can be utilised in the formulation of a strategic plan and the ensuing control of operations

Based on their experience MRS has developed a Control Room Management course. Candidates who complete the course are equipped to take charge during emergencies.

Table 5.7: Total Training Conducted during 2006

	HTT	Compr.		Qtr Train	Advanced		Rope Rescue		Medical		Train-ing	Visi-tors	Total
	Induc	Init	Ref		Init	Ref	Init	Ref	Init	Ref	Other		
Men	379	241	44	2933	136	1	121	434	36	128	503	377	5333
Shifts	379	1124	207	2933	349	3	361	568	382	128	515	377	7326

During 2006 there were some 241 new Brigadesmen trained which represents 28% of 815 Brigadesmen. This annual turnover may be higher than expected but is influenced by many uncontrollable factors e.g. promotion, medically unfit, age etc.

5.9 Traumatic Incident Stress Counselling

The possibility of psychological screening for new as well as current brigadesmen candidates is being investigated. Provision to ensure that brigadesmen receive counselling following traumatic events has been formalised. Furthermore it is envisaged that all MRS staff as well as all team captains and vice captains will be trained to identify any "danger signs" as well as the basic skills of counselling.

Counselling for brigadesmen is strictly voluntary and is offered by mines through Employee Assistance Programmes [EAP]. These programmes vary from company to company and are usually staffed by counsellors and psychologists. The scope of study does not allow for a detailed review of the contents of these programmes and the staffing requirements. Following traumatic incidents, rescuers are advised to undergo counselling. Family members of brigadesman may also undergo counselling through EAP.

5.10 Deployment Strategy

5.10.1 Call out procedure

In the event of an emergency where brigadesmen have to be used to either rescue personnel or property, the mine management will initiate the rescue procedure by calling out one of the mine teams. Where additional teams are required, i.e. the home mine cannot cope with the extent of the call out, additional brigadesmen from other mines are sourced through the MRS.

5.10.2 Role of MRS at an Emergency

In all emergencies when rescue teams are required, MRS will be notified. At the emergency, MRS will be present and will assist the manager in charge. Services offered by MRS include the following.

- Advice and recommendations on fire extinguishing methods and types of equipment and materials available;
- Arranging for the supply of this equipment/material;
- Advice on team modus operandi;
- Team protection;
- Radio communication;
- Operation in hot and humid atmospheres;
- Provide Continuous gas monitors;
- Identification of potential hazards by the first team entering the area or teams operating in area [risk assessment];
- Obtaining of specialist's knowledge;
- Current technology available;
- The control and requests for assistance from outside teams;
- Repairs and maintenance to breathing apparatus as well as spot checks on leakage tests/systems checks;
- Meeting teams and informing them of strategies in progress and history of the fire;
- Ensuring Brigadesmen's compliance to code of practice with respect to inter alia:
    - Modus Operandi;
    - Ancillary and safety equipment;

  - Medical examinations;
  - Leakage/Systems checks on breathing apparatus;
  - Competency levels to special tasks;
- Control the issuing of sub-strata radios and the re-charging of flat batteries.

5.11 New Technologies Used MRS

5.11.1 Inertisation

Fighting mine fires with inert gas is not new to the industry as it has been used for nearly 150 years. The means of application has however changed over the years. To boost their ability to supply effective inertisation abilities, MRS in conjunction with the coal mining industry, is investing in a Floxal inertisation unit from AirLiquide

5.11.2 Monitoring of Mine Fires

Although there will always be an application for the hand held detector pump for gas spot measurements, this method lacks the accuracy for continuous monitoring of mine fire gases.

Mine Rescue Services has become one of the world leaders in the field of gas analysis by using equipment such as the TRUGAS gas analysis system and the portable Gas Chromatograph.

TRUGAS gas analysis system
The "Transportable Underground Gas Analysis System" [TRUGAS] is comprised of five easily transportable components with a total of twelve reels of sampling tubing and sensor cabling.

The five major components are:
- The gas analysing unit;
- Sample draw unit;
- Calibration unit;
- Sampling conditioning unit, and
- Power supply unit.

The capabilities of the TRUGAS include:
- Continuous monitoring of mine fire gases;
- Onboard data logging;
- Telemetry interface; and
- Remote monitoring and sampling

Unfortunately, the TRUGAS has some limitations such as cross sensitivity between carbon monoxide and hydrogen and being unable to detect ethylene and propylene, which are the signature gases of coal heating.

The MTI P200 Gas Chromatograph
In order to overcome the known limitations of the TRUGAS and to allow MRS to provide a complete underground analysis service to the mining industry, a MTI P2300 portable Gas Chromatograph was acquired. This is a dual channel, high speed, portable gas chromatograph that incorporates an injector as well as a column and thermal conductivity analyser.

Some of the features of this instrument are:

- Speed – Analysing times of 130 seconds makes it one of the fastest Gas Chromatograph commercially available;
- Portability – The briefcase size instrument can be carried to the most remote locations complete with a battery pack and carrier gas cylinder; and
- Accuracy – The lower detectable limit is 1ppm and 5ppm for Hydrogen. This is comparable to larger conventional Gas Chromatographs.

5.11.3 Collieries Rescue Drill Units

MRS has two types of drill units. One of the units is used for the rapid drilling of 165 mm probe holes to locate trapped miners and supply them with emergency supplies and communication. The second unit is used to drill either a 560 mm or a 635 mm hole which is used to extract trapped miners from a mine.

To drill the probe holes a DHD-260 down-hole percussion drill mounted on a T-4 Drillmaster is used. The purpose of the drill is to drill holes through the strata in order to search for and establish contact with survivors trapped underground. Features of the drill include:

- Capability of drilling a 165 mm [6,5 inches] diameter hole;
- Drill rates of 35 to 50 meters per hour in soft strata and 10 meters per hour in dolerite;
- The mobile, self contained unit can travel up to 80 kilometers per hour;
- Carries 80 meters of rods with it and additional rods on a trailer;
- Will drill a hole to search and locate trapped miners and provide them with air, food, communications and other essential services; and
- Surveillance probe, fitted with low-light video camera and on-board lighting as well as two-way audio communication system.

To drill the escape boreholes an Ingersoll-Rand DHD-124 down hole drill on a T-5 Drillmaster mounting is used. This is the same unit used in Pennsylvania State for escape borehole drilling. Specially trained brigadesmen descend down the drilled boreholes in order to carry out rescues of trapped people either from refuge bays or in other areas of the mine. A special torpedo type capsule fits into the 635 mm diameter borehole which is used to lower and lift men from the mine. Alternatively brigadesmen can be lowered down the borehole in a parachute type harness. A need has been identified for a similar type of operation, which would have the capability of reaching a depth of 1 000m.

Information on the present drilling system includes:

- Capability of drilling a 635 mm [25”] or 560 mm [22”] hole;
- A DHD – 130 drill is used to drill casing holes through overburden;
- Drill rods are 9,1 meter [30 feet] long;
- Each rod has a mass of 1,6 tons and diameter of 508 mm [20 inches];
- Sufficient rods to drill hole of 270 meters; and
- Cuttings are removed from the hole by.

In order to manage the 1,6 ton drill rods, the 4 ton down hole hammer and bit, and the numerous other heavy items associated with the drill rig, a 15 ton mobile crane with a 15 meter collapsible boom forms an integral part of the Rescue Drill Unit.

5.11.4 Bullard Thermal Imaging Camera

MRS uses the Bullard Thermal Imaging camera T3MAX to allow rescue teams to search for missing persons in areas of zero visibility, and to detect areas of heating. It is a small and versatile, high performance thermal imaging camera suited for operations in enclosed areas. The camera is not intrinsically safe. However, following a risk assessment of the situation, the manager in charge of the incident can authorize the use of the camera.

MRS currently has two units, one at the head office and one at the Evander rescue station. A third unit will be acquired for the Welkom rescue station in due course.

5.11.5 Underground Divers

MRS investigated the possibility of training selected brigadesmen as specialised divers to cope with rescue and recovery operations in the aftermath of uncontrolled water inrushes at mines. After a thorough investigation it was concluded that professional diving institutions would be best suited to meet these needs.

5.11.6 Communication/Tracking [Post disaster installations]

The following devices are being used:

- Substrata radios;
- Gene phones ;
- Trapped person location device;
- Thermal imaging;
- Surveillance probe, fitted with low-light video camera and on-board lighting as well as two-way audio communication system;
    - Designed to search for and establish contact with survivors trapped underground ;
    - The unit can be lowered down a 150 mm hole;
    - It is housed in a mobile caravan and all functions are operated from a control desk in the caravan;
    - The probe can be rotated and tilted and can distinguish objects up to 60 meters;
    - Audio system picks up sound up to 30 meters away;
- Tracking device available from CSIR – [Not yet implemented].

5.11.7 Body cooling garments

Irrespective of their degree of heat tolerance, all brigadesmen are provided with body cooling garments when expected to perform strenuous work in wet bulb temperatures that exceed 32,5°C. Continuous research and development is however required in order to provide brigadesmen with the most ergonomically and effective garments available.

5.12 Alterations to MRS Protocols

The Board of Directors needs to be consulted should any alterations to the management systems of the MRS be required. Any internal non urgent issue could be discussed with a resolution being achieved within 6 months, whilst an urgent issue could be resolved almost immediately via round robin conversations with Board Members.

6 Useful Websites

All websites referred to below was active as on 09 September 2008.

1. Chamber of Mines of SA: http://www.bullion.org.za/
2. Mine Health and Safety Council: http://www.mhsc.org.za/
3. Department of Minerals and Energy: http://www.dme.gov.za/mhs/mine_safety.stm
4. CSIR Kloppersbos Explosion Testing Facility: http://www.csir.co.za/fires_and_explosion_testing/index.html

Appendix A: Literature and Information Sources Used for this Report

Appendix A: Literature and Information Sources Used for this Report

A comprehensive literature and information search for all the available documentation on escape and rescue strategies, practices and regulations currently used by South Africa's underground coal mining industry was undertaken. The sources consulted for the compilation of this report recorded below.

Legislative

1. Mine Health and Safety Act, Act no 29 of 1996;
2. Guideline for the compilation of a mandatory code of practice for the prevention of flammable gas and coal dust explosions in collieries [reference number DME 16/3/2/1 – A1, issue date 1 February 2002];
3. Guideline for the compilation of a mandatory code of practice for emergency preparedness and response – Approved by the Mine Health and Safety Council – not yet issued to industry for implementation;
4. Guideline for the compilation of a mandatory code of practice for minimum standards of fitness to perform work [reference number DME 16/3/2/3-A1];
5. Regulations pertaining to fires and explosions and escape procedures [Government gazette number 23583, dated 2 July 2002];
6. Regulations pertaining to Self Contained Self Rescuers [Government gazette number 569, dated 17 May 2002].
7. Regulations pertaining to emergency preparedness and response [Government gazette number 86, dated 1 February 2008].

Mine standard procedures

Documentation relating to Escape and Rescue was sourced and scrutinized from three of the major coal mining companies in South Africa. These companies are:

1. Anglo Coal;
2. SASOL Coal; and
3. Xstrata Coal S.A

The following documents were sourced from these mining groups:

Anglo Coal

1. Mandatory Code of Practice: The prevention of flammable gas and coal dust explosions
2. Voluntary Code of Practice: Emergency preparedness and response

SASOL Coal

1. Voluntary Code of Practice: Emergency preparedness and response [reference number V5.2.3, dated 4 February 1998]
2. Emergency Procedure Brandspruit & Block 3E [reference number MGRMBR447001, dated 27 October 2002]
3. Code of Practice on Rescue strategy [document number V5.2.03 – not dated]

Xstrata Coal

1. Mandatory Code of Practice: The prevention of flammable gas and coal dust explosions [reference number GS GEN COP M007]
2. Voluntary Code of Practice: Emergency preparedness and response.
3. Voluntary Code of Practice: Escape and rescue [reference number GS GEN HSEC P01, dated May 2008]

Mine Rescue Services

1. Fire/incident control centre/room - Structure and procedure;
2. Duties and responsibilities in the emergency control room during fires and/or incidents [checklist];
3. Fire/incident control centre/room - structure and procedure;
4. Mines rescue services South Africa - An overview [Power Point presentation];
5. Annual report – 2007;
6. Mines rescue services brigadesman interview document;
7. Rescue Managers reference

Conference proceedings

1. Safety in coal mining [CSIR and MVS – October 1987]
2. A review of the rescue strategy in South African coal mines [Mine Ventilation Society of South Africa – May 1992]
3. Managing diversity [Mine Ventilation Society of South Africa – March 2004]
4. Mine Environmental Control – 2013 and beyond [Mine Ventilation Society of South Africa – May 2008]

Publications – Chamber of Mines of South Africa

Nil – No Index of publications is available for scrutiny and consequent analysis of reports.

Mine Ventilation Society - Journals

Publications from 1979 to present were scanned for information pertaining to this topic:

1. The early detection of inflammable gas at the working face E. Steyn, 1985, number 7];
2. The introduction of self contained self rescuers into the South African mining industry [H. Rose, 1985, number 9];
3. Selection, design and use of underground refuge chambers [S. P. Muller, 1986, number 12];
4. The functional performance of formal gold mine and colliery refuge bays with special reference to air supply failure [A. J. Kielblock et al, 1988, number 5];
5. The feasibility of using compressed air cylinders for refuge bay ventilation [G. Durandt, 1988, number 11];
6. Mine rescue services in South Africa in the next millennium [C. De Klerk, 1998, number 4];
7. Work load training; enhanced safety standards for rescue brigades' operations in the South African mining industry [A. J. Kielblock et al, 1999, number 2];
8. Self rescuers – lessons from the past to the future [D. Ramsden, 1999, number 1];
9. Performance monitoring of SCSR in the South African mining industry [W. Schreiber, 2000, number 4];
10. Premature performance deterioration in chemical based SCSR deployed in the SA mining industry [W. Schreiber, 2001, number 2];
11. Performance monitoring of SCSR in the SA mining industry [W. Schreiber, 2001, number 4];

12. Mine rescue preparedness – 2000 – A plan for survival [M. Smith' 1998, number 4];
13. Portable refuge chambers: aid or tomb in underground escape strategies [J. M. Venter et al, 1999, number 1]
14. New mine rescue techniques [M. van der Merwe, 1999, number 1];
15. Emergency control rooms [D. Walters, 1989, number 1];
16. Emergency control rooms – structures and procedures [N. Graham, 1996, number 4];
17. Mine rescue services South Africa – an overview [C. de Klerk, 2003, number 3];
18. An analysis of underground fires in South African coal mines from 1970 to 1985 [R. Morris, 1987, number 10];
19. A review of the Mine Ventilation Society's colliery branch workshop on rescue strategies in South African coal mines [A. J. Kielblock, 1992, number 11];
20. An alternative method to supply respirable air to refuge bays of collieries [J. M. Venter, 1997, number 4];

Chamber of Mines Research Organization [COMRO]

Although research into Escape and Rescue was conducted by COMRO, none of the reports can be used in a public domain.

Safety in Mines Research Advisory Council [SIMRAC]
The following work has been conducted on that could be of assistance for ERP

Ref No	Project Title
COL 108	The use of ULF for communication and control following an explosion
COL 316	Training guidelines for safe use of electricity to minimise fire hazards
COL 601	Remote flammable gas detection/measuring device
GEN 101	Procedures to overcome disorientation and visibility after explosions
GEN 705	Ranging open path remote flammable gas detection/monitoring device
SIM 02 04 01	Training Package to reduce the risk of gas explosions
SIM 02 04 04	Ranging path remote methane detector
COL 034	A discussion document of research needs of the SA coal industry
COL 115	Assessment of the design of refuge bays in coal mines
COL 224	Feasibility of using radio-assisted location of refuge bays [REBLE]
COL 307	Reasons for unsafe acts & neglect in SW and HW accidents
COL 605	Manual of best practice for emergency response procedures
COL 620	Compendium of all coal-related SIMRAC research projects
COL 814	Integrated design & planning of underground coal mining processes
GAP 610	Risk to personnel during continuous mining operations
GEN 006	Self-rescuer monitoring
GEN 102	Analysis of incidents involving SCSR activation
GEN 105	Develop means of assessing occupational risk for mine employees
GEN 413	Early warning communication system for irrespirable atmospheres
GEN 502	Develop a trapped miner location system and rescue technology
HEALTH 801	Analysis of emergency care provided for injured miners in SA Mines

South African Coal Mining Industry
Meetings with representatives from three of the major coal producers were held on Escape and Rescue procedures. These being:

1. Anglo Coal;
2. SASOL Mining; and
3. Xstrata Coal SA.

Appendix B: Mine Health and Safety Act. 1996 Regulations. Chapter 16. Rescue, First Aid and Emergency Preparedness and response

Appendix B: Mine Health and Safety Act, 1996 Regulations. Chapter 16. Rescue, First Aid and Emergency Preparedness and Response

16.1 Reports to Employer Relating to Explosions, Fires and Flooding

1] The employer must ensure that a competent person reports to the employer, at appropriate intervals determined in accordance with the mine's risk assessment, on the adequacy of escape and rescue procedures at the mine relating to explosions, fires and flooding.

16.2 Issuing of Self-contained Self-Rescuers

Coal Mines

1] The employer of every coal mine must ensure that no person goes underground at the mine without a body-worn self-contained self-rescuer, which complies with the South African Bureau of Standards specification SABS 1737.

Mines other than Coal Mines

2] If at any mine other than a coal mine, the risk assessment in terms of section 11 shows that there is a significant risk that employee's may be exposed to irrespirable atmospheres at any area at the mine, the employer must ensure that no person goes into such area without a body-worn self-contained self-rescuer, which complies with the South African Bureau of Standards specification SABS 1737.

Sole Allocation of a Self-contained Self-Rescuer

3] Any body-worn self-contained self-rescuer supplied to any employee, employed in a full time capacity at the mine, in terms of sub regulations 16.2[1] and 16.2[2], must be allocated to the employee for that employee's sole use for the duration of the deployment of that self-contained self-rescuer at the mine or until that self-contained self-rescuer becomes defective and the employee is issued with another self-contained self-rescuer as required by these regulations.

16.3 No Defective Self-contained Self-Rescuer is Issued

Employer to ensure no defective self-contained self-rescuer is issued

1] The employer must ensure that no defective self-contained self-rescuer is issued for use to any employee at a mine.

16.4 Monitoring Program

Annual testing of a Self-contained Self-Rescuer

1] The employer must annually have a representative sample of the self-contained self-rescuers at the mine tested by an organization accredited to do so in terms of the South African National Accreditation System for assessment of the structural integrity and functional performance. Such representative sample must not be less than 1% of the self-contained self-rescuers at the mine and must be representative of the age and deployment of the self-contained self-rescuers.

Record keeping

2] The employer must keep the following information, on self-contained self-rescuers at the mine, covering the preceding 24 months: -

a] total number and makes of self-contained self-rescuers in service at the mine;

b] number and make of self-contained self-rescuers purchased by the mine in that period;

c] number and make of self-contained self-rescuers withdrawn from use by the mine in that period;

d] the number of shifts worked per day [1 , 2 or 3];

e] number of self-contained self-rescuers in daily use [average for each month];

f] number of employees underground [average per shift];

g] number of spare self-contained self-rescuers available [average per month];

h] a tabulation of the type of defects found;

i] number of self-contained self-rescuers repaired/refurbished; and

j] number of self-contained self-rescuers tested in terms of regulation 16.4[1].

16.5 Emergency Preparedness and Response

Definitions

For purposes of regulation 16.5, unless the context indicates otherwise -
"**emergency**" means a situation, event or set of circumstances at a mine that could threaten the health or safety of persons at or off the mine, and which requires immediate remedial action, such as the evacuation, rescue or recovery of persons, to prevent serious injury or harm, or further serious injury or harm, to persons;

"**breathing apparatus**" means an apparatus, which renders the user independent from breathing from the atmosphere for a minimum of two [2] hours.

1] The employer at every underground mine must-
   a] provide and maintain, readily available at the mine, mine rescue teams, consisting of at least five competent persons, per mine rescue team, in the following minimum proportions determined by the maximum number of persons who could be underground at any one time-
      i] where there could be between 100 and 1100 persons underground, at least 1 mine rescue team;
      ii] where there could be between 1101 and 3600 persons underground at least 2 mine rescue teams;
      iii] where there could be between 3601 and 8100 persons underground at least 3 mine rescue teams; and
      iv] where there could be more than 8100 persons underground at least 3 mine rescue teams and at least 1 additional mine rescue team for every additional 6300 persons who could be underground;
   b] have readily available, at the mine for use by the rescue team members contemplated in regulation 16.5[l][a], sufficient breathing apparatus that may be required in any emergency and which breathing apparatus must continually comply with SANS 50145:1997/EN 145:1997 "Respiratory protective devices - Self-contained closed-circuit breathing apparatus - Compressed oxygen or compressed oxygen-nitrogen type - Requirements, testing, marking";
   c] enter into a contract with a mines rescue service provider to coordinate and facilitate the provision of mines rescue teams and other services, relating to an emergency, on a cooperative basis; and
   d] immediately notify such mines rescue service provider should any emergency occur at the mine that may require the use of rescue team members, contemplated in 16.5[l][a], or the use of the services of such mines rescue service provider.

2] For the purposes of regulation 16.5[l][c] and [d], a mines rescue service provider must-
   a] be an organization/institution which has personnel with specialist knowledge and experience in mines rescue and emergencies and which has access to rescue equipment and training facilities, including facilities for Heat Tolerance Testing, Workload Testing and Simulated Training;
   b] render an emergency rescue service on a co-operative basis;
   c] provide mines rescue services with emphasis on mobilisation of mine rescue teams, quantity or access to rescue teams, emergency communication, additional emergency resources, back up facilities and transport;
   d] ensure that any breathing apparatus that may be used by mine rescue teams continually complies with SANS 50145: 1997lEN 145:1997 "Respiratory protective devices - Self-contained closed circuit breathing apparatus - Compressed oxygen or compressed oxygen-nitrogen type - Requirements, testing, marking";
   e] ensure that their personnel is competent to check and maintain any rescue equipment used by it in accordance with the Original Equipment Manufacturer's specifications;
   f] test and maintain the functional performance of any other rescue equipment used by it in accordance with the Original Equipment Manufacturer's specifications; and
   g] ensure that the rescue team members used by them to provide mines rescue services meet the qualification requirements as prescribed in Chapter 22.

3] Every mines rescue service provider, referred to in regulation 16.5[2], must-
   a] keep a register of all persons who have been found competent to practice as a rescue team member by that mines rescue service provider;

b] implement and maintain a system to issue licences to practice to persons contemplated in 16.5[3][a] and who meet such criteria as determined by the rescue service provider, which criteria must include at least the following-

i] the person has not attained the age of 46 years;

ii] the person has been declared medically fit in terms of the requirements of the mine's "Code of Practice on Minimum Standards of Fitness to Perform Work at the Mine" as may be amended from time to time. prepared in accordance with the : Guideline for the Compilation of a Mandatory Code of Practice on Minimum Standards of Fitness to Perform Work at a Mine;

iii] the person has undergone and passed the Heat Tolerance Test, conducted in terms of Chamber of Mines of South Africa Research Organization Research Report No. 29/87 - "A guide to the selection and classification of rescue brigadesmen on the basis of Heat tolerance", initially and thereafter at intervals not exceeding 24 months;

iv] the person has undergone refresher-training sessions as determined by the mines rescue service provider at intervals of not more than 3 months. At least 2 of these trainings per annum must be in a mine or simulated mine, in an atmosphere filled with smoke, whilst using a breathing apparatus; and

v] the person has undergone and passed the Work Load Test, conducted in terms of the Chamber of Mines of South Africa S & TS Circular No. 39/93 dated 5 April 1993, initially and thereafter at intervals not exceeding 12 months.

c] monitor compliance by persons, issued with a licence to practice by it, with the requirements contemplated in regulation 16.5[3][b] and suspend or revoke any such licence if the person no longer meets any of those requirements, and re-issue a licence when the person again meets the requirements.

4] Whenever an emergency occurs at a mine that requires the deployment of mine rescue teams, the employer and any mines rescue service provider notified in terms of regulation 16.5[l][d] and whose assistance has been requested, must take reasonable measures to ensure that the required mine rescue teams are deployed as soon as possible.

5] No employer or mines rescue service provider may allow any rescue team member contemplated in regulation 16.5[l][a] to be deployed as a member of a mine rescue team during an emergency unless such rescue team member is in possession of a valid licence to practice , as contemplated in regulation 16.5[3] and has passed a pre-operational medical examination, determined by the mines rescue service provider, to ensure that the rescue team member is medically fit at the time to be so deployed.

Appendix C: Excerpts From “Review of Best Practices Regarding the Use of Refuge Chambers in South Africa,” BBE Report No. 5207, September 2007

Appendix C: Excerpts from "Review of best practices regarding the use of refuge chambers in South Africa", BBE Report No. 5207, September 2007

Regulatory Mechanisms
To empower the Minster of Minerals and Energy to fulfill one of the objectives of the DME [safe and healthy working environments in mines], the MHSA allows the minister to develop a regulatory framework. The principal elements of the regulatory framework are:

- Regulations;
- Guidelines for Mandatory Codes of Practice;
- Chief Inspectors Instructions or Directives; and
- Guidance Notes.

Often the proper regulation of a topic would require making use of more than one of these regulatory mechanisms. The principle regulatory mechanisms are discussed in the following Sections.

Regulations
Regulations are drafted where an issue is common to all mines and can be complied with. Regulations must be drafted in such a nature that mines would not need to apply for exemption from these regulations. Furthermore, regulations are to be outcomes based and hence should not prescribe to the employer on how to address a significant risk, identified in terms of the hazard identification and risk assessment [HIRA] process, but should allow the employer to implement a hierarchy of control measures to reduce or eliminate the risk.

Guidelines for Mandatory Codes of Practice
Guidelines are drafted where site specific flexibility is required as a result of varying conditions existing at the different mines.

Chief Inspectors Instructions and Directives
Directives or instructions are issued by the Chief Inspector of Mines on any health and safety matter that requires attention or to distribute information relating to health and safety at mines.

Guidance Notes
A guidance note sets out good practice.

Appendix D: Unit Standard for Understanding of Basic Emergency Preparedness and Response

Appendix D: Unit Standard for Understanding of Basic Emergency Preparedness and Response

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

REGISTERED UNIT STANDARD:

Demonstrate basic knowledge and understanding of emergency preparedness and response

SAQA US ID	UNIT STANDARD TITLE		
116533	Demonstrate basic knowledge and understanding of emergency preparedness and response		
SGB NAME		**REGISTERING PROVIDER**	
SGB Occupational Health and Safety			
FIELD		**SUBFIELD**	
Field 09 - Health Sciences and Social Services		Preventive Health	
ABET BAND	**UNIT STANDARD TYPE**	**NQF LEVEL**	**CREDITS**
Undefined	Regular-Fundamental	Level 2	2
REGISTRATION STATUS	**REGISTRATION START DATE**	**REGISTRATION END DATE**	**SAQA DECISION NUMBER**
Reregistered	2007-08-07	2010-08-07	SAQA 0160/05

PURPOSE OF THE UNIT STANDARD

This unit standard requires learners to demonstrate basic knowledge an understanding of emergency preparedness and response. Learners credited with this unit standard are capable of:

- Discussing the different types of emergencies that may be encountered in the workplace
- Explaining emergency preparedness and demonstrating response appropriate to the situation

LEARNING ASSUMED TO BE IN PLACE AND RECOGNITION OF PRIOR LEARNING

The Unit Standard outcomes and credits are based on the assumption that learners attempting this Unit Standard can already read, write and communicate at ABET 3 or equivalent.

UNIT STANDARD RANGE

Specific range statements are provided in the body of the unit standard where they apply to particular specific outcomes or assessment criteria. Note: Emergencies must include: Floods, Fires, Explosions, Seismic events, power failures, Emission of gas, sudden release of gases, Chemical incidents, and equipment failure.

UNIT STANDARD OUTCOME HEADER

N/A

~~Specific Outcomes and Assessment Criteria:~~

SPECIFIC OUTCOME 1
Discuss different types of emergencies that may be encountered in a workplace.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
Different types of emergencies that may be encountered in a workplace are listed and are according to specified requirements.

ASSESSMENT CRITERION 2
Effects that these emergencies in the workplace may have on worker health and safety is described in accordance with specified requirements.

ASSESSMENT CRITERION 3
The purpose of warning, mandatory, statutory and informative signs is explained and is according to specified requirements.

ASSESSMENT CRITERION 4
The importance of adhering to the symbolic signs is explained in terms of the consequences to health, safety and production.

SPECIFIC OUTCOME 2
Explaining emergency preparedness and demonstrating response appropriate to the situation.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
Explanation of immediate personal action to be taken, in the event of an emergency, is in accordance with specified requirements.

ASSESSMENT CRITERION RANGE
Personal action includes: withdrawal, warning of other workers, reporting, first aid treatment and donning of self-contained-self-rescuer.

ASSESSMENT CRITERION 2
Emergency preparedness is explained in terms of specified requirements.

ASSESSMENT CRITERION 3
Explanation of restricted and confined areas, traveling ways and escape routes is according to specified requirements.

ASSESSMENT CRITERION 4
Demonstrations of actions to be taken during prescribed situations confirm understanding of specified requirements.

UNIT STANDARD ACCREDITATION AND MODERATION OPTIONS
Assessment of learner achievements takes place at providers accredited by a relevant ETQA [RSA, 1998b] for the provision of programs that result in the outcomes specified for this unit standard. Anyone assessing a learner against this unit standard must be registered as an assessor with a relevant ETQA. Any institution offering learning that will enable achievement of this unit standard must be accredited as a provider with a relevant ETQA. The relevant ETQA according to the moderation guidelines and the agreed ETQA procedures will oversee moderation of assessment and is responsible for moderation of learner achievements of learners who meet the requirements of this unit standard.

UNIT STANDARD ESSENTIAL EMBEDDED KNOWLEDGE
Essential embedded knowledge will be assessed through assessment of the specific outcomes in terms of the stipulated assessment criteria. Learners are unlikely to achieve all the specific outcomes, to the standards described in the assessment criteria, without knowledge of the listed embedded knowledge. This means that for the most part, the possession or lack of the knowledge can be directly inferred from the quality of the learner's performance. Where direct assessment of knowledge is required, assessment criteria have been included in the body of the unit standard.
Credited learners understand and can explain:
- Legal and specified requirements
- The different types of emergencies that may be encountered in the workplace
- Emergency preparedness

UNIT STANDARD DEVELOPMENTAL OUTCOME
N/A

UNIT STANDARD LINKAGES
N/A

~~Critical Cross-field Outcomes [CCFO]:~~

UNIT STANDARD CCFO IDENTIFYING
Identify and solve problems and make decisions using critical and creative thinking. Note: The ability of the learner to interpret emergency situations contributes to his/her problem solving skills.

UNIT STANDARD CCFO WORKING
Work effectively with others as members of a team, group, organisation or community. Note: The ability and willingness of the learner to accept, interpret and delegate work instructions correctly, when and if required, in an appropriate manner indicates that he/she can work effectively as a team member in the bigger organisational structure.

UNIT STANDARD CCFO ORGANISING
Organize and manage themselves and their activities responsibly and effectively. Note: Competence in applying acquired knowledge will indicate that the learner can organize and manage activities in his/her working environment.

UNIT STANDARD CCFO COLLECTING
Collect, analyze, organize and critically evaluate information. Note: The ability of the learner to evaluate and interpret situations will indicate proficiency.

UNIT STANDARD CCFO COMMUNICATING
Communicate effectively, using visual, mathematical and / or language skills in the modes of oral and / or written presentations. Note: The ability of the learner to use visual, mathematical and language skills will indicate his/her effectiveness to communicate information in the modes of oral and written presentations.

UNIT STANDARD CCFO SCIENCE
Use science and technology effectively and critically showing responsibility towards the environment and health of others.

UNIT STANDARD CCFO DEMONSTRATING
Demonstrate an understanding of the world as a set of related systems by recognizing that problem-solving contexts do not exist in isolation. Note: The ability of the learner to identify and refer anomalous behaviour to a specialist confirms understanding that a specific observation, inference, action or decision can have an interrelated effect.

UNIT STANDARD ASSESSOR CRITERIA
Assessors should keep the following principles in mind when designing and conducting assessments against this unit standard:

- Focus the assessment activities on gathering evidence in terms of the main outcome expressed in the title to ensure assessment is integrated rather than fragmented. Remember we want to declare the learner competent in terms of the title. Where assessment at title level is unmanageable, then focus assessment around each specific outcome, or groups of specific outcomes.
- Make sure evidence is gathered across the entire range, wherever it applies. Assessment activities should be as close to the real performance as possible, and where simulations or role-plays are used, there should be supporting evidence to show the learner is able to perform in the real situation.
- Do not focus the assessment activities on each assessment criterion. Rather make sure the assessment activities focus on outcomes and are sufficient to enable evidence to be gathered around all the assessment criteria.
- The assessment criteria provide the specifications against which assessment judgements should be made. In most cases, knowledge can be inferred from the quality of the performances, but in other cases, knowledge and

understanding will have to be tested through questioning techniques. Where this is required, there will be assessment criteria to specify the standard required.

- The task of the assessor is to gather sufficient evidence, of the prescribed type and quality, as specified in this unit standard, that the learner can achieve the outcomes again and again and again. This means assessors will have to judge how many repeat performances are required before they believe the performance is reproducible.
- All assessments should be conducted in line with the following well documented principles of assessment: appropriateness, fairness, manageability, integration into work or learning, validity, direct, authentic, sufficient, systematic, open and consistent.

UNIT STANDARD NOTES

Specified requirements include legal and site-specific requirements and are contained in one or more of the following documents:

Legal requirements:

- OHS Act and Regulations 85 / 1993
- Mine Health and Safety Act and Regulations 29/1996
- Guideline for mandatory Codes of Practice

Site-specific requirements:

- Managerial instructions
- Codes of Practice
- Company Standards
- Standard Task Procedures
- Health Management Programme
- Risk Assessment Documentation
- Working Guides
- Manufacturers` specifications.

QUALIFICATIONS UTILISING THIS UNIT STANDARD:

	ID	QUALIFICATION TITLE	LEVEL	STATUS	END DATE
Core	48804	National Certificate: Occupational Safety, Hygiene and Environment	Level 2	Reregistered	2010-08-07
Core	21842	National Certificate: Surface Mining Rock breaking	Level 2	Reregistered	2009-11-07
Core	57121	National Certificate: Rock breaking: Quarrying	Level 3	Registered	2009-11-16
Elective	58722	National Certificate: Engineering Fabrication	Level 2	Registered	2010-08-16

Appendix E: Mines Rescue Services Heat Tolerance Screening Procedures

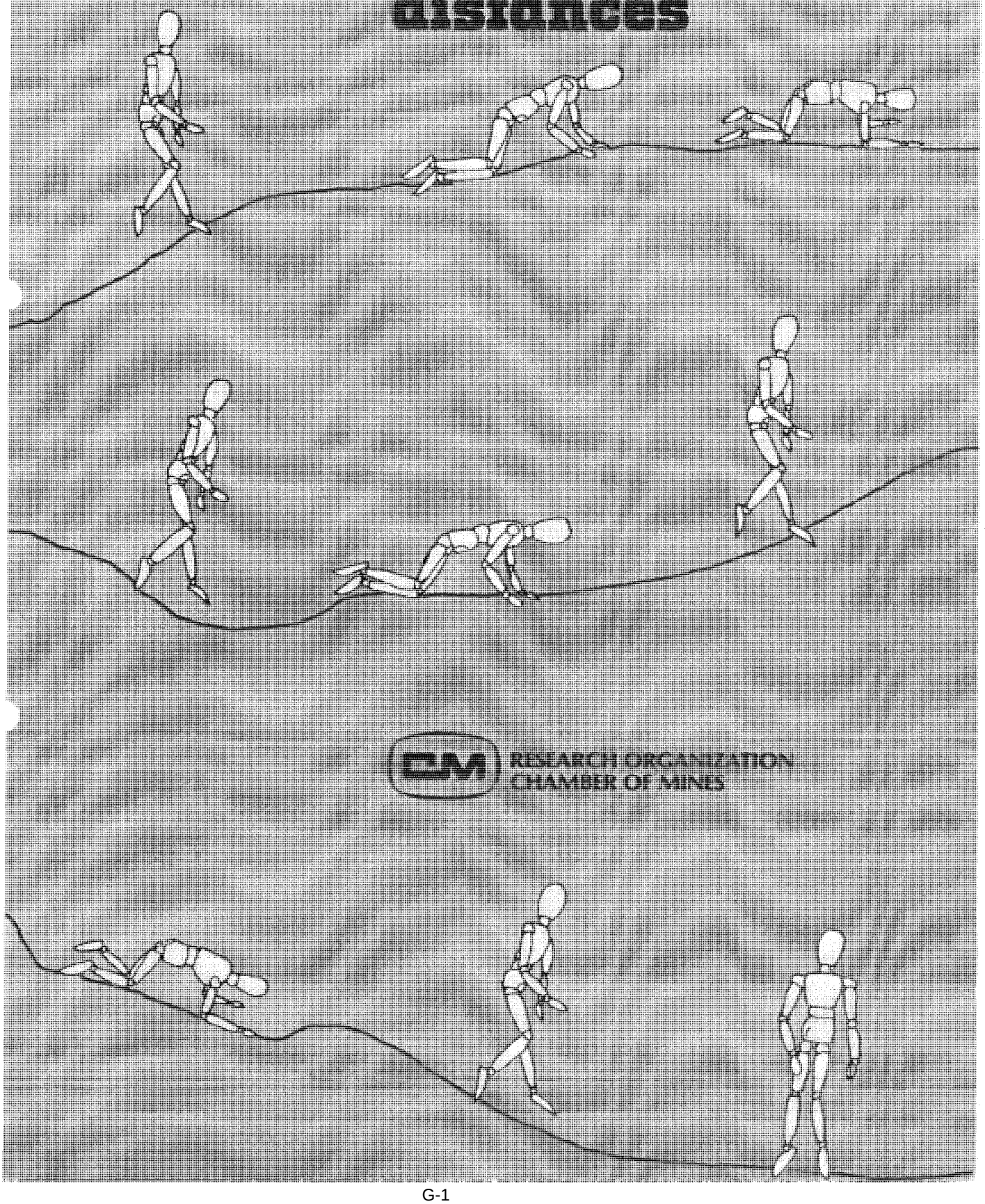
Reference Not Available

Appendix F: Mines Rescue Services Work Load Test Procedures

Reference Not Available

Appendix G: RES-Q-PAC DISTANCE BROCHURE

ResQpacs - How to calculate safe travelling distances



RESEARCH ORGANIZATION
CHAMBER OF MINES

Self-contained self rescuers (generically known as ResQpacs) protect mine workers from respiratory hazards that could result from fires or explosions. They prevent the inhalation of noxious fumes and provide oxygen to enable the wearer to reach a place of safety.

Apart from inherent technological features, the performance of ResQpacs is determined by a variety of factors, including the physiological characteristics of the wearer and the nature of the escape route.

Studies have shown that in general the maximum safe distances which can be covered from a working place to a point where the ResQpac will be exhausted should typically not exceed

1500 m in high seam collieries
750 m in low seam collieries
750 m in gold mines

Since conditions on and between mines vary significantly, a method has been developed for determining more accurately the maximum safe distances to refuge bays or back-up facilities on individual mines. This method applies to escape routes where Dräger Oxyboks K, Fenzy Spiral I, and MSA/Auer SSR 30/100 ResQpacs are used.

The method

- provides for a realistic assessment of the operating duration of a ResQpac,
- allows the design of an integrated escape and rescue strategy for the entire mine,
- allows the most cost-effective use of available safety resources.

The accuracy of the method was confirmed by correlating experimentally recorded distances covered with ResQpac in mines against those calculated on the basis of energy expenditure. It was shown that the method provides a conservative estimate of the maximum distances, with a safety margin more than adequate to cater for all workers and, within reasonable limits, all escape routes. The effects of disorientation in an emergency, poor visibility, and obstacles are, however, being investigated further.

The ResQpac generates a fixed amount of oxygen, but the time and distance over which it can sustain a man depends upon the ventilatory demand (the rate at which oxygen is drawn from the system).

Ventilatory demand is dependent primarily on the nature of the escape route, which is determined by two factors:

- ***Ceiling height***

  Ceiling height will determine whether locomotion of the man is erect, stooped or crawling.

  The respective ceiling heights are:

  for erect locomotion: 1,5 m and greater

  for stooped locomotion: between 1,1 m and 1,5 m

  for crawling: less than 1,1 m

- ***Inclination of route***

  Inclined locomotion is

  horizontal at 0°

  slight at 10° and less

  moderate at 10° to 20°

  severe at 20° and more

Note:

- *These inclinations apply only to routes leading upwards. For escapes leading downwards, the ventilatory demand is as for horizontal locomotion.*

- *Where locomotion is inclined, the influence of ceiling height is lessened and for practical consideration is not considered.*

How to calculate maximum safe distances from the face to the refuge bay or back-up facility

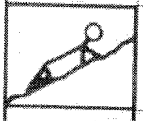
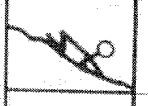
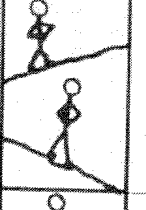
STEP 1: Categorize the components of the escape route in terms of body posture, ceiling height and inclination. Record the ventilatory demand for each component from Table 1.

STEP 2: Measure and record the respective distances (in metres) for each component.

STEP 3: Starting with the component where the men are working, multiply the length of each component with the respective ventilatory demands given in Table 1 to determine the ventilation volume (in litres) required.

STEP 4: When the sum of the respective ventilation volumes is equal to 750 *ℓ*, the maximum safe distance over which a ResQpac can safely sustain a man is reached.

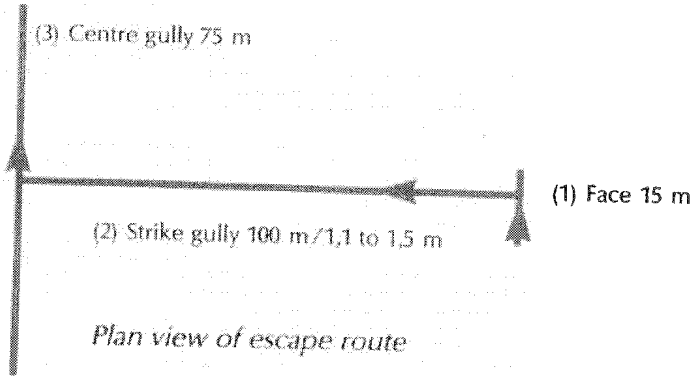
Table 1: Ventilatory demand of escape route components

Body posture	Escape route component	Inclination (relative to horizon)	Ceiling (m)	Ventilatory demand V_e* (ℓ/m)
	Gold mine panel/face	Up	<1,1	4,6
	Gold mine panel/face	Down	<1,1	2,7
	Colliery face (low seam)	Horizontal	<1,1	2,4
	Gold mine strike gully/ colliery main/tail gate/ low seam bord and pillar	Horizontal	<1,1 to >1,5	1,6
	Gold mine centre gully/ any other inclined components	+10° +20° +30° (ladder) +30° (no ladder) Down	N/A N/A N/A N/A N/A	1,2 2,4 2,7 5,4 0,9
	Gold mine cross-cut/main/tail gates/strike gullies/main haulages/high seam operations	Horizontal	>1,5	0,6

* *Estimates of V_e are based on the ventilatory demands of the '95th percentile man' in accordance with international convention, in order to cater for virtually all underground workers.*

ESCAPE A — Hypothetical escape route for a gold mine

The route makes provision for an escape which is negotiated through one panel (1), strike gullies with a restricted ceiling height (2) and a centre gully (3) where the average dip upwards does not exceed 20°. After leaving the stope, back-up facilities will be reached via the haulages where locomotion is horizontal.



Plan view of escape route

Basic information:

COMPONENT	SEQUENCE	DISTANCE (m) x V_e (ℓ/m) = V_t (ℓ)		
Panel	1	15	4,6	69
Strike gully	2	100	1,6	160
Centre gully	3	75	2,4	180
TOTAL	—	190 (d_s)	—	409

The residual capacity (V_r) of the ResQpac at the exit from the centre gully is therefore

$$V_r = 750 - V_t$$
$$= 341\ \ell$$

The only remaining component to negotiate is the haulage. Table 1 indicates a demand of 0,6 ℓ/m, and the remaining distance (d_r) which can be covered is

$$d_r = V_r/0{,}6$$
$$= 341/0{,}6$$
$$= 568\ m$$

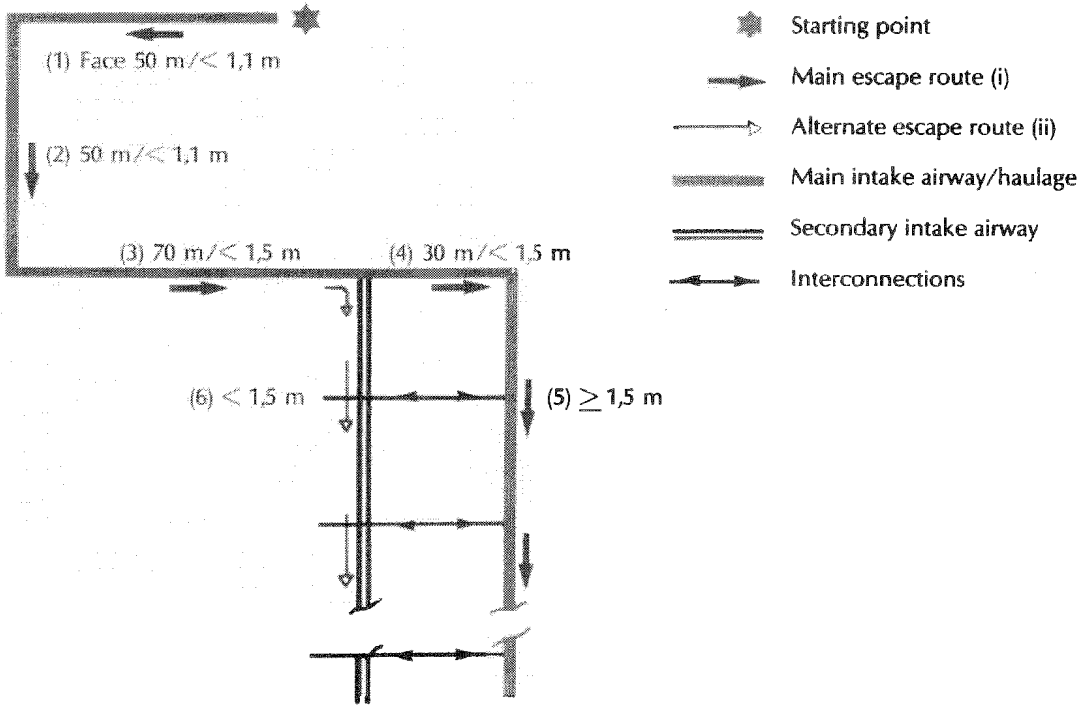
The total distance which can be safely covered (d_t) is the sum of the stope components (d_s) and the remaining distance negotiated in the haulage (d_r).

$$d_t = ds + dr$$
$$= 190 + 568$$
$$= 758\ m$$

The refuge bay or back-up facility should therefore be sited at a distance not exceeding 758 m from where men may be working in the stope.

ESCAPE B — Hypothetical escape route for a low-seam colliery

The route commences at the face, and during the initial stages (1 and 2) the ceiling height is below 1,1 m. Component 3 enforces a stooped body posture (ceiling height < 1,5 m) for 70 m. After (3) the worker must choose between (i) continuing on the normal escape route or (ii) taking the option of a more arduous route via a secondary intake airway the latter being intended for use only when the main route is blocked. (Local and international experience has underlined the crucial need to make provision for an alternative route). Both routes are essentially horizontal.



Plan view of escape route

ROUTE i

Basic information:

COMPONENT	DISTANCE (m)	x	V_e (ℓ/m)	=	V_t (ℓ)
1	50		2,4		120
2	50		2,4		120
3	70		1,6		112
4	30		1,6		48
TOTAL	200 (d_s)		—		400

The residual capacity (V_r) of the ResQpac is therefore

$$V_r = 750 - V_t$$
$$= 750 - 400$$
$$= 350\ \ell$$

The remaining component (5) can be negotiated without any ceiling height restriction and at a demand of 0,6 ℓ/m (Table 1). The remaining distance (d_r) is

$$d_r = V_r / 0{,}6$$
$$= 350 / 0{,}6$$
$$= 583\ m$$

and the total distance from the face to the refuge bay or back-up facility (d_t) is the sum of (d_s) and (d_r).

$$d_t = d_s + d_r$$
$$= 200 + 583$$
$$= 783\ m$$

The potential use of an alternative route must be taken into account before siting a refuge bay or back-up facility.

ROUTE ii

Basic information:

COMPONENT	DISTANCE (m)	x	V_e (ℓ/m)	=	V_t (ℓ)
1	50		2,4		120
2	50		2,4		120
3	70		1,6		112
TOTAL	170 (d_s)		—		352

The residual capacity (V_r) of the ResQpac is therefore

$$V_r = 750 - V_t$$
$$= 750 - 352$$
$$= 398\ \ell$$

The remaining component (6) must be negotiated at a demand of 1,6 ℓ/m and the remaining distance (d_r) which is covered is

$$d_r = V_r / 1{,}6$$
$$= 398 / 1{,}6$$
$$= 248{,}8$$
$$\sim 249\ \text{m}$$

The total distance which can be covered from the face is therefore

$$d_t = d_s + d_r$$
$$= 170 + 249$$
$$= 419\ \text{m}$$

Therefore, although the refuge bay or back-up facility may be situated 780 m from the face using Route i, this would be inadequate for Route ii.

General considerations

- Depending on the mining operation, escape routes may increase in length (as, for example, a result of face advance in gold mines) or shorten (as in a low-seam longwall operation in a coal mine). This means that escape routes should be reviewed periodically.

- Where possible, escape routes should be designed to minimize the effort required to negotiate them. At excessive ventilatory demands the capacity of the set to provide respirable air at an acceptable temperature and breathing resistance may be exceeded.

If this occurs

- the escapee may not be able to continue and, in a state of panic he may even remove the mouthpiece leaving him unprotected in a lethal atmosphere

- refuge bays or back-up facilities would have to be placed so close to working areas that their own life-saving potential may be jeopardised in the event of a disaster.

Reference

KIELBLOCK, A.J. and VAN RENSBURG, J.P. (1987). Self-contained self rescuer performance as a function of human mechanical efficiency and of escape route terrain, Proc. Symposium on Safety in Coal Mining, paper 8.2, CSIR Conference Publication S.420, Pretoria.

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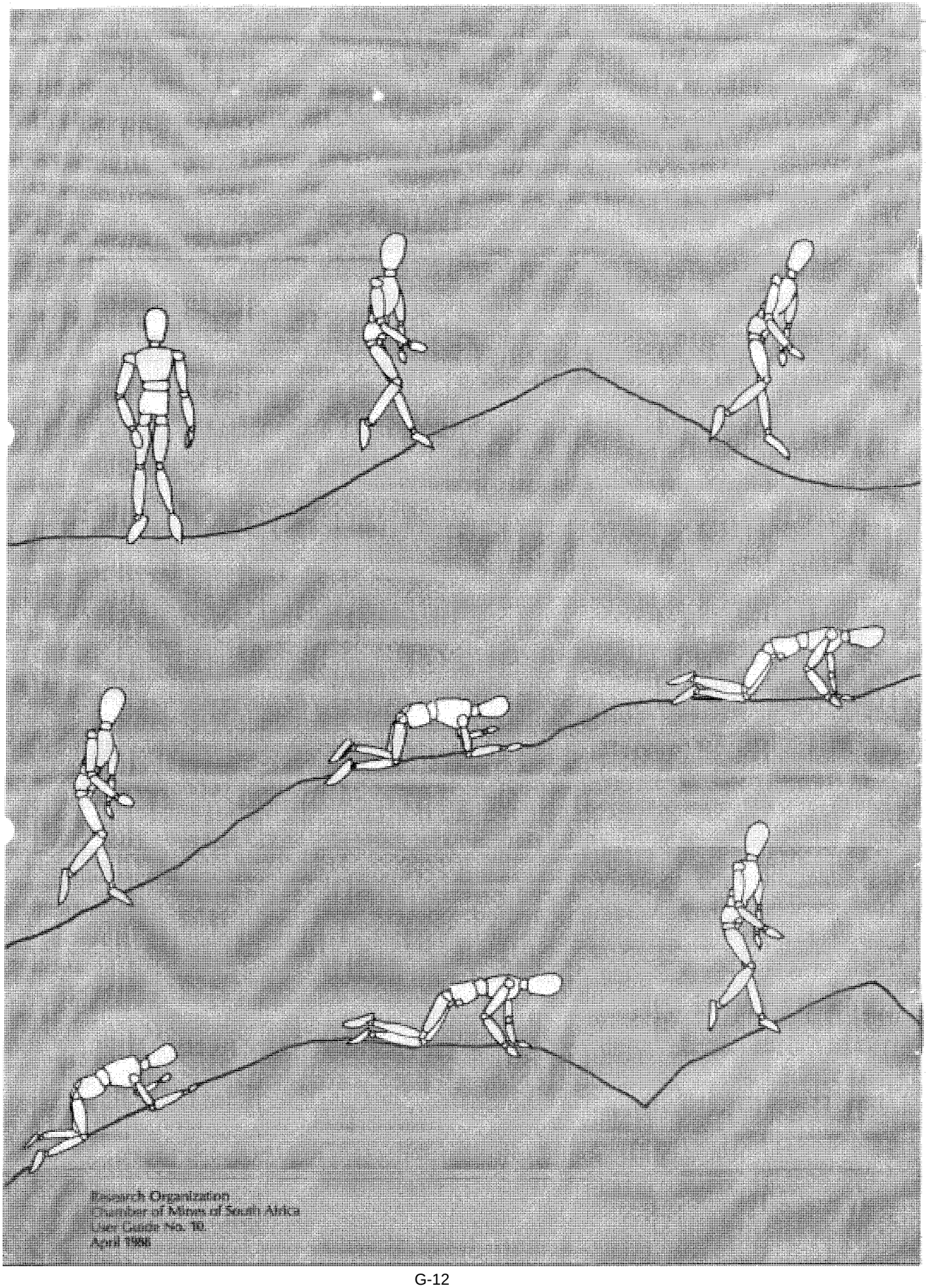
Research Organization
Chamber of Mines of South Africa
Loan Leaflet No. 10
April 1990

Appendix H: MRS Annual Report for 2007

ANNUAL REPORT

2007

MINES RESCUE SERVICES (PTY) LTD

ANNUAL REPORT 2007

I N D E X

1.0 EXECUTIVE OVERVIEW

During the past year there has been a decrease in the number of underground fires but unfortunately there has also been a decrease in the number of brigadesmen.

The mine membership has decreased by 6 from 121 to 115. The number of “A” class members decreased by 1 while “B” class members decreased by 5. Unfortunately, after three consecutive years of an increase in the number of brigadesmen, during the past year there has been a decrease from 815 to 810 while the number of rescue teams remained the same at 116 teams. What is still of concern is that 30% of the brigade has less than one year’s experience. The number of HDSAs increased from 118 to 141 whilst the whites decreased from 697 to 669.

The number of fires reported during the year decreased from 62 the previous year, to 58 in 2007. This has resulted in a decrease in the number of rescue teams utilized from 681 the previous year to 384 teams in 2007. Six brigadesmen sustained minor injuries during these fires and 3 brigadesmen were injured during training. Unfortunately twenty nine illegal miners lost there lives during two underground fires at gold mines.

I am grateful for the continued support of the Board of Directors, the Committee of Management and the staff of Mines Rescue Services. I will continue to strive to maintain the provision of the highest standard of emergency rescue for the mining industry.

C DE KLERK
GENERAL MANAGER

TABLES

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2.0 STRUCTURE OF MINES RESCUE SERVICES

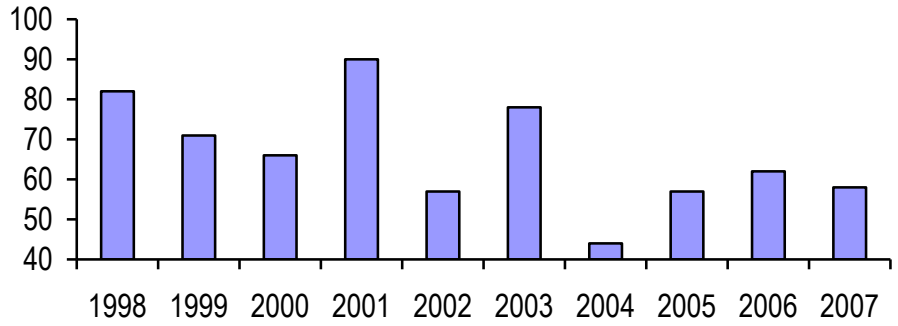
The following persons held office at Mines Rescue Services as at 31 December 2007.

NAME	COMPANY	DESIGNATION
AJ Field	Anglo Platinum	Chairman of the Board of Directors
C de Klerk	Mines Rescue Services	General Manager/ Director/ Chairman of Committee of Management
M Beukes	Anglogold Ashanti	Director
S van der Woude	Chamber of Mines of SA	Director
FW Knox	Ingwe Coal	Director
MZT Masondo	Anglo Coal (Pty) Ltd.	Director
D Roets	Gold Fields International Plc	Director
JEC Quinton	Impala Platinum Ltd	Director
W Uys	SASOL	Director
A Pretorius	Harmony Gold	Director
MMA Zondi	Dept. of Minerals & Energy	Director
E Gcilitshana	Labour Representative	Director
JW Johnson	Mines Rescue Services	Financial Manager / Public Officer/ Member of Committee of Management
SJ Orchardson	Chamber of Mines of SA	Company Secretary
JJ du Preez	Bosjesspruit Colliery	Member of Committee of Management
MJ Bleeker	New Clydesdale Colliery	Member of Committee of Management
P J Becker	RPM Rustenburg	Member of Committee of Management
B H Haumann	Beatrix Mine	Member of Committee of Management
AJ Espach	Mines Rescue Services	Superintendent (Carletonville)
TN Fourie	Mines Rescue Services	Superintendent (Evander)
G Batteson	Mines Rescue Services	Superintendent (Welkom)

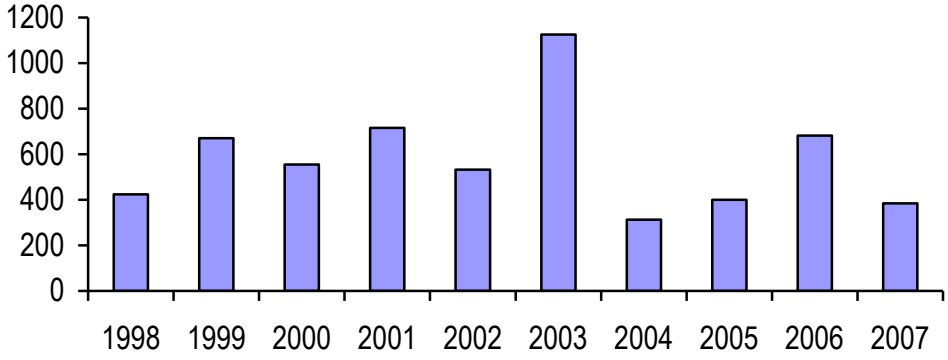
3.0 FIRES/INCIDENTS

During 2007 there was a decrease in the number of fires reported as well as in the number of teams utilized to bring these fires under control. Of the 329 incidents reported, 58 were call outs to fires that required the use of 384 rescue teams. (See Table 2).
Furthermore, during the year there were 271 other incidents that required 1226 rope rescue technicians, 44 mines rescue medics and 419 rescue teams. These rescues resulted in the rescue of 28 persons and the recovery of 20 bodies.

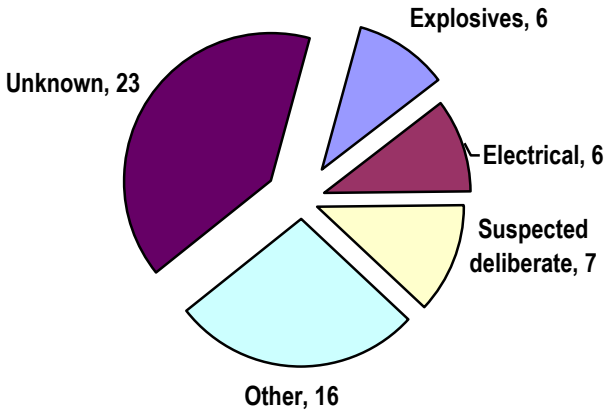
FIRES REPORTED



USE OF RESCUE TEAMS DURING FIRES



CAUSES OF FIRES

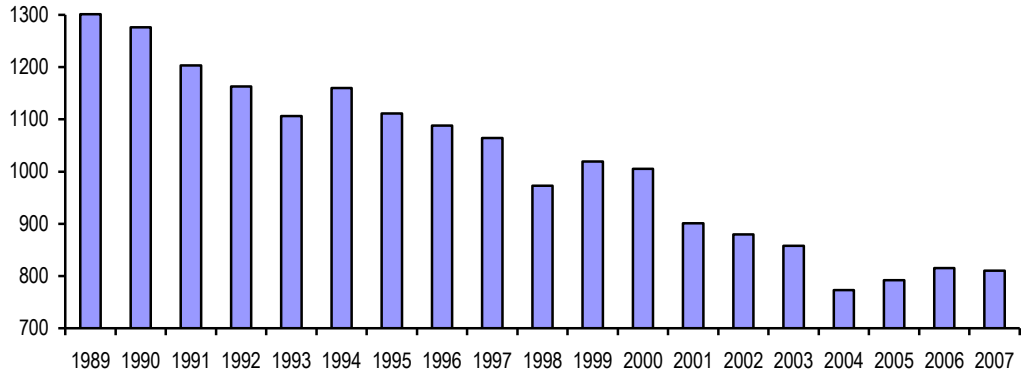


The majority of the fires' causes remain unknown, however suspected deliberate, electrical problems and explosives are of the known causes.

4.0 STRENGTH OF THE RESCUE BRIGADE

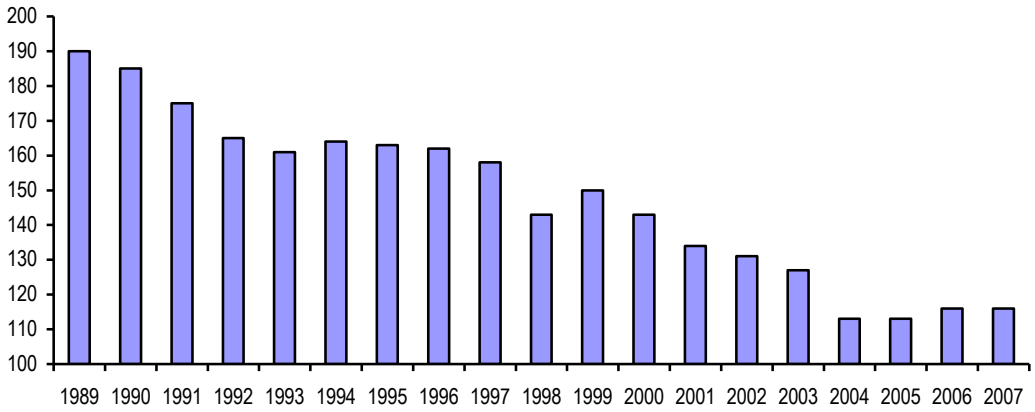
This year has shown a decrease of brigadesmen from 815 to 810. It is the first time in three consecutive years that there has been a decrease in the number of brigadesmen.

BRIGADE STRENGTH



The number of rescue teams has remained the same at 116.

BRIGADE TEAMS

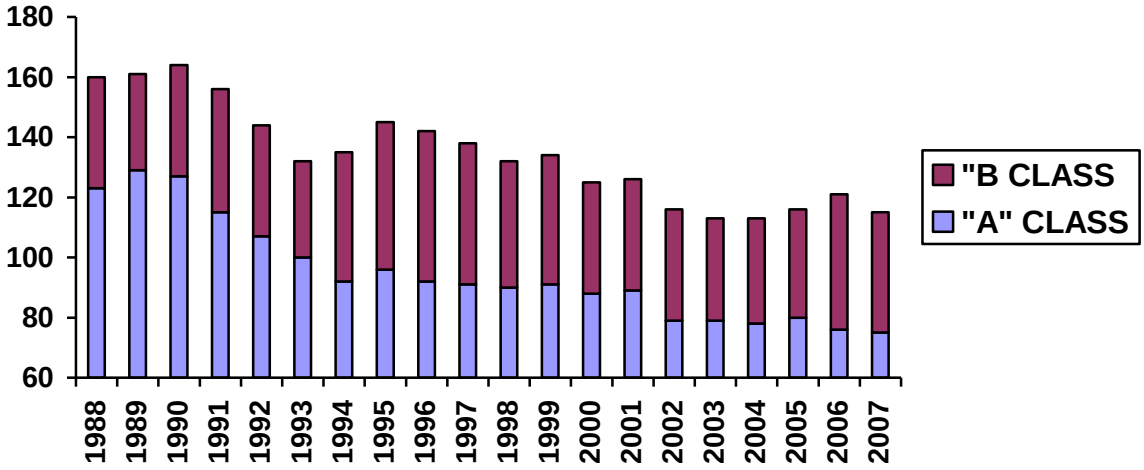


5.0 MEMBERSHIP OF MINES RESCUE SERVICES

At the end of December 2007 there were 75 “A” Class and 40 “B” Class member mines (total of 115).

The number of “A” Class member mines decreased by 1 from the previous year and the “B” Class member mines has also decreased by 5.

MEMBER MINES



6.0 TRAINING

Initial Comprehensive Rescue Course

During 2007, a total of 247 new candidates were trained on the BG4 breathing apparatus which represents 30 percent of all brigadesmen.

The following table reflects the causes why prospective brigadesmen were unsuccessful in completing the initial Heat Tolerance Test and/or the Initial course.

TOTAL 2006	TOTAL 2007	CAUSE
14	7	Claustrophobia
16	11	Unfit
10	3	Could not pass oral examination
1	0	Face piece does not fit
13	3	Workload Test
1	0	Overweight
1	0	Pain in Chest
2	0	Distress
28	8	Failed Initial HTT
86	**32**	

Resignation of brigadesmen.

The trend, where very few production employees joined the brigade whilst half of the resignations came from the production sphere, continued during 2007. The table below indicates the reasons why brigadesmen resigned.

REASONS	2006	2007
No apparent reasons (Mostly due to peer pressure)	59	30
Left mine	98	100
Retired due to age	9	24
Medical reasons	11	11
Dismissed from mine or from rescue team	23	17
Work pressure	4	38
Promoted	7	14
Retrenched	4	2
Emigrated	2	0
Overweight	3	0
Seriously injured in vehicle accident	1	2
Transferred	2	3
Not interested anymore	1	5
Asthma	2	0
TOTAL	**226**	**246**

Composition of Rescue Brigade

The composition of the rescue brigade has changed in that the percentage HDSAs increased from 14, 3% in 2006 to 17, 4% this year. The percentage of HDSAs who attended the initial course also increased from 17, 1% to 23, 8 %.

	CARLETONVILLE	EVANDER	WELKOM	2006	2007
HDSA	29	73	39	**118**	**141**
WHITE	244	244	181	**697**	**669**
TOTAL	273	317	220	**815**	**810**

Injuries to Brigadesmen

Brigadesmen injured during training

DATE	NAME	MINE	CAUSE AND INJURY
16/02/07	C A van Vuuren	Bosjesspruit	Heat Exhaustion on completion of Workload test.
30/07/07	C J F Hayton	Rasimone	Sprained lower back during Work Load Training
14/09/07	P A Joubert	Tshepong	Severe cramping during Heat Tolerance Test

Brigadesmen injured during Incidents. (Bona Fide Calls)

DATE	NAME	MINE	CAUSE AND INJURY
09/01/07	P J van Zyl	Kroondal at Kroondal	Burn wounds whilst extinguishing transformer fire
20/03/07	W M Mavukuthu	Unisel at Bambanani	Bumped head against ventilation column
22/07/07	J Lourens	Kopenang at Moab Khotsong	Contact with body fluids whilst performing body recovery
02/09/07	A J Peach	Kloof at Driefontein	Seismic event – back injuries and laceration to ear
09/11/07	F S Masemula	Mponeng at Kloof	Heat exhaustion
09/11/07	P J de Wet	Mponeng at Kloof	Slipped and fell on left knee

BG4 Breathing Apparatus Training

There is currently a total of 978 BG4 breathing apparatus in use at our member mines. Due to the problems encountered with the Monitron, which measures the pressure of the oxygen cylinder, it was decided to replace all the Monitrons with Body Guards. To date approximately a third of all the apparatus have been upgraded and plans are in place to have all the sets fitted with the Body Guard by the end of 2008.

Except for the minor replacements of “A” frames and “T” pieces on a few apparatus, no major improvements were made.

As part of the OEM’s recommendations, all of the oxygen reducers of the apparatus under the control of the Carletonville rescue station were overhauled.

Tests have been conducted on a full face mask with a water attachment which will enable brigadesmen to re-hydrate whilst using the apparatus. These tests will continue during 2008.

Mines Rescue Services in conjunction with Dräger South Africa are continuously evaluating the performance of the apparatus and where deemed necessary, improvements are made.

Advanced Rescue Course

During the year, a total of 86 potential captains received training and successfully completed the advanced rescue course.

Currently all rescue teams meet the required criteria, (In terms of the Code of Recommendations), for mandatory certified Captains and Vice Captains.

The quality of the projects produced by the candidates is of a high standard, which is reflected in the administrative and operational activities of teams.

Captain's meetings were scheduled at each rescue station, where topical issues were discussed.

Quarterly Training

The company conducted a total of 2930 quarterly training shifts during the year.

Mine Training

On-the-mine training conducted on surface, underground and in control rooms, was carried out in order to evaluate the overall mine emergency preparedness. The Carletonville rescue station conducted trainings at all of their member mines during the 4th quarter of the year.

These trainings provided management the opportunity of assessing and improving their emergency preparedness procedures.

Specialised Training

Specialised courses such as the Rope Technicians, BAA and Trapped Person Locating Device courses continued during 2007.

Control Room Management Course. (C.R.M).

During the year, there has been an increase in the number of requests to present the Control Room Management course. In Evander six courses were presented on the mines where 126 candidates attended these courses. At Carletonville eight courses were presented at MRS and 119 candidates attended. An additional five courses were presented on the mines where 89 candidates attended. Candidates who have attended these courses are better equipped to take charge during emergencies.

Basic Ambulance Assistants course (BAA)

During the year under review, a total of 210 persons were re-registered with the Health Professions Council of South Africa.

Three initial courses were held during the year at the Mines Rescue Services' accredited college and 17 candidates passed. A total of 141 persons attended refresher courses during the year. Reports

have been received of 44 BAA's utilized during emergencies but the number of BAA's utilized during non Bona-fide calls are not known.

7.0 EQUIPMENT

Trapped Person Location Device (TPLD)

During the year all the brigadesmen received training in the use of the TPLD.

Bullard Thermal Imaging Camera

A second unit was acquired by Mines Rescue Services during the year and is housed at the Evander rescue station. This device can be utilized by rescue teams to travel through areas with zero visibility, search for missing persons and to detect areas of heating.

A third unit will be acquired for the Welkom rescue station.

Emergency Rescue Winders

The rescue winder stationed at Carletonville was utilized during numerous incidents.

On 8 July 2007 the winder was used at Lonmin Marikana to assist in the rescue of 12 persons stuck in a conveyance 93 meters below surface.

On 12 July 2007 the winder was utilized to lower the Cyclops camera down a shaft at Crown mines and on 16 August 2007 the winder was utilized at Daggafontein 2 Shaft to search for a missing person.

Eleven Evander teams, comprising of 74 men have been trained in borehole rescue techniques. The teams trained are: Bosjesspruit, Brandspruit, Koornfontein, Savmore, Twistdraai, Syferfontein, Matla 2, Middelbult, Bank and Goedehoop.

Besides the new bore hole at Syferfontein, a second bore hole is now also available for training at Goedehoop colliery.

Eight staff members have been trained and found competent as emergency winder operators.

Long Duration Self Contained Self Rescuers (SCSR's)

The number of SCSR's available on mines increased from 914 in 2006 to 960 this year. Only units that are within 10 years of the OEMs manufacturer date will be used during emergencies.

High Pressure Oxygen Booster Pumps

All the rescue rooms together provide a total of 87 booster pumps.

8.0 STRATEGIC ISSUES

ISO 9001:2000 accreditation

Mines Rescue Services was subjected to the third stage audit process since its inception in 2004. The audit was conducted by Anglo Japanese American Registrars (AJA) to determine the extent of conformance with the requirements of the nominated ISO9001:2000 standards. The audit concluded that the system documents were comprehensive, well presented and addressed all the requirements of ISO 9001:2000. The auditors complimented the organisation on the achievement of the company's objectives in providing the mining industry with skilled rescue teams.

Workshop with brigadesmen

During the year, the company hosted various workshops with brigadesmen to address their concerns in connection with the work which they have to perform. As a result of these workshops the following was recommended and approved for implementation in January 2008:

- Introduction of a 5 year service award – to retain brigadesmen
- Serious review of monthly retainer rates to further retain brigadesmen and reward for additional responsibilities
- Introduction of a service increment to further retain brigadesmen with long service
- Introduction of a Rescue Co-ordinator (Proto Manager). He will be paid a monthly retainer and will liaise and address any difficulties experienced by the brigadesmen

Changes to Legislation

Mines Rescue Services continued to participate in a tripartite committee who completed the proposed new regulations pertaining to emergency preparedness and response that includes rescue brigades. The new regulations will be promulgated during 2008.

Unit Standards

During the year a Technical Reference Group (TRG30) was established at the Mine Qualification Authority (MQA) to examine mines rescue unit standards. The company is actively involved in this process.

International Contacts

The General Manager attended the third International Mines Rescue conference which was held during August in Nashville in the United States of America. The company continued to host international delegates at the various rescue stations.

9.0 FINANCIAL OVERVIEW

The financial year ended on 30 June 2007 and does not represent the same period in this report, however the financial overview addresses the financial period 1 July 2006 to 30 June 2007.

The actual expenditure of R 15,551 million was over spent by R389, 000 not accounting for some R1, 0 million provisions. As the company budgets on a break even basis, additional income of R 2, 5 million was received against a budgeted income of R 13,815 million.

This additional income of team usage, stock handling and interest was used to finance, primarily the provisions of the medical aid liability (R7, 695 million)

The Mines Rescue Services Trust, which is the shareholder of the company and holds all immovable and movable assets, acquired additional assets of R 1216,000

Table 1

5 YEAR COMPARISON OF CAUSES OF FIRES IN THE INDUSTRY

CAUSES	2003	2004	2005	2006	2007
Explosives	15	6	7	8	6
Electrical	15	7	10	13	6
Cut & Welding	7	0	5	2	0
Friction	1	1	3	1	4
Smoking	2	1	0	0	0
Susp. Deliberate	3	2	6	6	7
Vehicles	2	4	3	0	2
Flam. Gas Ignitions	2	0	0	2	2
Spon. Combustion	0	0	1	6	6
Unknown	30	22	20	23	23
Other	1	1	2	1	2
TOTAL	**78**	**44**	**57**	**62**	**58**

Table 2

SUMMARY OF FIRES AND TEAMS USED

CATEGORY	MRS TRIPS/ATTEND			TEAM USAGE		
FIRES	YES	NO	TOTAL	HOME	OUTSIDE	TOTAL
FIRES	38	20	58	132	252	384
SPECIALISED INCIDENTS	28	169	197	296	39	335
RECONNOITRES	20	12	32	70	15	85
GRAND TOTALS 2007	**86**	**201**	**287**	**498**	**306**	**804**
GRAND TOTALS 2006	**67**	**158**	**225**	**534**	**380**	**914**

Table 3

ASSESSMENT OF SPECIALISED BRIGADESMEN

STATION	BAA MEDICS	ROPE TECHNICIANS	BAA UTILIZED DURING 2006	RT UTILIZED DURING 2006
Carletonville	45	147	6	422
Evander	32	180	0	181
Welkom	27	115	46	259
TOTAL	**104**	**442**	**52**	**862**

Table 4

STRENGTH OF BRIGADE

	CVILLE		EVANDER		WELKOM		TOTALS	
	MEN	TEAMS	MEN	TEAMS	MEN	TEAMS	MEN	TEAMS
GOLD	124	21	33	5	190	24	347	50
COAL	-	-	204	30	-	-	204	30
DIAMOND	-	-	8	1	9	1	17	2
MANGANESE	-	-	-	-	13	2	13	2
ASBESTOS	-	-	-	-	-	-	-	-
COPPER	-	-	17	3	-	-	17	3
ANTIMONY	-	-	4	-	-	-	4	-
CHROME	5	1	7	-	-	-	12	1
PLATINUM	136	20	30	4	-	-	166	24
URANIUM	8	1					8	1
TITANIUM	-	-	-	-	-	-	-	-
NICKEL	-	-	13	2	-	-	13	2
IRON	-	-	-	-	-	-	-	-
LEAD	-	-	-	-	9	1	9	1
TOTAL 2007	**273**	**43**	**316**	**45**	**221**	**28**	**810**	**116**
TOTAL 2006	**287**	**42**	**315**	**46**	**213**	**28**	**815**	**116**

Table 5

MINE MEMBERS OF THE MINES RESCUE SERVICES

MINES	RESCUE STATIONS			TOTAL	
	CVILLE	EVANDER	WELKOM	2006	2007
GOLD	11	4	18	**36**	**33**
COAL	-	40	-	**46**	**40**
DIAMOND	1	1	6	**8**	**8**
COPPER	-	1	-	**1**	**1**
ANTIMONY	-	1	-	**1**	**1**
ASBESTOS	-	-	-	**0**	**0**
CHROME	4	3	-	**7**	**7**
MANGANESE	-	-	2	**2**	**2**
PLATINUM	10	8	-	**16**	**18**
URANIUM	1	-	-	**0**	**1**
SILICA	-	-	-	**0**	**0**
LEAD	-	-	1	**1**	**1**
TITANIUM	-	-	-	**1**	**0**
NICKEL	-	2	-	**2**	**2**
IRON	-	-	-	**0**	**0**
ZINC	-	-	-	**0**	**0**
OTHER	1	-	-	**0**	**1**
TOTAL	**28**	**60**	**27**	**121**	**115**

Table 6

"A" AND "B" CLASS MEMBERS OF MINES RESCUE SERVICES

	CVILLE	EVANDER	WELKOM	TOTAL 2006	TOTAL 2007
GOLD "A" CLASS	9	4	16	**29**	**29**
GOLD "B" CLASS	2	0	2	**7**	**4**
COAL "A" CLASS	-	22	-	**26**	**22**
COAL "B" CLASS	-	18	-	**20**	**18**
OTHER "A" CLASS	11	9	4	**21**	**24**
OTHER "B" CLASS	6	7	5	**18**	**18**
TOTAL	**28**	**60**	**27**	**121**	**115**

Table 7

SUMMARY OF TRAINING 2007

CARLETONVILLE

	HTT	COMPR.		QTR	ADVANCED		ROPE RESCUE		MEDICAL		TRAINING	VISITORS	TOTAL
	IND	INIT	REF		INIT	REF	INIT	REF	INIT	REF	OTHERS		
MEN	117	61	16	1002	26	63	44	119	29	76	606	182	2341
SHIFTS	117	305	80	1002	78	63	132	119	580	76	606	182	3340

EVANDER

	HTT	COMPR.		QTR	ADVANCED		ROPE RESCUE		MEDICAL		TRAINING	VISITORS	TOTAL
	IND	INIT	REF		INIT	REF	INIT	REF	INIT	REF	OTHERS		
MEN	208	112	8	1150	29	18	71	125	4	28	222	390	2367
SHIFTS	208	486	36	1150	87	18	211	125	79	28	230	390	3048

WELKOM

	HTT	COMPR.		QTR	ADVANCED		ROPE RESCUE		MEDICAL		TRAINING	VISITORS	TOTAL
	IND	INIT	REF		INIT	REF	INIT	REF	INIT	REF	OTHERS		
MEN	126	74	3	778	31	-	29	136	-	46	320	195	1749
SHIFTS	126	350	15	778	92	-	87	136	-	46	320	195	2145

TOTAL TRAINING - MINES RESCUE SERVICES 2007

	HTT	COMPR.		QTR	ADVANCED		ROPE RESCUE		MEDICAL		TRAINING	VISITORS	TOTAL
	IND	INIT	REF		INIT	REF	INIT	REF	INIT	REF	OTHERS		
MEN	451	247	27	2930	86	81	144	380	33	150	1148	767	6457
SHIFTS	451	1141	131	2930	257	81	430	380	659	150	1156	767	8533

TOTAL TRAINING – MINES RESCUE SERVICES 2006

	HTT	COMPR.		QTR	ADVANCED		ROPE RESCUE		MEDICAL		TRAINING	VISITORS	TOTAL
	IND	INIT	REF		INIT	REF	INIT	REF	INIT	REF	OTHERS		
MEN	379	241	44	2933	136	1	121	434	36	128	503	377	5333
SHIFTS	379	1124	207	2933	349	3	361	568	382	128	515	377	7326

Table 8 RESCUE STATIONS BRIGADE AND EQUIPMENT

MINES RESCUE SERVICES - CARLETONVILLE

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
GOLD "A" CLASS MEMBERS					
Blyvooruitzicht GM Co Ltd	12	1	50	11	2
Driefontein Consolidated (Pty) Ltd	28	2	17	22	4
Elandsrand Gold Mining Co. Ltd	8	1	15	8	1
Kloof Gold Mining Co. Ltd	43	5	30	32	6
Randfontein Operations	16	2	17	7	1
South Deep	21	1	8	12	2
Mponeng Mine	14	1	24	13	2
Savuka Mine	14	1	15	6	1
Tautona Mine	16	1	32	13	2
TOTAL "A" CLASS GOLD	**172**	**15**	**208**	**124**	**21**
GOLD "B" CLASS MEMBERS					
Gold Reef City	0	0	0	0	0
Rand Quest Syndicate Ltd	0	0	0	0	0
TOTAL "B" CLASS GOLD	**0**	**0**	**0**	**0**	**0**

OTHER "A" CLASS MEMBERS					
Aquarius Platinum - Kroondal Mine	11	1	0	5	1
Bafokeng Rasimone Platinum Mine	14	2	20	11	2
Barplats Mines Ltd. – Crocodile River Mine	6	1	6	5	1
Ezulwini Mining Company (Pty) Ltd	8	1	0	8	1
Impala Platinum Limited	24	1	20	24	3
Lonmin Platinum – Marikana Division	24	2	16	23	3
Northam Platinum Ltd – Zondereinde	21	1	22	20	3
RPM - Amandelbult Section	16	1	14	16	2
Rustenburg Section	21	1	27	21	3
Union Section	16	1	8	11	2
Samancor – Western Chrome Mines	8	1	8	5	1
TOTAL "A" CLASS OTHER	**169**	**13**	**141**	**149**	**22**
OTHER "B" CLASS MEMBERS					
Bombela Joint Civils	0	0	0	0	0
Helam Mining (Pty) Ltd – Diamond	0	0	0	0	0
Henric Ferrochrome – Maroelabult Chrome	0	0	0	0	0
International Ferro Metals (SA)(PTY)LTD	0	0	0	0	0
Lanxess Mining (Pty) Ltd – Chrome	0	0	0	0	0
Xstrata Alloys -Waterval & Kroondal	0	0	0	0	0
TOTAL "B" CLASS OTHER	**0**	**0**	**0**	**0**	**0**

RESCUE STATIONS BRIGADE AND EQUIPMENT

MINES RESCUE SERVICES - CARLETONVILLE

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
GOLD "A" CLASS	172	15	208	124	21
GOLD "B" CLASS	0	0	0	0	0
OTHER "A" CLASS	169	13	141	149	22
OTHER "B" CLASS	0	0	0	0	0
TOTAL CARLETONVILLE	**341**	**28**	**349**	**273**	**43**

RESCUE STATIONS BRIGADE AND EQUIPMENT

MINES RESCUE SERVICES - EVANDER

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
GOLD "A" CLASS MEMBERS					
Barberton Mines (Pty) Ltd	12	1	9	9	1
East Rand Proprietary Mines Ltd	12	1	12	7	1
Evander Gold Mines Limited	16	1	16	10	2
Petrex – Grootvlei, Cons Modder & Nigel GM	8	1	0	7	1
TOTAL "A" CLASS GOLD	**48**	**4**	**37**	**33**	**5**
GOLD "B" CLASS MEMBERS					
TOTAL "B" CLASS GOLD	**0**	**0**	**0**	**0**	**0**
COAL "A" CLASS MEMBERS					
Arnot Colliery	8	1	10	7	1
Bosjesspruit Colliery	8	1	10	7	1
Brandspruit Colliery	8	1	10	5	1
Douglas Colliery Services Ltd	8	1	20	7	1
Exxaro Matla/Coal a Division of Eyesizwe	24	3	26	19	3
Goedehoop Colliery including Bank Colliery	22	2	20	19	3
Greenside Colliery	8	1	4	6	1
Khutala Mining Services (Pty) Ltd	14	1	0	15	2
Kriel Colliery	12	1	10	12	2
Koornfontein Mines	8	1	24	9	1
Middelbult Colliery	8	1	12	9	1
Morupule Colliery (Pty) Ltd	7	1	0	8	1
New Denmark Colliery	10	1	4	9	1
Savmore Colliery (Kangra Group)	8	1	8	6	1
Sigma Colliery	7	1	10	4	0
Syferfontein Colliery	8	1	6	6	1
Tshikondeni Mining Company	15	1	0	11	2
Tweewaters Fuel (Pty) Ltd t/a Springlake	8	1	8	7	1
Twistdraai Colliery/Export Mines	16	2	8	13	2
Xstrata Coal Ltd. Tweefontein	14	2	12	7	1
Xstrata Coal (Pty) Ltd - Impunzi					
Xstrata Coal (Pty) Ltd – Southstock	8	1	10	5	1
Zululand Anthracite Colliery	8	1	8	7	1
TOTAL "A" CLASS COAL	**237**	**27**	**220**	**198**	**29**

MINES RESCUE SERVICES – EVANDER – (Continued)

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
COAL "B" CLASS MEMBERS					
Black Wattle Colliery	0	0	0	0	0
Delmas Coal (Pty) Ltd	0	0	0	0	0
Dorstfontein Coal Mines (Pty) Ltd	0	0	0	0	0
Elandsfontein Colliery (Pty) Ltd	0	0	0	0	0
Forzando Colliery	0	0	0	0	0
Gideon Mining	0	0	0	0	0
Glisa Colliery	0	0	0	0	0
Golfview Mining (Pty) Ltd	0	0	0	0	0
Magdalena Colliery (Slater Coal)	0	0	0	0	0
Maloma Colliery – Swaziland	0	0	0	0	0
Masala Resources – Wesselton Section	0	0	0	0	0
Masala Resources – Geluk Mine	0	0	0	0	0
Siphethe Coal	0	0	0	0	0
Slater Coal – Aviemore Colliery	0	0	0	0	0
Usutu Colliery	0	0	0	0	0
Vaalkrants Colliery (Leeuw Mining & Expl)	0	0	0	0	0
Wakefield Investment – Leeuwfontein Myne	0	0	0	0	0
Xstrata Coal SA – Tselentis, Spitzkop	6	1	0	6	1
TOTAL "B" CLASS COAL	**6**	**1**	**0**	**6**	**1**

OTHER "A" CLASS MEMBERS					
BCL limited – Botswana	12	1	18	13	2
Consolidated Murchison	6	1	0	4	0
Cullinan Diamond Mine	8	1	0	8	1
Dwarsrivier Chrome	8	0	8	3	0
Eastern Chrome Mines	6	1	0	4	0
Lebowa Platinum Mines	12	1	7	9	1
Lonmin Platinum – Limpopo Division	7	1	0	6	1
Modikwa Platinum	14	1	10	15	2
Palabora Mining Company Limited	24	1	14	17	3
TOTAL "A" CLASS OTHER	**97**	**8**	**57**	**79**	**10**

MINES RESCUE SERVICES – EVANDER
(Continued)

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
OTHER "B" CLASS MEMBERS					
Xstrata Alloys - Thorncliffe Division	0	0	0	0	0
Dilokong Chrome Mine (Pty) Ltd	0	0	0	0	0
Twickenham Platinum Mine	0	0	0	0	0
Everest Mine	0	0	0	0	0
Two Rivers Platinum Mine	0	0	0	0	0
Marula Platinum	0	0	0	0	0
Nkomati Joint Venture	0	0	0	0	0
TOTAL "B" CLASS OTHER	**0**	**0**	**0**	**0**	**0**

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
GOLD "A" CLASS	48	4	37	33	5
GOLD "B" CLASS	0	0	0	0	0
COAL "A" CLASS	237	27	220	198	29
COAL "B" CLASS	6	1	0	6	1
OTHER "A" CLASS	97	8	57	79	10
OTHER "B" CLASS	0	0	0	0	0
TOTAL EVANDER	**388**	**40**	**314**	**316**	**45**

RESCUE STATIONS BRIGADE AND EQUIPMENT

MINES RESCUE SERVICES - WELKOM

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
GOLD "A" CLASS MEMBERS					
Harmony – Bambanani and West	16	1	42	18	2
Harmony – Brand 3 & 5, Unisel and St Helena 4,7,8 7 10	17	2	20	19	2
Harmony – Joel Mine	7	1	20	6	1
Harmony - Masimong 4 & 5 and Saaiplaas	8	1	27	7	1
Harmony – Merriespruit M1 and M3 / Harmony H2 and H3	12	1	7	13	1
Harmony – Target	12	1	16	16	2
Harmony – Tshepong, Phakisa, Nyala and Eland	16	1	28	13	2
Harmony – Orkney	16	2	28	14	2
Beatrix	14	1	10	15	2
Oryx (Beatrix 4#)	8	1	13	8	1
President Steyn GM (Freestate) (Pty) Ltd	8	0	0	10	1
Anglo Gold Ashanti– Great Noligwa	20	1	20	17	2
Anglo Gold Ashanti – Kopenang	11	1	4	8	1
Anglo Gold Ashanti -Tau Lekoa	8	1	0	7	1
Anglo Gold Ashanti – Moab Khotsong	9	1	0	8	1
Simmer & Jack / Buffelsfontein	16	1	6	11	2
TOTAL "A" CLASS GOLD	**198**	**17**	**241**	**190**	**24**

GOLD "B" CLASS MEMBERS					
Aflease Limited	0	0	0	0	0
Harmony – (Care and maintenance shafts)	0	0	0	0	0
TOTAL "B" CLASS GOLD	**0**	**0**	**0**	**0**	**0**

OTHER "A" CLASS MEMBERS					
Assmang Limited	9	1	18	8	1
Black Mountain Mineral Division Co (Pty) Ltd	11	1	6	9	1
Finsch Diamond	16	0	11	7	1
Hotazel Manganese Mine - Samancor	8	0	16	5	1
TOTAL "A" CLASS OTHER	**44**	**2**	**51**	**29**	**4**

MINES RESCUE SERVICES – WELKOM
(Continued)

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
OTHER "B" CLASS MEMBERS					
Blaauwbosch Mine – Bellsbank Number One	0	0	0	0	0
De Beers – Kimberley Mine	0	0	0	0	0
De Beers – Koffiefontein Mine	7	0	5	2	0
Sedibeng Diamond incl.Messina & Dancarl	0	0	0	0	0
Star Diamond	0	0	0	0	0
TOTAL "B" CLASS OTHER	**7**	**0**	**5**	**2**	**0**

MINE	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
GOLD "A" CLASS	198	17	241	190	24
GOLD "B" CLASS	0	0	0	0	0
OTHER "A" CLASS	44	2	51	29	4
OTHER "B" CLASS	7	0	5	2	0
TOTAL WELKOM	**249**	**19**	**297**	**221**	**28**

SUMMARY ALL STATIONS

AREA	BG 4	BOOSTER PUMP	LDSCSR	MEN	TEAMS
CARLETONVILLE	341	28	349	273	43
EVANDER	388	40	314	316	45
WELKOM	249	19	297	221	28
TOTAL	**978**	**87**	**960**	**810**	**116**

Table 9

MINE FIRES AND EXPLOSIONS - SUMMARY

GROUP	SEVERITY			MRS ATTEND		CAUSE												TEAMS	
	MAJOR	MINOR	MBPM	YES	NO	UNKNOWN	OTHER	CUT & WELD	ELECTRICAL	EXPL & BLAST	FRICTION	SPON COMB	SUSP DELIB	VEH & LOCO	SMOKING	FLAM GAS	FATALITIES	OUTSIDE	HOME
ANGLOPLATS	2	2	3	5	2	2	-	-	1	-	-	-	2	2	-	-	-	9	9
ANGLOGOLD ASHANTI	-	3	4	7	-	7	-	-	-	-	-	-	-	-	-	-	-	30	40
AFLEASE	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2	0
ANGLO COAL	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	1	0
AQUARIUS	-	-	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-	1	1
BCL - BOTSWANA	4	3	-	-	7	-	-	-	-	-	1	6	-	-	-	-	-	-	7
DURBAN ROODEPOORT DEEP	-	2	3	4	1	-	-	-	2	2	-	-	1	-	-	-	-	10	6
DISSEL	-	3	1	3	1	2	-	-	1	-	-	-	1	-	-	-	-	28	2
EXXARO	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1
GOLD FIELDS OF SA	1	4	-	2	3	-	1	-	1	-	1	-	1	-	-	1	-	30	19
HARMONY	3	2	7	12	-	8	1	-	-	3	-	-	-	-	-	-	25	134	41
METOREX	-	2	-	-	2	2	-	-	-	-	-	-	-	-	-	-	4	0	2
RIO TINTO	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	0	2
SASOL	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
SIMMER & JACK	-	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	2	1
XSTRATA	-	-	2	2	-	-	-	-	-	-	1	-	1	-	-	-	-	3	1
TOTAL	**11**	**24**	**23**	**40**	**18**	**23**	**2**	**0**	**6**	**6**	**4**	**6**	**7**	**2**	**0**	**2**	**29**	**251**	**133**

MINE FIRES AND EXPLOSIONS

MINE	SEVERITY			MRS ATTEND		CAUSE												TEAMS	
	MAJOR	MINOR	MBPM	YES	NO	UNKNOWN	OTHER	CUT & WELD	ELECTRICAL	EXPL & BLAST	FRICTION	SPON COMB	SUSP DELIB	VEH & LOCO	SMOKING	FLAM GAS	FATALITIES	OUTSIDE	HOME
ANGLOPLATS																			
AMANDELBULT	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1
MODIKWA	-	-	1	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2
RPM RUSTENBURG	-	-	2	2	-	-	-	-	-	-	-	-	2	-	-	-	-	2	4
RASIMONE	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	2	2
UNION	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	2	0
TWICKENHAM	1	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	2	0
TOTAL	**2**	**2**	**3**	**5**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**9**	**9**
ANGLOGOLD ASHANTI																			
SAVUKA	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	3	1
TAUTONA	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	13	18
GREAT NOLIGWA	-	2	3	5	-	5	-	-	-	-	-	-	-	-	-	-	-	14	21
TOTAL	-	3	4	7	-	7	-	-	-	-	-	-	-	-	-	-	-	30	40

MINE FIRES AND EXPLOSIONS

MINE	SEVERITY			MRS ATTEND		CAUSE												TEAMS	
	MAJOR	MINOR	MBPM	YES	NO	UNKNOWN	OTHER	CUT & WELD	ELECTRICAL	EXPL & BLAST	FRICTION	SPON COMB	SUSP DELIB	VEH & LOCO	SMOKING	FLAM GAS	FATALITIES	OUTSIDE	HOME
AFLEASE																			
URANIUM ONE	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2	0
TOTAL	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**0**
AQUARIUS																			
KROONDAL	-	-	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-	1	1
TOTAL	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**
ANGLO COAL																			
GOEDEHOOP	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	1	0
TOTAL	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**0**
BCL - BOTSWANA																			
BCL	**4**	**3**	**-**	**-**	**7**	**-**	**-**	**-**	**-**	**-**	**1**	**6**	**-**	**-**	**-**	**-**	**-**	**0**	**7**
	4	**3**	**-**	**-**	**7**	**-**	**-**	**-**	**-**	**-**	**1**	**6**	**-**	**-**	**-**	**-**	**-**	**0**	**7**

MINE FIRES AND EXPLOSIONS

MINE	SEVERITY			MRS ATTEND		CAUSE												TEAMS	
	MAJOR	MINOR	MBPM	YES	NO	UNKNOWN	OTHER	CUT & WELD	ELECTRICAL	EXPL & BLAST	FRICTION	SPON COMB	SUSP DELIB	VEH & LOCO	SMOKING	FLAM GAS	FATALITIES	OUTSIDE	HOME
DURBAN ROODEPOORT DEEP																			
BLYVOORUITZIGHT	-	1	2	3	-	-	-	-	1	1	-	-	1	-	-	-	-	2	3
ERPM	-	1	1	1	1	-	-	-	1	1	-	-	-	-	-	-	-	8	3
TOTAL	**-**	**2**	**3**	**4**	**1**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**10**	**6**
DISSEL																			
PRES. STEYN	-	3	1	3	1	2	-	-	1	-	-	-	1	-	-	-	-	28	2
TOTAL	**-**	**3**	**1**	**3**	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**28**	**2**
EXXARO																			
MATLA 2	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1
TOTAL	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1
GOLD FIELDS OF SA																			
KLOOF	1	1	-	2	-	-	-	-	1	-	-	-	1	-	-	-	-	30	16
DRIEFONTEIN	-	1	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	0	0
SOUTH DEEP	-	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	0	2
BEATRIX	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	0	1
TOTAL	**1**	**4**	**-**	**2**	**3**	**-**	**1**	**-**	**1**	**-**	**1**	**-**	**1**	**-**	**-**	**1**	**-**	**30**	**19**

MINE FIRES AND EXPLOSIONS

MINE	SEVERITY			MRS ATTEND		CAUSE												TEAMS	
	MAJOR	MINOR	MBPM	YES	NO	UNKNOWN	OTHER	CUT & WELD	ELECTRICAL	EXPL & BLAST	FRICTION	SPON COMB	SUSP DELIB	VEH & LOCO	SMOKING	FLAM GAS	FATALITIES	OUTSIDE	HOME
HARMONY																			
ELANDSRAND	-	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1
RANDFONTEIN	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	3	1
FREESTATE – BAMBANANI	1	-	1	2	-	2	-	-	-	-	-	-	-	-	-	-	-	44	10
FREESTATE – TSHEPONG	1	-	2	3	-	2	-	-	-	1	-	-	-	-	-	-	-	27	11
FREESTATE – ST HELENA	-	-	2	2	-	1	1	-	-	-	-	-	-	-	-	-	25	13	7
FREESTATE – HARMONY H2	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1
FREESTATE – VIRGINIA	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	43	8
KLERKSDORP - ORKNEY	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	2	2
TOTAL	**3**	**2**	**7**	**12**	**-**	**8**	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**25**	**134**	**41**
METOREX																			
BARBERTON - FAIRVIEW	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	4	0	2
CONS MURCHISON	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	0	0
TOTAL	**-**	**2**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4**	**0**	**2**
RIO TINTO																			
PALABORA	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	0	2
TOTAL	**-**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0**	**2**

MINE FIRES AND EXPLOSIONS

MINE	SEVERITY			MRS ATTEND		CAUSE												TEAMS	
	MAJOR	MINOR	MBPM	YES	NO	UNKNOWN	OTHER	CUT & WELD	ELECTRICAL	EXPL & BLAST	FRICTION	SPON COMB	SUSP DELIB	VEH & LOCO	SMOKING	FLAM GAS	FATALITIES	OUTSIDE	HOME
SASOL																			
MIDDELBULT	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	0	1
TOTAL	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**0**	**1**
SIMMER & JACK																			
BUFFELSFONTEIN	**-**	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	2	1
TOTAL	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**
XSTRATA																			
THORNCLIFFE	**-**	-	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	2	0
TWEEFONTEIN	**-**	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1
TOTAL	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**3**	**1**

Table 10

SUMMARY OF INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

* RR TECH = ROPE RESCUE TECHNICIAN

GROUP	INCIDENTS	MRS ATTEND		PLANNED	UNPLANNED	SPECIALISTS		HOME	OUTSIDE	TOTAL		
		YES	NO			R.RES TECH	BAA				FATALS	RESCUES
ANGLOGOLD ASHANTI	4	1	3	3	1	15	0	6	7	13	2	0
ANGLO PLATINUM	122	0	122	121	1	650	19	163	0	163	1	0
AFGEM	1	1	0	0	1	10	2	0	1	1	0	0
AQUARIUS	2	1	1	2	0	10	0	1	1	2	0	0
CENTRAL RAND GOLD	4	4	0	4	0	0	0	0	2	2	0	0
DRD	3	1	2	1	2	13	0	3	0	3	0	1
EXXARO	4	0	4	4	0	20	0	4	0	4	0	0
GOLDFIELDS	13	6	7	6	7	26	3	23	7	30	5	3
HARMONY	32	11	21	19	13	158	9	31	11	42	10	7
IMPALA	37	0	37	37	0	229	0	37	0	37	0	0
LONMIN	3	1	2	0	3	10	11	6	0	6	1	15
NOTHAM	9	1	8	8	1	80	0	18	10	28	1	0
SIMMER & JACK	1	0	1	1	0	0	0	1	0	1	0	0
XSTRATA	2	0	2	2	0	0	0	2	0	2	0	0
RIO TINTO	1	0	1	0	1	5	0	1	0	1	0	2
TOTALS	238	27	211	208	30	1226	44	296	39	335	20	28

INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

DATE	GROUP	MINE	W/PLACE	MRS ATTEND	PLANNED	UNPLANNED	SPECIALISTS		HOME TEAMS	OUTSIDE TEAMS	TOTAL TEAMS	NATURE OF INCIDENT
							RR TECH	BAA				
	ANGLOGOLD ASHANTI											
Feb 2007	"	TAUTONA	VARIOUS	NO	YES	-	5	-	1	-	1	Ore pass inspection
26/05/2007	"	GREAT NOLIGWA	68EE 1 60N	NO	YES	-	5	-	1	-	1	Ore pass inspections
27/05/2007	"	GREAT NOLIGWA	68EE 1 60N	NO	YES	-	5	-	1	-	1	Ore pass inspections
20/07/2007	"	MOAB KHOTSONG	101 RAW	YES	-	YES	-	-	3	7	10	FOG – recovered 2 bodies
			TOTAL	**1**	**3**	**1**	**15**	**0**	**6**	**7**	**13**	**Recovered 2 bodies**
	ANGLO PLATINUM											
27/1 – 7/2	"	RPM	VARIOUS	NO(6)	Y(6)	-	30	-	6	-	6	Ore pass inspection
24/02/07	"	RASIMONE	PLANT	NO	YES	-	7	-	2	-	2	Clean silo
2/03/07	"	AMANDELBULT	15-16 REEFPASS	NO	YES	-	5	-	2	-	2	Ore pass inspection
29/4 &19/5	"	RPM UNION	SURFACE HIGH WALL	NO(2)	Y(2)	-	12	-	4	-	4	Remove pipes
7/07/07	"	RPM UNION	PLANT SILO	NO	YES	-	6	-	2	-	2	Cleaned silo
July 2007	"	PAARDEKRAAL	17 – 19 LEV	NO(3)	Y(3)	-	15	-	3	-	3	Cleaned ore pass
VARIOUS	"	AMANDELBULT	VARIOUS	NO(15)	Y(15	-	67	2	29	-	29	Ore pass inspection
2/8 – 14/10	"	RPM UNION	VARIOUS	NO(15)	Y(15	-	75	15	15	-	15	Ore pass inspection

INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

DATE	GROUP	MINE	W/PLACE	MRS ATTEND	PLANNED	UNPLANNED	SPECIALISTS		HOME TEAMS	OUTSIDE TEAMS	TOTAL TEAMS	NATURE OF INCIDENT
							RR TECH	BAA				
	ANGLOPLATINUM (CONT)											
9/9 – 26/10	"	AMANDELBULT	OREPASS	NO(9)	Y(9)	-	90	-	18	-	18	Ore pass inspection
Jan-Nov 07	"	RPM	VARIOUS	NO(55)	Y(55)	-	275	-	55	-	55	Ore pass inspection
30/11/2007	"	AMANDELBULT	15 EAST 1	NO	YES	-	6	-	2	-	2	Ore pass inspections
14/12/2007	"	AMANDELBULT	19-20 ORE PASS	NO	YES	-	8	-	2	-	2	Ore pass inspections
Dec 2007	"	RPM	BLESBOK	NO	YES	-	4	-	1	-	1	Ore pass inspection
Dec 2007	"	RPM	PAARDEKRAAL	N0	-	YES	-	2	1	-	1	1 X Body recovery
12/8-27/9	"	MODIKWA	VARIOUS	NO(10)	Y(10)	-	50	-	21	-	21	Ore pass inspections
			TOTAL	**0**	**121**	**1**	**650**	**19**	**163**	**-**	**163**	**Recovered 1 body**

INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

DATE	GROUP	MINE	W/PLACE	MRS ATTEND	PLANNED	UNPLANNED	SPECIALISTS		HOME TEAMS	OUTSIDE TEAMS	TOTAL TEAMS	NATURE OF INCIDENT
							RR TECH	BAA				
	AFGEM											
17/08/07	"	SIMOLOTSE	ARDO SHAFT	YES	-	YES	10	2	-	1	1	Winder broke
			TOTAL	**1**	**-**	**1**	**10**	**2**	**-**	**1**	**1**	
	AQUARIUS											
21/02/07	"	KROONDAL	35 LEVEL	-	YES	-	5	-	1	-	1	Clear ore pass
21/12/07		KROONDAL	K5	YES	YES	-	5	-	-	1	1	Ore pass inspection
			TOTAL	**1**	**2**	**-**	**10**	**-**	**1**	**1**	**2**	
	CENTRAL RAND GOLD											
23/06/07	"	2# MARAISBURG	CROWN MINES	YES	YES	-	-	-	-	-	-	Shaft examination – camera
26/06/07	"	CROWN MINES	CROWN MINES	YES	YES	-	-	-	-	-	-	Shaft examination - camera
12/07/07	"	CROWN MINES	CROWN MINES	YES	YSE	-	-	-	-	1	1	Shaft examination - camera
16/07/07	"	VILLAGE MAIN	VILLAGE MAIN	YES	YES	-	-	-	-	1	1	Back-up for shaft examination
			TOTAL	**4**	**4**	**-**	**-**	**-**	**-**	**2**	**2**	

INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

DATE	GROUP	MINE	W/PLACE	MRS ATTEND	PLANNED	UNPLANNED	SPECIALISTS		HOME TEAMS	OUTSIDE TEAMS	TOTAL TEAMS	NATURE OF INCIDENT
							RR TECH	BAA				
	DURBAN ROODEPOORT DEEP											
25/01/07	"	BLYVOOR	1A SUB VERT.	NO	-	YES	5	-	1	-	1	Skip door opened in shaft
16/05/07	"	BLYVOOR	35/20 STOPE	YES	-	YES	4	-	1	-	1	Rescue 1 person from O/pass
26/11/07	"	BLYVOOR	18 LEV TRANS.	NO	YES	-	4	-	1	-	1	Ore pass inspection
			TOTAL	**1**	**1**	**2**	**13**	**-**	**3**	**-**	**3**	**Rescued 1 person**
	EXXARO											
01/07/07	"	MATLA 2	SILO	NO	YES	-	5	-	1	-	1	Inspect silo
02/08/07	"	MATLA 2	SILO	NO(3)	Y(3)	-	15	-	3	-	3	Inspect silo
			TOTAL	-	4	-	20	-	4	-	4	
	GOLDFIELDS											
18/01/07	"	KLOOF	43 LEV REEF TIP	YES	-	YES	5	-	1	-	1	Recovered 1 body from O/pass
30/04/07	"	KLOOF	34/37 STOPE	YES	-	YES	4	2	1	-	1	Rescue 1 person from O/pass
27/05/07	"	SOUTH DEEP	87 LEV R/BORE	YES	YES	-	4	-	1	1	2	Remove grizzly from O/pass
15/05/07	"	DRIEFONTEIN	8/47 STOPE	NO	-	YES	-	-	3	-	3	FOG recovered 1 body
23/06/07	"	SOUTH DEEP	93 LEV STN TIP	YES	-	YES	4	-	1	1	2	Recovered 1 body from O/pass
31/05/07	"	KLOOF	43/61 STOPE	NO	-	YES	-	1	2	-	2	Persons exposed to fumes

INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

DATE	GROUP	MINE	W/PLACE	MRS ATTEND	PLANNED	UNPLANNED	SPECIALISTS		HOME TEAMS	OUTSIDE TEAMS	TOTAL TEAMS	NATURE OF INCIDENT
							RR TECH	BAA				
	GOLDFIELDS (CONTINUE)											
1/09/07	"	DRIEFONTEIN	46/30A STOPE	YES	-	YES	-	-	3	5	8	FOG recovered 1 rescued 2
21,26/11/07	"	SOUTH DEEP	95 LEV 2 WEST	NO(2)	Y(2)	-	9	-	4	-	4	Ore pass inspection
16,17,19/11	"	SOUTH DEEP	TM3	NO(3)	Y(3)	-	-	-	6	-	6	Erect seal
22/10/07	"	BEATRIX	22B2N5	YES	-	YES	-	-	1	-	1	FOG recovered 1 body
			TOTAL	**6**	**6**	**7**	**26**	**3**	**23**	**7**	**30**	**Recovered 5 bodies rescued 3**
	HARMONY											
18/01/07	"	COOKE 3 #	COOKE 3#	YES	-	YES	-	-	1	-	1	FOG recovered 2 bodies
28/01/07	"	COOKE 2#	7957	NO	-	YES	-	-	1	-	1	Recovered 2 bodies
31/01/07	"	COOKE 3#	11852 W X/CUT	NO	-	YES	-	-	1	-	1	Recovered 1 body
22/05/07	"	RANDFONTEIN	207 SILO	YES	-	YES	3	1	1	-	1	Rescued 3 persons from silo
30/06/07	"	ELANDSRAND	95/11 W3	NO	-	YES	-	-	1	-	1	FOG recovered 1 body
VARIOUS	"	ELANDSRAND	VARIOUS	NO(11)	Y(11	-	55	-	11	-	11	Ore pass inspections
18,28/09/07	"	ELANDSRAND	VARIOUS	NO(4)	Y(4)	-	20	-	4	-	4	Ore pass inspections
23/11/07	"	ELANDSRAND	100 LEV BAC	YES	-	YES	-	-	1	2	3	FOG Recovered 1 body

INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

DATE	GROUP	MINE	W/PLACE	MRS ATTEND	PLANNED	UNPLANNED	SPECIALISTS		HOME TEAMS	OUTSIDE TEAMS	TOTAL TEAMS	NATURE OF INCIDENT
							RR TECH	BAA				
	HARMONY (CONTINUE)											
6,10,22/10	"	ELANDSRAND	95-98 O/PASS	NO(3)	Y(3)	-	15	-	3	-	3	Ore pass inspections
05/01/07	"	JOEL	110 LEVEL	YES	-	YES	9	-	1	1	2	Vent column down shaft
14/04/07	"	MASIMONG 5 #	1810 W1	YES	-	YES	-	-	1	1	2	Recovered 1 body
14/03/07	"	JOEL	NORTH SHAFT	YES		YES	11	-	2	2	4	Recovered 1 body from shaft
11-12/07/07	"	TARGET	50 LEV O/PASS	YES	YES	-	12	-	2	2	4	Ore pass inspection
25/09/07	"	TSHEPONG	60 LEVEL	YES	-	YES	11	2	-	1	1	Rescued 1 person from pass
08/11/07	"	PHAKISA	75 LEV SETTLER	YES	-	YES	11	3	-	1	1	# Accident rescued 3 persons
12/11/07	"	ST HELENA	24 LEVEL TIPS	YES	-	YES	11	3	-	1	1	Recovered 1 body
06/12/07	"	BAMBANANI	66/61	YES	-	YES	-	-	1	-	1	Seismic event
			TOTAL	**11**	**19**	**13**	**158**	**9**	**31**	**11**	**42**	**7 rescued, recovered 10 bodies**
	IMPALA											
5-13/02/07	"	IMPALA	VARIOUS	NO(7)	Y(7)	-	42	-	7	-	7	Ore pass inspections
Sept 2007	"	IMPALA	VARIOUS	NO(10)	Y(10	-	50	-	10	-	10	Ore pass inspections
05/10/07	"	IMPALA	6 SHAFT	NO	YES	-	4	-	1	-	1	Ore pass inspection
VARIOUS	"	IMPALA	VARIOUS	NO(19)	Y(19	-	133	-	19	-	19	Ore pass inspections
			TOTAL	**-**	**37**	**-**	**229**	**-**	**37**	**-**	**37**	

INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

DATE	GROUP	MINE	W/PLACE	MRS ATTEND	PLANNED	UNPLANNED	SPECIALISTS		HOME TEAMS	OUTSIDE TEAMS	TOTAL TEAMS	NATURE OF INCIDENT
							RR TECH	BAA				
	LONMIN											
25/02/07	"	KAREE	SHAFT O/PASS	NO	-	YES	5	5	1	-	1	Recovered 1 body from pass
01/03/07	"	KAREE	EASTERN B3	NO	-	YES	-	6	3	-	3	FOG 2 persons rescued
08/07/07	"	MARIKANA	1 LIFTER SHAFT	YES	-	YES	5	-	2	-	2	# Accident rescued 13
			TOTAL	**1**	**-**	**3**	**10**	**11**	**6**	**-**	**6**	**Recovered 1 rescued 15**
	NORTHAM											
13/03/07	"	NORTHAM	MINE	YES	-	YES	-	-	8	10	18	Recovered 1 body
22/6-15/09	"	NORTHAM	VARIOUS	NO(8)	Y(8)	-	80	-	10	-	10	Ore pass inspections
			TOTAL	**1**	**8**	**1**	**80**	**-**	**18**	**10**	**28**	**Recovered 1 body**
	SIMMER & JACK											
10/05/07	"	BUFFELSFONTEIN	77 INCLINE	NO	YES	-	-	-	1	-	1	Install pump
			TOTAL	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	
	XSTRATA											
20/01/07	"	TWEEFONTEIN	1N2W2	NO	YES	-	-	-	1	-	1	Water inundation
21/01/07	"	TWEEFONTEIN	1N2W2	NO	YES	-	-	-	1	-	1	Plugged bore hole
			TOTAL	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**	

INCIDENTS REQUIRING SPECIALIST BRIGADESMEN

DATE	GROUP	MINE	W/PLACE	MRS ATTEND	PLANNED	UNPLANNED	SPECIALISTS		HOME TEAMS	OUTSIDE TEAMS	TOTAL TEAMS	NATURE OF INCIDENT
							RR TECH	BAA				
	RIO TINTO											
27/09/07	"	PHALABORA	SILO NO. 1	NO	-	YES	5	-	1	-	1	Rescued 2 persons from silo
			TOTAL	**-**	**-**	**1**	**5**	**-**	**1**	**-**	**1**	**Rescued 2 persons**

Table 11

RECONNOITRES – HOLING EXAMINATIONS

GROUP	MINE	MRS ATTEND		TEAM USAGE			DESCRIPTION
		YES	NO	HOME	OUTSIDE	TOTAL	
ANGLOGOLD ASHANTI	KOPANANG	YES	-	1	3	4	RECCE VENT WAYS
ANGLO COAL	GOEDEHOOP	-	NO	3	-	3	CHECH FOR WATER AND METHANE
AMPLATS	UNION	-	NO	2	-	2	INVESTIGATE CO PLUG
AMPLATS	AMANDELBULT	-	NO	1	-	1	POWER FAILURE – CLEAR SHIFT
DRD	BLYVOOR	-	NO	1	-	1	INSTALL SEALS
EXXARO	MATLA 3	YES	-	2	-	2	HOLING EXAMINATION
EXXARO	MATLA 3	YES	-	2	-	2	CHECK VENT WALLS
EXXARO	MATLA 2	YES	-	2	3	5	CLEAR METHANE
EXXARO	MATLA 2	YES	-	1	1	2	RECLAMATION
EXXARO	MATLA 2	YES	-	2	2	4	INSTALL VENT BRATTICE
EXXARO	MATLA 2	YES	-	1	1	2	DE-GAS AREA
EXXARO	MATLA 3	YES	-	2	-	2	CHECK HOLING
EXXARO	MATLA 2	YES	-	1	1	2	INSTALL BRATTICES
EXXARO	MATLA 2	-	NO	3	-	3	CLEAR GAS FROM SHORT WALL
EXXARO	MATLA 2	YES	-	2	-	2	REPAIR VENT CONTROL

RECONNOITRES – HOLING EXAMINATIONS (CONTINUE)

GROUP	MINE	MRS ATTEND		TEAM USAGE			DESCRIPTION
		YES	NO	HOME	OUTSIDE	TOTAL	
EXXARO	MATLA 2	YES	-	2	-	2	REPAIR VENT CONTROL
EXXARO	MATLA 2	YES	-	2	-	2	REPAIR VENT CONTROL
EXXARO	MATLA 2	YES	-	2	-	2	INSTALL SEALS
EXXARO	MATLA 2	YES	-	2	-	2	INSTALL SEALS
EXXARO	MATLA 2	YES	-	2	-	2	INSTALL SEALS
GOLDFIELDS	DRIEFONTEIN	-	NO	3	-	3	RECCE ESCAPE ROUTES
HARMONY	ELANDSRAND	-	NO	1	-	1	RECCE ESCAPE ROUTES
HARMONY	ELANDSRAND	YES	-	1	-	1	SHAFT ACCIDENT
HARMONY	ELANDSRAND	YES	-	1	1	2	CLOSED WATER COLUMN
HARMONY	EVANDER	-	NO	2	-	2	INSTALL SEALS
NORTHAM	NORTHAM	-	NO	18	-	18	INSTALL VENT CONTROLS
RIO TINTO	PALABORA	-	NO	2	-	2	INPECT OPEN PIT – RAIN
RIO TNTO	PALABORA	-	NO(3)	4	-	4	INSTALL VENT COLUMN
SASOL	MIDDELBULT	YES	-	1	1	2	CHECK SOURCE OF WATER
XSTRATA	TWEEFONTEIN	YES	-	1	1	2	FLOODING- PUMP WATER
XSTRATA	TWEEFONTEIN	YES	-	1	1	2	FLOODING
TOTAL		8	13	24	8	32	

SUMMARY RECONNOITRES – HOLING EXAMINATIONS

GROUP	MRS ATTEND		TEAM USAGE		
	YES	NO	HOME	OUTSIDE	TOTAL
ANGLOGOLD ASHANTI	1	-	1	3	4
ANGLO COAL	-	1	3	-	3
AMPLATS	-	2	3	-	3
DRD	-	1	1	-	1
EXXARO	14	1	28	8	36
GOLDFIELDS	-	1	3	-	3
HARMONY	2	2	5	1	6
NORTHAM	-	1	18	-	18
RIO TINTO	-	4	4	-	4
SASOL	1	-	1	1	2
XSTRATA	2	-	2	2	4
TOTAL	20	13	69	15	84

Appendix I: EXAMPLE OF ERP COP

xstrata coal	**XSTRATA COAL SA**
	STANDARD: *Escape and Rescue*

DOCUMENT REFERENCE NUMBER	*Per the document control procedure GS GEN HSEC P001*
REVISION NUMBER	001
PRINCIPAL AUTHORS/INITIATORS	*SK Ambrosio*
EFFECTIVE DATE	*May 2008*
REVISION DUE DATE	*May 2010*

SCOPE	*This document details the applicable and standards and procedure for the escape and rescue of underground workers in the event of a fire or explosion.*
APPLICABILITY	XCSA employees & contractors.
PROCEDURAL DOCUMENT	*RELATED / SUPPORTING PROCEDURES, LEGAL OR XC plc REQUIREMENT (list / ref no)*

REVISION DATA				
Revision No.	**Page**	**Revision Details**	**Date**	**Approved By**
001	All	First formal issue	May 2008	Standards Committee

All Health, Safety, Environmental and Community issues were considered during the drafting of this procedure, e.g.:

Health issues: Any ergonomic problems associated with the plant, equipment, also considering the creation dust, gases, chemicals, radiation and noise;

Safety issues: Revealing hazards which may be present in plant, equipment, operating procedures and work systems which could result in physical harm;

Environmental issues: Identification of all hazardous substances, hydrocarbon spillage and contamination, uncontrolled discharge, pollution, soil erosion and poor water management, and;

Community issues: Any adverse affects that site operations may have on the surrounding community, i.e. noise, dust, erosion, sinkholes, etc.

1. OBJECTIVE

To ensure the safety and health of workers in the event of an underground emergency involving a fire, explosion or unexpected exposure to noxious gas by detailing the required systems and equipment that must be in place to enable workers to escape from the workings to a Place of Safety.

2. DEFINITIONS

- A **Place of Safety** is defined as an area that will support human life. Such places may be a Refuge Chamber or Escape Shaft to surface
- **SCSR** means a Self-Contained Self-Rescuer.
- **Long Duration SCSR** means a Self-Contained Self-Rescuer that has duration of 90 minutes.

3. ROLES AND RESPONSIBILITIES

Operations Managers

The Operations Manager shall:

- Implement this standard at all XCSA Operations
- Provide sufficient resources to ensure that it is effectively managed
- Ensure all employees are aware of this standard and of their responsibilities
- Review this standard every 2 years or if new information becomes available

Departmental Managers

Departmental Managers shall:

- Ensure that employees within his/her department are aware of this standard
- Implement this standard at a departmental level

Supervisors

Supervisors shall:

- Ensure that this standard is implemented and adhered to within his/her team and by contractors engaged on shift.
- Identify and monitor this standard within the work team.
- Take corrective actions to manage the risk factors that may occur in relation to non adherence to this standard.
- Ensure employees within his/her team have access to training and information relating to the management of this standard.

Employees/Contractor Employees

Employees shall:

- Ensure they follow the requirements of this standard.
- Attend training/education relating to the management of this standard.
- Report any deviations from this standard to their Team Leader.
- Apply the training they have received regarding the management of this standard to reduce the risk of deviations from this standard in the workplace.

4. IMPLEMENTATION PERIOD AND EXCEMPTIONS

4.1 Implementation Period

Operations will have 6 month period in which they are required to meet the requirements of this procedure.

4.2 Exemptions

No exemptions will be considered in terms of the Escape Route and Long Duration SCSR Cache's. Operations that have existing Refuge Chambers will be exempt from the requirements of this procedure in terms of the specific types of equipment in use in the Refuge Chambers underground. In such cases the minimum requirements in terms of the performance of the stipulated equipment must be met. In all cases the spirit and intent of this procedure must be met.

4.3 New / Alternative Systems

From time to time operations may wish to try alternative escape and rescue systems. Such systems may only be tested with the permission of the responsible General Manager and the General Manager – Health and Safety. Should such a trial be successful, this document must be amended to incorporate the new system.

5. STANDARD

5.1 Escape and Rescue Strategy

The Escape and Rescue Strategy of Xstrata Coal SA is the personal allocation of a belt-worn Self-Contained Self-Rescuer (SCSR) to all underground personnel. In the event of an emergency that may render the atmosphere irrespirable, personnel will be required to don their SCSR's and proceed (via a predetermined and prepared Escape Route) to a Place of Safety (e.g. a Refuge Chamber).

Such Place of Safety will be located within 750m from the workplace in accordance with the duration of the SCSR. In the event that it is impossible to construct a Refuge Chamber within the required distance from the workplace, use will be made of a Long Duration SCSR Cache (within 750m from the workplace) where personnel will be able to change from their SCSR's to the Long Duration SCSR's in safety. Personnel will then proceed to the nearest Place of Safety. A maximum of one Long Duration SCSR Cache System may be used in any given Escape Route (i.e. a maximum of one SCSR and one Long Duration SCSR per employee).

5.2 Self-Contained Self-Rescuers (SCSR's)

All employees of Xstrata Coal SA that work in the underground environment will be issued with a SCSR that has been individually allocated to him or her. SCSR's may not be shared. These SCSR's are required to supply approximately 30 minutes of oxygen in accordance with SABS specifications.

Only two models are allowed for use within Xstrata Coal SA operations. These are:

5.2.1 The Dragar (Oxyboks K Unit)

5.2.2 The MSA (SavOx unit)

Minor variations on these specific models are acceptable. All SCSR's will be inspected by Lamproom staff in accordance

with the OEM's instructions. Repairs may only be conducted by the OEM.

5.3 Long Duration Self-Contained Self-Rescuers (SCSR's)

Long duration SCSR's will be used in underground SCSR Cache's that may be required where Escape Routes are longer than the stipulated requirement.

These SCSR's are required to supply approximately 90 minutes of oxygen in accordance with SABS specifications. In addition, these units must be able to supply immediate oxygen to the wearer without the need for the wearer to breathe into the unit to get it started.

Only one model is allowed for use within Xstrata Coal SA operations, namely:

5.3.1 Ocenco (EBA 6.5 IS unit)

All long duration SCSR's will be inspected by Lamproom staff in accordance with the OEM's instructions. Repairs may only be conducted by the OEM. In order to conduct these inspections, these SCSR's must on a monthly basis be brought to surface by the responsible mining official for inspection at the Lamproom.

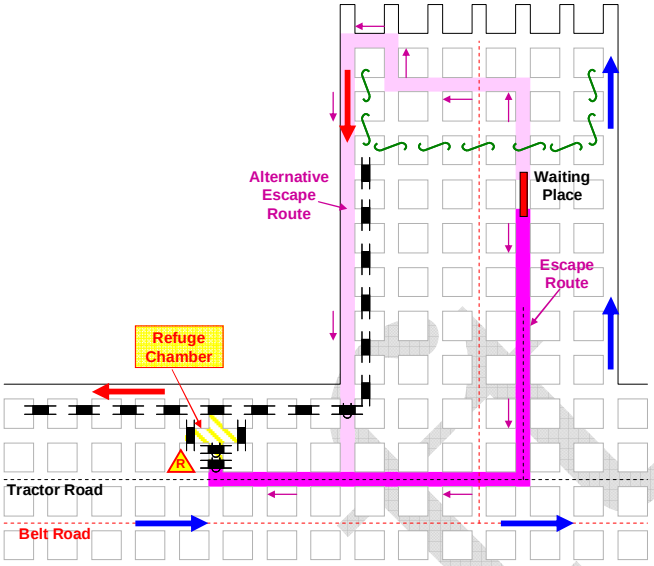
5.4 Escape Route

5.4.1 Design of the Escape Route

The Escape Route will be designed on a standard ventilation layout as specified by the Complex Occupational Hygienist in consultation with the relevant mining officials. The following provisions will apply:

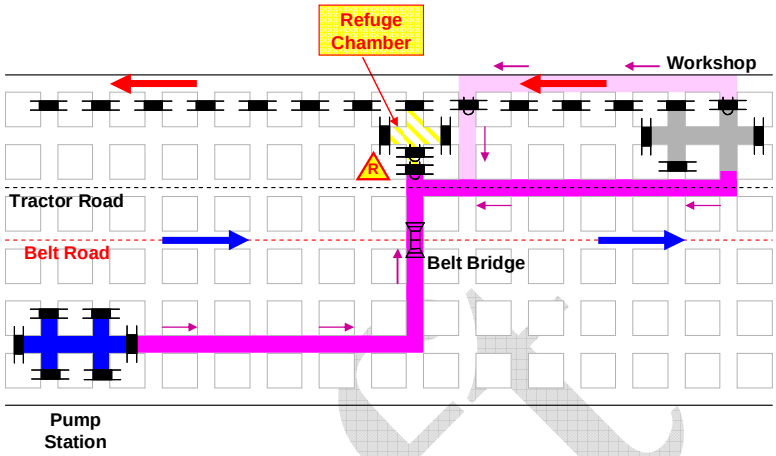
- All construction work required must be stipulated in the layout.
- The Escape Route will follow the shortest practical walking route from the working place to a Place of Safety.
- Production Sections:
  - The Escape Route will start at the tip of the section, through the waiting place of the production section and will follow the intake airway (along the travelling way or tractor road as far as reasonably practicable) to the Place of Safety.
  - Where it is determined by means of a risk assessment that a fire may occur in the intake airway an alternative Escape Route must be planned that will start at the waiting place of the production section and will follow the return airway to the Place of Safety .

ESCAPE ROUTE (from a Production Section)



- Outbye Working Places (workshops, stores, pump stations, etc.):
  - The Escape Route will start at the waiting place of the area concerned and will follow the intake airway (along the travelling way as far as reasonably practicable) to the Place of Safety.
  - Where it is determined by means of a risk assessment that a fire may occur in the intake airway an alternative Escape Route must be planned that will start at the waiting place of the area concerned and will follow the return airway to the Place of Safety .

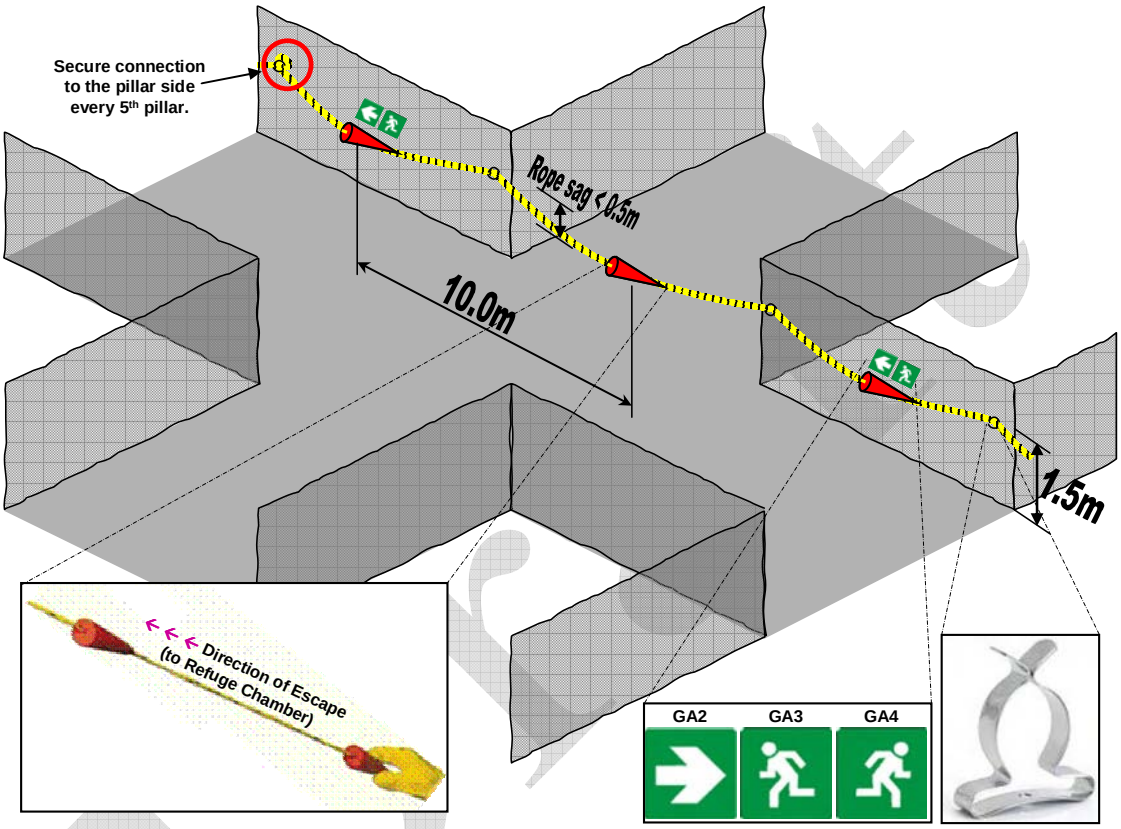
ESCAPE ROUTE (from Outbye Working Places)



- Other Outbye Areas:
  - The Escape Route will be located along the travelling way to the nearest Place of Safety.

5.4.2 Equipping / Construction of the Escape Route

- A Life Line will be installed along the full length of the Escape Route. Such Life Line will consist of the following as per the diagram below:



  - o A yellow 7mm braided rope, mounted to the pillar rib side which will specifically define the Escape Route.
  - o A series of angled directional cones which are fixed to the Life Line. The angled directional cones must be fixed to the Life Line at a minimum of 10.0m intervals over the span of the Life Line.
  - o The Life Line and cones will be installed in such manner that when the Life Line is being used, personnel are able to walk only in the direction of safety (this is indicated by a hand that is holding the Life Line being able to smoothly pass over the cone). A person, that is travelling in the

wrong direction, whose hand is holding the Life Line will be stopped (or obstructed) by the flat side of the directional cone.

- Life Lines will be secured to either end of the pillar side by means of 25mm suspension (tool) clips made from spring steel as per the diagram.

- The life line may not sag more than 0.5m between suspension clips.

  This is important in order to prevent excessive Life Line being present along the Escape Route. Excessive line may result in confusion amongst persons trying to escape.

- IMPORTANT: Life Lines must be secured in such a manner that they can be easily unclipped. The only places where a Life Line may be tied to anything is at the following places:
  - At the beginning and ending of the Life Line
  - Where the Life Line is tied to another Life Line (e.g. where two Life Lines meet).
  - Once every 5th pillar.

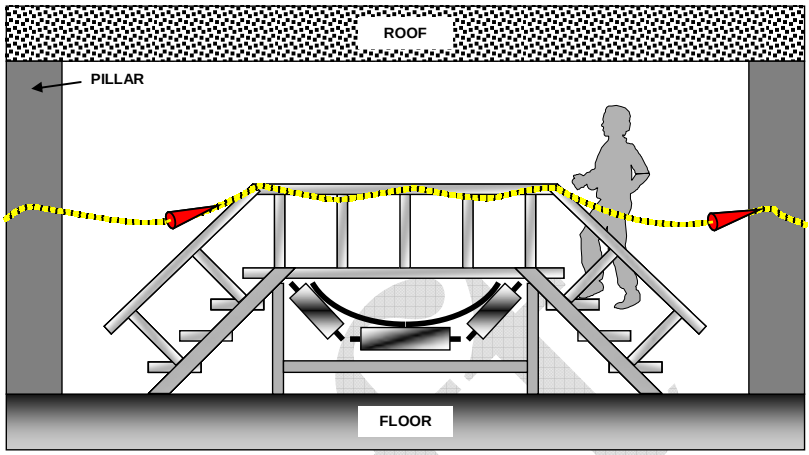
    This is important in order to prevent excessive Life Line being present along the Escape Route. Excessive line may result in confusion amongst persons trying to escape.

- A pair of Symbolic Safety Signs will be installed on each pillar along the Escape Route. These signs will consist of a General Direction sign (GA2) and a Direction to Escape Route sign (GA3 or GA4 – depending on direction) located next to one another. The following criteria applies to these signs:

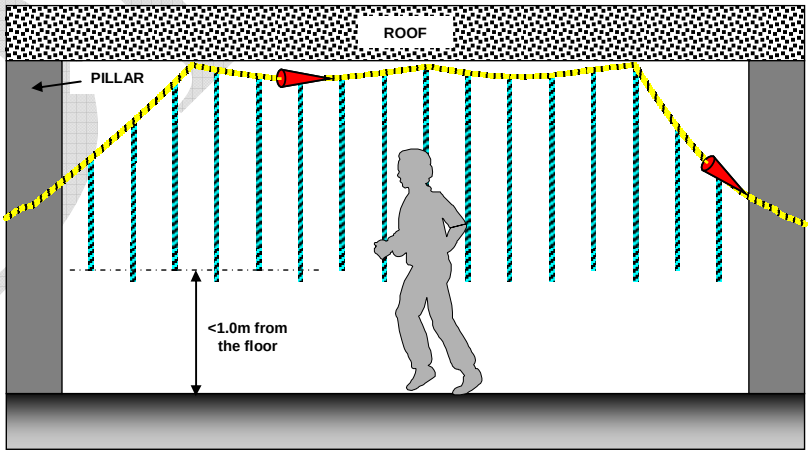
  - Size: 150mm x 150mm
  - Photo luminescent in nature.
  - Constructed of steel or plastic.

- Where it is required for the Life Line (Escape Route) to pass over conveyor belt, a belt bridge needs to be installed and the Life Line must be

mounted against the side of the belt bridge as per the diagram below.

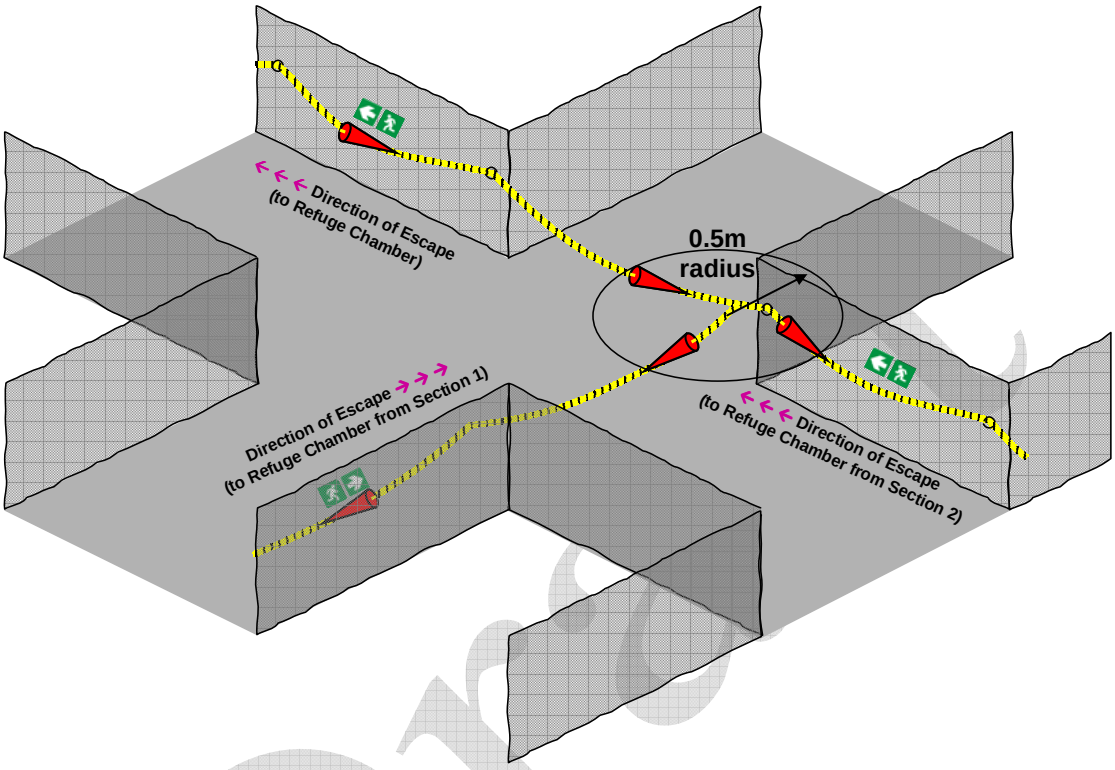


- Where it is required for the Life Line (Escape Route) to pass over travelling way (tractor road) the Life Line must be mounted against the roof. Attached to this Life Line must be a series of ski ropes that hang from the Life Line. The ski ropes must hang at least 1.0m from the floor and must be spaced in such a manner that makes it impossible for a person to walk through these ski ropes without touching one of them.



- Where it is required that two Escape Routes will join in order to follow a shared route to a Refuge Chamber the two Life Lines may be joined. The joint must be a secured in such a manner that it does not move or "slip". Note that in order to avoid confusion to escapees, cones must be

placed within 0.5m of that joint as per the diagram below:



5.4.3 Maintenance of the Escape Route

- The Escape Route of an underground production section will be cleaned (sweep with CM, Loader or LHD) after each belt extension.
- Any accumulation of water, falls of ground and or obstructions must be removed.
- The Escape Route will be kept up to date with proper stone dusting (after each belt extension).
- In all Escape Routes the roof and sides must be sound and well barred down in order to ensure employees' safety when using this route.

5.4.4 Inspections

- Inspections of the Escape Route must be conducted by the following employees at the prescribed frequencies:
  - Shift Overseer – Monthly

- Mine Overseer – Quarterly
- Occupational Hygiene Department – Monthly (As part of surveys)

5.4.5 Emergency Drills

- Emergency Drills of the Escape Route must be conducted by the following employees at the prescribed frequencies:
  - All Employees – Monthly (for each shift)
  - New employees – Within 48 hours
  - Following section moves – Within 48 hours (for all employees for each shift)

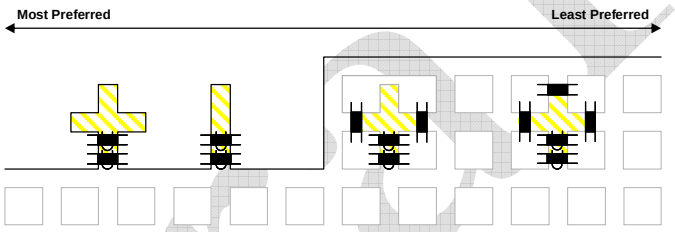
5.5 Refuge Chambers

5.5.1 Location

All Refuge Chambers will be located within 750m from the working place. Where this can not be done for practical reasons, use will be made of Long Duration SCSR Cache's. Refuge Chambers will always be located with its entrance in an intake airway.

Where possible Refuge Chambers will be situated within solid barrier pillars and, where this can not be achieved, they will be located in the splits of the intake airway. Where possible use should be made of long pillars to minimise the number of stoppings that will be required (as per the diagram below):

Preferred Refuge Chamber Location



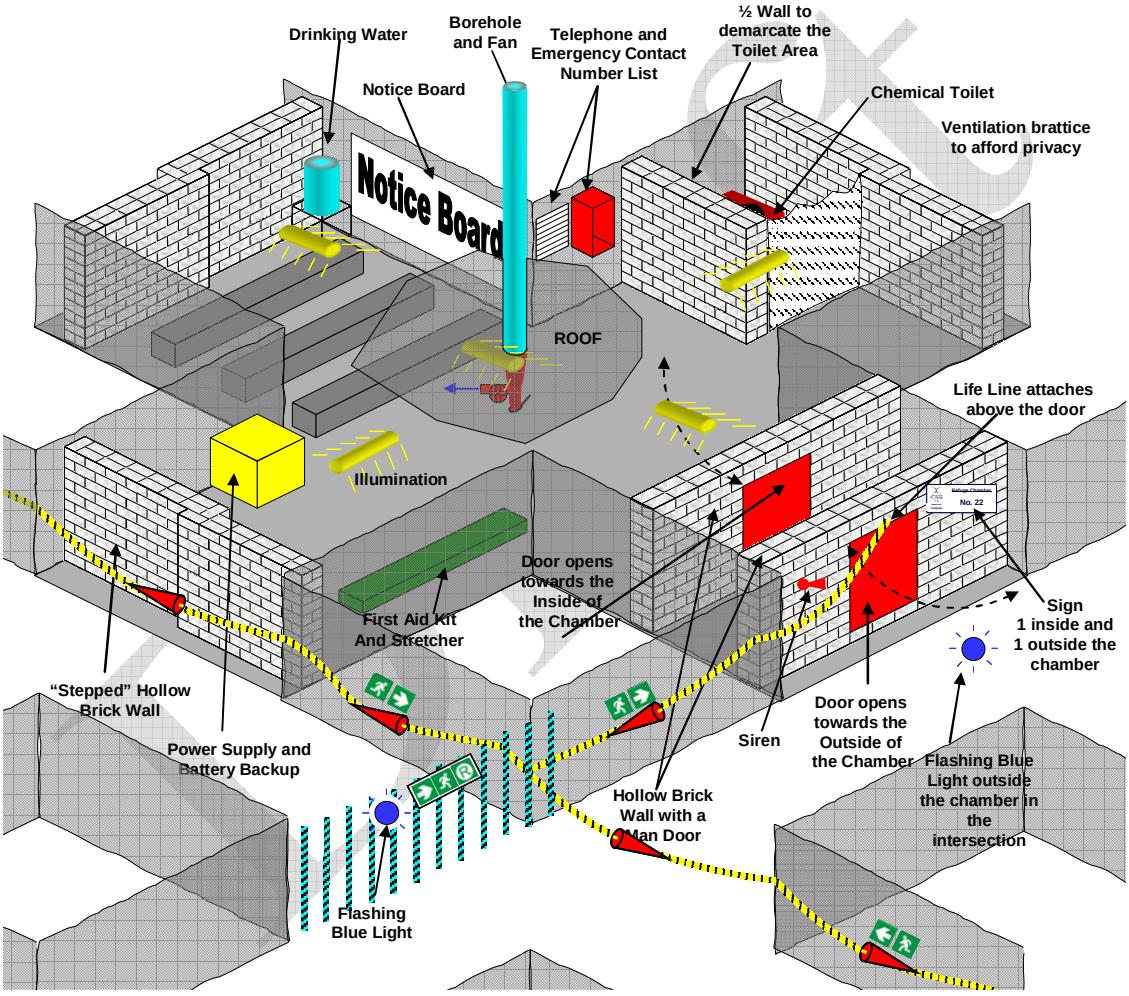
5.5.2 Equipping / Construction of the Refuge Chamber

The following diagram details the overall requirements for a Refuge Chamber. Each of these items as well as other requirements will be stipulated in detail:

- General Requirements:
  - Size – The Refuge Chamber size must be designed in such a manner as to allow a minimum area of $0.7m^2$ for each of the maximum number of people that are expected to escape to that Refuge Chamber in the event of an emergency.
  - Adequate seating must be provided for each of these persons. This is normally constructed of concrete / brick benches.
  - The roof and sides of the Refuge Chamber must be adequately supported in terms of the mines

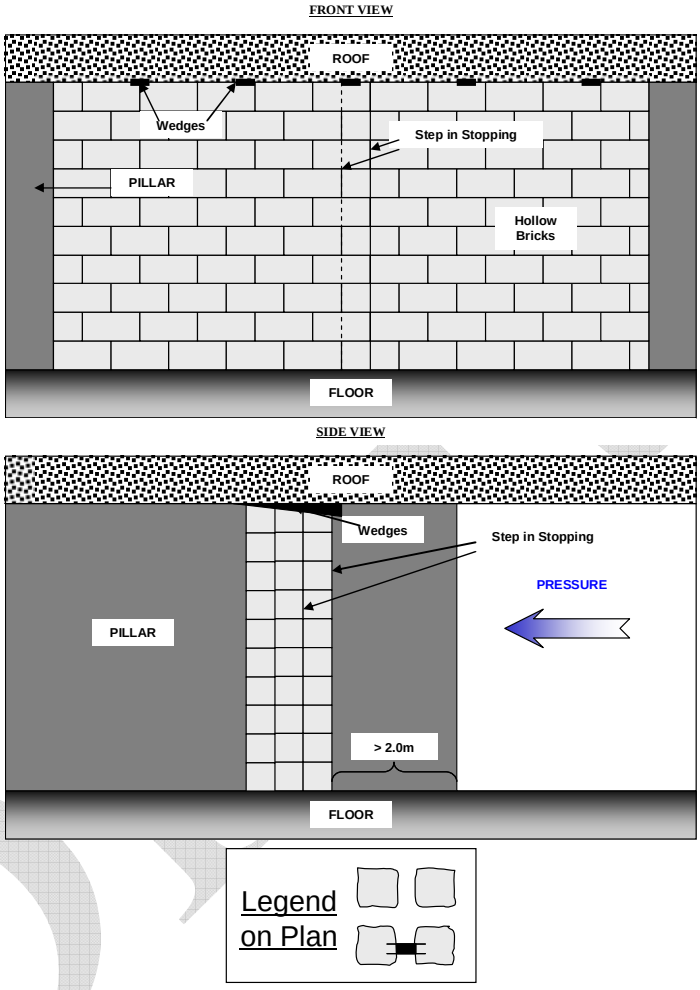
standard. All scaling or loose coal on pillars must be removed.

- The Refuge Chamber must be kept dry at all times. As often happens, the borehole required is often a source of water. If this is the case the operation should ensure that the water is contained in a bund wall and is regularly pumped or drained out of the chamber.

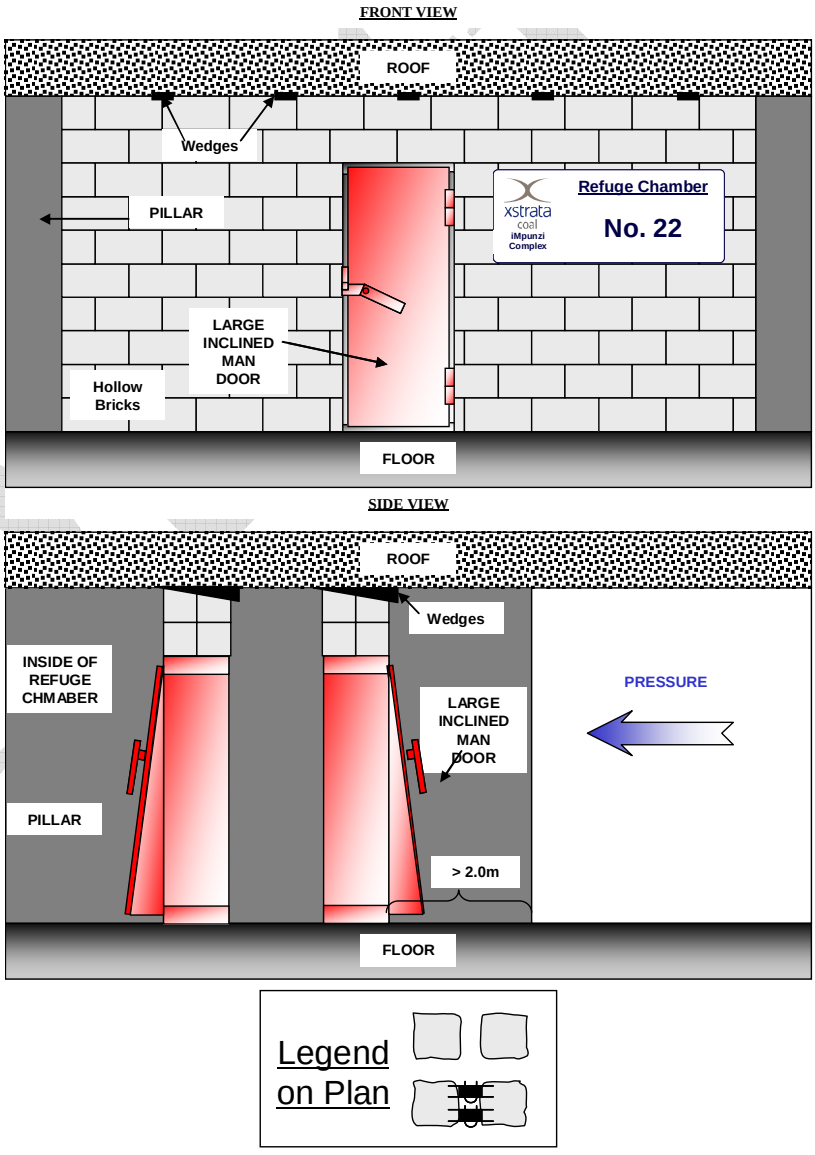


- <u>Walls:</u>
  - Walls (or Stoppings) will be constructed of large hollow bricks cemented together. These walls must consist of 2 rows of bricks (double thick). In order to withstand the concussion effects of explosions these stoppings must be stepped (for extra support) and wedged.

- These walls must also be sealed with cement, plaster or a similar material.



- Entrance Doors and Walls (Airlock):
  - The Entrance Doors and Walls (or Stoppings), commonly referred to as the Airlock, are two walls with juxtaposed (opening in opposite directions) large man doors.
  - The walls will be constructed of large hollow bricks cemented together. These walls must consist of 2 rows of bricks (double thick). In order to withstand the concussion effects of explosions these stoppings must be wedged.



- These walls must also be sealed with cement, plaster or a similar material.
- The doors are to be constructed of steel and inserted into the frame at an angle in such a manner that the door will close automatically. The handle will have a locking mechanism that will allow the door to latch in the closed position.

- Drinking Water:
  - Potable and palatable drinking water must be supplied in the Refuge Chamber.
  - Water supply may vary in form, from a mains fed pipe to a water container.
  - The responsible mine overseer must ensure that there is sufficient water available.
  - To ensure the quality of the water the Complex Occupational Hygienist must ensure that chemical and bacteriological analysis of this water is conducted on a monthly basis.

- Notice Board:
  - The notice board must display the following information:
    - The correct procedure to be followed when making use of the Refuge Chamber in an emergency situation
    - The refuge bay number.
    - An appropriately scaled mine plan indicating the position of the Refuge Chamber relative to the workings. Included on this plan will be the ventilation arrangements / appliances, mining sections, shafts and travelling roads. Such plan must be updated quarterly.
    - All valid Escape Route plans relevant to that Refuge Chamber.

- Any information to locks and keys for the first aid equipment (*as described in the first aid section*).

- Clear plastic sheeting must be provided over the board to protect the above information that is displayed.

- <u>Borehole:</u>
  - A 150mm (6") internal diameter (ID) steel cased borehole must be drilled from surface into the Refuge Chamber in order to supply fresh air into the chamber.
  - Note that the 150mm (6") internal diameter (ID) is a minimum requirement to enable SCSR's, food, water or telecommunications to be passed down the borehole. Larger diameter boreholes may be considered.

- <u>Illumination:</u>

  A minimum of 5 x 12V fluorescent lights must be installed the Refuge Chamber. Such lighting must meet the following criteria:
  - 1 Light must be located in the centre (in the intersection) of the Refuge Chamber.
    - This light must be connected to the main power supply and to the backup power supply. i.e. this light will work when the main power supply is interrupted.
  - Each 1 of the 4 remaining lights must be located in each split of the Refuge Chamber (as per the diagram).
    - These lights must be connected to the main power supply.
  - All the above illumination is a minimum requirement and care should be taken to ensure that adequate illumination is supplied that complies with an average illumination

intensity of 10 Lux (measured on the floor during main power supply conditions) throughout the Refuge Chamber.

- Stone Dust:
  - The Refuge Chamber must be adequately stone dusted to meet an 80% incombustible content requirement.

- Fan:
  - Air will be supplied into the Refuge Chamber by means of a 12V centrifugal force fan mounted on a fibreglass (or similar material) pipe.
  - It must be kept running at all times.
  - This fan must be connected to the main power supply and to the backup power supply.

- Power Supply and Battery Backup:
  - The normal (main) power supply will consist of a 220V power feed that has been stepped down to 12V.
  - All powered items in the Refuge Chambers must be 12V.
  - In the event of a power failure, the Refuge Chamber must be equipped with a 12V battery power supply.
  - The battery back-up must be of sufficient strength to supply both the fan and 1 light.

- Telephone:
  - A standard underground telephone must be installed and must be maintained in a working condition.

- Emergency Contact List:
  - The emergency telephone list must be located adjacent to the telephone in such a manner that a person whilst using the phone can clearly read the list.
  - The emergency telephone list must display the following information:
    - The refuge bay number.
    - The refuge bay's telephone number.
    - The control room's telephone number.
    - All the responsible mining, engineering, safety, occupational hygiene, medical, fire and emergency response personnel's telephone numbers.
  - Clear plastic sheeting must be provided over the list to protect the above information that is displayed.

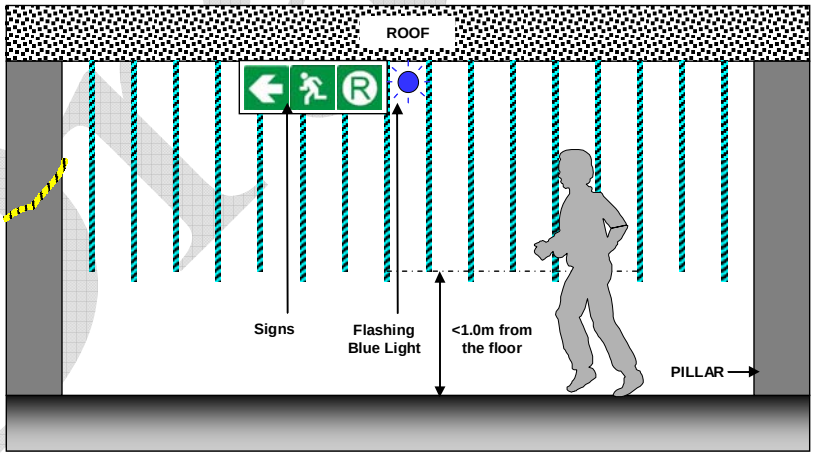
- Chemical Toilet:
  - Any chemical toilet may be used provided that such toilet is maintained in a hygienic manner. Note that only a chemical toilet is acceptable and toilet buckets are not considered sufficient.
  - A half brick wall must be provided with a suspended ventilation brattice to afford privacy to those persons making use of the toilet.

- First Aid Kit and Stretcher:
  - A standard first aid kit and stretcher (with blankets) must be provided and maintained.
  - Where it is required that a lock and key will be used to ensure that the first aid equipment is not pilfered, clear instructions on how to open the first aid kit in the case of an emergency must displayed on the notice board as well as the information of the person in possession of the key. This instruction must take into account

that the key holder may not be present in an emergency.

- <u>Pinch Bar:</u>
  - A standard pinch bar appropriate to the relevant operations needs must be made available inside the Refuge Chamber.

- <u>Refuge bay indicators</u>
  - A series of ski ropes that hang from the roof must be installed in the travelling way (tractor road) at the location where Life Line intersects the location of the Refuge Chamber. The ski ropes must hand at least 1.0m from the floor and must be spaced in such a manner that makes it impossible for a person to walk through these ski ropes without touching one of them.



  - In addition to the above, Symbolic Safety Signs will be installed in the travelling way (tractor road), preferably in the middle of the road, clearly visible form each direction of approach.
  - These signs will consist of a General Direction sign (GA2), a Direction to Escape Route sign (GA3 or GA4 – depending on direction) located

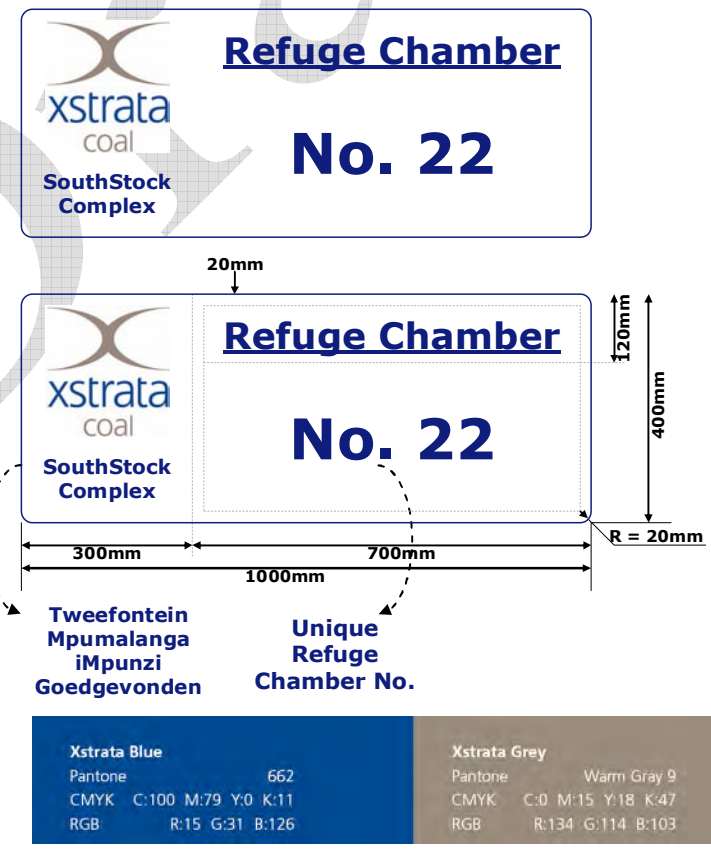
next to one another and A Refuge Chamber Sign (GA12). The following criteria applies to these signs:

- Size: 150mm x 150mm
- Photo luminescent in nature.
- Constructed of steel or plastic.

o Two continuously working flashing blue lights must be located in the middle of roadway intersection outside the entrance to the Refuge Chamber Refuge Chamber and in the travelling way (tractor road).

o A siren that can be activated when the Refuge Chamber is in use. The details of such activation must be included in the emergency procedure.

o A sign must be installed on the outside and inside walls next to the entrance demarcating the Refuge Chamber. The following diagram applies:



5.6 Refuge Chambers (Surface requirements)

5.6.1 Location

All Refuge Chambers will be required to have a borehole to surface for the purposes of fresh air supply. The following requirements apply:

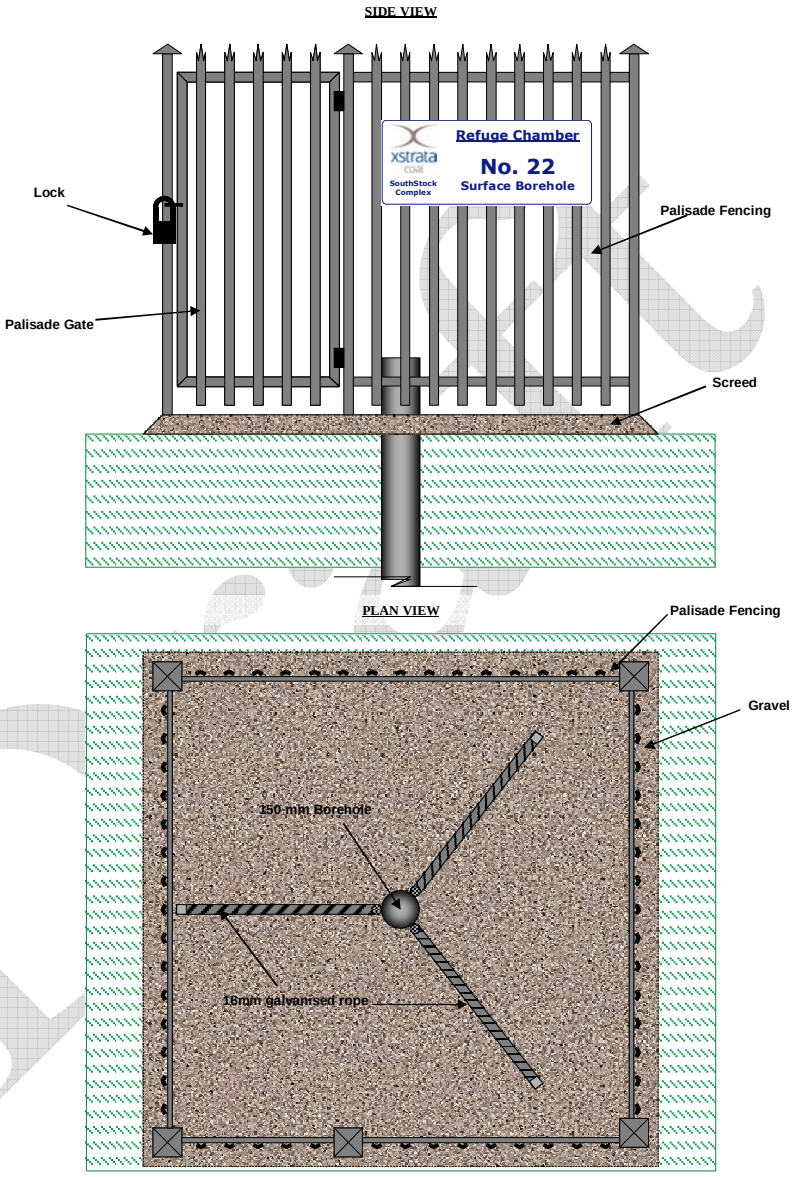
- Site Selection;

  Not withstanding the requirements for the location of Refuge Chambers underground, the selection for the location of the borehole must take into account the following:

  - It must not be located in such a manner that it is at risk of inundation of water. Water passes, vleis and rivers must be avoided. If this is unavoidable reasonable measures must be taken to prevent inundation. Alternatively a Long Duration SCSR Cache System must be considered over a Refuge Chamber.
  - The Borehole should as far as possible be located adjacent to roads (tarred or otherwise). If this is not possible a road will be required to be constructed to allow ease of access for rescue teams.
  - All surface structures and related servitudes must be avoided.

5.6.2 Equipping / Construction of the Surface Infrastructure

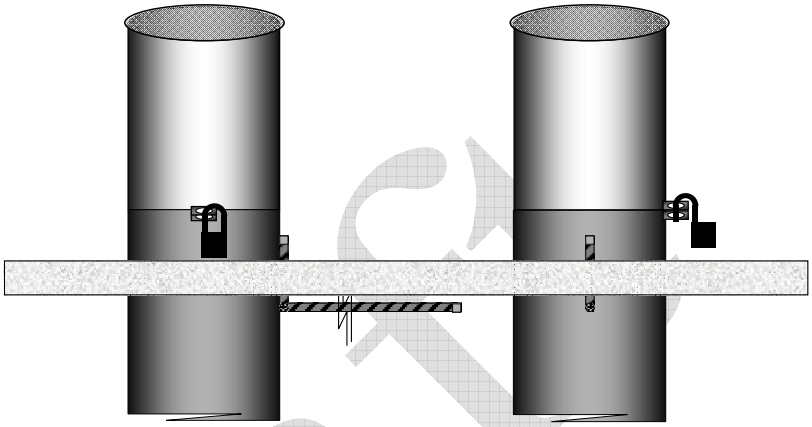
The diagram below details the overall requirements for the surface infrastructure. Each of these items as well as other requirements will be stipulated in detail:



- Borehole
  - As previously mentioned the borehole must be steel clad. Such cladding must project at least 0.5m above the ground level.
  - A steel cap slightly large than the diameter of the cladding must be installed over the end of

the borehole cladding and secured in place by means of a latch that can be locked with a padlock.

- The cap must be equipped with an expanded metal cover to allow air to pass freely through it.

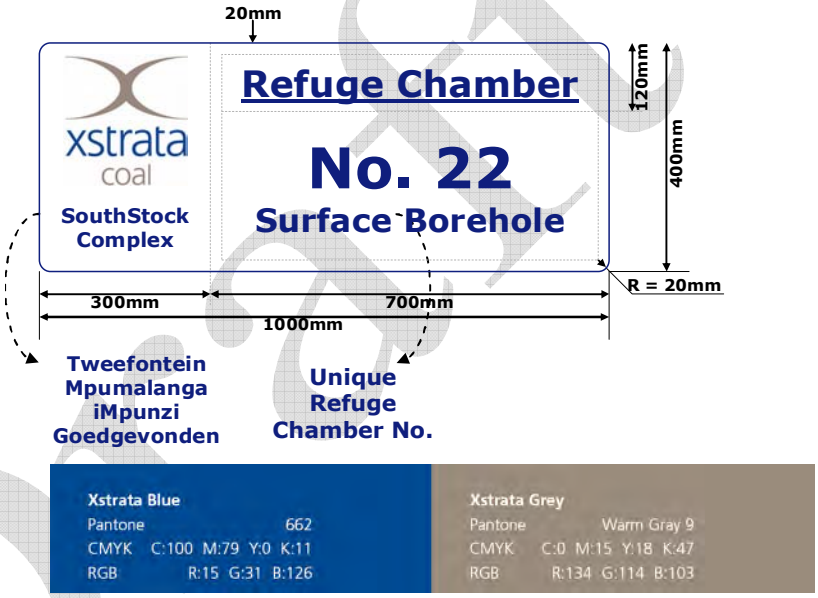


- The borehole must be earthed by means of at least 3 x 1.0m lengths of 16mm galvanised rope. The galvanized rope must be bolted to the pipe with a galvanized bolt.
- Note that it must be ensured that the borehole is free from any obstructions in it that prevent SCSR's, food, water or telecommunications to be passed down the borehole (when the cap is removed).

• <u>Security</u>

- The borehole must be fenced by means of palisade fencing equipped with a lockable door.
- All keys (for the door and borehole cap) are to be kept in the relevant operations control room.
- Such palisade fencing must not be less than 2.0m x 2.0m in area (4.0m^2).
- The spacing between the palisades must be such that a human being may not be able to fit through it.

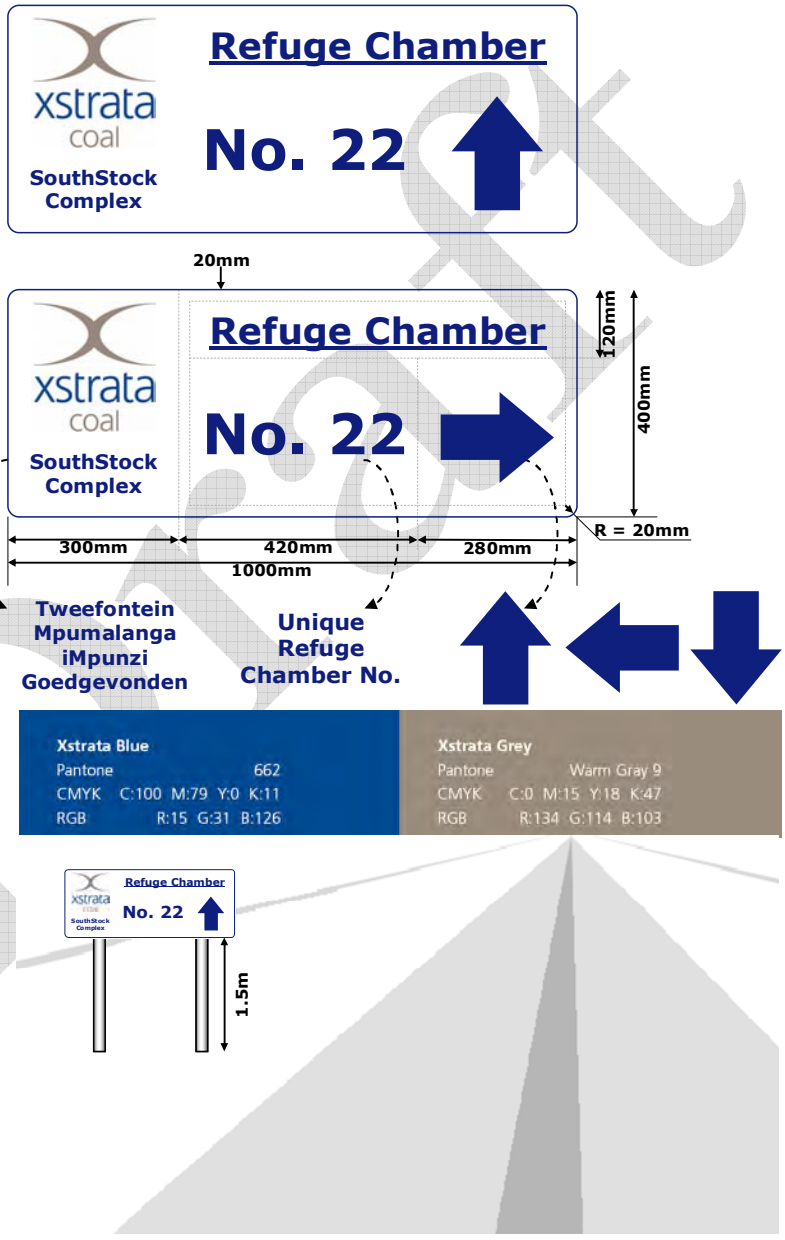
- Borehole Sign
  - A sign must be installed on the outside of the fence next to the door. The following diagram applies:



- Ground around the Borehole
  - To prevent the ground around the borehole from becoming muddy or eroding away the ground within the fenced of area must be covered with at least 5.0cm of gravel.

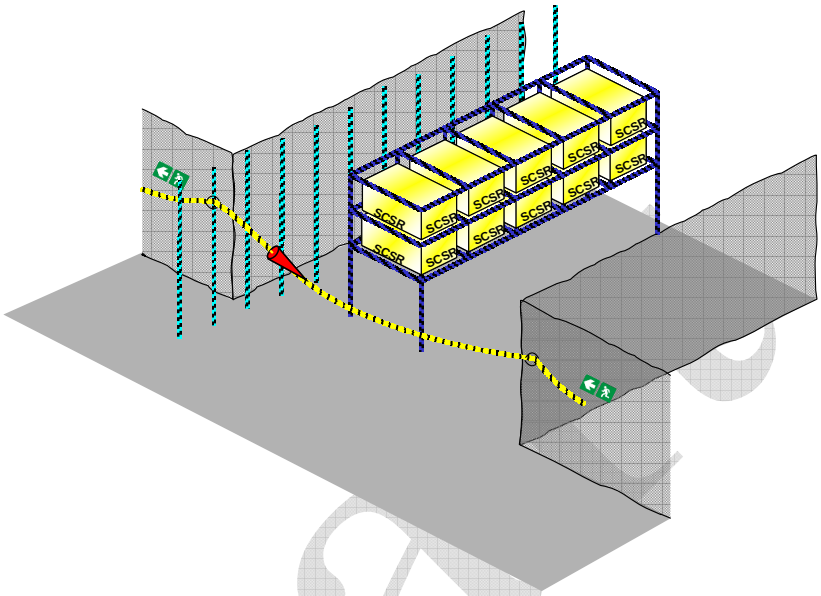
5.6.3 Demarcation of the Route to the Borehole

The route to a Refuge Chamber borehole must be adequately demarcated at each intersection of change of direction from the relevant mining operation to that borehole. These signs must be located at least 1.5m above the ground level. The following standards with regard to the types of signs to be used apply:



5.7 Cache Systems

5.7.1 Construction of Cache Systems



- Construction of Cache
  - The cache must be so constructed as to accommodate the number of Long Duration SCSR's that may be required by all persons escaping from an affected area in an emergency.
  - The cache must be placed on a cleaned out split adjacent to the Escape Route.
  - A series of ski ropes that hang from the roof must be installed at the location where Life Line intersects the location of the cache. The ski ropes must hang at least 1.0m from the floor and must be spaced in such a manner that it makes it impossible for a person to walk through these ski ropes without touching one of them.

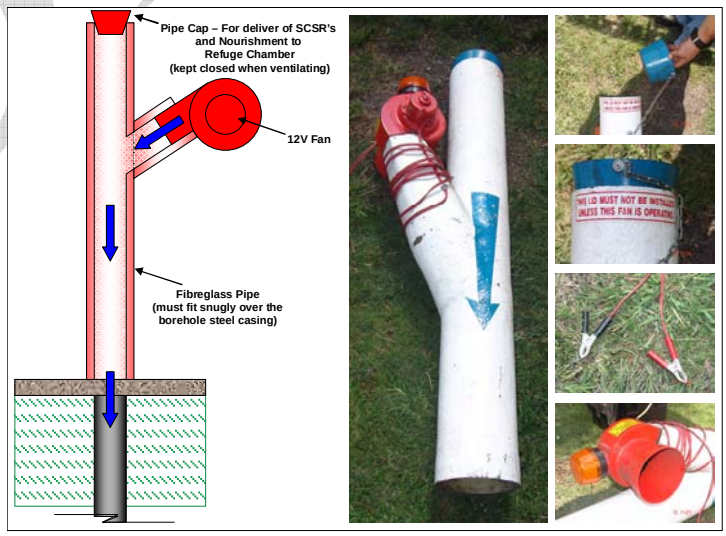
5.8 Proto Team Equipment Requirements

Not withstanding the provisions of the Mine Health and Safety Act as well as those requirements stipulated by Mine Rescue Services. Mine Proto (Rescue) Teams will need to provide for the following equipment:

5.8.1 A Borehole Fan

In the event of an emergency the mine proto teams may be required to provide backup force ventilation to Refuge Chambers (e.g. the fan in the Refuge Chamber fails to work). In order to meet this need the following equipment is required:

- A 12V centrifugal force fan mounted on a fibreglass (or similar material) pipe.
    - The construction of such pipe is shown below and consists primarily of:
        - Main pipe.
        - A side pipe to which the fan is mounted.
        - A cap to seal off the end of the main pipe. This is typically in the closed position when the fan is operating and only opened when items are lowered through the pipe.



- The pipe must have an internal diameter large enough to fit snugly over the borehole steel casing.
- The pipe must have an internal diameter large that also allows the following objects to be able to pass freely though the pipe (when lowered down the borehole by the proto team):
  - The Self-rescuer SSS-1PV (as used by Proto Teams)

  - Food and drink steel capsules

  - For the above an appropriate lowering rig must be available.

In order to power the fan the following is required:

- A generator capable of supplying 12V to the fan for a period of at least 12 hours. Means to provide proper connection to the fan must be provided for.

- Note that if a 12V generator cannot be sourced a 220V generator may be used provided a step down transformer (like a battery charger) is used.

- A battery backup supply capable of supplying 12V to the fan for a period of at least 12 hours.

- This is an extra precautionary measure intended to provide backup for the generator. Means to provide proper connection to the fan must be provided for.

7. TRAINING

This document will be forwarded to the Training Centre where all persons that may be affected by the implication of the contents will be trained in it. The following personnel must be trained:

- All underground workers
- All XCSA Management and Heads of Department must be conversant with this procedure and must disseminate the information to the persons directly affected by this procedure. In addition, they must ensure implementation of the relevant portions of this document in their area of responsibility.
- All Lamproom staff are to be suitably trained to inspect the SCSR's in use.
- All personnel required to make use of a cache system must be trained on its location, the use of a long duration SCSR and the safe manner in which the normal SCSR is exchanged for the long duration SCSR.