

SIMRAC

A MANUAL FOR BEST PRACTICE FOR EMERGENCY RESPONSE PROCEDURES

PART 2

THE MANAGEMENT OF INRUSHES, FIRES, EXPLOSIONS AND OTHER EMERGENCIES

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1 Introduction

With the exception of those incidents that are solely attributable to nature, virtually all other incidents, the hand of man can usually be detected to a greater or lesser degree. It would be fair to say that if the myriad of laws, regulations, standards and Codes of Practice that govern mining operations were scrupulously adhered to, there would be very few untoward incidents.

However, in reality, one must anticipate that, at times, things will go wrong and some times they will go badly wrong. It is therefore prudent that mine management, having done their best to prevent an incident occurring to begin with, have in place plans, facilities and equipment to manage the situation when the incident occurs. This is achieved by introducing and rigorously enforcing a system of Hazard Identification and Risk Assessment right down to the individual sections. Thereafter putting in place appropriate and if necessary, site specific Emergency Response Strategies and Procedures.

By having a plan of action, facilities, all the necessary equipment in place, and a management team familiar with what they are required to do, the handling of any situation becomes much easier and the consequences of the incident invariably much reduced.

What has become apparent, is that a major programme of quality assurance is necessary to ensure that the standards, Codes of Practice and regulations are diligently put into practice, thus minimising the chances of a disaster.

2 Escape and rescue

Escape and rescue can be categorised into six sections:

- Pre-planning.
- Awareness of the emergency situation.
- Self rescue procedures - Self Contained Self Rescuers (SCSR).
- Locating and reaching a place of safety.
- Refuge bays.
- Training.

The following should be considered "Emergency Situations"

- Fire.
- Explosion.
- Smoke detected by sight or smell.
- CO concentrations in excess of 100 ppm in the general body of the air.
- Flammable gases in an explosive concentration in the general body of the air.
- Suspected irrespirable atmosphere.

The essential constituents of a comprehensive escape and rescue strategy are discussed further as follows:

2.1 Emergency response strategy

In order to deal with any emergency effectively it is essential that everyone involved, from the workforce underground to the Mine Manager, know what is expected of them. There should be in place a formal document detailing the emergency response strategy for every working place / section covering:

- The location of the workforce.
- Their escape route(s). (Shown on plan).
- Instructions for reaching safety.
- Details of the refuge bay or place of safety .
- Telephone numbers in the section and in the refuge bay or place of safety.
- The number of persons likely to be involved.
- Names and positions of the supervisors from Miner upwards.

This document requires updating at regular intervals and at any time that the section moves or any significant or relevant changes are made involving the section.

A copy should be posted up at the waiting place and switchgear of every section as well as at workshops, stores etc. All affected workers should have the escape and rescue procedure explained to them in the course of escape drills.

A copy should be kept in the Emergency Control Room and the original document kept securely in the ventilation department.

This document should be drawn up by the responsible production officials in consultation with the ventilation department and countersigned by all relevant parties.

2.2 Emergency awareness

Apart from those situations where the emergency situation is detected by the human senses, detection by electronic instruments and by the raising of an alarm must also be considered.

Electronic instruments: The specification, maintenance, deployment and issuing of electronic instruments are catered for in the guidelines for Codes of Practice for Lamprooms issued by the DME and by statutory requirements. It is advisable that persons are issued with individual gas detection instruments and that a quality assurance programme for checking their operation by the issuers and users should be put in place.

Suitable means of raising the alarm in the event of an emergency should also be used. SIMRAC Report GEN 101 is of the opinion that a telephone system is inadequate for this purpose and that manually activated sirens located at the section switchgear or other such means should be considered.

It is imperative that all employees are aware of Emergency Procedures and what to do in the event of an emergency. This must be included in the training of all employees and reinforced on their return from leave.

Regular and documented drills need also to be carried out to ensure the competence of all employees in their different situations.

2.3 Self contained self rescuers (SCSRs)

It is a statutory requirement that all persons going underground in a colliery be equipped with a SCSR and trained in its use.

The type, capacity, storage, issuing, monitoring and maintenance of SCSRs are the subject of Codes of Practice, DME guidelines and statutory requirements.

It is most important to have in place a monitoring protocol for SCSRs. The efficiency and reliability of SCSRs can deteriorate depending on age and the conditions to which they have been subjected. By having a defined, statistically reliable, independent testing and evaluation programme, problems can be detected and appropriate measures introduced.

Reliable checking and maintenance of SCSRs in conjunction with the Original Equipment Manufacturers is also a requirement. In addition a good record keeping system tracking the history of maintenance, issuing and use of individual SCSRs should be in place. Computer programs are available for this purpose.

When caches of long duration SCSRs are used, a suitable programme of monitoring and recording their condition and disposition should also be put in place. Having long duration SCSRs available does not however relieve the mine of its obligation to supply belt worn SCSRs to each person underground.

SCSRs should be deployed by persons underground when:

- CO concentration exceeds 400 ppm in the general body of the air.
- Smoke is detected visually.
- Any time an irrespirable atmosphere is suspected.
- When instructed to do so by a supervisor.

2.4 Locating and reaching a place of safety.

Due to the strong likelihood of low visibility, disorientation and psychological trauma that can exist following a fire or explosion in a colliery, it is imperative that adequate provision be made to ensure that affected persons reach a place of safety. This requires that persons are trained in the use of and have available a suitable means of physically guiding them to the refuge bay or place of safety. The best means of doing so is a rope or wire fitted with cones to indicate the direction of travel placed along the route, against the pillar or sidewall, about 800 mm above the ground, that leads directly to the refuge bay door or other place of safety. Black PVC pipe with wedges cut out at 1 – 2 m intervals indicating the direction of travel has also proved successful.

There can be no gap in this route and therefore any place that persons who are trying to find their way in zero visibility could get lost or take a wrong turning must be catered for. Such areas must be barricaded off to prevent inadvertent entry. When conveyor belts are to be crossed over, suitable bridges must be provided.

SIMRAC Report GEN 101 “Practices and Procedures to Overcome Problems Associated with Disorientation and Low Visibility in the Aftermath of Mine Explosions of Fires” investigated some of these problems and the following highlights are extracted directly from this report:

- (a) "the speed at which escape routes can be negotiated is reduced significantly irrespective of audible orientation cues; obviously safe travelling distances from the area of work to a back-up facility would have to be adjusted accordingly,
- (b) some form of support to assist the escapee to maintain his equilibrium, especially in the case of obstacle ridden escape routes, and to avoid injury appears to be crucial; the incorporation of a direction guidance system represents a further element of importance,
- (c) belt roads, although regarded as generally suitable, should not be regarded as a dedicated primary escape route,
- (d) the pinpoint location of refuge rays and refuge bay entrances in the event of real emergencies appears to have been underestimated severely by planning departments."

and

- "that a guidance rope or cable be installed along dedicated escape routes. The rope/cable should run from a known point in the working sections to a place of safety (i.e. a refuge bay or cache of long duration SCSRs),
- that an effective early warning method be developed and installed to timeously warn underground personnel against impending danger,
- that methods and means be introduced to assist mine personnel in orientating themselves in working sections, and following designated escape routes,
- that, owing to complications introduced by low visibility, back-up facilities be placed closer to the workings. Previous guidelines in this regard should thus be revised and the installation of intermediate or less formal refuge bays should be considered to reduce travelling distances,
- that travelling roads be regarded as the preferred escape routes instead of conveyor belt roads,
- that personnel be trained to use designated escape routes, .i.e. workers should familiarise themselves fully with the escape route by walking the route,
- that the provision of directional guidance to refuge bay doors is imperative, and finally,
- that the possibility of equipping all workers with goggles to provide eye protection against airborne irritants be investigated."

In order to provide guidance, a continuous line of rope or cable should run between predetermined points and places of safety i.e. refuge bays, mine exits etc. This line should be equipped so that the direction of the place of safety can be determined by feel.

Barricades suspended across the full width of roadways except travelling ways in such a manner as to prevent persons from passing a place of safety or diverting from the route to a place of safety can be determined by feel.

2.5 Refuge bays

The mine should be equipped so that every person working or travelling underground may reach a refuge bay or other place of safety within the duration of his SCSR even when used

under adverse conditions (i.e. zero visibility). This therefore includes not only production sections but also workshops, stores and all personnel (including contractors) working or travelling outbye of the sections.

It is suggested that this distance be experimentally determined for each mine by selecting a number of test subjects from a spread of the worker population (including some new employees) and conducting trials with blindfolded subjects and ascertain how far they could travel (including time required to locate the life line) within a percentage (60-70 percent) of the known duration of the particular SCSR in use on the mine. This figure would then give a good indication for maximum refuge bay spacing on a particular mine.

It must be borne in mind that these escapes will be made in the aftermath of an explosion or during a fire and basing the spacing on anything approaching normal conditions would not be best practice.

SIMRAC Report COL 115 – “Assessment of Refuge Bay Designs in Collieries” discusses the characteristics of explosions, design criteria for bulkheads and makes appropriate recommendations.

One of the problems encountered is, that due to rapid face advance, keeping up with the building of formal refuge bays can present problems. Consideration can be given to the construction of either less formal refuge bays or transportable refuge bays equipped with oxygen generators that are capable of surviving an explosion.

The CoP for Escape and Rescue should clearly specify the siting, construction requirements and equipping of refuge bays of all types and the procedures to be followed in an emergency.

Formal colliery refuge bays should be of adequate size to cater for the anticipated number of persons expected to occupy it, plus a 20 per cent factor of safety and the size should be based on 1,0 m² per person. Walls should be capable of withstanding a pressure differential of 140 kPa. Steel, self-closing airlock doors and suitable bleeder pipe must be installed. In addition, they are required to comply with Regulation 24.20.2.2.

Colliery refuge bays can either be ventilated by a borehole from surface or by oxygen generators or cylinders of compressed air, whichever is appropriate in the prevailing circumstances.

It is essential that the condition and equipment of all refuge bays be checked and logged regularly by a person, who is accountable, appointed in writing.

All refuge bays or places of safety should have suitable instructions posted up. These should be in appropriate languages and pictorially, to cater for illiterates.

Where refuge bays are ventilated from surface the mine should have two or more systems to enable fresh air to be pumped down the borehole and have arrangements with local mines to draw on additional units that can be immediately connected on arrival. i.e. power supply, connections etc. are compatible.

Finding the borehole sites, particularly at night in an emergency, can be problematic. Therefore, it is recommended that the borehole locations are not only clear marked on plans but, are clearly signposted on surface, along with the routes to them.

3 Training

In order to ensure that the escape and rescue systems that have been put into place on the mine are effective in the event of a life-threatening incident, it is essential that all personnel involved are properly trained in evacuation and refuge bay procedures.

The mining industry is aware of numerous instances where persons have either not received timeous warning, have not located refuge bays, or have passed them by in an attempt to escape, often with fatal results. Therefore, it is essential that adequate initial and refresher training programmes be in place on the mine.

3.1 Receiving adequate warning:

The distribution of CO warning and measuring devices should be such that *all* persons in the area can be warned to evacuate.

Some gas detection instruments are sophisticated, multi-functional devices that give a great deal of information. However, numerous instances have been encountered where considerable (and dangerous) confusion has been observed over the interpretation of the information they provide.

Instruments that provide numerical readouts can lead to confusion. Serious consideration should be given to CO warning devices *for use by the "general population"* be of the "go - no go" type. i.e. One red light and a buzzer which is set for 100 ppm CO would give the alert to evacuate. A second light and other buzzer set at 400 ppm would give the alert to don the SCSR.

3.2 Self contained self rescuers

Once the issue of adequate and timeous warning is addressed, training in the use of the SCSR must be carefully considered. Being a device, which is hopefully never actually used, persons tend to forget about it.

The training programme should be developed in conjunction with the supplier utilising the appropriate training aids, including training sets, breathing simulators, videos and posters.

This training is required by statute to be repeated six monthly, and when a person has been absent for more than 30 days it should be repeated. It must also be part of the regular on the job safety training.

3.3 Locating the refuge bay or place of safety

Having to escape in adverse conditions (i.e. zero visibility) can cause considerable psychological trauma and panic. It is therefore suggested that as part of the initial and refresher training all workers be put through a "*stressful*" blindfolded simulated escape, using the lifeline to find their way to a refuge bay. Once in the refuge bay they are given appropriate instruction on refuge bay procedures.

All members of the work force must not only know exactly what to do in the case of an emergency but have practised it underground.

3.4 Escape drills

Regular escape drills must be carried out and these must be logged, with appropriate comments by the supervisors. Persons who require further training must be given it.

The effectiveness of the training and the retention of the information received during the training must be monitored. This is best done by rigorous, independent audits not only of the actual training programme in the Training Centres and the routine safety training, but also of the workforce itself in the actual work place.

4 Disaster management

In any emergency situation it is essential that those involved in the management as well as rescue and recovery operations know beforehand the Emergency Response Strategy and Management Plan, what facilities they have available and where assistance can be obtained.

Any event that could result in an emergency or indeed any abnormal situation that could have an adverse effect of the operations of the mine should have a formal, approved response procedure available.

These procedures should be familiar to members of the mine's management team and they should be readily available for consultation during any situation.

These procedures should be subject to regular review. It is suggested this be done annually or when any change in circumstances necessitates a review. The various procedures should be in the charge of the appropriate member of the management team, who should be accountable for ensuring the review. Any review (even if there are no changes) must be dated and signed by the responsible person(s).

4.1 Control rooms and associated facilities

When any emergency is to be managed, proper facilities and equipment are essential. In the mining situation it is prudent that the location of any control be pre-arranged and all relevant persons are aware of how to establish contact with it.

Control rooms should have adequate communications facilities, working space and storage space for the necessary procedures and plans.

Dedicated control rooms are the preferred option. However, existing facilities can be utilised with some forethought. (i.e. installation of extra telephone lines, additional filing and plan holding facilities). There is often a need for the immediate availability of stationery and a sealed pre-packed box of stationery is useful.

The immediate availability of call-out lists giving up to date office and residential/cellular telephone numbers is a requirement and this should be prominently displayed. Normal and after-hours contact numbers for emergency services (including Mines Rescue Services) and adjacent mines should also be available. These call out lists should be comprehensive and be such that even a miner can be contacted after hours in the event that either his services or his intimate local knowledge of the working place is required.

There should be an adequate selection of materials and equipment immediately available to deal with any emergency situation. The Mines Rescue Services are in a position to provide advice on what should be held.

4.2 Situation management and rescue operations

When any emergency arises, it is essential that those involved are fully aware of their duties and responsibilities. This requirement extends to all levels of personnel and should be part of the initial training and of any training or information transfer, that takes place on promotion.

The general duties of each department in an emergency should be formally laid out in a procedure.

Initially, the most senior, technically qualified person takes charge and issues such immediate instructions as deemed necessary to safeguard life and property until formal control can be established.

In general, the head, or in his absence his deputy, of the appropriate department is contacted, briefly appraised of the situation and then contacts the appropriate subordinates putting into action the required response from his department.

It is essential that all instructions given and information received be clearly and fully recorded in a situation logbook giving the date and time on a 24 hour clock system. It is always best to have a technically competent person acting as scribe under such circumstances.

Before any rescue team is sent into a mine following a fire or explosion, the possibility of an explosion or secondary explosion must be considered and assessed as far as is reasonably practical. This should be recorded in the log of control room actions.

Such decisions should 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 flammable gas due to walls of sealed areas being damaged.
- Likelihood of survivors.

5 Disaster recovery

Once the emergency has passed, control room involvement can either be reduced or terminated and work commenced to recover from the situation and restore operations to normal.

All instructions, including sequence of actions, should be formally documented. Appropriate supervision must be put in place to ensure the instructions are carried out in a correct and safe manner.

6 Media relations

Any emergency, particularly those that involve multiple fatalities, damage to third parties, cause environmental pollution or are likely to be of public interest are 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 and according the media reasonable facilities 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 and/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, Manager or designated media liaison officer. No off-the-cuff interviews and ad-hoc comments should be given by other officials. They should refer any media queries to the Manager or media liaison officer.

7 Quality assurance

The mining industry (and other industries) is full of cases where excellent plans, procedures and standards have been drawn up but are have either not been properly implemented, or reviewed and updated. Otherwise they have just simply fallen by the wayside to a greater or lesser extent. This is particularly true with procedures that are not in daily use, or which are perceived as a “nuisance” to carry out without immediate tangible benefit.

The only way to ensure that best practices are used in any organisation is to implement a rigorous system of quality assurance.

This requires a *formalised* monitoring programme within the organisation with clearly laid down responsibilities and backed up by an independent audit applying the benchmark of industry best practices.