
EMERGENCY PREPAREDNESS FOR UNDERGROUND FIRES IN METALIFERROUS MINES

GUIDELINE

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FOREWORD

This Department of Industry and Resources guideline has been issued to assist in identifying hazards, and developing both appropriate preventative strategies, and training and action plans to deal with any fire emergency which may occur. Adequate emergency preparedness and response capacity is fundamental to the duty of care.

It is emphasised that this guideline is not totally inclusive of all factors concerning Emergency Preparedness and that in some respects, it may not be totally suited to the individual requirements of every mine.

Comments on, and suggestions for, improvements to the guidelines are encouraged. The guideline will be revised as appropriate to accommodate comments, as well as reflect legislative changes, new information, improvements in technology and operational experience.

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1. INTRODUCTION

The Emergency Preparedness and Response Guidelines published by the Department of Industry and Resources in September 1992, contain a broad strategy for preparedness and response. Appendix C of that document discusses the four elements of emergency management; namely prevention, preparedness, response, and recovery.

This Guideline is framed for underground Metalliferous mines and outlines the major issues to be considered when reviewing or auditing emergency preparedness and response systems and capacity.

Recent data has shown that out of 155 underground fires reported in W.A.; at least three vehicles were completely destroyed and two persons hospitalised.

An analysis of underground fires that were reported in the last three financial years shows that diesel vehicles accounted for 89% of the incidents. Automotive diesel fuel and oil leaks contributed to over half of these cases and electrical problems contributed over 30%.

The need for prevention is fundamental:--

"While there are combustible materials present underground, the risk of fire remains. No hazard is more to be feared, and every underground mine should be prepared for such an event."

This guideline has been compiled on the basis of extensive auditing of industrial practice, consultation and interaction between the Inspectorate and Industry.

2. LEGISLATIVE REQUIREMENTS (WESTERN AUSTRALIA)

The Mines Safety and Inspection Regulations 1995 contains regulations in Part 4, Division 3 - Emergency Preparation, that apply to the planning, facilities, training and procedures deemed necessary for underground emergencies.

Preparation of emergency plan

Regulation 4.30

- (1) The principal employer at, and the manager of, a mine must ensure that a plan for dealing with emergencies at the mine is prepared -
- (a) in the case of an existing mine, as soon as is practicable after the commencement day; or
 - (b) in any other case, before mining operations commence at the mine.

Penalty: See regulation 17.1

- (2) The plan referred to in subregulation (1) must -
- (a) identify hazards that might cause an emergency at the mine;
 - (b) assess the risk of such an emergency occurring; and
 - (c) consider means by which any such emergency may be prevented or dealt with, including by -
 - (i) the provision of appropriate facilities and equipment;
 - (ii) the provision of effective alarm systems;
 - (iii) the testing of alarm systems;
 - (iv) the development of procedures to deal with emergencies;
 - (v) the training of employees in emergency procedures;
 - (vi) the training of employees in fire fighting, mine rescue and other relevant emergency response functions; and
 - (vii) the review of facilities, equipment and procedures.

- (3) The principal employer at, and the manager of, a mine must ensure that the plan is updated and revised whenever it is necessary to do so due to any change in mining operations, equipment, systems or procedures at the mine.

Penalty: See regulation 17.1.

Mine rescue equipment for underground mines

Regulation 4.33

- (1) The principal employer at, and the manager of, an underground mine must ensure that -
- (a) adequate rescue equipment and breathing apparatus are provided at the mine; and
 - (b) persons trained in the use of that equipment and apparatus are available or on call at the mine at all times while persons are working in the mine.

Penalty: See regulation 17.1

- (2) In subregulation (1) (a) -

"adequate" means adequate having regard to the nature and extent of mining operations conducted at the mine the degree of risk to persons working at the mine and the availability of other rescue equipment and personnel outside the mine.

Self rescuers in underground mines

Regulation 4.34

- (1) The manager of an underground mine must ensure that any person who goes underground in the mine -
- (a) is provided with (at least) a filter self rescuer or (preferably) a self contained self rescuer; and
 - (b) is fully trained in the use and limitations of the self rescuer provided.

Penalty: See regulation 17.1.

- (2) If there is a risk of a dust explosion or an identified risk from naturally occurring noxious or asphyxiant gases in an underground mine, the manager of the mine must ensure that all persons who go underground in the mine are provided with self contained self rescuers.

Penalty: See regulation 17.1

- (3) A person in an underground mine must not -
- (a) wilfully damage a self rescuer; or
 - (b) use a self rescuer for a purpose other than the preservation of life or to demonstrate how it works.

Procedures for accounting for persons in underground mines

Regulation 4.35

The manager of an underground mine must ensure that adequate procedures are in place at the mine to enable all persons who are working underground in the mine to be promptly accounted for in the event of an emergency.

Penalty: See regulation 17.1.

Specific emergency precautions required to be taken for underground mines

Regulation 4.36

- (1) This regulation applies to any of the following potential incidents -
- (a) a fire;
 - (b) an accidental explosion (including a sulphide dust or coal dust explosion);
 - (c) a failure of the primary ventilation system;
 - (d) flooding;
 - (e) an inrush of mud or tailings;
 - (f) an inrush or outburst of gas; or
 - (g) the extensive collapse of workings.
- (2) The principal employer at, and the manager of, an underground mine must ensure that, so far as is practicable, the following things have been done to ensure the safety of persons working underground in the mine in the event of a potential incident to which this regulation applies -
- (a) an alarm system has been installed and a procedure has been established for activating the system;
 - (b) a procedure has been established for the prompt notification of rescue and fire fighting teams;
 - (c) a procedure has been established for evacuating persons working underground;
 - (d) fire refuge chambers and fresh air bases are provided for persons working underground;
 - (e) provision has been made for the safety of drivers of winding engines at underground shafts;
 - (f) all employees are adequately trained and retrained in emergency procedures and the use of emergency equipment and facilities; and
 - (g) emergency drills have been conducted on a regular basis.

Penalty: See regulation 17.1

Flammable materials or explosives not to be stored near mine openings

Regulation 4.37

The manager of an underground mine must ensure that flammable liquids, flammable materials or explosives are not stored within 50 metres of any entrance to the mine.

Penalty: See regulation 17.1.

3. RECOGNITION AND AWARENESS OF FIRE HAZARDS

Every Manager should ensure that all working areas, installations and equipment used, in underground mining operations, are managed in such a way that the initiation or support of a fire or combustion is minimised. An emergency preparedness plan should be in place and understood by all personnel working in the mine and adequate appliances for the suppression of fire should be provided.

In 1992 - 95, 155 underground fires were recorded. All but 14 of these were associated with diesel powered equipment, however there remains the need to be diligent with all fire precautions. In particular, for example, where welding activities are taking place near shafts, timbered areas, conveyors and where polypipe or cables are present.

3.1. Potential Fire Situations.

There are many underground fire hazards that are not associated with diesel equipment and these require close attention with regard to fire precautions and fire protection. Examples are:-

- ◆ battery charging stations;
- ◆ polypipe installations and storage;
- ◆ main and working party magazines;
- ◆ timbered areas, particularly shafts;
- ◆ workshops, (greases, degreasers, thinners, solvents, paints);
- ◆ oil and fuel storage areas;
- ◆ stores, cribsrooms and refuge chambers;
- ◆ old workings;
- ◆ methane or other combustible or explosive gases;
- ◆ sulphide dust ignitions;
- ◆ pumps and fans;
- ◆ electrical distribution, substations and starter boxes; and
- ◆ coal shales and rock types prone to spontaneous combustion.

4.0 EQUIPMENT FIRE HAZARDS

In the two year period commencing 1 July 1992, 76 underground fires were associated with diesel powered equipment. Many of these fires resulted from hydraulic or fuel hose failures, allowing oil or fuel to spray on to hot parts. It will be necessary to improve inspection and maintenance if these occurrences are to be reduced.

Electrical distribution fires are always a possibility, and fighting fires in underground substations is hazardous, especially if the power is not easily isolated. Substations could be provided with an emergency "isolation" switch located outside the fencing for use in event of a fire. This isolation switch would be in the low voltage control circuit, where fitted.

All Portable fire extinguishers are classified and rated when new. With dry chemical extinguishers the rating can be reduced if refilled with chemical other than the original type. To overcome any false sense of security, consideration should be given to having maintenance and refills performed by professionals, such as companies with Quality Endorsement by Standards Australia.

4.1 Diesel Equipment Inspection

All underground diesel equipment, including stationary compressors, should be inspected for fire risk by a competent person. This inspection should include a check of:-

- ◆ the fuel system with attention to the integrity of the fuel tank filler cap, breather system, fuel lines and their connections and support brackets;
- ◆ the hydraulic hoses to ensure they have the correct pressure rating and fittings, and that they are located away from engine bay or hot exhaust areas; ducting or shielding may be required;
- ◆ the hydraulic hoses and electrical harness to ensure that there is adequate protection from rub and wear damage;
- ◆ the emergency engine shutdown device to ensure that it operates in accordance with manufacturer's specifications and is fail safe;
- ◆ the battery, to ensure integrity of earthing, and that the battery is effectively protected from any adverse effects of heat;

- ◆ the provision of fire fighting equipment in accordance with Australian Standard AS 2444 "Portable Fire Extinguishers- Selection and Location", where applicable as well as ensuring loaders, trucks and other turbocharged vehicles have been professionally fitted with a fixed AFFF or FFFP system;
- ◆ the battery isolation switch to ensure it is close to the battery, and on 4 x 4 light vehicles, it is in an easily accessible location but not under the bonnet;
- ◆ alternators which should be of the marine type (water and dust proof) with a direct drive preferable to belt drive; and
- ◆ stand alone diesel compressors which should be liquid cooled and equipped with a heat sensor in the discharge port which should initiate a warning or engine shut down at 150°C.

4.2. Maintenance Checks on Diesels

Maintenance practices should ensure that :-

- ◆ replaced hydraulic hoses are correctly sized, rated, located and secured against wear;
- ◆ when portable fire extinguishers are refilled or serviced (refer Australian Standard AS 1851.1), they still comply with the original rating (refer Australian Standard AS 1850);
- ◆ all underground diesel storage and fuelling areas continue to comply with the requirements of the regulations; and
- ◆ AFFF or FFFP systems are activated and tested at 12 monthly (or less) intervals to the manufacturer's specifications by a competent person.

4.3. Diesel Equipment Fire Precautions

Consideration should be given to modifications and systems to reduce the incidence and severity of fires on diesel equipment.

Suggestions include:-

- ◆ the installation of brake drag/brake temperature indicators;
- ◆ the suitable fusing and insulation of high current electrical systems;
- ◆ a fail safe engine shut down system;
- ◆ the installation of engine fire walls, in particular in loaders;

- ◆ the relocation of electrical wiring and hydraulic hosing from the engine compartment;
- ◆ the shielding of hot parts from possible oil or fuel spray; and
- ◆ the integration of the activation of the AFFF system with the engine management system.

Reference should also be made to the guidelines concerning underground diesel engined mining equipment.

4.4. Hot Work Procedure

Where a blow torch, welding, cutting or other hot work equipment is used underground in a location where a fire may endanger a mine entrance or exit or where the fumes from the fire may jeopardise the safety of persons in the mine, implementation of standard written procedures for the safe use of such equipment is essential. In critical or identified fire risk areas a "work permit" system is warranted. This would not necessarily apply in workshops or other recognised maintenance areas that are protected by a suitable fire suppression system.

The procedure when work is to be performed in a shaft, timbered area or fire risk area should include:-

- ◆ hot work permit to be signed by a competent person;
- ◆ examining above, below and around the workplace for potential fire hazards;
- ◆ wetting down (this excludes electrical equipment), prior to work commencing;
- ◆ thoroughly cleaning items to be welded or cut;
- ◆ wetting down when the work is stopped and the worker intends to leave the area;

- ◆ wetting down again approximately two hours after the work has stopped;
- ◆ having sufficient fire protection equipment to hand that is appropriate for the hazard;
- ◆ provision to protect persons from fumes gases or vapours produced by the hot work; and
- ◆ a fire watch person.

4.5. Electrical Equipment

Procedures and suitable fire fighting facilities should be in place and notices placed close to electrical installations to ensure correct procedures are followed in case of fire. Fire fighting equipment is best located on the ventilation intake side of the hazard.

5. TRAINING FOR UNDERGROUND FIRE EMERGENCY

Managers should recognise that one of their priorities is to ensure that underground workers are effectively trained and retrained for underground emergencies.

Effective training is probably the most crucial factor determining the success of personnel protection strategies. Analysis of mine fire disasters in various countries shows that in many instances a lack of understanding of the appropriate action to take in an emergency contributed to the death toll.

5.1. Essential Training

A training package is required that includes:-

- ◆ basic recognition of fire hazards and fire prevention;
- ◆ response to various types of fires (eg. selection and use of extinguishers);
- ◆ use of communication systems and emergency message techniques;
- ◆ when and how to use self rescuers, and their limitations;
- ◆ orderly evacuation procedures and use of escape routes;
- ◆ use of refuge chambers and fresh air bases;
- ◆ survival techniques when trapped or lost underground; and
- ◆ industrial first aid.

5.2. Emergency Team Training (not mine rescue)

In an underground emergency it is equally important that the surface team performs to the high standard that is expected of persons underground. The use of "card

systems" is common and acceptable, as every person can read the duties assigned to them. A practice drill however even on an annual basis, will identify most problems that can occur, and serve to advise on how to streamline the written procedure. If the rescue team can be better briefed and underground 5 minutes earlier than on the previous occasion then a significant improvement has been achieved.

6. COMMUNICATIONS AND WARNING SYSTEM

Emergency warning methods commonly used in Australia and overseas include stench gas (ethyl mercaptan or tetrahydrothiophene), specialised devices such as PED or Canary, and two-way radio systems utilising leaky coaxial cable. Fibre optics systems have also been developed for both visual and radio communications.

6.1. Emergency Communications to Surface (monitored).

Every underground mine should have a direct telephonic communication system between underground and surface. That system should include a surface number for emergency calls. This number must be monitored at all times whilst persons are underground. It could include a paging service or a line that is redirected to a person on-call during the back shifts or at the weekend. Most mines achieve this by using a pit or plant controller, first aid station, winder driver, emergency services personnel or even a private security company. Any person receiving an emergency call from underground must be trained to ask the correct questions and have a procedure to correctly pass on or immediately deal with the emergency message.

6.2. Emergency Warning System.

There needs to be an effective method of warning all persons underground that the mine is to be evacuated (by stench gas, radio, etc.), and which can be activated quickly in the event of an emergency call.

Emergency warning systems need to be tested, using emergency evacuation drills.
(see Section 11.0)

7.0 SURFACE BASE FACILITIES

Collecting and collating information as an emergency progresses is most important. Such information must be reviewed in context with other available data to assist decision making and for use in the briefing of mine rescue teams.

7.1. Surface Control Room

A surface based facility should be available as a control room that is properly equipped and manned throughout the emergency.

7.2. Record of Events

A log book is required in the surface base facility that is used to record all messages and information, both in and out, including the times, names and the messages given. Tape recording of these messages is ideal, as these can be referred to as management and rescue teams are briefed on their arrival.

7.3. Mine Plans Available

Plans are required that include location of telephones, fresh air bases, refuge chambers, fuel storage areas, sub-stations, magazines and emergency exits. The latest ventilation survey figures, airflow directions and location of fans should also be included on the plans.

7.4. Telephones

Where a telephone is the primary contact with underground, attachment to a speaker facility is recommended. This enables those present to be immediately familiar with incoming calls and to prepare pertinent questions. A second telephone is recommended in order that outside phone calls can be made without interrupting incoming calls .

7.5. Emergency Call-in List

An up-to-date call-in list is required, that provides telephone numbers for the essential personnel (eg. manager, ventilation officer, rescue team members, first aid attendant) and the relevant paging numbers.

8. IDENTIFICATION AND LOCATION OF PERSONS UNDERGROUND

The use of tag boards is the most common method of accounting for persons underground. The integrity of such systems should be maintained at all times. The presence of an additional tag, or the absence of one is critical in determining search and rescue criteria for mines rescue team briefing, and can cause unnecessary delays where time is precious.

8.1. Identification of Persons Underground

A method is required to determine quickly and accurately the names and working locations of all persons underground. This is commonly achieved by use of a tag board that is checked by all supervisors at the start and end of every shift, and by the use of daily time sheets.

8.2. Identification and Possible Location of Unaccounted Persons

A system is required that is able to determine quickly if and how many persons are trapped underground and their approximate locations, preferably prior to the mine rescue team reporting for instructions. Persons located in refuge chambers or fresh air bases should be instructed to remain there and to contact base only if their safety conditions change or other persons arrive.

8.3. All Persons Evacuating Mine to Report

An established routine is required where persons evacuating the mine are checked against the list of persons known to be underground. This may require a person to be posted at each of the surface openings (muster points) of emergency escape routes to ensure they are unlocked and unobstructed, and to arrange orderly transfer to the emergency headquarters for debriefing. Any person leaving the minesite during an emergency should be required to personally sign out. This will ensure that everyone can be accounted for within the duration of the emergency.

9. UNDERGROUND REFUGE CHAMBERS

The location of refuge chambers underground should be based on strategic rather than convenience factors. Mine activity, ventilation and proximity to working places should be evaluated in the mine planning process when determining the siting of refuge chambers. Management should be aware of the time limitations and active duration of the self rescuers used at their mine, and this information should be taken into consideration when locating refuge chambers. In many instances a refuge chamber will replace an alternative egress through return air that could become contaminated in a fire situation. The induction process and emergency procedure should specify if employees are to proceed to refuge chambers or escape routes from the mine in the event of fire. All emergency related information signs should be rectangular and be white on a green background in accordance with Australian Standard AS 1319.

9.1. Fresh Air to Refuge Chambers

A dedicated fresh air line to the refuge chamber(s) should be available and the source of that air must be pure, and if possible to the quality specified in Appendix A of Australian Standard AS 1715 (as the compressed air is for breathing). Ensure that the compressor is not being contaminated by mine exhaust, and the compressor (if not oil-free) is fitted with an effective oil filter. Where a dedicated fresh air line of high integrity (steel) is not possible or practicable, alternative methods can be considered. These may include an airtight capsule provided with sufficient air/oxygen (and if necessary a means of removing carbon dioxide) for each person for a minimum duration of six hours or by supplementing a polypipe airline with medicated air in cylinders. In this event the refuge chamber needs to be sealed and sufficient demand valves, masks, (or therapy masks) are required for the number of persons expected to be present. The amount of medicated air available shall be calculated on the basis that each person requires 10 litres of air per minute for a minimum 6 hours. For cylinder compressed air or oxygen, the gas quality specifications should conform with Australian Standard AS 2896.

Where polypipe is used to supply air, this source should be used first in an emergency thus ensuring the maximum duration available to the occupants. Where a polypipe airline is ringfied to a refuge chamber and is fitted with suitably located velocity (or over-centre) valves, line integrity during an emergency may be extended.

The Chamber of Mines Research Organisation in South Africa in their investigations of refuge chambers concluded that:- "Gas clearance rates vary considerably between refuge bays and are dependent on the shape of the chamber and the configuration of the compressed air piping and release arrangements. It is most effective to release the air at a single outlet at the rear of the chamber so as to displace contaminated air in a single continuous column".

9.2. Conduct in Refuge Chambers

The standing instructions for conduct of persons entrapped in refuge chambers during an emergency should be established, with all persons made totally conversant with them and reminder instructions posted in the refuges.

9.3. Location and Equipping of Refuge Chamber

Where refuge chambers are provided, they need to be audited weekly by a responsible person and be maintained in operating order at all times. Refuge chambers should be:-

- ◆ located on the normal route of the employees to and from the working place, clearly visible, easily accessible, and sign posted;
- ◆ equipped with a reliable communication system to surface within the chamber;
- ◆ internally illuminated to a minimum of 200 lux, and have walls and roof of a light colour;
- ◆ positioned such that employees are able to reach one at a walking pace in a reasonable time; less than 50% of self rescuer duration. A maximum distance of between 1000 - 1500m is considered a prudent limit, taking into account steep gradients and any ladder climbing involved;
- ◆ equipped with notice boards displaying the emergency communication procedures, the refuge chamber procedure and appropriate escape route and ventilation plans for use in the event that employees are instructed to leave the refuge chamber during or after an emergency;
- ◆ provided with a first aid box, adequately equipped for underground injuries, and a stretcher;
- ◆ provided with a cache of self contained self rescuers;

- ◆ provided with an independent compressed air line of high integrity (metal) with noise suppression, or an alternative system as referenced in 9.1 above;
- ◆ externally constructed with non-flammable materials; and not located within 3 metres of any flammable matter;
- ◆ of sufficient size to accommodate the maximum number of persons likely to be working in the area;
- ◆ capable of being sealed to prevent the entry of gases, if not able to be effectively pressurised;
- ◆ maintained in clean and hygienic condition at all times;
- ◆ provided with a supply of fresh potable water; and
- ◆ have a means of removing water from the compressed air line within the refuge chamber.

9.4. Latrine

The provision within refuge chambers of a chemical toilet with a privacy screen may be considered.

9.5. Vehicle Parking Arrangements

Procedures should include instructions for vehicle parking during an emergency. Access to the workings, the refuge chamber or fresh air base should not be impeded by vehicles, as this can hinder rescue operations. When parking vehicles during a mine evacuation, the engine should be shut down and the means of starting the equipment left in the cabin.

9.6. Fresh Air Bases

Fresh air bases, when properly selected, can be used in an emergency evacuation procedure. They should be located adjacent to a fresh air source, (eg. plat), be identified by signs, contain a copy of the most recent emergency procedures and be

equipped with a communication device to surface, a means for the supply of potable water and a compressed air source.

9.7. Considerations in Event of Power Failure

In the event of a total power failure at the mine the integrity of refuge chambers and fresh air bases is jeopardised. The refuge chamber may lose compressed air and the fresh air base will be subject to natural ventilation when the fans stop. Standby services provision should be considered, such as air supply, power, water, etc.

10. ESCAPE ROUTES

An alternative escape route is required in every underground mine as specified in the Regulations, however many escape routes are in return airways or exhaust shafts. In a fire emergency such airways can be expected to have limited visibility and persons utilising the escape route ladderway would be wearing a self rescuer. Many mines have fresh air bases and/or refuge chambers as an alternative to travelling through smoke.

10.1. Integrity of Escape Routes to Surface

Escape routes that cannot be maintained in fresh air with certainty during a fire emergency should be evaluated to determine if they should or should not be used in the event of fire. The alternative to using the escape routes to surface is to use refuge chambers, fresh air bases or a combination of these. Employees should be notified through induction and regular retraining on where to report in a fire emergency.

10.2. Escape Route Signs

Escape route signs and notices posted underground, should be properly maintained and marked in accordance with the Regulations and Australian Standard AS 1319. They should also be conspicuous and located at a low elevation in order to be visible in smoke (smoke tends towards the backs initially). In areas that are difficult to traverse in low visibility, the strategic placement of lighting, ropes or chains to guide employees to safe egress is of benefit.

10.3. Ladderways to Surface

Escape routes to surface via ladderways should be frequently inspected and properly maintained. The area within the raise or shaft access to the ladderways should be safely fenced and clear of refuse. In an emergency it is in such locations and bottlenecks that panic could occur.

10.4. Unfamiliar Escape Routes

Escape routes from the workplace may include travelling in parts of the mine not normally travelled by some employees. All floor openings should be fenced and the escape route well marked.

10.5. Rescue Team Access

All escape routes and ladderways giving workplace access in a mine should be of sufficient dimensions to permit stretchers and mine rescue team members using breathing apparatus to pass without undue hindrance.

10.6. Entrapped Procedure

All persons who are required to work or visit underground need to be instructed in entrapped procedures, or be accompanied by a person with the knowledge of entrapped procedures. An incidence of fire or explosions underground, can expose a person or persons to an irrespirable atmosphere, where escape to a fresh air base or refuge chamber is not possible.

In such an event, where it is felt that the self rescuer will not allow a safe escape, it is necessary to take a course of action for self preservation.

There are several courses of action to be included in the training, depending on the resources available. These can be summarised as follows:-

- ◆ compressed air available;
- ◆ compressed air not available;
- ◆ using a filter self rescuer;

- ◆ using an oxygen self rescuer; and
- ◆ using more than one self rescuer.

Decisions to be made by the entrapped person need to be conservative in order to avoid unwarranted risk, and having decided upon an action, the person needs to remain calm and relaxed, but alert. It may be necessary to respond to changes in the circumstances whilst awaiting rescue.

11. EMERGENCY EVACUATION DRILLS

Management should use evacuation drills to evaluate and streamline procedures. Information and feedback on items such as the time a person detects stench gas, or the time a refuge chamber or fresh air base is reached, or the response time to call-ins, should be noted and analysed, after such drills.

11.1. Frequency of Drills

Full mine evacuation drills should be planned so that every employee has a minimum of one drill per annum. Drills need to be carried out on the backshift(s) as well as a day shift each year, to ensure preparedness for a fire at any time.

11.2. Drill Protocol

When drills are conducted and calls made to the RFDS, police district inspector, local hospital and registered manager, these people should be told immediately that a drill is in progress and that communications are being checked. This practice presupposes that prior contact has been established with such bodies when the systems are set up. It is also advisable to warn persons on site of the drill, but this decision is usually at the discretion of the drill co-ordinator.

12. MINE RESCUE EQUIPMENT

Equipment for mine rescue teams should be of high standard and checked regularly for integrity. This is necessary to ensure that the objectives of mine rescue and recovery work are not jeopardised by sub-standard or defective apparatus and equipment.

12.1. Breathing Apparatus and Rescue Equipment

In underground metalliferous mines closed circuit breathing apparatus is essential. An inventory of all the underground mine rescue equipment provided on a minesite should be kept. This inventory should be critically reviewed on a regular basis in order that sufficient apparatus and equipment, suitable to the needs of the mine, is always available in an operational condition. In addition a list of other useful equipment, and how it can be accessed (pumps, cranes etc.) should be maintained.

12.2. Maintenance of Rescue Equipment

Maintenance of mine rescue equipment is absolutely necessary from a duty of care viewpoint and should be of a high standard. The maintenance requirements and recommendations provided by the manufacturers or suppliers of all specialised equipment should be followed. A maintenance - use log book should be maintained for each unit of equipment.

12.3. Additional Oxygen Self Rescuers

Self contained self rescuers are recommended for mine rescue members to carry as part of their minimum equipment during search and rescue operations.

13. WINDERS AND CONVEYANCES

Winder drivers are to be included in the emergency plan.

13.1. Winder Activities in an Emergency

During an emergency the cage (or conveyance) should only make trips authorised by the fire director; usually limited to the evacuation of personnel and the deployment of rescue services. A platman (cage attendant) should take charge of any automatic cage or hoisting system.

13.2. Secure Conditions for Underground Winder Driver

Provision should be made for maintaining the operating capacity of underground winders. Such a provision should be regularly checked and maintained. Where breathing apparatus is provided, the drivers and cagetenders need to be trained in the use and limitations of the supplied gear. A trained person equipped with SCBA should be assigned to remain with any underground winding engine driver on duty in an evacuation or emergency. Alternatively an enclosed booth with a positive supply of uncontaminated air is needed.

14. WRITTEN PROCEDURES

Every emergency or practice emergency requires persons to be familiar with the duties they are expected to perform. Similarly a written record of events, messages, telephone calls and checks, including times, needs to be incorporated into an ongoing diary. A person or persons should be allocated this task as part of the emergency procedure

14.1. Duty Cards

For every person allocated duties during an emergency, a procedure detailing actions required and reporting functions has to be provided. This includes everybody from the fire director to the clerk and lamp attendant.

14.2. List of Essential Contacts

A complete list of external contact numbers and the means required to obtain additional resources that may be called upon during an emergency should be compiled. The list would include information detailing contacts for back-up rescue teams, pumps, fire fighting equipment, police, RFDS, SES, and medical resources. All persons or bodies on the list need to be advised, prior to an event, that they may be called upon.

15. SELF RESCUERS

Self rescuers are required to be used in all underground mines in Western Australia. Self contained self rescuers which provide a supply of oxygen via a chemical reaction, are preferred, and essential where there is a risk of a dust explosion or an identified risk from naturally occurring noxious or asphyxiant gases.

The competent authority on self rescuers in Australia is the Mines Safety Unit of the Department of Mineral Resources in NSW., which recommend that the maximum service life for filter self rescuers, prior to a manufacturers test, is between 45 and 48 months. The Department also states that the maximum service life for these devices is 8 years. Self contained self rescuers have a nominal service life of five years, which may vary depending on the type purchased.

15.1. Maintenance of Self Rescuers

At any mine or rescue station where filter self rescuers (FSR), or self contained self rescuers (SCSR) are provided, a responsible person should be appointed to maintain and service the equipment.

15.2. Quality of Spare Parts and Repairs

When spare parts are required for FSRs, they should be supplied by the manufacturer or his agent. Repairs and maintenance should be carried out only in accordance with the manufacturer's instructions.

There are no spare parts available for self contained self rescuers, although the suppliers can provide a retro-fit service for units that have been opened.

15.3. Maintenance Records

A complete maintenance record of each FSR should to be kept at each minesite.

15.4. FSR Markings and Instructions for Use

The permanent markings and the instructions for use printed on the outside casing of each FSR, need to be legible.

15.5. Routine Examination and Weight Test

The FSR's routine examination consists of a visual inspection, for dents in the case and to ensure that the seal is unbroken. The weight of the complete unit is also to be checked monthly and if weighing shows an increase greater than one percent in

mass, the equipment should be discarded or returned to the manufacturer for filter element replacement and resealing. The original mass is stamped on the casing of the FSR.

15.6. Training.

Every person entering an underground mine needs to be inducted in the use of the self rescuer(s) used on that mine.

16. MINE RESCUE TEAMS

Members of underground mine rescue teams need to have good physical and mental qualities and have successfully completed a course of training to an acceptable standard. These standards are determined by the Mines Rescue Committee under the auspices of the Western Australian Chamber of Mines and Energy. Training is required in self contained breathing apparatus, first aid, search and rescue and fire fighting as a minimum.

Other skills that tend to be developed, especially if the mine has a surface plant or open cut, include rope work and the ability to deal with hazardous substances.

It is important that a rescue team not go past their forward fresh air base, or enter an irrespirable atmosphere, for any reason until it is known that full backup for them is immediately available.

16.1. Training

In the selection of trainers of rescue team members the manager should be satisfied that the trainer is competent in the required field or fields of specialisation. Reference training texts for rescue team members include:-

- ◆ "A Manual on Mines Rescue, Safety and Gas Detection 1990" by J. Strang and P. Mackenzie-Wood of the Southern Mines Rescue Station in NSW.; and
- ◆ "Handbook of Training in Mines Rescue and Recovery Operations 1992" by the Ontario Ministry of Labour. (ISBN 0-7778-0390-9).

16.2. Medical and Physical Fitness

In addition to qualifying as a mine rescue team member through successfully completing a course of training to an acceptable standard, a member of a rescue team should, amongst other requirements:-

1. be in good health and physically fit,
2. have good vision and hearing, and
3. be capable of performing long and arduous physical labour.

It is important therefore that all volunteers have an annual medical assessment which should consist of a health questionnaire and a medical examination to ensure appropriate health status. This would include questions on past and current medical problems and current medication, all of which could significantly effect the fitness of an individual. Once a volunteer is passed as being medically fit then an assessment for physical fitness can be determined. Physical fitness may be assessed by either of two methods:

- ◆ an exercise treadmill test which allows an accurate method of aerobic fitness through oxygen consumption, or
- ◆ a task specific assault type course, which would include a battery of activities lasting four to five minutes each, totalling 25-30 minutes.

Although standardised tests do assess certain elements of fitness they may not assess the ability to do mine rescue tasks under duress.

16.3. Competitions

Participating in, or just observing a mines rescue competition, is a valuable learning experience. It is recommended that mine management provide incentive, support and encouragement for their team members to compete in or attend at least one of the various competitions in the state each year.

16.4. Training Future Underground Managers

Not all Managers or Underground Managers have had the experience of being a member of a mine rescue team. Not knowing the limitations and the main objectives of mine rescue can be a disadvantage in an emergency situation, and could result in incorrect decisions being made in the haste and pressure of a crisis. Mining engineering graduates are appropriate candidates for rescue team membership, and

as future underground managers should receive training in mines rescue while gaining their early experience.