HSE

Health and Safety Executive

Guidance on the prevention and control of fire and explosion at mines used for storage and other purposes

Contents:

Introduction

This information and guidance was prepared, in consultation with the Health and Safety Executive (HSE), by a working group representative of the storage mine sector. It represents what members of the working group and HSE consider good practice.

Members of the working group on the prevention and control of fire and explosion in mines used for storage and other purposes

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What this booklet is about

1. This guidance is for mines and parts of mines used for the storage of materials, products or documents and for other non-producing mines used for other purposes.
2. It should be read in conjunction with the HSE/Home Office guidance 'Fire Safety, An Employer's Guide', ISBN 0-11-341229-0. This booklet contains additional guidance addressing circumstances, both legal and technical, that are particular to operations carried on in mines used for other purposes. It will help mine owners and managers:
    - Comply with the law;
    - Identify fire and explosion hazards and carry out fire and explosion risk assessments;
    - Identify the measures necessary to avoid, control and mitigate the risks;
    - Prepare fire and explosion protection plans.
3. These risk assessments will also help mine managers to prepare their emergency plans setting out the action to be taken to effect the evacuation and rescue of people from below ground in the event of a fire or explosion.

Who should read this booklet?

4. It should be read by:
    - Mine owners;
    - Mine managers;
    - Other mine staff who have a role in ensuring fire safety through supervision, inspection and maintenance etc;
    - Safety and employee representatives;

    It can be used as a tool for training and refresher training.

Legal framework

Primary legislation

5. The two main pieces of primary legislation (Acts of Parliament) relevant to fire and explosion in mines are:
    - **The Mines and Quarries Act 1954**, which includes provisions that have a bearing on fire and explosion.
    - **The Health and Safety at Work etc Act 1974**, which contains duties relating to safe systems of work and ensuring the health and safety of employees and others who may be affected by a work activity.

Provisions relating to worker protection

6. Beyond the general duties set out in primary legislation there are a number of legal provisions that collectively require employers/mine owners, and in some cases mine managers, to assess the likelihood of a fire or explosion, its nature and extent, and the numbers of people who would be put at risk:

- Regulation 3 of **The Management of Health and Safety at Work Regulations 1999** requires all employers and self-employed people to assess the risks to workers and any others who may be affected by their work or business. That assessment must include the risks from fire and explosion hazards where they exist.
- Regulation 4 of **The Mines Miscellaneous Health and Safety Provisions Regulations 1995** requires mine owners to produce a health and safety document that demonstrates that the risks to which people at work at the mine are exposed have been assessed in accordance with regulation 3 of The Management of Health and Safety at Work Regulations 1999. In particular:
    - Regulation 4(1) requires that these plans must be based on a risk assessment, the outcome of which demonstrates that adequate measures concerning the design, use and maintenance of the mine and its equipment have, and will continue to be taken. The health and safety document must also set out how the measures will be co-ordinated, taking account of both normal and emergency situations.
    - Regulation 4(2)(a) and 4(5)(a) respectively require an explosion and fire protection plan to be included in the health and safety document.
- Regulation 4 of **The Escape and Rescue from Mines Regulations 1995** requires managers to prepare and maintain a written plan (emergency plan) setting out the action to be taken to effect safely and promptly the evacuation and rescue of people from the mine should an emergency situation occur. In preparing this plan, managers should take account of any relevant risk assessment made in accordance with regulation 3 of the Management of Health and Safety at Work Regulations 1999.
- **The Provision and Use of Work Equipment Regulations 1998** impose requirements upon employers in respect of work equipment provided for or used by their employees at work. The requirements also apply to the self-employed and people in control of premises.
- **The Dangerous Substances and Explosive Atmospheres Regulations 2002** apply to mines apart from the provisions of regulations 5(4)(c), 7 and 11. They impose requirements for the purpose of eliminating or reducing risks to safety from fire, explosion or other events arising from the hazardous properties of a ‘dangerous substance’. The duties fall on employers, and include requirements for them to:
    - Carry out assessments of risk from dangerous substances (which, where they are present, will include flammable gases and flammable dust);
    - Eliminate or reduce risk so far as is reasonably practicable;
    - Make arrangements for dealing with accidents, incidents and emergencies;
    - Provide employees with information, instruction and training in relation to dangerous substances;

- Ensure that containers and pipes clearly identify their contents.

7. There are also a number of other provisions relating to general fire precautions:

    - Regulations 31 to 35 of **The Miscellaneous Mines (General) Regulations 1959** relate to mine specific fire precautions.
    - **The Fire Precautions (Special Premises) Regulations 1976** require that any building on the surface at any mine that is connected with the working of that mine have a fire certificate.
    - Paragraph 6, Schedule II to regulation 6 of **The Mines Miscellaneous Health and Safety Provisions Regulations 1995**, requires mines to limit the amount of flammable materials taken below ground to that which is strictly necessary.

Provisions relating to the supply of products

8. Relevant product directives (otherwise known as Free Market Directives) usually apply to manufacturers and suppliers and set standards for them to achieve in order to be able to 'CE' mark their machinery and equipment. The main ones relevant to fire and explosion in mines are:

    - The **Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996** ('the EPS Regulations') require people placing equipment on the market and putting into use to ensure that it meets relevant safety standards in relation to explosion protection.
    - **The Supply of Machinery (Safety) Regulations 1992** apply to all machinery and the essential health and safety requirements cover all hazards, including fire and explosion hazards, caused by machines.

Fire and explosion Risk Assessment

Introduction

9. Mine owners, as employers, must have in place procedures to ensure that fire and explosion risks are assessed at each of their mines.

10. The Management and Administration of Safety and Health at Mines Regulations 1993 provide for mine owners to appoint others to discharge legal duties on their behalf. This does not relieve owners of their duty to ensure that suitable and sufficient risk assessments are done at each of their mines. However, mine managers, assisted by members of staff with competence in the relevant areas, will often be better placed than owners to undertake these assessments.

11. Where there is any lack of knowledge, expertise or competence that might prejudice the assessments, those carrying out the assessments should seek the advice of specialists.

Risk Assessment

12. Every employer has to undertake risk assessments for the purpose of identifying the measures he needs to take to comply with the requirements and prohibitions imposed on him by or under the relevant statutory provision.

13. Assessing risks is important in order to identify their relative significance and to obtain information on their nature and extent. This will help both to prioritise risks and determine where to place the most effort in prevention and control, and to make decisions on the adequacy of existing control measures.

Main stages

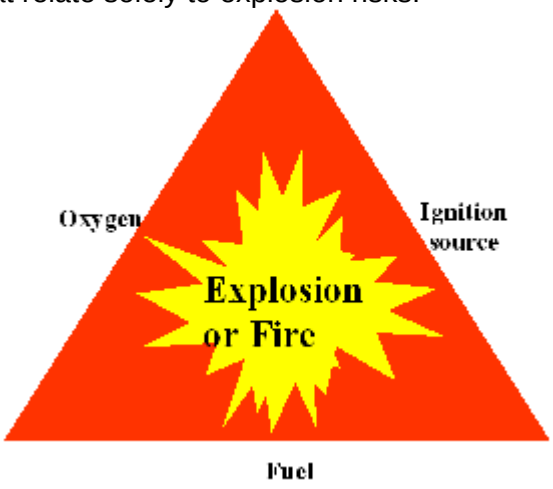
14. The main stages of the fire and explosion assessment process are to:

- Identify the hazards - the potential sources of ignition and materials that would cause a fire or explosion to spread;
- Consider the precautions already in place for the prevention and mitigation of each fire and explosion hazard;
- Evaluate the likelihood of a fire or explosion occurring due to a particular hazard;
- Consider the consequences of a fire or explosion, and decide who might be harmed and how;
- Determine what further measures are necessary to prevent, control or mitigate a fire or explosion;
- Record significant findings; these should be included within the fire protection plan and the explosion protection plan;
- Review the risk assessment periodically, or when you think that a change in circumstances will significantly affect the risks to which people are exposed (e.g. storing flammable materials for the first time).

Identifying the hazards

15. While fire hazards are the main concern at storage mines there may also be the risk of explosive atmospheres occurring. For example, at a battery charging station, or as a secondary effect of a fire.

16. While fire hazards are likely to be present at storage mines, if there are no explosion hazards present then there will be no risk to people from an explosion and therefore no need to introduce any explosion prevention and control measures. In this case there is no need to read the parts of this guidance that relate solely to explosion risks.



Sources of fuel

17. Anything that can burn is potential fuel for a fire or, in some cases, an explosion. These include:

    - Paper (including stored documents);
    - Cardboard (including packaging);
    - Plastics (including electronic media, X-ray plates, packaging etc);
    - Other stored materials or items;
    - Spirits;
    - Wood;
    - Diesel;
    - Tyres;
    - Mineral oils and grease;
    - Rubbish and other waste material;
    - Bottled gases e.g. acetylene, propane.

Sources of ignition

18. Owners and managers will also need to consider what can cause an explosion or start a fire. A source of ignition is anything that has the potential to get hot enough to ignite a material, substance or atmosphere in the workplace. These sources of heat might include:

    - Electrical and mechanical machinery and equipment, including;
        - Electrical sparking and hot surfaces from electrical equipment and distribution systems;
        - Short circuits and earth faults on electrical equipment and distribution systems;
    - Internal combustion engines – exhaust systems, air inlets, hot surfaces;
    - Friction; for example from seized brakes on vehicles;
    - Natural sources, for example electrostatic discharges and lightning;
    - Hot work – burning, welding, and grinding;
    - Smokers' materials, e.g. cigarettes, lighters and matches.

Sources of oxygen

19. The main source of oxygen for a fire or explosion is in the general body of air. Unless a fire or explosion occurs in an enclosed space, such as a small storeroom or within pipe work, it is safe to assume that it will always have a ready supply of oxygen as the mine's ventilation system will continue to draw air around the workings.

20. There are also other sources of oxygen that you may need to take into account when making your risk assessment, such as bottled oxygen,

compressed air distribution systems and chemicals that release oxygen when heated (oxidising agents) such as hydrogen peroxide. Manufacturers' labels should identify which chemicals are, or contain, oxidising agents. Oxidising agents or substances containing an oxidising agent should be labelled with the international standard symbol;

Evaluating the likelihood

21. The next stage is to evaluate the likelihood of a fire or explosion occurring and to decide whether there are sufficient measures in place to avoid, control or reduce them, or whether you need to do more.

22. These assessments should take account of the control measures that are in place. For example, the likelihood of a fire caused by the electrical distribution system will be less if the system is already ignition protected.

23. The assessments will also need to consider:

    - Whether there are any areas of the mine where additional control measures may be necessary (e.g. in rooms where there is only one way in or out);
    - Any abnormal circumstances which might arise;
    - Special situations, e.g. when maintenance work is being carried out.

Deciding who might be harmed and how

24. When assessing risks that might arise from fire and explosion hazards owners and managers should consider the effects on those in the immediate area and to others. The outcomes of this process will help determine the necessary preventative and protective measures for inclusion in the fire and explosion protection plans.

25. The assessment will have to consider the potential risks arising from:

    - The nature and extent of any flame, heat or blast wave;
    - The possible disruption of the ventilation system; for example, due to doors being blown open or left open, or due to the buoyancy effects of hot gases affecting the airflow;
    - The potential for oxygen depletion;
    - The reduction in visibility due to smoke;
    - The spread and possible concentrations of toxic and noxious gases and other products of combustion;
    - The distance to a place of safety.

Recording significant findings

26. Having completed the risk assessment process you should record:

- The significant findings of those assessments;
- Any group of employees identified by the assessment as being at risk;
- Particulars of the avoidance and control measures taken or proposed:
- Other information relating to the workplace and work processes.

27. Additionally mine owners must prepare a health and safety document which:
    - Demonstrates that risks have been assessed;
    - Demonstrates that adequate risk avoidance and control measures have and will continue to be taken;
    - Includes a statement of how these measures will be coordinated.
28. The health and safety document should include a fire protection plan and an explosion protection plan. In other words where the assessment indicates there are fire risks the health and safety document should include a fire protection plan, and where there are explosion risks, an explosion protection plan.
29. Further guidance on fire protection and explosion protection plans can be found later in this document.

Reviewing the assessments

30. Mine owners must review their assessments if they have reason to suspect that they are no longer valid or if there has been a significant change in the matters to which they relate. For example if there are changes to either:
    - the layout of the mine (e.g. when a new storage area is brought into use etc.), or;
    - the flammability of stored items, or:
    - working methods.

    as any of these may change the nature of the hazards and different risks may develop. For example, moving a battery-charging station may also require moving the fire fighting equipment so that it remains on the upstream side available for fighting fire.
31. In any event, the assessments should be reviewed at least annually, and more frequently at mines where there is a high level of activity.
32. Where a review identifies any new or changed significant findings the mine owner must record these and implement any measures necessary to control adequately the new or changed risks.

Risk assessment and the emergency plan

33. The assessment of the residual risks that remain after all reasonably practicable measures have been taken should form the basis for the emergency plan for safe evacuation and rescue.
34. Those making the assessments should consider the direct effects to those in the immediate area of a fire or explosion. Because mine ventilation systems provide air to all places in the mine where people work or pass all people below ground are likely to be at some level of risk should a fire break out or

an explosion occur. The level of risk to which each person is exposed will vary depending on a number of factors including:

- How close they are to the fire or explosion;
- Whether they are on the intake side or downstream;
- How far they are from the nearest unaffected place or safe haven;
- How long it would take them to reach a place of safety, bearing in mind such factors as the loss of visibility in smoke-affected roadways;
- The type and duration of self-rescuers, where provided..

Fire and explosion prevention and control

35. The standard of housekeeping, implementation and supervision of management controls are significant fire prevention and reduction measures. Part 3 of the HSE/Home Office publication 'Fire Safety – An Employers Guide', pp28-38 provides further information on fire prevention through good management.
36. The objective of fire and explosion control measures is to avoid any fire or explosion risks by eliminating either the potential ignition sources or potential fuel sources, or both. However, it is likely that some potential fuels and some ignition sources will remain, so these need to be reduced by:
    - Minimising the inventory of potential fuels;
    - Minimising the number of potential ignition sources;
    - Keeping potential ignition sources apart from potential fuel.
37. Although the undertaking of some storage mines is to store flammable materials such as paper documents they should still minimise the potential amount of fuel by:
    - Limiting the amount of other flammable materials taken below ground;
    - Where reasonably practicable, using fire resistant fluids instead of mineral oils;
    - Ensuring that rubbish and other flammable waste material is removed regularly;
    - Progressively replacing any oil-filled electrical equipment and bitumen-filled electrical cable couplers and joints with safer alternatives;
    - Keeping to a practical minimum flammable material in structures below ground.
38. Sources of ignition in all mines can be minimised by:
    - Using ignition-protected electrical distribution systems;
    - Reducing the number of plug and socket electrical connections; for example, cable couplers;
    - Closely monitoring any remaining oil-filled electrical equipment and bitumen-filled couplers;

- Using battery-powered vehicles instead of those with internal combustion engines;
- Avoiding hot surfaces and frictional sparking through good design, installation, commissioning and by regular inspection, testing and maintenance, including the periodic and effective monitoring of brakes, motors etc;
- Checking that moving parts are not unintentionally rubbing against fixed objects;
- Ensuring proper lubrication;
- Removing ignition sources from equipment that is out of use; for example, vehicle batteries;
- Prohibiting the use of flame cutting unless safety precautions are in place;
- Banning or controlling smoking below ground.

39. Fuel and potential ignition sources can be kept apart by:

- Minimising the amount of electrical equipment in zones where flammable materials are used or stored;
- By delineating adequate clear zones of at least 2m in any plane around electrical equipment and other potential ignition sources;
- Avoiding the use of internal combustion engines in zones where flammable materials are used or stored;
- Where diesel vehicles are used, separating electric cables, fuel and hydraulic pipes from hot components in engine compartments by routing and the provision of physical barriers.
- Shrouding or enclosing any hot components (such as diesel exhausts, space heaters etc).

40. Where the risk assessments indicate that the control measures already in place are not sufficient then the next step is to identify what additional control measures are needed, for example by:

- Increasing the level of monitoring of plant and equipment that pose ignition risks;
- Increasing the number of fire detectors in vulnerable places;
- Reducing compartment sizes to prevent or reduce further the spread of heat, smoke and fumes;
- Improving the fire resistance rating of walls and doors;
- Installing automatic fire suppression equipment.
- Avoiding or minimising the inventory of materials that give off very toxic fumes when burnt – such as polythene, some types of shrink wrap, polyurethane foams and urea-formaldehyde foams.

41. The control measures adopted should be proportionate to the amount of harm that could be caused. Later sections of this guide give further information on specific control measures.

Fire Protection and Emergency Plans

Fire protection plan

42. Where there are fire hazards at any mine the owner must ensure that their health and safety document includes a fire protection plan. The plan must take into account:

    - Likely sources of fire, taking into account the presence of fuel, ignition sources and oxygen;
    - Precautions to be taken to protect against, to detect and combat the outbreak and spread of fire.

43. The plan should provide clear instructions on:

    - Avoiding or controlling sources of ignition;
    - Minimise the amount of flammable materials below ground other than items intended for storage;
    - Detecting fires and giving warning in the event of fire;
    - Minimising the spread of fire, smoke, fumes or toxic gases;
    - The actions to be taken on discovering a fire.

The Emergency Plan

44. The emergency plan should identify as appropriate:

    - Safe means of egress from the mine;
    - Routes to any safe havens;
    - Evacuation procedures;
    - The organisational arrangements required to implement fire-fighting measures and set the roles and responsibilities of those who have duties under it;
    - Emergency arrangements, including where appropriate the procedures for contacting the mines rescue service and, in the event of a fire on the surface, other emergency services;
    - Arrangements to contact HM Inspectorate of Mines.

45. It is important that safety-checking systems at the mine are effective in keeping track of who is below ground.

Fire avoidance and control measures

Avoidance and control of sources of ignition

46. This section covers the following:

    - Selection, provision and use of suitable work equipment;
    - Inspection and maintenance of work equipment;
    - Control of naked flames and ‘hot work’.

Selection, and use of equipment

General

47. There are a number of legal provisions that relate to the safe use of equipment. In selecting equipment for use below ground mine owners and managers should make manufacturers or suppliers aware of the environment in which the equipment is to operate so that they can reduce fire hazards to a minimum.

48. The use of flammable materials in equipment designed specifically for use below ground in mines should already have been minimised by the equipment manufacturers. Where equipment designed for surface use is adapted for use below ground, or where equipment is assembled by the user for their own use, it should meet the essential health and safety requirements contained within The Supply of Machinery (Safety) Regulations 1992.

49. While mine owners should try and avoid using diesel powered vehicles in places where flammable materials are stored, where they are used there should be in place sufficient measures to ensure that flammable materials do not come into contact with surfaces hot enough to ignite them, for example, turbo chargers and exhaust systems on internal combustion engines.

50. Where reasonably practicable the fluids used in any hydraulic system should be fire resistant. This means the hydraulic fluid should be both difficult to ignite and should satisfy the specification approved by the Health and Safety Executive in relation to fire resistance and hygiene.

51. Where it is not reasonably practicable to use fire-resistant hydraulic fluids suitable and sufficient fire protection measures should be taken including:

    - Separating hydraulic lines and cables etc from hot surfaces such as exhaust systems and turbochargers by routing and the provision of physical barriers;
    - The provision of temperature monitoring on hydraulic systems to warn of excessive fluid temperature;
    - The provision of fire suppression systems.

52. Mines can reduce the likelihood of a failure leading to a fire by ensuring that operators use equipment only within its rated duty.

Electrical equipment

53. In addition to the requirements relating to all work equipment mine owners and managers should ensure that electrical systems are constructed and maintained to prevent danger.

54. To prevent electrical equipment becoming an ignition source, it should be:

    - Ignition protected to a suitable British or international standard;
    - Rated for normal operation and for foreseeable faults;
    - Protected against mechanical damage, particularly in relation to cables;
    - Protected electrically against dangers arising from overloading, leakage current and short circuits;

- Maintained and operated in accordance with the manufacturer or supplier's instructions.

55. Because of the fire risk, regulation 23 of The Electricity at Work Regulations 1989 prohibits the introduction below ground of electrical equipment using oil as a means of cooling, insulation or arc-suppression. Whilst it does not prohibit the continued use of existing oil-filled electrical equipment below ground, such equipment should be replaced progressively with safer alternatives.

56. Other measures that will reduce the likelihood of a fire occurring include:

    - Using resin instead of bitumen in cable couplers/connectors/joints, and progressively replacing existing bitumen filled couplers;
    - Not allowing dust to accumulate on electrical equipment to the extent that it might overheat;
    - Not allowing ventilation openings to become blocked;
    - Operating short time rated equipment only within its time rating;
    - Providing vehicles used below ground with battery isolators or circuit breakers, to enable the battery circuit to be isolated when the vehicle is not in use. Vehicles designed for surface use will require such devices fitting before they are taken below ground.

The aftermath of a fire in a lead acid battery following a short-circuit

Machinery and equipment monitoring

57. Monitoring can be useful both for controlling health and safety risks and for asset protection. Mines should consider remote continuous monitoring for equipment that runs unattended for long periods of time whose failure might result in a fire that would give rise to significant risks to people below ground.

58. The amount and type of monitoring that it is reasonably practicable to install will depend on the potential fire hazards and risks identified during assessment. Where there is no fire risk, or the fire risks are very low, monitoring may not be a reasonably practicable control measure. However, as the fire risks increase so should the level of monitoring.

59. The monitoring system should give an indication locally and to a suitable control point, either above ground or in some secure place below ground, where someone can hear or see it and react to it if necessary.

60. Temperature devices that generate a continuous signal are more flexible than ones that only produce a signal in an alarm condition. They will allow mines to configure the monitoring system software to both generate alarms if certain temperatures are exceeded and initiate a stop sequence if a monitor indicates a hazardous situation.

61. A senior person the management structure should be responsible for defining warning, alarm and trip levels. The setting levels for individual monitors should be recorded as part of the planned preventative maintenance scheme and should not be changed without permission from the responsible person.

62. The monitoring system should be set to generate an alarm if the temperature measured by any probe reaches a predetermined level above the normal maximum operating temperature. This level should be high enough not to generate false alarms but not so high that the monitored equipment could cause a fire before generating the alarm.

63. When monitoring systems generate frequent false alarms, because the alarm level is not set high enough above the normal maximum running temperature, operators soon become used to cancelling alarms because they know that, in most circumstances, there is no real risk. However, this makes them far less likely to respond quickly or appropriately to a real emergency. The senior management member responsible for the monitoring system should therefore ensure as far as possible that alarms operate only when there is a genuine reason for them.

64. Excess temperature **alarm** levels should be no more than 10^{o}C above the maximum running temperature under normal conditions. The monitoring system should **automatically stop** the equipment if a temperature of 20^{o}C above the normal maximum running temperature is detected, or an alarm at a lower temperature persists in excess of 30 minutes.

65. Monitors should stop equipment or machinery through local circuitry rather than through data transmission systems.

66. Any machinery or equipment that has been stopped by the monitoring system either due to overheating, or other alarm condition indicating a potentially hazardous state, should not be restarted unless a competent person has thoroughly examined it and either found it to be safe or rectified any defect.

67. Monitoring systems should be designed to detect the failure of any monitor and, in the event of a malfunction any safety-critical monitor, stop the equipment prevent it from re-starting.

Inspection, testing and maintenance

68. Regular testing, inspection and maintenance of equipment can reduce risks. Owners and managers can find further guidance on the manager's scheme of maintenance in the Approved Code of Practice to The Management and Administration of Safety and Health at Mines Regulations 1993 and on equipment installation and maintenance in guidance to The Provision and Use of Work Equipment Regulations 1998.

69. As part of their inspection, testing and maintenance regimes, mines should use routine condition monitoring techniques where the failure of a component might lead to a fire. Where the mine does not have the knowledge or experience to carry out such procedures, managers should consider using specialist contractors.

70. The installation, testing and maintenance scheme should include all equipment monitors and protective devices, and should include procedures to ensure that these are regularly checked to ensure that the devices are properly calibrated, their trigger levels are appropriate, and that they operate as intended.

Naked lights/flame/hot work

71. Mines should not use open flame apparatus, such as burning and welding equipment, where there is a risk of fire unless control measures are first put in place to prevent the accidental ignition of materials or substances and the spread of fire.

72. Where mines cannot avoid the use of open flame apparatus control measures could include:

    - Removing flammable materials and substances from the immediate vicinity;
    - Using tools with non-flammable components; for examples, hoses or cables;
    - Using a spark-igniter rather than an open flame;
    - Using flashback arrestors and non-return valves at the cutting or welding torch;
    - Wetting down the immediate area where coal or other flammable materials are present;
    - Partitioning off the area to prevent the spread of sparks, flames and hot metal;
    - Spreading non-flammable dust beneath the work area to catch sparks and hot metal;
    - Ensuring that only competent persons undertake and supervise such work;
    - Frequent inspections by a competent person before, during and after the work. Inspections should continue until it is certain that there is no smouldering material;

73. The measures taken to protect against the spread of fire may include fire extinguishers, automatic fire suppression systems, and an adequate water supply for fire fighting. Published guidance on burning and welding includes:

    - HSE Information Sheet on the Use of Acetylene;
    - HSE guidance sheet HSE 8 ‘Oxygen: Fire and explosion hazards in the use and misuse of oxygen’;
    - British Standards BS 5741 and BS 5120;
    - Codes of Practice CP4, CP5, CP6 and CP7 issued by the British Compressed Gases Association and approved by HSE.

Smoking and smoking materials

74. Where mines store flammable materials or substances, mine owners and managers should consider either banning smoking below ground, or

encouraging people not to smoke. Where people are allowed to smoke they should do so only in designated places.

Control of flammable materials below ground

75. Mines must limit the quantity of flammable materials taken below ground to the amount strictly necessary. Storage mines whose business may be storing documents, materials or substances that are flammable, should still take steps to limit the amount of unnecessary flammable materials below ground, such as excess packaging etc.
76. In addition to controlling the amount and types of flammable materials that are taken below ground, owners and managers will also need to ensure that there is a system in place to remove flammable waste promptly from any areas of risk. This will include for example, wood off-cuts, rags, packaging materials, tyres and other flammable parts of equipment etc.
77. The fire protection plan should set out measures to control the amount and location of flammable materials below ground. This includes limiting the amount of:
    - Flammable liquids stored and used below ground;
    - Non-metallic materials used; e.g. plastics/fibreglass, rubber, wood;
    - Flammable waste.
78. Where mines store flammable materials the fire protection plan should also set out the conditions under which they are to be stored; including sectioning the parts of the mine off into compartments to limit the spread of fire..
79. Where flammable liquids are stored mines should take steps to limit the amount stored in any compartment and to introduce measures to contain the liquids in the event of a leak (by the use drip trays or stillages etc) or spillage (by the use of absorbent materials etc).
80. There should be a ready supply of suitable materials that can be used to soak up the spilled liquids. Used absorbents should be removed from the mine as soon as is practicable.
81. Owners and managers of storage mines should avoid taking highly flammable materials below ground. Where this cannot be avoided they should be kept in a fireproof rooms, compartments or boxes.

Fire resistant materials in structures above and below ground

82. Mine owners should use fire resistant materials wherever practicable in structures both below and above ground.
83. Fires spread can be limited by using only fire resistant materials in the construction of buildings and structures such as:
    - Storage compartment partitions;
    - Electrical sub-stations;
    - Transformer houses;
    - Battery charging and battery transfer stations;
    - Fuel stores and refuelling points;

- Other buildings or structures housing materials or equipment that could give rise to a significant fire.

84. Fires in cable ducts on the surface have also led to smoke being drawn down shafts, and these should also be constructed of fire resistant materials and be sealed at the shaft side.

85. Equipment on the surface containing flammable materials, for example, winding engine transformers that contain large volumes of mineral insulating oil, should be sited well away from the shafts.

Fire safety checks

86. Mine inspections should include a fire safety check to ensure that all fire precautions are in place and that nothing that will burn is in contact with a potential ignition source. If the fire risk assessment identifies places where there is a higher likelihood of fire these should be examined before the premises is vacated overnight or any other protracted period.

87. Further guidance on fire safety checks is given in the HSE/Home Office guide on fire safety referenced at the beginning and end of this booklet.

Detecting fires and raising the alarm

88. A fire below ground in a confined space can give rise to greater risks than a similar sized fire above ground, because of the much greater potential fire energy for a given amount of fuel, the entrained ventilation system and longer escape distances. Fire detection systems below ground therefore need to be effective.

89. The primary purpose of a fire detection system is to give an early warning to those who may be affected by fire, so that they can either commence fighting the fire if it is safe to do so, or to evacuate to a place of safety.

90. Fire detection and warning systems are not a substitute for effective fire prevention measures.

91. The fire risk assessment should identify fire hazards and those areas where people are potentially at risk. This will enable mines to determine what fire detection measures are needed.

92. The measures that it is reasonably practicable for a mine to take will vary according to the level of risk within the mine.

93. At mines storing flammable materials the consequences of fire will be high and it will be reasonably practicable for owners to install comprehensive fire detection systems, including addressable alarm systems that detect which monitor has alarmed and relay that information to a central control point.

94. However, any properly sited and maintained environmental monitor will increase safety, even at low risk mines, particularly where they monitor areas of the mine where people do not regularly pass.

Fixed fire detectors

95. Examples of areas where the use of fire detectors should be considered include:

- Within rooms or compartments where flammable materials are stored;

- Within sub-stations or any other room or compartment containing equipment that could give rise to a significant fire;
- At either side of fire doors that close automatically;
- At battery-charging stations;
- At intervals along main intake and return roadways.

96. There are various types of detectors, such as smoke sensors, products of combustion (POCs), carbon monoxide (CO) and infrared monitors. Where there is any doubt about the suitability of a particular type of fire detector in a particular location, or where a mine has insufficient expertise to properly manage the monitoring system, the owner or manager should seek the advice of a competent person.

97. Mines should have in place procedures to ensure that they site monitors to give the best chance of detecting a fire, or impending fire, at a very early stage. Managers therefore need to ensure that they have effective arrangements for positioning, installing, and commissioning them.

98. Detectors should be sited in the best possible place for detection whilst ensuring facilities are provided to allow easy testing and maintenance.

99. Mines should also have arrangements to check that fire detector positions are still appropriate following any change that might affect the ability of a detector to detect a fire.

100. Extraction type smoke detectors, where a pump draws air through a series of tubes to detector heads, have the potential to draw samples from different areas of a compartment or room and, when operating as part of an addressable system, can indicate the part of the room or compartment where smoke is present. As such they offer an alternative to using several fixed detector heads.

101. Infrared heat monitors do not rely on measurement of any resultant fire products in the environment but detects the rise in infrared radiation as a result of increasing temperature, for example, of a faulty machinery component or an overheating electrical connection. Fixed point, non-contact infrared detectors are available that can be sited to protect high-risk components or zones.

The detection system layout

102. It is important in the event of a fire that the fire detection system remains operational for as long as possible to provide information for those who have to make decisions about whether to attempt to fight the fire or the timing of the subsequent re-entry into the mine or a compartment following an evacuation.

103. The control point for an addressable alarm system should be sited on the surface or at some secure point in the mine that is unlikely to be affected by heat, smoke or fumes; for example, near the bottom of the main intake ventilation shaft or drift (slope shaft).

104. The wiring for the fire detection system data transmission network should be routed back to the control point through one or more of the escape routes as these should be that last to be affected in the event of a serious fire. The wiring should not be routed through other storage compartments as

a fire in one of these could render ineffective at an early stage the fire detection system over a large area of the mine. Where mines cannot achieve this they should use fire-protected cable (FP200).

105. Where the wires from several fire detectors are brought together into a junction or relay box, the box itself should be sited on the outside of the firewall with the wires brought through a sealed opening in the wall. This will eliminate a potential source of ignition within the compartment.

Local sampling arrangements

106. The ability to sample from outside a compartment the condition of the general body of mine air within can help operators decide when it is sufficiently safe to re-enter following a fire. If someone is missing local sampling arrangements should also help the rescue service provider(s)decide whether it is safe to mount a rescue attempt.

107. Mine operators should therefore consider providing a tube or tubes through which air samples could be drawn from within a compartment in the event of a fire. The tubes should be fire-resistant and sited so that samples can be drawn from the worst affected area, likely to be near the roof. The end(s) of the tube(s) outside the compartment should be sited such that the person taking the air samples is unlikely to be at significant risk.

108. Where extraction type monitors are used the local control panel housing the air pump should also be sited outside of the compartment. In the event of a fire within a compartment the pump will continue to extract a small quantity of air from within the compartment that could be sampled with hand-held monitors.

Alarm systems

109. The location of audible or visible fire alarms depends on the layout of the mine and the likely rate that smoke and fumes from a fire would spread. Mines should design alarm systems to provide immediate warning to anyone who may be at risk either in the vicinity or on the return side of a fire.

110. Alarms may be incorporated with the automatic operation of fire suppression equipment such as water mist or sprinkler systems.

111. There should also be a system for people to raise an alarm. This can be via the telephone, intercom or radio system, which can include audible alarms that people can activate.

112. Where possible the fire detection system control point should be monitored at all times when people are at work below ground.

113. Where the control point is not continuously attended mines should arrange for repeater alarms at appropriate points, which can be heard by someone who can react and, where necessary, initiate the mine emergency plan. Such personnel will need appropriate training or instruction in these procedures.

Alarm levels

114. Setting appropriate alarm levels is key to an effective monitoring and warning system. Trigger levels should not be set so high that they do not generate an alarm until a fire is well established, neither should they be set

so low that they repeatedly generate false alarms; for instance when a diesel-powered vehicle passes a detector.

115. As with equipment monitors a senior member of the management structure should be responsible for:

- Setting warning and alarm levels;
- Ensuring that these are reassessed periodically or following any significant change in circumstances;
- Prioritising them.

116. The setting levels for individual monitors should be recorded as part of the planned preventative maintenance scheme and should not be changed without permission from the responsible person.

Testing and inspection

117. The manager's scheme of maintenance should set out the arrangements for testing at regular intervals both individual detectors and the alarm system(s). This should include arrangements for the periodic recalibration of detectors.

Preventing the spread of fire

118. Preventing the spread of fire, smoke and fumes is important both to maximise people's opportunities to escape and to protect the mine's assets and the assets of third parties who store things there or operate equipment.

Fire resisting walls and doors

119. The spread of any fire can be mitigated by the provision of fire-resisting walls and doors and by the ability to close off ventilation to the affected area.

120. Where flammable materials are to be stored, or where potentially flammable equipment operates (for example large IT hardware installations), and a fire would give rise to significant risks, the mine should be sectioned off into compartments to limit the spread of fire, heat, smoke and fumes. The fire risk assessments should give some indication of the rate a fire would develop and hence the level of compartmentalisation necessary to allow people to escape to safety.

121. Fire-resisting walls and the doors through them should be:

- Constructed and tested to an appropriate standard (for example BS 476:1987);
- Given a fire rating by the supplier – this should be at least [30] minutes, or longer if the fire risk assessment indicates this is necessary to allow people to escape;

122. Mines should ensure that firewalls are erected to their specification so as not to compromise their fire rating. This may require the use of specialist contractors.

123. The roof, floor and sides of mine openings may need dressing down before firewalls are installed, to ensure that the wall can be sealed to

competent, unbroken rock. Only skilled people, competent in this type of mining operation, should carry out this work.

124. Once built the firewalls should be sealed to the roof, floor and sides with a suitable fire-resistant sealing compound that also meets the requirements of BS476:1987 on fire resistance. Any penetrations through a firewall, for example to allow the passage of pipes or electric cables should be similarly sealed. However, recent research indicates that in the early stages of a fire in a sealed compartment there will be a pressure increase. Small vents should therefore be provided at low level in the firewalls to provide pressure relief. These should be baffled to allow gases to flow out of the compartment but not allow fresh air to flow in once the excess pressure stage has passed.

125. Fire doors should be designed to minimise the spread of smoke, heat and fumes. Pedestrian doors should be fitted with devices that close the doors.

126. Doors that are normally kept open to allow safe vehicular passage should be arranged so that they close automatically in the event of a fire alarm. Where vehicle doors are arranged to close automatically, pedestrian doors should be provided alongside them.

127. There should be a clear gap of not less than 2m between stored flammable materials and any partition wall to reduce the thermal stress on fixing points in the event of a fire.

Ventilation control

128. Mines should arrange their ventilation systems to be shut down in the event of a fire, unless the assessments indicate that the balance of risk is in favour of continuing to ventilate the mine; for example if stopping the ventilation would lead to an unacceptable risk of explosion or would prejudice escape.

129. Mines should site the ventilation control point on the surface or at some secure point in the mine that is unlikely to be affected by heat, smoke or fumes.

130. Where compartments are equipped with local auxiliary ventilation systems to control humidity the fans should be arranged to stop and the inlet and outlet ducts to close automatically in the event of a fire where the fire risk assessment indicates that this is necessary. The louvers should have at least the same fire resistance as the partitions through which they are installed.

Fire fighting

When to fight fire

131. The fire protection plan should contain the procedures for people to follow when a fire is discovered or when a fire alarm sounds. For most people this will mean that they immediately evacuate to a place of safety in line with the arrangements set out in the emergency plan. However, the procedures should also cover details of what those discovering a fire should do as well as the steps to be taken by those whose duties involve investigating whether a fire alarm is false or genuine.

132. When a fire is discovered whoever finds it will need to decide quickly whether or not it is safe to fight it. The fire protection plan should give some indication of what size and type of fire they consider safe for someone to fight. If a person cannot extinguish a fire by the application of a single 9kg extinguisher of equivalent then they should withdraw to a place of safety.

Fire-fighting measures

133. The fire risk assessment will help managers determine what type of fire-fighting equipment is appropriate and where to site it.

Selection and siting

Selection

134. In selecting fire-fighting equipment, managers should take account of the nature of the fire hazard. This is particularly important if the fire might involve electrical equipment and/or flammable liquids. Further guidance on the selection of suitable fire-fighting equipment is contained in the HSE/Home Office Fire Safety Guide pp 58-63.

135. In addition to the types listed there, high pressure, pulsed water systems are now available, both as portable units (back packs) and small vehicle or trailer mounted units (fire appliances). These are safe for use on most non-electrical fires and are perhaps the most effective way of fighting a paper fire.

Siting

136. As far as possible fire-fighting equipment should be sited on the upstream side of places where a fire may occur and in a position where it is unlikely to sustain mechanical damage.

137. Fire-fighting equipment should be clearly visible and its location conspicuously indicated with a reflective sign. The Health and Safety (Safety Signs and Signals) Regulations 1996 are relevant and describe suitable signs. It is important that users are able to gain access to the equipment without exposing themselves to risk. Such equipment should not be sited beneath or on the tight side of conveyors or other equipment.

Fire extinguishers

138. Mines should site fire extinguishers:

- At places where flammable materials are stored;
- In conspicuous positions close to any machinery or equipment that gives rise to the fire risks;
- On mobile plant and equipment;
- In other locations indicated by the outcome of the fire risk assessment.

139. Fire extinguishers should be provided near electric motors, transformers or switchgear (including fixed electrical sub-stations, transformer houses and motor rooms), workshops below ground (especially those where burning and welding take place), and battery charging and battery transfer stations.

140. Mines should ensure that fire extinguishers are suitable for the type of fire that may occur and that they have adequate capacity to either extinguish the fire or to contain it sufficiently long enough to allow people to escape. In deciding what is appropriate, managers should consider:

- What type of fire might occur?
- What other fire fighting measures are available; for example, mains water, dust or sand?
- What backup provision needs to be made against the possibility that an extinguisher could fail to operate, particularly in safety-critical locations, such as where a fire could threaten an escape route?

On-board fire fighting systems

141. Mobile plant should be fitted with suitable fire-fighting equipment taking into account its power source and the materials it carries.

142. Where diesel-powered machines are used underground, they should carry both portable fire extinguishers and should be fitted with a fixed fire-quenching system containing sufficient outlets to cover the main potential fire sources.

143. Automatic fire-quenching systems should generally be capable of manual operation from the operator position and, on large machines, from at least one other suitable position on the outside structure of the machine.

144. Where smaller vehicles or other equipment with a low fire load are fitted with a fire-quenching system that relies on the melting of a pressurised plastic tube to release the quenching agent, there is no need to provide for manual operation. The pressurised plastic tube should be carefully routed as close as practicable to the potential fire sources to ensure prompt discharge of the extinguishant.

Other fire suppression systems

Fixed point, automatic discharge units

145. Risk assessment may identify places where the response to a fire alarm may be delayed increasing the likelihood of a fire that would give rise to significant risks to people below ground. Examples include unattended equipment such as electrical sub-stations and power distribution boards, particularly those electrically protected by fuses rather than MCBs, and battery-charging stations. In these circumstances operators should consider installing automatic fire suppression systems, such as automatic dry powder extinguishers, to assist in the early control of fire to provide both asset protection and life safety benefits.

146. While such protective devices generally operate automatically by means of a fusible link, manual initiation from a remote point may be desirable where this provides the most effective system to suit the local conditions.

147. When a fire suppression system protecting electrical equipment operates automatically, mines should where possible provide a circuit breaker to de-energise the equipment immediately the automatic system operates. This should be arranged to provide an indication to a control point that the barrier has operated.

148. Facilities should be provided to enable routine testing of the automatic fire suppression system in accordance with the requirements of BS 5839-1:2002; Code of Practice for Fire Detection and Fire Alarm System Design, Installation, Commissioning and Maintenance.

Mobile and mains water fire-fighting systems

149. At places where there are unavoidably large amounts of fuel giving rise to the possibility of a significant fire, it is unlikely that portable fire extinguishers will have sufficient capacity to extinguish such a fire. In these circumstances mines should consider whether fixed installations - such as sprinklers, mist, water deluge, foam inlets, hydrants, hoses and other equipment – or mobile fire-fighting units are necessary for either escape or asset protection purposes.

150. The hazards present in some storage mines may give rise to risks that make reasonably practicable the installation of sprinkler systems. Where installed these give valuable added protection by:

- Immediately attacking the fire;
- Limiting damage to the immediate area;
- Protecting staff who work in the area;
- Significantly reducing the risks to fire and rescue workers;
- Reducing environmental pollution from toxic gases, smoke and fire water run off;
- Significantly reducing down time and loss of business;
- Protecting business reputation.

151. Where mine operators decide to install sprinkler systems or to provide other mains water fire fighting equipment they should ensure that the water distribution system can provide a sufficient volume of water at a high enough pressure to ensure that they can operate effectively.

Inspection, testing and maintenance of equipment

152. Fire-fighting equipment (including fire-fighting systems on board vehicles) should be included within the manager's scheme for planned preventative maintenance and should be regularly inspected, examined, tested and maintained.

153. Inspection officials assigned to a zone should ensure that fire-fighting equipment in that zone is kept clean and free from damage.

154. They should note any defects on the report they are required to complete at the end of each shift. Wherever possible, they should try to either remedy the defective equipment within their shift or ensure that it is dealt with on the next working shift.

Training

155. The Fire Protection Plan will identify the need to train or instruct mineworkers in fire fighting techniques, and managers should include the arrangements for such training within their training schemes. The training

should be appropriate to the fire hazards identified by the Fire Risk Assessment and the fire fighting measures provided.

156. The scheme should specify who has responsibilities for fire fighting training, both on the surface and below ground. It will also include details of:

- The type of training and refresher training;
- The frequency at which to carry out particular types of training and refresher training;
- Who should receive training (see paragraphs 3 and 4 of the Model Rules on Mine Fires);
- Who should deliver the training – this might include the local authority fire service, the mines rescue provider or other specialists with relevant expertise.

157. The training scheme should also set out arrangements for on-site instruction and practice in fire fighting.

158. Every person at a mine who may need to use fire-fighting equipment should receive refresher training annually. In addition, they should receive instruction at intervals not exceeding six months; for example, by on-site briefing (toolbox talks) given by a competent person who has received suitable training.

159. The content of the training sessions should include:

- Fire prevention measures;
- What to do when an alarm sounds;
- Raising the alarm if a person discovers a fire before the alarm system activates;
- When to attempt to fight a fire and when not to (see paragraphs 131-132);
- Types of fire extinguishers and their use;
- Means of egress in an emergency situation.

160. Those whose duties involve investigating fire alarms should receive additional training on how to do this without putting themselves at undue risk.

Surface personnel

161. All people who work on the surface, including those who do not work there full-time, should receive instruction on the action to be taken in the event of fire at intervals not exceeding twelve months. This should include as appropriate:

- Practice in the evacuation of the premises;
- How to deal with fires;
- Use of fire hoses and attachments;
- Practice in the operation of fire extinguishers (mines can tie this in to the fire extinguisher maintenance regime); and
- Such other provisions that are required by any fire certificate.

162. The HSE/Home Fire Safety Guide gives further advice.

Arrangements for Escape

163. Guidance on safe escape and rescue in an emergency situation is contained in the Approved Code of Practice to the Escape and Rescue from Mines Regulations 1995, and in the HSE/Home Office Fire Safety Guide.

164. Further information on the use of self-rescuers is given in the HSE guide 'Guidance and information on escape and rescue from mines' (HSE Guide L71, ISBN 0-7176-0939-1) available from HSE Books.

Explosion Risk Assessment

165. This section contains information on matters solely related to explosion hazards. It deals with hazards that arise from substances sometimes taken into mines, such as paints, fuels, degreasing agents, and bottled gas, and from activities such as storage battery charging.

The risk of explosion

166. Explosive atmospheres may not only cause a hazard at the place where they occur, but also along the mine's return airways and any other interconnected roadways in the mine workings, even if it is only for a short duration and/or at a particular location. This has the potential to expose large numbers of people to serious risks, so the risk assessment should consider what area might be affected.

167. Where a dangerous substance is, or is liable to be, present at the workplace, regulation 5 of The Dangerous Substances and Explosive Atmospheres Regulations 2002 requires, the employer to make a suitable and sufficient assessment of risks that arise from the use of that substance. Mine owners should consider this as part of the overall risk assessment procedures.

168. Where there are explosion risks mine owners should include within their health and safety documents an explosion protection plan that demonstrates risks have been assessed and which identifies the necessary preventative and protective measures.

Explosion hazards

Mists and vapours

169. Some substances give off mists or vapours at ambient temperature and pressure and can form explosive atmospheres. These will include:

- Petrol;
- Cellulose-based paints;
- Aerosols commonly used as an aid to starting diesel engines above ground.

170. Diesel fuels, most mineral oil lubricants and resins used for strata control purposes can also give off vapours although these are not normally explosive at ambient temperature and pressure.

Flammable gases

171. At most storage mines and mines used for other non-mining purposes there is little or no likelihood of an explosive atmosphere caused by gas from the strata, but there may be other opportunities for a flammable gas explosive atmosphere to occur. Mine owners and managers will still need to consider circumstances in which such an atmosphere may occur, such as:

- A hydrogen flammable atmosphere due to lead-acid battery charging;
- A propane or acetylene flammable atmosphere resulting from some mishap with flame welding or cutting equipment.

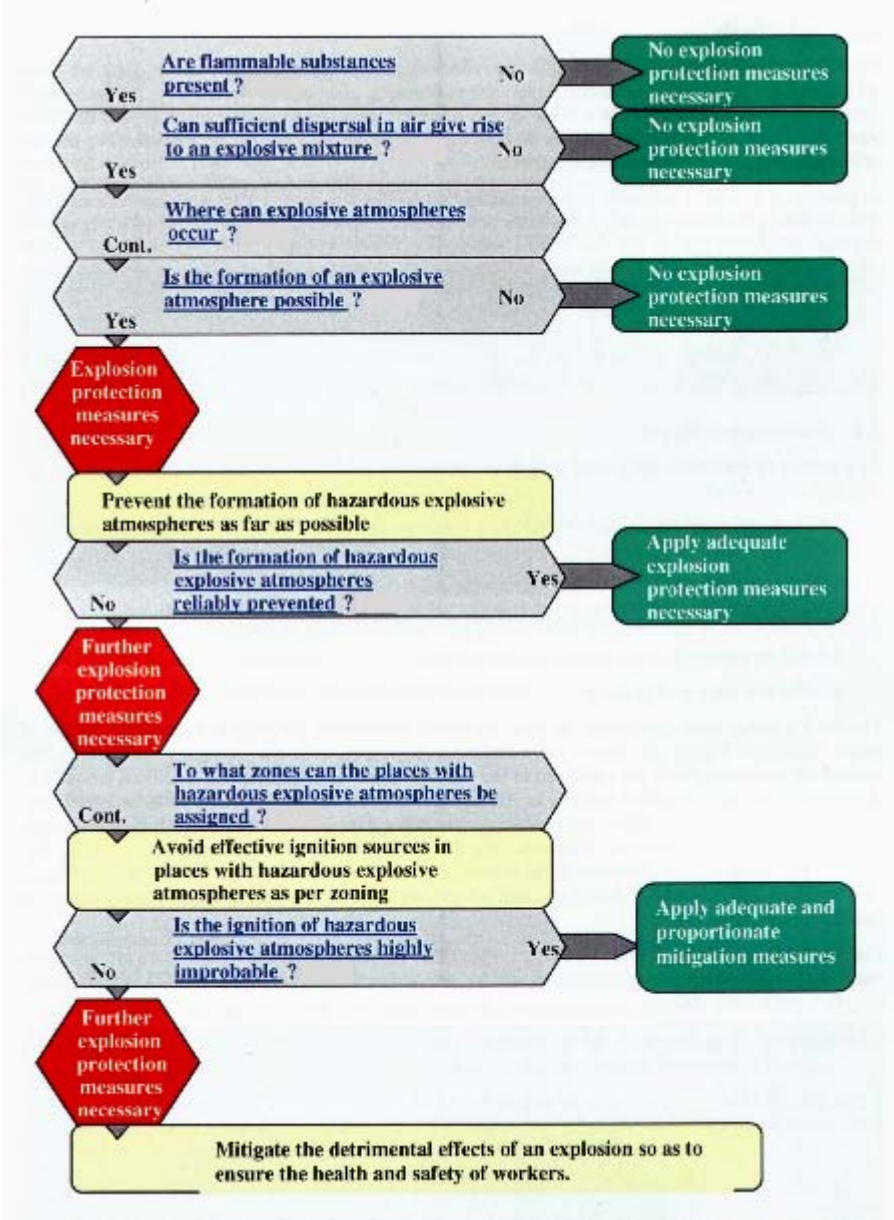
Assessing explosion risks

172. The assessment of risks arising from explosion hazards should take account of the control measures that are in place. For example, in the case of potentially explosive flammable gas, mist and vapour atmospheres effective ventilation will reduce the likelihood of an explosive atmosphere occurring and will therefore mitigate the risks.

173. Comparing the measures necessary with those that are already in place will enable owners and managers to identify what, if any, further reasonably practicable measures they need to introduce to effectively control the explosion risks present.

174. Having established that all reasonable measures have been taken to reduce the chance of an explosion occurring, mines should identify what precautions are in place to mitigate an explosion should one occur and assess whether they are sufficient to properly address the remaining risks.

175. The flow chart below summarises this process:



Explosion Protection Plan

176. The fire and explosion risk assessment process will have identified the potential fire and explosion hazards present, the risks they give rise to, and the measures necessary to avoid and control those risks. The explosion protection plan required by regulation 4 of The Mines Miscellaneous Health and Safety Provisions Regulations 1995 should set out those measures to be taken:

- To prevent an explosive atmosphere occurring;
- To exclude, or control, potential sources of ignition;
- In the event of an explosive atmosphere of any type occurring; and
- To mitigate the consequences if an explosion occurs.

177. The measures which should be set out in the plan may include:

- The provision of suitable work equipment; including appropriately certified electrical and mechanical equipment;
- Procedures for monitoring, testing and preventative maintenance of safety-critical equipment;
- Procedures for monitoring the build up on any explosive gas such as hydrogen;
- The use of protective systems to mitigate the effects of any explosion, including fire extinguishing systems;
- Preventative and protective systems on the mine surface, such as those designed to prevent flash backs in cutting and burning equipment;
- Any other relevant explosion control measures below and above ground.
- The emergency arrangements identified as a consequence of the explosion risk assessment should be included within the Emergency Plan required by regulation 4 of The Escape and Rescue from Mines Regulations 1995.

178. Mine owners and managers should review the explosion protection plan and the emergency plan periodically or after any significant change in circumstances.

Explosion control measures

179. These fall into six broad categories:

- Zoning of the workplace;
- Selection of suitable equipment;
- The prevention of explosive atmospheres;
- De-energising equipment in explosive or potentially explosive atmospheres;
- The control of other ignition sources;
- Degassing operations.

Zoning

180. The zoning requirements in the Dangerous Substances and Explosive Atmospheres Regulations 2002, which apply to all types of potentially flammable atmospheres, do not apply to mines either above or below ground. However, if the explosion risk assessment identifies areas where an explosive atmosphere may occur it will still be necessary to define a zone and use only suitable ignition-protected equipment within it.

APPENDIX

Law relevant to fire and explosions

The following list contains the main provisions relevant to fire and explosion in non-producing mines or parts of mines used for storage or other purposes. In the mining legislation section, principal provisions are referenced where appropriate.

Legislation of general application

The Health and Safety at Work etc Act 1974
The Supply of Machinery (Safety) Regulations 1992
The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996
The Management of Health and Safety at Work Regulations 1999
The Provision and Use of Work Equipment Regulations 1998
The Dangerous Substances and Explosive Atmospheres Regulations 2002

Legislation applying only to mines

The Mines and Quarries Act 1954 (MQA)

Section 55 – adequate ventilation

Section 58 – means of ventilation

The Miscellaneous Mines (General) Regulations 1956
Regulations 31-35: precautions against fire
The Mines (Safety of Exits) Regulations 1988
Regulation 9: fire precautions in certain intake airways
The Mines Miscellaneous Health and Safety Provisions Regulations 1995
Regulation 4: health and safety document, fire protection plan, and explosion protection plan
Regulation 8: hydraulic fluids
Schedule 1 Part II, paragraphs 3 (smoking and use of flame), 4 (fire-fighting) and 6 (flammable materials taken below ground)

The Escape and Rescue from Mines Regulations 1995
Regulation 4: emergency plan