NSW Resources
Resources Regulator

Technical reference guide 1032

Development of a fire or explosion principal hazard management plan

(MDG1032)

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Amendment schedule		
Date	Version	Amendment
May 2024	Consultation draft	Replaces MDG (Mine Design Guides) 1032 *Guideline for the prevention, early detection, and suppression of fires in coal mines. This TRG now applies to* all mining operations including coal, non-coal mines and quarries.
September 2024	V1	Stakeholder feedback consultation addressed

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1. Introduction

This technical reference guide (TRG) 1032 replaces MDG 1032 Guideline for the prevention, early detection, and suppression of fires in coal mines. This TRG applies to all mining operations in NSW including underground mines, open cut mines and quarry operations. Section 5 “Fire protection in coal mines” of this TRG applies only to coal mining operations.

This TRG provides mine operators with guidance on developing and documenting a principal hazard management plan (PHMP) for fire or explosion in all mining operations. The PHMP sets out the overall strategy that mine operators must use for managing their site’s health and safety risks for fire or explosion and its integration into the mine’s broader safety management system.

The following is out of scope for this TRG:

- storage, handling and use of explosives (mine operators should refer to the Explosives Act 2003 and develop an explosives and explosives precursor control plan as part of the mines safety management system)
- storage, handling and use of flammable and combustible material listed as hazardous chemicals in Schedule 11 of the Work Health and Safety Regulation 2017 where mines have manifests reportable under the section 348 of the Work Health and Safety Regulation 2017. If a mine operators manifest of hazardous chemical is reportable, the mine operator should prepare a separate PHMP[1] as part of the mines safety management system
- coal dust explosion suppression in underground coal mines. Mine operators should refer to the TRG Coal dust explosion suppression in underground coal mines and develop a management plan as part of the safety management system at the mine.

The mine operator should read this TRG in conjunction with:

NSW Work Health & Safety (WHS) Laws (including Mining and Petroleum Sites)[2]

NSW codes of practice:

- Work health and safety consultation, cooperation, and coordination
- How to manage work health and safety risks
- Safety management systems in mines.
- Mechanical engineering control plan
- Electrical engineering control plan
- Managing risks of hazardous chemicals in the workplace
- Emergency planning for mines

[1] Section 4(a)(ix) of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 defines principal hazard. Section 28 of the Work health and Safety (Mines and Petroleum Sites) Regulation 2022 requires a mine operator to prepare a principal hazard management plan for each principal hazard that has been identified at the mine

[2] The NSW WHS laws are:

Work Health and Safety Act 2011 (WHS Act)

Work Health and Safety Regulation 2017 (WHS Regulation)

Work Health and Safety (Mines and Petroleum Sites) Act 2013 (WHS (MPS) Act)

Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (WHS (MPS) Regulation)

- Roadway dust analysis in underground coal mines

NSW Resources Regulator's guidance material, for example:

- Guide - Preparing a principal hazard management plan.
- MDG 15 – Mobile and transportable plant for use on mines and petroleum sites
- Fact Sheet – testing of fire-resistant hydraulic fluid materials
- TRG - Hot work (cutting and welding)
- TRG Ventilation control plan

In underground coal mines:

- TRG - Coal dust explosion suppression and prevention
- TRG – Nonmetallic materials for use in underground coal mines and reclaim tunnels in coal mines
- TRG – development of the spontaneous combustion PHMP
- TRG - development of a gas outburst PHMP
- MDG 43 Technical standard for the design of diesel engine systems for use in underground coal mines
- TRG - Gas outbursts principal hazard management plan guidance
- TRG Main fans, booster fans, auxiliary fans in underground coal mines
- TRG Windblast management in underground coal mines

Australian and International Standards in related fields, for example:

- AS ISO 31000: 2018 Risk Management — Guidelines
- AS/NZ ISO 45001: 2018 Occupational Health and Safety Management Systems – Requirements with guidance for use
- The Globally Harmonized System of Classification and Labelling of Chemicals.
- AS 5062 2022 – Fire prevention and protection for mobile and transportable equipment

The WHS (MPS) Regulation 2022 identifies fire or explosion as a prescribed principal hazard[3] requiring a PHMP. Mine operators must consider the principal hazard individually and cumulatively with other hazards at the mine when conducting risk assessments for each identified principal hazard [4].

2. Developing and documenting a PHMP for fire or explosion

The mine operator should develop a PHMP for fire or explosion following the steps detailed in the Resources Regulator's Guide Preparing a principal hazard management plan. After initially

[3] NSW Work Health and Safety (Mines and Petroleum Sites) Regulation 2022. The Regulation defines a principal hazard as any activity, process, procedure, plant, structure, substance, situation or other circumstance relating to the carrying out of mining operations that have a reasonable potential to result in multiple deaths in a single incident or a series of recurring incidents.

[4] Section 27(3)(b) WHS(MPS) Regulation 2022

describing the scope and context of the plan, the mine operator should develop a comprehensive hazard description within the context of the risk management approach. The associated risks are then identified, and a control management system is developed that includes planned assurance activities for continual improvement. Worker representation is an essential element of each of the stages.

This section further outlines the types of risk-based tasks and information that the mine operator should include when developing and documenting a fire or explosion PHMP.

2.1. Scope and context of the PHMP

An important first step is to document a clear description of the hazard under investigation. It defines the parameters for the future stages of the plan, including the analyses and risk assessments and the development of the risk control strategy.

Mine operators should establish and document the scope and context for the fire or explosion PHMP and include[5] objectives for the plan, including:

- reviewing the geotechnical, operational environment or context in which the hazard exists
- exploring the nature of the hazard unique to the mine
- defining how the hazard interacts with other potential hazards on site
- describing how the implementation of control measures under the fire or explosion PHMP will be coordinated with other PHMPs and control plans
- flammable, combustible and explosive substances and materials
- sources of ignition
- propagation of fire or explosion to other parts of the mine
- flammable material with a flash point of less than 61°C
- management and control of the transport and storage of combustible liquids
- prevention of fires, including the types and location of systems for the early detection and suppression of fires
- the equipment for fighting fires
- hot work
- for an underground mine — the arrangements for the management and control of volatile or hazardous materials.

2.2. Interaction with other plans and overall safety management system

PHMPs form part of the safety management system (SMS) for a mine. For more information about safety management systems, see the safety management systems in mines code of practice.

Before writing the PHMP, the mine operator should consider how the PHMP is to be integrated with other plans. The fire or explosion PHMP would interact closely with the following plans:

[5] WHS(MPS) Regulation 2022 Schedule 1 principal hazard management plans, Part 2 Mine and petroleum site (9) Fire and explosion

- Mechanical engineering control plan
- Electrical engineering control plan
- Emergency management plan
- Ventilation control plan in underground mines
- Spontaneous combustion PHMP in coal mines
- Gas outburst PHMP in coal mines.
- Control plan for explosives and explosives precursors
- Frictional ignition management plan

2.3. Consultation process

When managing risks, mine operators must consult with workers and other duty holders at the mine. This includes other persons conducting a business or undertaking (PCBUs) such as contractors. Details are found in the Guide - Preparing a principal hazard management plan. Further guidance on consultation, cooperation and coordination can be found in the:

- NSW Code of practice: Work health and safety consultation, cooperation and coordination
- Contractors and other businesses at mines and petroleum sites guide
- Consulting workers fact sheet.

2.4. Abbreviations and definitions

A partial list of references and associated documents is included in Appendix A.

Abbreviations	
AS	Australian Standard
AS/NZS	Australian / New Zealand Standard
EMP	Emergency management plan
PHMP	Principal hazard management plan
SMS	Safety Management System
WHS	Work health and safety
WHS (MPS) Act	*Work Health and Safety (Mines and Petroleum Sites) Act 2013*
WHS (MPS) Regulation	Work Health and Safety (Mines and Petroleum Sites) Regulation 2022

Definitions	
Combustibility	The ease with which a substance or material is able or likely to catch fire or burn.
Combustible Gas	A gas that will burn when it is within its flammable range.
Combustible Liquid	A liquid that has a flash point above 61^0 C.
Combustible Metal	A metal that will burn under certain circumstances.
Competent Person	A person who has acquired through training, qualifications or experience, or a combination of them, the knowledge, and skills to carry out that task.
Designed flow rate	Means the flow rate that the fire water reticulation system is designed to deliver at each fire hydrant. Note: This should be determined by the fire risk assessment but is typically 10 l/s at the hydrant, which allows sufficient flow for two fire hoses to operate simultaneously.
Dynamic pressure	Means the water pressure under flow conditions.
Explosibility	The ease with which a substance or device may suddenly produce a volume of rapidly expanding gas.
Fire hydrant	An assembly installed on a branch from a water pipeline, which provides a valved outlet to permit a supply of water to be taken from the pipeline for firefighting.
Fire depot	Means a depository of fire equipment readily available and suitable for connecting to an adjacent fire hydrant. Note: Typically, this provides for a quick response to fight any fire in the fire risk area intended to be covered by the adjacent fire hydrant.
Fire station	Means a depository of fire equipment suitable for dispatch to underground parts of a coal mine from an area on the surface of the mine adjacent to the transport entry to the mine. Note: Typically, this provides for additional fire equipment support for a fully developed fire.
Fire substation	Means a depository of fire equipment strategically located in specific districts throughout the mine. Note: Typically, this provides for a quick response for additional fire equipment support to that provided at the fire depot.
Flammability	The ease with which a substance is capable of catching fire.

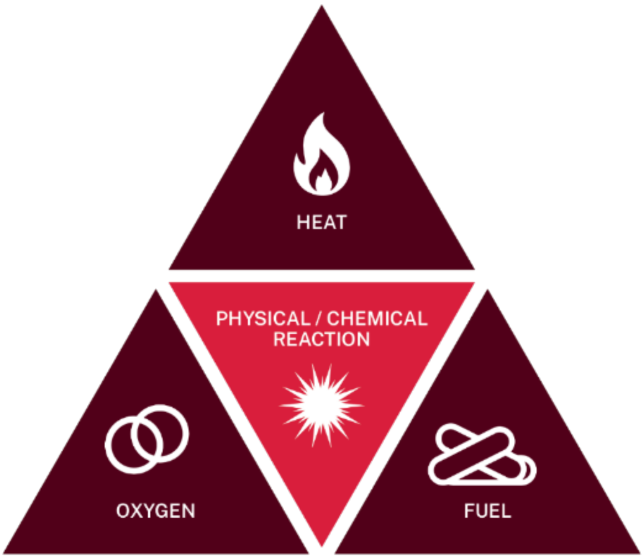
<table>
<tr><th colspan="2">Definitions</th></tr>
<tr><td>Flash point</td><td>The lowest temperature at which a substance produces enough vapour to ignite and burn when an ignition source is applied but will stop when the source is removed.</td></tr>
<tr><td>Ignitability</td><td>The ease with which a substance or material is able or likely to catch fire or burn.</td></tr>
<tr><td>Flammable range</td><td>The range of concentrations, expressed as a percent by volume, over which a gas or vapour is flammable.</td></tr>
<tr><td>Globally Harmonized System of Classification (GHS):</td><td>The Globally Harmonized System of Classification and Labelling of Chemicals, 7th Revised Edition, published by the United Nations as modified by Schedule 6 to the WHS Regulation.</td></tr>
<tr><td>Hazardous area:</td><td>An area in which:
an explosive gas is or may be present in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant, or
a combustible dust is present or could reasonably be expected to be present in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant.
Information on hazardous areas can be obtained from the following Australian Standards:
AS/NZS 60079.10.1: Explosive atmospheres — Classification of areas — Explosive gas atmospheres
AS/NZS 60079.10.2: Explosive atmospheres — Classification of areas — Combustible dust atmospheres.</td></tr>
<tr><td>Must</td><td>Indicates a mandatory legislative requirement, (i.e., a requirement of an Act or Regulation)</td></tr>
<tr><td>Mine Operator</td><td>Means a mine operator under the WHS (MPS) Act 2013</td></tr>
<tr><td>Residual pressure</td><td>The remaining water pressure measured at a point within a system at the designed flow rate.</td></tr>
<tr><td>Safety of workers</td><td>Applies to any worker who may be harmed by the effects of a fire or explosion and includes:
machine operators
workers fighting a fire
workers in the vicinity of a fire or explosion
other workers who may be affected by the fire or explosion effects.</td></tr>
<tr><td>Should</td><td>Indicates a statement is ‘recommended.’</td></tr>
</table>

Definitions	
Static pressure	The pressure in the line at no flow.
Volatility	The ease with which a substance will evaporate.

3. Fundamentals of fire or explosion

3.1. The properties of fire

Figure 1 – The fire triangle



Fire is a combination of chemical and physical changes in which substances interact with each other to release heat, light, smoke, and ash. Fire requires three main elements to start – combustible material (fuel), heat (ignition) and oxygen. Eliminating one of these elements will result in the fire going out (which is the basic principle of firefighting). Flames can be eliminated by cooling or smothering them, removing oxygen, or depriving them of fuel.

3.2. Fuel sources

- Class A carbonaceous solids, such as (but not limited to):
  - environmental - coal dust, coal stockpiles and other coal deposits such as longwall goafs (spontaneous combustion)
  - plant materials – non-metallic materials such as textiles, rubber, plastics, timber, urethane, electrical insulation, fabrics, and tyres
  - Operational materials – rags, paper, timber, and plastics.
- Class B - flammable and combustible liquids such as (but not limited to):
  - plant – diesel, petrol, hydraulic oil, brake fluid and greases
  - Operational materials - such as solvents, degreasers, and alcohol.
- Class C - combustible gases such as (but not limited to):

  - environmental - methane, hydrogen, and carbon monoxide
  - plant - fuel vapour and, LPG
  - Operational materials - such as acetylene and hydrogen.
- Class D - combustible metals such as magnesium, aluminium, lithium, sodium, potassium, sulphide, and their alloys.
- Class E - electrically energised equipment e.g., fuels of any class.

3.3. Sources of ignition

There are many sources of heat and ignition in a mine. Heat sources may be from normal operations, or equipment, or as the consequence of an unplanned event or incident.

Ignition sources may include:

- **Heat energy** – such as diesel engines, hot drill bits, exhaust systems, turbochargers, pumps, heat exchangers or radiators, brakes, hydraulic systems, tyres, hot work (cutting and welding), contraband in underground mines and hazardous areas with explosive atmospheres (naked flame and arcing).
- **Electrical energy** – such as electrical arcing, static electric discharge causing arcing/sparking, cables and equipment overheating, lightning and optical energy.
- **Mechanical energy** – such as frictional heating (from failed component surfaces rubbing or bearings, conveyors), frictional sparking (from failed components, impact damage, grinding, air tools machinery) and strata failure (piezo-electric or frictional) (Frictional ignition is not always from a failed component).
- **Chemical energy** – such as spontaneous combustion of coal, contraband, chemical reactions (chemical used on site reacting in process or with another chemical, oxidizing material), stockpile heating's in coal mines.
- **Radiant energy** – such as welding, overheating of motors, heated surfaces (hot work).

Notes: In underground coal mines:

1. the temperature of all external surfaces must be less then 150^{0}C to prevent coal dust igniting, and
2. the use of items made of, or containing, light metal alloys must be controlled due to the potential for a thermic reaction when struck by rusty steel.

3.4. Oxygen (oxidising agent)

For a fire or explosion to occur, it needs atmospheric oxygen. Other sources of oxygen include some chemicals or substances that release oxygen when heated (oxidising agents). These include hydrogen peroxide, halogen gasses, Ammonium Nitrate Fuel Oil (ANFO or its main component, ammonium nitrate), bottled oxygen and compressed air.

3.4.1. Oxygen and underground mines

The main source of oxygen for an underground fire or explosion is in the general body of air. Many fires will have a ready supply of oxygen as the ventilation system draws air around the mine. An exception to this is where a fire or explosion occurs in an enclosed space (such as in a sealed goaf in underground coal mines, storeroom or within pipe work).

Mine operators can control an explosive atmosphere through the ventilation system and local arrangements. In a well-ventilated mine, the airflow will course through the workings, picking up and propagating potentially combustible products as it flows.

Low rates of airflow provide sufficient oxygen to the combustion process but may not be strong enough to carry fire products away. The low airflow rates may create an intense local fire, identified by the smell of fire products slowly being released into the mine airflow.

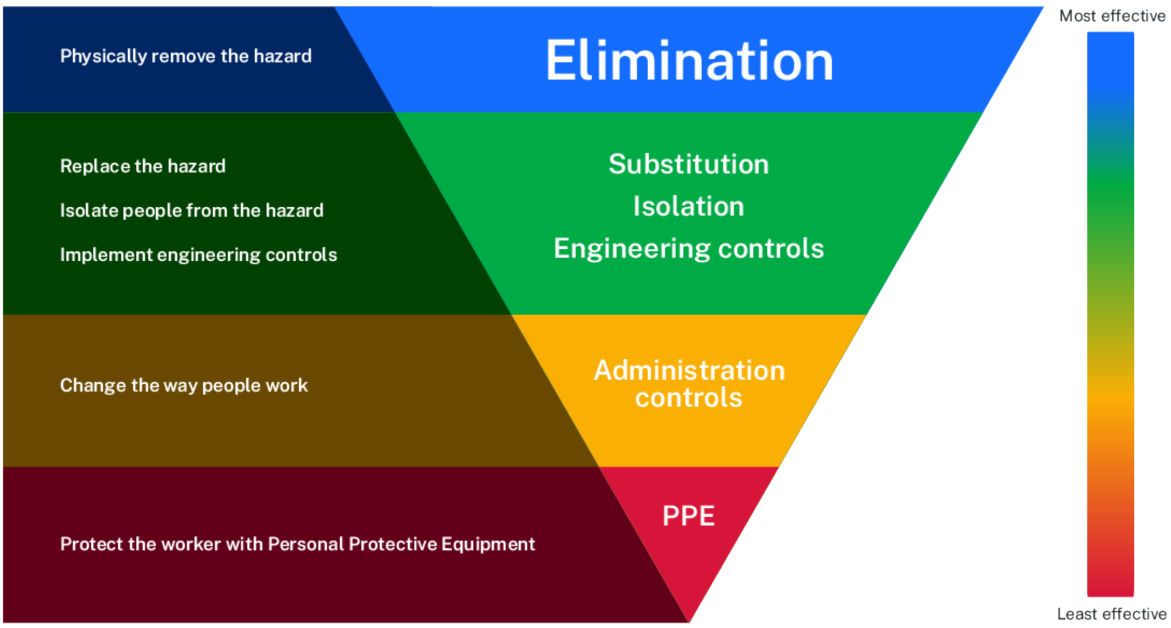
Higher velocities will have the strength to carry heat and products further into the workings, potentially enlarging the fire zone.

Airflow passing over a fire may also carry hot products to areas where there is an accumulation of gases, or combustible material, which in turn also ignites.

4. Fire or explosion risk management

Principal hazard assessment and identification processes are intended to ensure that the mine operator adopts the best control measures to manage the risks associated with the hazard. There are many ways to control risks. Some control measures are more effective than others. Mine operators must consider the various control options using the hierarchy of controls, selecting the control that eliminates the risk, or minimises the risk, so far as is reasonably practicable. Figure 2 below shows the hierarchy of control.

Figure 2 – Hierarchy of controls



The most effective control measure is eliminating the hazard, to eliminate any associated risk. However, it may not be reasonably practicable to eliminate a hazard if doing so means the task cannot be completed. Where it is not reasonably practicable to eliminate a hazard, mine operators must apply the hierarchy of risk controls to minimise the risks associated with the hazard.

A key component of a PHMP is the identification of controls, activities and organisational systems used to manage the risks associated with the hazard. Information must be presented in a way that demonstrates the mine operator has met their obligations regarding the adequacy of the measures to be implemented.

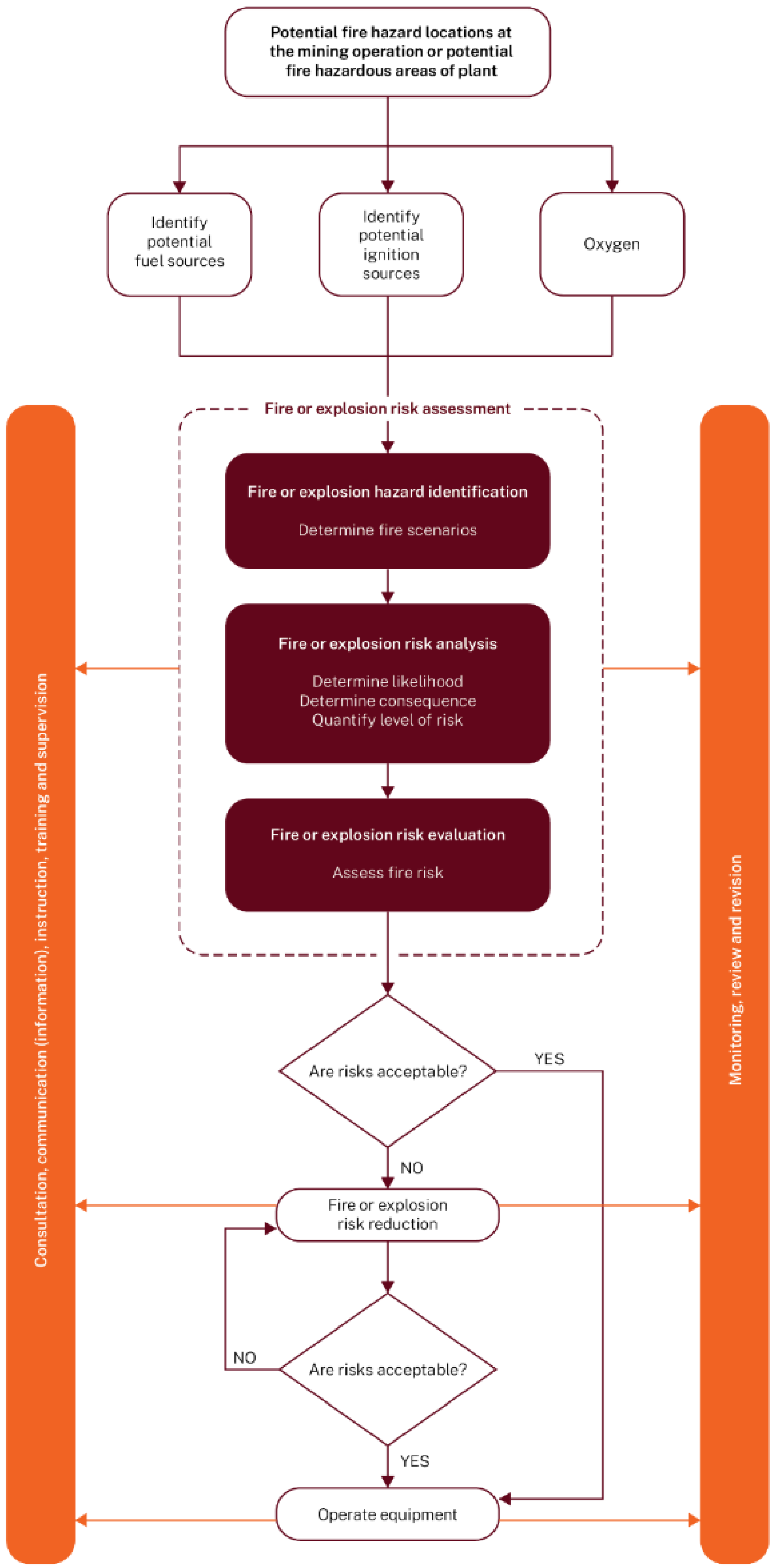
A 'Control management system' is the overarching collection of controls, control monitoring, support and verification activities and organisational systems deployed to manage unacceptable risk to as low as reasonably practicable. For further details see Guide – Preparing a principal hazard management plan.

Mine operators should consider the following in developing the control measures to manage the risks of fire or explosion:

- the potential sources of flammable, combustible and explosive substances and materials, both natural and introduced, including gas, dust, ores, fuels, solvents, and timber
- the potential sources of ignition, fire, or explosion, including plant, electricity, static electricity, spontaneous combustion, lightning, light metal alloys, hot work, and other work practices
- the potential for propagation of fire or explosion to other parts of the mine or petroleum site
- the potential sources of flammable material with a flash point of less than 61°C, including materials on the top of a shaft at the mine
- arrangements for the management and control of the transport and storage of combustible liquids
- arrangements for the prevention of fires or explosions, including the types and location of systems for the early detection and suppression of fires or explosions
- the equipment for fighting fire at the mine,
- for an underground mine — the arrangements for the management and control of volatile or hazardous materials.
- details of procedures to be used for carrying out hot work at the mine[6].
- A fire or explosion risk management process is the systematic application of management policies, procedures and practices to identify, analyse, control, monitor and review fire or explosion risks for the mine, and includes fixed, mobile and portable plant.
- The fire or explosion risk management process should be carried out using Figure 3 below, the code of practice How to manage work health and safety risks, AS ISO 31000: 2018 Risk Management Guidelines, or equivalent risk management standard.
- Previous industry fire or explosion experiences on similar equipment and in similar circumstances should be considered in the risk management process (refer to MDG15 and AS5062 Fire protection for mobile and transportable equipment).

[6] TRG - Hot work (cutting and welding)

Figure 3 - Fire or explosion risk management



4.1. Fire or explosion hazard identification

The mine operator must identify all fire or explosion hazards at the mine and assess the risks. The mine operator must eliminate hazards or, if not practical to eliminate, control them to minimise the risk to health and safety to as low as reasonably practicable.

4.1.1. Fire or explosion hazard locations

Fire or explosion hazard identification should cover the whole mining operation. All mine operators when identifying fire or explosion hazards should consider the following :

- infrastructure, such as (but not limited to)
  - office buildings, workshops (hot work areas)
  - flammable material storage areas (e.g. pressurised flammable and other gases, fuels
  - oils, solvents, and greases)
  - electrical switch rooms and transformers
  - overhead power lines.
- preparation or processing plants, such as
  - multi-story buildings and structures fire or explosion hazards may pose different risks depending on the level above ground
  - hot work
  - plant/machinery failure
  - product spillage/accumulations
  - combustible and flammable materials.
- rail and road delivery terminals such as
  - plant/machinery
  - haulage equipment
  - product spillage/accumulations
  - flammable materials.
- material handling areas such as
  - Reclaim tunnels (e.g., spillage/accumulations, coal dust, methane)
  - conveyor belts, feeders
  - flammable materials
  - hot work
  - materials handling bins
  - stockpiles.
- bush fires
- roads and other vehicle operating areas

  - mobile plant such as trucks, excavators, drag lines, shovels, and dozers
  - fixed plant such as conveyor belts and material handling machinery
  - storage areas such as explosive magazines and diesel fuel depots.
- all underground mines
  - bolting plant
  - ventilation return parts – such as returns, sealed areas, caving/goaf areas, auxiliary/ventilation fans.
- underground coal mines only
  - longwall and continuous miners
  - methane drainage lines.

4.1.2. Hazardous plant

Mine operators when carrying out fire or explosion hazard identification should cover all plant in use. Typical fire or explosion hazardous plant may include (but not limited to):

- mobile plant (refer to MDG 15 and AS 5062 for guidance) including:
  - tyre explosion
    - through heating during a fire
    - during tyre changing and repair.
  - fires
    - egress
    - hot surfaces
    - fuel and ignition sources.
- pressure vessels
  - unsecured during use and handling
  - regulator failure
  - vessel failure.
- conveyor belt systems including
  - material spillage/accumulations
  - coal dust
  - brakes, idler/pulley failure
  - fluid couplings
  - belt rubbing
  - belt/pulley slippage and static charge.
- underground equipment including
  - frictional ignition of flammable gas

- bearing failures
- mechanical component failures
- mechanical friction
- hose failures
- fluid couplings
- coupling failures
- accumulations of oil/grease
- cooling system failures.

- electrical including
  - over heating
  - charging of batteries
  - short circuit.

4.2. Fire or explosion risk assessment

When conducting a fire or explosion risk assessment, mine operators should use the Code of practice How to manage work health and safety risks, AS ISO 31000: 2018 Risk Management Guidelines, or equivalent risk management standard.

The mine operator's fire or explosion risk assessment process should follow Figure 3 above and should identify and document:

- all potential fuel sources and fuel load
- all potential ignition sources
- all potential fire or explosion risk areas and plant that may present a fire or explosion risk used in the mine
- all possible fire or explosion risk scenarios for each fire or explosion risk area and ask
  - what can happen?
  - when/where can it happen?
  - why/how can it happen?

Note NFPA 1620: 2020 Standard for fire pre incident planning may be useful in carrying out fire scenarios.

- the fire or explosion effects
- fuel properties and oxidation
- the maximum reasonable consequence and likelihood for each fire or explosion risk scenario
- the risk to health and safety of people
- the risk to property, production, and the environment
- the required measures to control the fire or explosion risk to the lowest level reasonably practicable

- the information requirements to workers including contractors on the mine site
- the instruction and training requirements
- the emergency management system requirements[7].

4.2.1. Risks to workers

The mine operator's risk assessment should consider harm to the health, safety, and welfare of workers through the following (not limited to):

- a fire or explosion initiating a flammable gas or dust explosion in an underground mine or confined/restricted space
- a fire impeding the means for emergency escape (through impairing visibility due to smoke or loss of respirable atmosphere) of personnel from:
  - the underground mine or confined space
  - mobile plant; and
  - fixed plant, buildings, structures, and gantries
  - hazardous area with a flammable atmosphere.
- asphyxiation or poisoning of workers in the vicinity and/or downstream of the fire of the products of combustion. (e.g., oxygen (O_2) depletion, carbon monoxide (CO), carbon dioxide (CO_2)
- products of fire combustion being of a toxic and/or carcinogenic nature (due to the fuel type)
- heat stress or heat stroke of workers
- fires involving non-metallic materials such as tyres, conveyor belting, electrical insulation materials and other non-metallic materials in an underground mine or confined/restricted space creating a toxic atmosphere
- tyre fires initiating a tyre explosion
- a fire or explosion preventing operating plant (either fixed or mobile) being brought to rest safely
- exposure to smoke carried by mine ventilation
- an increase in fire severity by spreading from plant or point of origin to other combustible materials in the vicinity
- a ventilation flow reversal due to fire or explosion induced ventilation increasing explosion risk
- a failure of a critical risk control such as (but not limited to):
  - a failure of the underground mine ventilation system (or methane drainage system in underground coal mines)
  - a failure of electrical explosion protection techniques, or
  - a failure of mechanical explosion protection techniques.
- static discharge, (particularly in potentially gaseous areas of an underground coal mine) a mechanical / electrical component failure (fault) or wear and tear of plant providing an ignition source

[7] Hansen R, Pre-incident planning of fires in underground hard rock mines: old and new risks AJEM Oct 2021

- a mechanical component failure (fault) or wear and tear of plant providing a fuel source
- materials of plant construction being combustible and potential fuel sources.

4.2.2. Operating environment and operating conditions

When assessing the fire or explosion risks, he mine operator should consider the operating environment, and the potential for unfavourable operational conditions that increase the fire or explosion risk, including:

- areas of the mine with flammable material
- areas of the mine holding flammable gasses (in underground coal mines including methane in sealed areas, goafs, gas drainage pipelines) creating a flammable atmosphere
- poor operational and maintenance practices
- potential for the failure of, or wear and tear of plant (or components of plant)
- areas where battery charging takes place.

4.2.3. Fire or explosion effects

The mine operator should consider fire or explosion effects in the risk assessment, including:

- fire propagation
- thermal radiation
- toxic products of combustion
- fire effluent
- impact on the work environment
- collapsing structures
- overpressure and projectiles
- explosion propagation.

4.2.4. Site specific issues

The mine operator should consider site specific issues such as (but not limited to):

- fire or explosion risk history of the mining operation
- methods of mining
- relationship between autonomous organisations occupying the one site (e.g., open cut, underground or declared plant)
- surface plant, equipment, and location
- contractors and contractor activity
- levels of worker training and competence
- sources of information, which may include relevant standards, legislation, past records, relevant experience, industry practice and experience, relevant literature, specialist, and expert judgements
- geographical location and proximity to emergency services and water supply

- support from external emergency services
- any other relevant background information.

Operators of coal mines should consider:

- the history of abandoned adjacent mines
- the coal seam(s) being mined
- other coal seams that have been mined
- the propensity of coal to spontaneously combust.

4.2.5. Fuel properties and oxidation

The mine operator's risk assessment on fuel properties and oxidation should include:

- ignitability
- flammability
- explosibility
- combustibility
- quantity and continuity of supply of fuel
- vapour point
- flash point
- volatility.

4.2.6. Work environment, property and production

The mine operator's risk assessment should also consider the risks associated with:

- The work environment:
  - pollution at site
  - pollution external to site
  - pollution due to fire or explosion mitigation techniques
  - noxious, toxic, or explosive atmospheres
  - smoke hazard.

Note: pollution refers to air pollution, quality of air, noise, water from fire effluent and what is used for fire or explosion suppression and control.

- Property:
  - building design, size, damage, or loss
  - plant damage or loss
  - possible escalation of fire due to other fuel sources (e.g., gas cylinders) within the plant or buildings
  - exposures to adjacent plant, buildings, and fuel sources.
- Production:

  - processes and raw materials
  - the economic costs of a fire or explosion on a piece of plant, including property damage, business interruption costs and costs if fire spreads beyond the point of origin.

4.2.7. Outcomes of the fire or explosion risk assessment

For each identified fire or explosion risk scenario, the mine operator's explosion risk assessment should determine appropriate risk control measures (to control the fire or explosion risk to a level as low as reasonably practicable) for:

- the prevention of a fire or explosion initiating
- the method(s) for early detection of a fire, if initiated
- the methods for the suppression of a fire or explosion and extinguishment of a fire, after detection
- the system for the timely notification of workers to facilitate the opportunity for withdrawal or self-escape in case of a fire or explosion.

Note: The fire protection systems should be reliable.

4.3. Fire or explosion risk control

The mine operator should control the risk of fire or explosion by using the hierarchy of controls until the risk is minimised to the lowest level reasonably practicable.

Mine operators should implement risk controls with robust levels of system integrity to prevent a fire or explosion initiating where practicable, such as:

- correct storage and handling of combustible materials (AS1940)
- correct storage and handling of corrosive substances (AS3780)
- correct storage and handling of mixed classes of dangerous goods (AS3833)
- operation and use of plant under designed loads and conditions
- use of tyres with correct Ton Kilometres Per Hour (TKPH) ratings (Note: overloading tyres has initiated fires)
- safe design and use of pressure vessels and gas cylinders
- electrical protection and wiring to the applicable standards
- safe battery charging areas
- reducing the temperature of hot surfaces
- heat shields
- segregation of fuel and ignition sources
- limiting the quantity of potential fire or explosion fuels
- adequate ventilation
- permits for hot work activities. The Technical reference guide hot work (cutting and welding) at mines and petroleum sites provides guidance on the development of a hot work management system

- use of fire-resistant fluids. (Factsheet Testing of fire resistant hydraulic fluids and materials)
- storage and handling of explosives that meet the requirements of the NSW Explosives Act
- handling, storage, transport, and use of flammable materials, such as oils, greases, diesel fuel, rags, training for maintenance and inspection of equipment
- a comprehensive inspection regime for the mine environment (Note: Workers conducting inspections should be aware of the role their senses (sight, smell, hearing, touch) play in discovering fires)
- safe refuelling systems and procedures
- a high standard of plant maintenance practices and housekeeping.

Underground parts of a coal mine

Note: Mining operations that have an identified hazardous area with a flammable atmosphere should implement these additional control measures for minimising the risk of a fire or explosion initiating, where practicable:

- use of fire resistant and anti-static (FRAS) materials. The Technical reference guide non-metallic materials for use in underground coal mines and reclaim tunnels in coal mines provides guidance
- limiting the use of large quantities of non-metallic materials where toxicity of the products of combustion may create a risk in the underground environment and creates an additional fuel source
- adequate ventilation
- reduce exposed surface temperatures to less than 150^0C
- minimise or eliminate the accumulations of dust spillage or other combustible material
- limit the use of exposed light metal alloys in outbye areas to those applications that may be justified on grounds of health or safety
- use of explosion/fire protected plant
- use of water sprays on continuous miners and longwall shearers to minimise the risk of frictional ignition
- use of water sprays to suppress coal dust at locations where dust may be generated, such as on conveyor transfer points
- use of electrical equipment designed and maintained to the relevant standards
- minimise the use of cables with joints
- use of wet braking systems on mobile and fixed plant
- minimise areas where friction on plant may occur
- use of bearings with a suitable bearing life and appropriate seals for the underground mine environment
- use of plant within its rated capacity
- use of ventilation fans, which are designed following the Technical reference guide main fans, booster fans and auxiliary fans in underground coal mines.

4.3.1. Electrical switchgear

The mine operator's electrical engineering management plan should include placing in prominent positions:

- appropriate signage, notices, plans and electrical distribution diagrams at electrical switchgear
- appropriate signage, notices, plans and diagrams that provide advice on what to do in the event of a fire on or in electrical plant.

Electrical switch gear must not enable automatic restoration of power if there is a risk of fire or explosion.

4.3.2. Measures for fire detection in mines

Mine operator's should develop a system for the early detection of any fire in a mine through the risk assessment process.

Notes:

1. It is important that fires are detected as early as possible such that a response can be initiated to remove people from harm and suppress the fire.
2. The fire protection systems should be sufficiently reliable to control the risk to the lowest level reasonably practicable.

In parts of the mining operation where there is a potential that fire may impede worker escape, detection systems should be provided for the immediate indication of fire detection. Locations where these systems should be installed include:

- single entry development
- belt conveyors
- gantries
- reclaim tunnels.

Mine operators should consider the following risk controls for minimising the fire risk by early detection;

- implementing early warning and response systems to detect fires before they develop into a hazardous situation
- installing rapid and reliable work environment monitoring systems to detect fires early (e.g., use of CO, smoke, or other fire detection systems)
- using plant condition monitoring systems (sensors), such as bearing temperature, vibration, infra-red sensors, brake release, belt tracking, blocked chute, belt slip
- installing automatic trigger alarm systems for communicating to all persons at the mine and external response agencies
- implementing a comprehensive and effective inspection system.

4.3.3. Measures to suppress and extinguish a fire

The mine operator should develop systems for the suppression of all possible mine fires.

The following mitigating controls to suppress and extinguish a fire (once initiated) where practicable should be considered:

- automatic fire extinguishing systems on mobile plant
- water supply and reticulation to all fire risk areas of the mine
- sufficient water supply (or fire suppressing agent) to allow all workers to self escape while maximum expected water (or fire suppressing agent) usage rate is sustained
- appropriate automatic fire suppression to fixed plant (e.g., belt conveyors in tunnels or pits), where practicable and applicable
- portable fire extinguishers for initial attack response on fixed plant (in particular electrical switchgear) and mobile plant
- competent workers capable of fighting fires (Note: This requires personnel being adequately trained and educated in fire safety practices)
- provision of appropriate fire fighting equipment (for hydrant connection) readily available for use
- availability of fire fighting personnel for rapid response
- procedures and competency based training to cover all locations and all times of the day (shifts)
- available fire equipment and fire suppression systems (e.g. deluge systems)
- Use of water tankers fitted with cannons
- sufficient hose and appropriate fitting must be available to fight a fire on any part of a conveyor belt.

4.3.3.1. Fire extinguishers

The mine operator should provide appropriately rated and sized extinguishers in line with AS 2444 and AS 1850, as required by the mine operators fire risk assessment and the intended fire risk area being protected.

The preferred minimum size extinguisher for general purpose is a dry chemical 80ABE, where practicable.

Extinguishers should be provided at (but be not limited to):

- all mobile plant
- all operators' workstations on fixed plant
- preparation plants and conveyor gantries
- reclaim tunnels
- office buildings
- electrical switchgear
- other risk areas identified in the risk assessment.
- The fire extinguishers should be installed in safe locations *(e.g., located outside the switch room for a switch room fire)*, clearly identified and readily accessible. All fire extinguishers should be maintained following AS 1851.

Note: Fire extinguishers are most effective when used by trained workers. Considering the size and configuration of equipment, fires can be difficult, impossible, or dangerous to fight with a hand-held extinguisher. The key to worker protection is early detection of fires to provide warning to the worker, fuel shut-off to minimize fuel for the fire, and fire suppression during its initial stages.

4.3.3.2. The supply of fire fighting equipment

The outcomes from the mine operator's fire risk assessment should determine if these standards are adequate and identify additional requirements.

Mine operators should provide suitable firefighting equipment at:

- in or near each building on the surface of the mine
- at each place in which flammable materials are stored
- on each engine room or motor room; and
- at the entrance of every shaft in underground mines or means of egress
- fire hydrants and firefighting equipment should be clearly marked and labelled.

4.3.3.3. The maintenance of fire fighting equipment

The mine operator should develop a system to ensure the fire protection system and firefighting equipment remains functional. The mine operator should document the system and ensure it aligns with the relevant section of AS 1851.

4.3.3.4. The provision and supply of water storage and reticulation

The mine operators fire risk assessment should determine the minimum requirements for the supply and water reticulation for each identified fire hazard location or fire hazardous area.

There should be a sufficient water supply to allow all personnel to self-escape while the maximum expected water usage rate is maintained.

4.3.3.5. Reporting and replacement of damaged fire equipment

The mine operator should have a documented system for the reporting and replacement of damaged firefighting equipment.

4.3.3.6. Compatibility of fire equipment state fire brigades and adjacent mines

For consistency throughout NSW, the mine operator should use Storz hermaphrodite type fire hose couplings on new installations.

Where a 64mm x 4.8mm pitch (*2 1/2 x 5 1/5* TPI) FBT[8] type firehose is currently used at the mine site, the mine operator should provide suitable adaptors on the surface of the mine for connection to the Storz hermaphrodite type couplings. The fire safety guide Compatible Storz hose connections provides further information.

[8] To be compatible with FRNSW equipment, Storz hose connections are required to have a form, fit and function equivalent to the Storz hose couplings as fitted to firefighting hoses used by FRNSW. This means having a 65 mm Storz hermaphrodite hose connection complying with NEN 3374 Firefighting equipment – Fire hose couplings and ancillary equipment or an FBT-Storz adaptor suitable for firefighting application as detailed in FRNSW compatible hose connections. The Storz hose connection can be either forged aluminium or copper alloy. Cast aluminium hose connections are not permissible under any circumstance as they are not rated for firefighting pressures, and will need to be replaced with compliant Storz hose connections.

NSW fire brigade vehicles and appliances also have accessibility requirements that mining operations need to be aware of. The Fire safety guideline – Access for fire brigade vehicles and firefighters provides further information.

4.3.4. Establishing and training fire teams

The mine operator during risk assessment should determine if fire teams should be established as part of the emergency plan (see section 4.5.1 of this TRG).

The fire teams should be appropriately trained in firefighting and should be instructed in the use of mine plans and become familiar with the mine workings.

The fire teams should be trained upon the commencement of appointment and at regular intervals generally no more than 6 months apart.

The mine operator's training of fire teams should include, (but be not limited to):

- familiarity with the entirety of mine
- fire control systems are in all parts of the mine
- familiar with the emergency response system
- description of risk from products of combustion; location and controls (outcomes of fire risk assessment)
- the risks of recirculation and explosion in underground fires
- strategies and tactics in fire suppression
- team leader and team training (directing other workforce members in case of a fire).

4.4. Audit monitor and review

The mine operator should audit, monitor and review its fire risk management system at:

- appropriate periodic intervals, but not exceeding 3 years
- when there is a significant change to the fire risks, or
- following a fire or explosion event.

4.5. Documentation

The mine operator should integrate a fire management record keeping within the emergency management record system.

The mine operator should keep accurate records of all stages of the fire or explosion risk management process, particularly:

- fire hazard identification, risk assessments and risk controls
- firefighting plans
- fire risk management procedures and practices
- system audit and review reports
- fire emergency system.

4.5.1. Fire fighting plans included in the emergency plan

The mine operator's fire fighting plans should identify, but are not limited to:

- the positions in which pipe mains, hydrants, isolation valves, pressure reducing stations, hydrant depots, fire stations and fire substations are situated
- the designated static water pressure at various points along the pipe mains and the water flow and pressure at each hydrant
- the location of fire pump sets with the pressure and flow ratings
- the location of all fuel storage areas
- fuel/energy isolation points
- the equipment contained in hydrant depots, fire stations and fire substations.
- in underground mines:
  - the direction of ventilation in the roadways
  - the positions of stopping's, trap doors, prepared sealing locations, overcasts, air crossings, ventilation doors, regulators, belts, conveyors, main electric supply cables, fixed electrical apparatus, and telephones.

Note: For further information see the NSW Fire and Rescue guideline for tactical fire plans and Emergency services information package and tactical fire plans.

The plans should be readily available, kept on an easily readable scale and they should be regularly updated to reflect the current mine status.

4.5.2. Roles included in the safety management system

Based on the risk assessment, the mine operator's safety management system must include the roles of competent people to carry out specific actions. Nominated individuals should be familiar in the use of mine plans, the workings of the mine, the systems of work at the mine and the mines emergency management system.

Nominated individual(s) should oversee the mines fire or explosion principal hazard management plan and be responsible for the following functions:

- applying risk management, identifying fire or explosion hazards, assessing, and controlling fire or explosion risks in the mine
- implementing the fire or explosion PHMP at the mine
- advising the mine operator of any non-compliance with the mines fire or explosion PHMP or legislation
- implementing training requirements including, firefighting teams and general workforce
- auditing and reviewing the fire or explosion risk controls to those stated in the mines fire or explosion PHMP
- arranging for regular inspection and testing of the fire or explosion protection systems to verify functionality
- arranging for the testing, repair and maintenance of all fire or explosion protection systems and equipment

- managing a system for the recording of the results of inspections, tests, maintenance, defects, and repairs
- investigating any complaints and ensure any defective firefighting equipment is immediately replaced.

4.5.2.1. Appointment of a fire officer in underground coal mines

Operators of underground coal mines under Schedule 10(12) of the WHS (MPS) Regulation 2022 must appoint as a statutory function a fire officer. Fire officers must have the required competencies to carry out the function. The role of the fire officer is to inspect and maintain firefighting equipment at the mine.

4.5.3. Emergency fire or explosion procedures

The mine's emergency plan should include fire or explosion procedures such as:

- path of normal and emergency egress for personnel
- emergency reporting, communication, and response procedures
- evacuation and withdrawal of people from harm
- response to fighting a fire
- activating of systems such as the fire teams and external support agencies
- actions to be taken by persons who discover a fire:
  - communications to the surface for assistance and to other people downstream of the fire effects
  - safe systems of work to provide an initial fire-fighting response
  - whether one person or 2 people are needed.

4.6. Information, instruction and training

4.6.1. Information for workers

The mine operator must supply and communicate sufficient information to all workers (including contractors) to enable them to fulfil their work health and safety duties.

The information needed should be determined by risk assessments that include, but are not limited to:

- fire or explosion risk controls to prevent a fire or explosion from initiating
- fire detection methods and communication of fire detection
- fire or explosion suppression methods
- emergency procedures
- withdrawal conditions
- evacuation and self-escape
- isolation points for fuel / energy sources
- firefighting reticulation plans

- energy reticulation plans.

4.6.2. Worker training

The mine operator's emergency management plan must include worker training (including contractors) in the use of firefighting equipment.

Workers should be trained upon commencing employment and at regular intervals commensurate to the risk, generally no more than 24 months apart.

Worker training (relevant to place of work) should also include but not be limited to:

- fire or explosion hazards relevant to the place of work
- design measures and controls to reduce the fire or explosion risk
- fire or explosion protection systems on plant, if fitted
- actions in event of discovery of a fire including ensuring personal safety
- what to do and who to contact
- reporting of faults and defects
- made familiar with mine emergency or evacuation procedures for their place of work
- how to use initial response methods (e.g., portable fire hose)
- use of fire extinguishers – location, use, operation
- basic hose handling.

4.6.3. Competent person for specific roles

When developing a fire or explosion PHMP, mine operators should ensure a competent person carries out the following roles (but not be limited to):

- people designing the fire or explosion protection system
- people installing the fire or explosion protection system
- people inspecting and maintaining the fire or explosion protection system
- people testing the fire or explosion protection system
- general workforce in fire fighting
- fire teams in fire fighting
- the fire officer in underground coal mines.

5. Fire protection in coal mines

Mine operators and where appropriate, other duty holders under the WHS Act (such as designers, manufacturers, suppliers and installers) should apply the recommended requirements in this section at NSW coal mines.

5.1. Fire protection for surface plant and infrastructure

This section provides mine operators and other relevant duty holders with recommended minimum requirements for surface plant and infrastructure. A fire risk assessment should identify:

- all potential fire risk areas for surface plant and infrastructure
- methods to prevent, detect and extinguish any fire in those identified fire risk areas
- systems to provide safe egress and emergency procedures.

Duty holders should ensure all buildings, structures and fixed plant are protected with a suitable water supply, water reticulation and hydrant system. For existing installations, mine operators should carry out an assessment using the relevant parts of AS 2419.1.

Buildings and occupied facilities should have a fire hose system or a fire hydrant system, and/or pump sets carried out in accordance with the Building Code of Australia (BCA) for the relevant type of building. Refer to: www.abcb.gov.au

Note: The BCA is only relevant to occupied building classifications.

All new installations or any alterations to existing systems should be carried out using AS 2419.1, as far as reasonably practicable.

Fire protection pumpsets should be installed in accordance with AS 2941.

Notes:

1. The minimum safe quantity for a water source is based on a 4-hour duration at the specified flow rates.
2. Compliance with AS 2419.1 is not possible in coal stockpile areas.
3. Key points in AS 2419.1 include;
   - (i) based on minimum 4 hours duration of water supply at specified flows
   - (ii) hydraulic analysis to demonstrate system performance of most hydraulically disadvantaged hydrant
   - (iii) 10 l/s per hydrant with up to 4 hydrants operating simultaneously – depends on area of protection
   - (iv) pressure
     - – max. dynamic 1200 kPa, unless agreed by the relevant fire brigade
     - – min. dynamic 350 kPa (700kPa external when boosted)
   - (v) max. static 1300kPa unless agreed by fire brigade
   - (vi) all points in the building are protected within reach of a 10m hose stream from the end of a 30m hose
   - (vii) open yard areas within reach of a 10m hose stream from end of 60m hose
   - (viii) acceptable sources of water supply
   - (ix) dedicated ring main systems.

The fire risks associated with mobile plant on the surface of coal mines should be assessed and controlled using AS 5062 and MDG 15.

Fire protection systems should be maintained using AS 1851.

5.2. Fire protection in open cut parts of a coal mine

This section provides mine operators and other relevant duty holders with recommended minimum requirements for open cut parts of the coal operation.

A fire risk assessment should identify:

- all potential fire risk areas for open cut parts of the operation
- methods to prevent, detect and extinguish any fire in those identified fire risk areas; and
- systems to provide safe egress and emergency procedures.

The fire risks associated with mobile plant should be assessed and controlled using AS 5062 and MDG 15.

For extinguishing a fire, considerations should be given to:

- availability of water and any time restraints (e.g., water truck empty and refill time)
- time for external resources to arrive
- pressures and flows from water trucks.

5.3. Fire protection in underground parts of a coal mine

This section provides mine operators and other relevant duty holders guidance on recommended minimum standards for underground parts of the coal operation. A fire risk assessment should identify:

- all potential fire risk areas for underground parts of the operation
- methods to prevent, detect and extinguish any fire in those identified fire risk areas
- systems to provide safe egress and emergency procedures for those underground at the time of a fire.

Mine operators and other relevant duty holders should assess and control the fire risks associated with mobile plant using AS 5062, AS/NZS 4871 (series) and MDG 15, except where the plant is explosion protected to another standard.

Duty holders should design the supply of water storage, reticulation (including fire hydrant installations) and firefighting equipment, using sections 5.2, 5.3, and 5.4 of this TRG.

Notes:

1. The Regulator does not consider AS 2419.1 appropriate for direct application in underground parts of the coal mines.
2. This section provides minimum recommendations based on AS2419 as considered appropriate for underground coal mines.
3. NFPA15 provides guidance for *Water Spray Fixed Systems for Fire Protection.*
4. NFPA 120 provides guidance for *Fire Prevention and Control in Coal Mines*.
5. NFPA 122 provides guidance metal/nonmetal mining and mineral processing.

5.3.1. Supply of water and storage

5.3.1.1. Water supply

Mine operators and other relevant duty holders should ensure an adequate supply of water for firefighting is available to all fire risk areas and fire risk locations throughout the mine.

Note: An adequate source of water is a fundamental consideration in the design of a fire hydrant water reticulation system.

Acceptable sources of water supply should be in accordance with SECTION 4 'WATER SUPPLIES' of AS 2419.1, as applicable.

5.3.1.2. Water storage

Water storage capacity feeding the fire water reticulation system should be the greater of:

- a storage capacity large enough to supply water for a period sufficient to allow all personnel underground to self-escape while the designed flow rate is maintained continuously
- a storage capacity large enough to maintain the designed flow rate for a minimum 4-hour period; or
- the storage capacity of at least 200,000 litres.

Note: The fire risk assessment should identify the period required to allow people to self-escape

Water storage tanks and their capacities should be in accordance with SECTION 5 'WATER STORAGE' of AS 2419.1, as applicable.

Duty holders should arrange onsite storage so that during maintenance at least 50% of the required volume always remains available. Mine operators should arrange maintenance during periods of least risk (e.g., non- production and kept to a minimum time frame).

5.3.2. Reticulation of fire water underground

5.3.2.1. Reticulation system coverage

A fire water reticulation system should extend throughout the entire mine.

The mine's fire water reticulation system should be designed and installed so that all identified fire risk areas are within reach of a fire hydrant.

The following areas should all be within access (maximum of 190m) of a fire hydrant:

- entire length of every conveyor system
- all face production plant
- all electrical installations (e.g., isolators, switch rooms, substations)
- all garages, service bays, charging stations or refueling stations for mobile plant.

5.3.2.2. Reticulation and hydrant system design

There should be sufficient flow and pressure from each hydrant to:

- safely fight any fire that may develop
- effectively operate two separate firefighting hoses in parallel

- operate within the specified working ranges (pressure and flow) for the types of hose and nozzles intended to be used at each fire hydrant, with consideration to the number of fire hoses intended to be used at the hydrant.

The water flow velocity in pipework should not exceed 4 m/s.

The total hydraulic loss due to friction in pipes, valves and fittings should be minimised as far as reasonably practicable.

The mine operator's firefighting plans should specify the relevant flow rates and static/dynamic pressure for each hydrant.

5.3.2.3. Minimum dynamic pressure and flow

The required minimum dynamic pressure and flow rate from each hydrant should align with Table 1 below.

Table 1 - Hydrant residual pressure and flow requirements

Maximum hose length at the hydrant	Minimum hydrant flow	Minimum residual dynamic pressure
180m (6 hoses in series)	10 1/s	700 kPa
90m (3 hoses in series)	10 1/s	400 kPa

Notes

1. It is preferable for hydrants to have no more than 90m hose attached but may have up to 180m max.
2. 10 l/s from each hydrant is recommended for two fire hoses operating simultaneously from the same fire hydrant, refer AS 2419.1.

5.3.2.4. Maximum static pressure

The maximum static pressure at any hydrant should not exceed the rated working pressure of:

- the main reticulation pipework
- the hose and nozzles available in relevant fire depot next to each hydrant.

Note: Table 2 below sets out maximum static hydrant pressures for different classes of fire hose, as set out in AS 2792.

Table 2 - Maximum hydrant static pressure for class of fire hose

Hose class	Maximum static hydrant pressure (kPa)
High (H)	2,100
Medium (M)	1,400
Low (L)	1,000

5.3.2.5. Maximum dynamic pressure

The maximum dynamic pressure at any hydrant should not exceed:

- the maximum safe operating pressure specified by the hose nozzle manufacturer, for the hose nozzle intended to be used at the fire hydrant
- a pressure/flow rate combination that is too great for a single person to safely handle and use, where there is intended to be up to 90m of hose installed at the hydrant; or
- a pressure/flow rate combination that is too great for two people to safely handle and use, where there is intended to be up to 180m of hose installed at the hydrant.

Note: AS 2419.1 specifies a maximum dynamic pressure of 1,200 kPa.

5.3.2.6. Other services

Where the fire water reticulation system is used to supply water to any other firefighting system, such as deluge systems, sprinkler systems and the like (other than hose reels), the water supply system and system design should provide for the combined firefighting system requirements.

The firefighting system's design should align with the firefighting system requirements to combat any single fire.

Where the fire water reticulation system is used to supply production plant, a risk assessment should determine whether the fire reticulation system is required providing for the additional production requirements at the same time as the firefighting requirements.

5.3.2.7. Hydraulic analysis

An engineer should carry out a hydraulic analysis on the fire water reticulation and hydrant system. This engineer should have relevant competence.

The hydraulic analysis should:

- be carried out in accordance with the information on the mine firefighting plans
- demonstrate that the system can meet the specified performance requirements at each hydrant including the most hydraulically disadvantaged hydrant and each branch line
- verify and record the design pressure (static and dynamic) and flow at:
  - each branch point
  - each pressure reducing station
  - each pumpset
  - each location where a sprinkler or deluge system is installed
  - every 1,500m linear length of main reticulation pipe
  - where there is greater than a 50m rise or fall in the main reticulation pipe.

Note: For dynamic pressures, assuming the most hydraulically disadvantaged hydrant is discharging.

- demonstrate that the residual pressure and flow available to the nozzle for each hydrant is within a suitable range.

Note: This should be based upon the maximum number of hoses in use at the hydrant to reach the fire risk area (hydrant spacing) and any other firefighting system, such as sprinkler systems, that may be in operation at the same time.

- verify the system is safe to use and state any assumptions or limitations for its safe use.

5.3.3. Hydrants

5.3.3.1. Proximity to fire risk areas

Duty holders should ensure the location of fire hydrants allows access for fire protection to the fire risk area to be obtained within reach of a 10m hose stream issuing from a nozzle at the end of either:

- 3 lengths of hose (90m); or
- a maximum of six lengths of hose (180m) where the hydrant has sufficient residual pressure.

Note: Six lengths of hose will require two people and a higher residual pressure to overcome the additional hose frictional losses.

5.3.3.2. Location of fire hydrants

Duty holders should ensure fire hydrants are located near the fire risk area being protected. Hydrants should be located near and within a safe distance of the high-risk area including but be not limited to:

- conveyor drive heads, tripper drives, loop take-ups, transfers, tail rollers
- access and coverage for the full length of any belt conveyor
- garages, service bays, refuelling bays, charging bays or underground workshops
- bulk fuel, oil storage or combustible liquid storage areas
- electrical installations, (isolators, switch rooms, substations, transformers)
- booster fans
- underground compressors and longwall pump station
- within 190m of all face production plant.

Notes: These notes are based on past experience and are recommended by the regulator

1. Fire hydrants providing access to a belt conveyor should be spaced at 100m intervals for single person operation. This would require 90m of hose at the nearest fire depot.
2. If there is sufficient residual pressure at the hydrant and if the fire risk assessment considers two-person operation acceptable, the hydrant system may be spaced a maximum of 190m apart. This would require 180m hose at the relevant fire depot.
3. Fire hydrants may be installed in an adjacent heading to the belt conveyor (i.e., travelling road), provided the fire hose in the relevant fire depot will provide full access and coverage to fight a fire along the entire length of the belt conveyor.

5.3.3.3. Orientation of fire hydrants

Hydrants should face in the direction of the air flow, so the hose is connected in the direction of the air flow.

There should be at least 100mm clear around the hydrant valve and at least 1m in front of the hydrant valve wheel to allow safe access to the hydrant.

5.3.3.4. Hydrant labels

The relevant duty holder should state the designed water flow and required pressure at test hydrants and the most hydraulically disadvantaged hydrant to support testing and measurement.

The mine operator should:

- place signs in a visible area so that workers can identify all fire hydrants, fire depots, fire substations and other locations where firefighting equipment is located
- locate signs on travelling roads indicating their direction to the nearest hydrant. Signs should follow AS 1318 and AS 1319 and AS 1614.

5.3.3.5. Hydrant valves

Fire hydrant valves should:

- be following AS 2419.2
- have a 64mm x 4.8mm pitch or Storz hermaphrodite type fire hose couplings
- be equipped with protective caps and retaining chains.

Note: Underground parts of the coal mine. should not use aluminium fittings.

5.3.3.6. Hydrant testing

Mine operators and other relevant duty holders should ensure:

- a device or system for testing pressure and flow at each hydrant should be provided
- hydrant testing should be carried out periodically to verify the pressure and flow meets that determined by the hydraulic analysis
- testing should be conducted on the most hydraulically disadvantaged hoses and at the end of every branch line.

5.3.4. Main reticulation pipe-work

5.3.4.1. Test points

The main fire reticulation pipework should have test points placed along the entire reticulation system commencing from the surface of the mine or the bottom of the shaft and at intervals of approximately 50m vertical depth (500 kPa head) and at each branch point.

Each test point should have a means for using a pressure gauge and flow test meter.

Notes:

1. A hydrant may be used as a test point
2. This is not required for shafts.

5.3.4.2. Pressure gauges

Relevant duty holder should ensure they install an AS 1349-compliant pressure gauge:

- at either side of pressure reducing valves
- at the end of branch lines
- at intervals not exceeding 1500m in length.

All pressure gauges should have a scale compatible to the static and dynamic pressure range required to be measured.

5.3.4.3. Pipe system

Relevant duty holders should ensure all pipes, pipe fittings and valves used in fire hydrant installations comply with the following principles:

- the pipes, pipe fittings and valves should follow the relevant requirements of SECTION 8 'PIPEWORK AND VALVES' of AS 2419.1.
- the pipe system should be sectionalised such that branch lines can be isolated to allow maintenance without interrupting supply to the entire system
- plastic pipes, valves, and fittings should not be used for reticulation systems. Hydraulic hoses should not be used except in circumstances where it is not practical to use solid pipes (such as longwall monorails)
- steel pipes, fittings and supports should be galvanised following AS 4792 or AS 4680 (as applicable), or otherwise treated for corrosion
- pipe systems should not be less than DN100, unless the frictional losses of the section of pipework is less than 10m equivalent hydraulic length; in which case the pipe system shall not be less than DN 80
- pipes and pipe fitting should follow the relevant standards. AS 2419.1 nominates:
  - steel tubes and pipes – AS 1074, AS 1579, AS 1769 and ASTM A135 type of pipe
  - ductile iron pipes – AS 2280
  - cast iron fittings – AS/NZS 2544
  - systems designed for pressure piping application – AS 4041.

5.3.4.4. Supports

All pipework, pipe fittings and valves should be supported by galvanised steel supports. Combustible pipework supports should not be used.

Designers should ensure supports are designed to withstand:

- 2 times the mass of the pipework filled with water plus a mass of 115kg at each point of support
- the stress and load that may be imposed from all external forces
- transmission of vibration
- effects of corrosion
- designed to prevent swaying.

5.3.4.5. Stop valves

Relevant duty holder should ensure sufficient isolation valves are provided:

- at suitable intervals for maintenance, testing and emergency purposes
- in the branch of each branch line
- at pressure reducing stations.

Isolation valves should be able to be locked in the “off” position.

5.3.4.6. Pressure reducing stations

Relevant duty holders should ensure pressure reducing stations or other methods of controlling the water pressure are installed where necessary to maintain the designed fire system static and flow pressure.

Pressure reducing valves should be duplicated to facilitate the removal of either valve for servicing. Pressure reducing valves shall be of the type in which the controlling mechanism is operated by water flow through the valve from:

- the low-pressure side; or
- the differential pressure across the valve.

Isolation valves should be installed on either side of each pressure reducing valve and non-return valve.

Facilities should be provided to test pressure reducing valves.

5.3.4.7. Sprinkler and deluge systems

Fire suppression systems such as fixed sprinklers or foam/water should be installed following the AS 4587.

Automatic systems should be considered at high-risk areas.

5.3.4.8. Pumpsets

Pumpsets that are required to meet the specified pressure and flow requirements should comply with AS 2941, as far as reasonably practicable.

There shall be at least two pumpsets installed. One of those pumps should be for standby with automatic operation between each pumpset.

Backup power supplies or 3rd pumpsets from alternate power supplies should be installed. This will ensure that in the event of a power failure, a minimum residual pressure and flow of 250 kPa and 5l/s respectively can be maintained at the end of the fire hose nozzle attached to the most hydraulically disadvantaged hydrant on each branch line.

Notes:

1. A compressed air pumpset or a diesel pumpset may suffice as an alternative.
2. The 250kPa / 5l/s is at the hose nozzle, the residual pressure at the hydrant will be dependent on the hose resistance (i.e., whether there is required to be six or three hoses attached to the hydrant and the hose diameter).

5.3.4.9. Commissioning testing

After initial installation, every hydrant should be opened to ensure there is water present at each point. The static pressure at each hydrant should be recorded and verified against design requirements.

The most hydraulically disadvantaged hydrant on each branch line should be opened to verify the flow rates and pressures.

5.4. Fire fighting equipment

This section provides mine operators and other relevant duty holders guidance on firefighting equipment.

5.4.1. Fire hose

Mine operators should determine the maximum number of 30m length hoses required at each hydrant to reach the fire risk area. Alternative methods such as a jumper hose reels could be used if they provide effective coverage.

However, there should be no more than six 30m hoses in series at any hydrant, (i.e.,180m length).

Notes:

1. Six hoses require two men for safe and effective operation of the fire hose. Consideration should be given to immediate firefighting by one man while assistance or support is being sought.
2. It is preferable for hose length to be 90m or less when one person operation is required.

The fire hose and fittings should follow AS 2792 and should be rated at the maximum static pressure for each hydrant.

Fire hoses should have standard fittings which should have a 64mm x 4.8mm pitch or Storz hermaphrodite type fire hose couplings.

5.4.2. Extinguishers

Appropriately rated and sized extinguishers should be provided with consideration to AS 2444 and AS 1850, as required by the fire risk assessment and the intended fire risk area being protected.

Every hydrant depot should have extinguishers provided at every hydrant depot, on all mobile plant and at electrical switchgear.

The preferred minimum size extinguisher for general purpose is a dry chemical 80ABE, where practicable.

5.4.3. Hydrant depot

Hydrant depots should be located on the intake side and next to hydrants to cover the following areas:

- conveyor drive heads, tripper drives, loop take-ups, transfers, tail rollers
- garages, service bays, refuelling bays, charging bays or underground workshops
- bulk fuel, oil storage or combustible liquid storage areas
- electrical installations, (e.g., isolators, switch rooms, substations, transformers)
- booster fans
- underground compressors and longwall pump station
- within 190m of all face production plant.

For all other parts of the water reticulation system (including along belt conveyors) depots should be located such that an effective response to a fire in the shortest practicable time can be provided.

Notes:

1. It is preferable to install hydrant depots at every hydrant for a rapid response but may be extended to cover more than one hydrant.
2. The response time to place and assemble hoses and the environmental conditions such as ease of access, roadway conditions and transport access should be considered.

Where fire depots cover more than one hydrant, they should be capable of being easily moved between hydrants by one person. Serviceability of equipment should be maintained at all times.

Non-metallic hydrant depots should be antistatic or otherwise protected from the potential of a static electric charge build-up (see TRG – Non-metallic materials for use in underground coal mines and reclaim tunnels in coal mines).

5.4.4. Hydrant depot equipment

The hydrant depot should contain enough hose to cover a point past the next hydrant or the furthest point to be covered.

Mine operators should provide a fit-for-purpose container for depot equipment.

Depots should contain:

- a controlling dividing breeching piece which incorporates a shut-off valve that allows you to use two hoses in parallel
- enough hose to run two separate hose lines in parallel to the fire risk area, covered by the hydrant.

Note: If the hydrants are 180m apart, then 360m of hose is required,

- a 64-38mm adaptor if required
- spanners as required
- jets and a diffusing nozzle
- two branches.

5.4.5. Fire station

The fire station should be located on the surface near transport entry into the mine to enable ready dispatch of firefighting equipment underground.

A fire station should be designated as such and be a defined area with entries kept clear. The fire station should contain the following equipment as a minimum:

- foam generating equipment
- foam stock and supplies
- fire hoses, branches, tools, nozzles, fittings, and breaching pieces
- fire extinguishers
- firefighting plan
- a list of minimum equipment to be kept in the station
- other emergency equipment as specified by the mine or as identified through the PHMP.

5.4.6. Fire substation

Fire substations should be located throughout the mine, so they are readily accessible to each district in the mine as determined by the fire risk assessment and PHMP.

Each fire substation should be located near a travelling road and clearly signposted so that it is easily identifiable by any worker. Travelling roads into all parts of the mine serviced by the substation shall be sign-posted so that workers may navigate the route without delay.

The fire substation should be maintained in an effective state. The substation should have clear access (no items parked or stored in front of it), and be located adjacent to the travelling road in an intake roadway.

Suitable means of communication should be available at each substation.

Fire substations should be designed and constructed so they are portable and capable of being rapidly transported to a part of the mine where required for use.

The fire substation should contain the following equipment as a minimum:

- the contents of three hydrant depots
- five dry chemical fire extinguishers (80BE)
- low Expansion foam and applicator
- a list of minimum equipment to be kept in the substation
- other emergency equipment as specified by the mine
- a mine fire plan.

5.4.7. First response firefighting

At suitable intervals to cover the entire length of every belt conveyor roadway have a 25mm outlet valves. There should be sufficient hose, readily available, of minimum 20mm internal diameter to cover to the next 25mm outlet.

Note: Previous incidents have indicated this hose has provided the quickest response to belt conveyor fires.

5.4.8. Maintenance

Mine operators should maintain the firefighting system and associated equipment following AS 1851.

5.5. Other fire risk controls

This section provides mine operators and other relevant duty holder guidance on other fire risk controls.

5.5.1. Underground garages

There are designated areas within an underground mine where plant is regularly refuelled, serviced, repaired, or charged. For these areas, mine operators should consider TRG - Hot work (cutting and welding) and the following risk controls:

- two means of egress from the area to be provided

- adequate ventilation facility to direct products of combustion directly to return airway
- the area is constructed or lined with a non-flammable material
- has a smooth floor to allow ease of clean up for fuel, oil, grease spillage
- is provided with non-flammable absorbent material for clean up
- has a fire hydrant and sufficient fire equipment located on the intake side of the garage and within close proximity
- has fire extinguishers of an appropriate type and located for ease of use
- has a fireproof receptacle to dispose of any flammable material
- provision of foam extinguishant
- mine environmental monitoring inbye of garage.

Note: each diesel engine system has a specified minimum ventilation quantity.

5.5.2. Combustible liquid storage

The storage and handling of combustible liquids should follow AS 1940.

Where a container having a capacity of more than 60 litres is used to store combustible liquids or fluids (such as grease, or lubricating or hydraulic oil), there should be:

- adequate provision to minimise spillage
- adequate ventilation
- adequate provision for the collection of spilled oil in trenches, trays or pits filled with dry sand or some other non-flammable, absorbent material
- systems to remove any spillage as frequently as is necessary to keep the area in which the oil is stored or held free from spillage, and in any case not less often than once every 7 days
- no fixed machinery, cutting or welding equipment, or portable electric tools operated within 10 meters of the grease or lubricating or hydraulic oil or fluid
- fire extinguishers of a suitable type and capacity to deal with an oil fire provided nearby to be readily accessible.

5.5.3. Flammable materials

Mine operators should not store flammable material with a flash point of 23° Celsius or less in the underground parts of the mine except in a fireproof room, compartment, or box.

Any building or structure on the top of a shaft or outlet at the mine should not be made of, or should not comprise flammable material with a flash point of 61° Celsius or less. Pressurised flammable gas should not be stored underground on a long-term basis (over 1 day).

5.5.4. Diesel fuel

Diesel fuel should:

- be taken underground only in a safe container
- not be kept underground unless in a fuel tank or in a safe container
- consider ventilation requirements.

The total quantity of fuel in the underground parts of the mine at any one time should be minimised and should not exceed the total fuel consumption of transport at the mine (with normal operation) over the ensuing 7 days.

5.5.5. FRAS materials in underground coal mines

Ventilation appliances and conveyor belting, accessories and components should be flame resistant and anti-static (FRAS). Other non-metallic materials should be assessed for their fire risk.

Note: Technical reference guide Non-metallic materials for use in underground coal mines and reclaim tunnels in coal mines provides guidance on the use of non-metallic materials in underground coal mines.

5.5.6. Operation of belt conveyors

Belt conveyors should:

- follow AS/NZS 4024.3610
- be installed and maintained to prevent contact between the belt and any stationary items or materials (excluding those specifically allowed for in the design of the conveyor)
- have roof of sufficient height to allow the contour of the maximum load and the largest fragments carried by the conveyor to clear the roof and roof supports
- have roadway of sufficient width to provide a suitable passageway on at least one side of the conveyor to facilitate inspection and maintenance
- have sufficient clearance on each side of the conveyor to allow any spillage of coal to fall clear of the conveyor
- have a minimum clearance of 300 millimetres from the floor to the underside of the return belt (except at the most inbye loading point of the conveyor system if the mine manager establishes that such clearance is impracticable).

A belt conveyor used in an underground roadway shall not be operated if any belt fabric material is in contact with the shaft of any idler or pulley. Any accumulation of fibres from damaged conveyor belting should be immediately removed

The mine should have a system in place to identify defective rollers and bearings in the conveyor system and change-out components before they constitute a fire hazard.

Note: Stone dust or clean dry sand may aid in first response to extinguishing small fires.

5.5.7. Cleaning of underground roadways

Mine operators should clean all underground roadways in which belt conveyors are installed, and keep them free from spillage, loose coal, and rubbish.

5.5.8. Hot work

Mine operators should ensure that those doing hot work follow the Technical reference guide hot work (cutting and welding) at mines and petroleum sites. This TRG provides guidance on developing a management system for hot work that forms part of the mines safety management system.

The guide covers hot work, including welding, brazing, soldering, heating, cutting, or grinding that is likely to generate a surface temperature greater than 150 degrees Celsius. This includes activities such as thermal or oxygen cutting or heating, and related heat-producing or spark-producing operations, including buffing.

5.5.9. Fire resistant fluids

All hydraulic oil or fluid used for the following purposes should be of the fire-resistant type:

- fluid couplings and hydraulic torque converters except were designed to operate integrally with an oil filled gearbox
- hydraulic self-advancing roof supports used in connection with longwall or shortwall faces
- hydraulic breaker line supports
- hydraulic braking systems where the friction surfaces are designed to operate in a dry state.

Note: It is preferable to use wet brakes.

Testing should use the Fact sheet Testing of fire resistant hydraulic fluids and materials.

Appendix A – Guidance, standards, alerts and bulletins

Codes of Practice

Work health and safety consultation, cooperation and coordination

How to manage work health and safety risks

Safety management systems in mines

Mechanical engineering control plan

Electrical engineering control plan

Roadway dust analysis in underground coal mines

Managing risks of hazardous chemicals in the workplace

Emergency Planning for mines

Guidance

Contractors and other businesses at mines and petroleum sites guide

Consulting workers fact sheet

Guide - Preparing a principal hazard management plan

MDG 15 – Mobile and transportable plant for use on mines and petroleum sites

MDG 43 Technical standard for the design of diesel engine systems for use in underground coal mines

Fact Sheet – testing of fire resistant hydraulic fluid materials

TRG - Hot work (cutting and welding)

TRG - Coal dust explosion suppression

TRG – Non-metallic materials for use in underground coal mines and reclaim tunnels in coal mines

TRG – development of the Spontaneous combustion PHMP

TRG - development of a gas outburst PHMP

TRG main fans, booster fans and auxiliary fans in underground coal mines.

Australian Standards

AS 1074-1989	Steel tubes and tubulars for ordinary service
AS 1318-1985	Use of colour for the marking of physical hazards and the identification of certain equipment in industry (known as the SAA Industrial Safety Colour Code)
AS 1319-1994	Safety signs for the occupational environment
AS 1349-1986	Bourdon tube pressure and vacuum gauges
AS 1579-2001	Arc-welded steel pipes and fittings for water and wastewater
AS 1614 – 1985	The design and use of reflectorized signs for mines and tunnels
AS 1940:	The storage and handling of flammable and combustible liquids
AS 1769-1975	Welded stainless steel tubes for plumbing applications
AS/NZS 1850 – 2009	Portable fire extinguishers - Classification, rating, and performance testing
AS 1851-2012	*Maintenance of fire protection systems and equipment*
AS 1940-2017	The storage and handling of flammable and combustible liquids
AS 2118.6-2012	Automatic fire sprinkler systems - Combined sprinkler and hydrant
AS/NZS 2280:2020	Ductile iron pipes and fittings
AS 2419.1-2021	Fire hydrant installations - System design, installation, and commissioning
AS 2419.2-1994	Fire hydrant installations - Fire hydrant valves
AS 2441-2005	Installation of fire hose reels
AS 2444-2001	Portable fire extinguishers and fire blankets - Selection and location
AS/NZS 2544:1995	Grey iron pressure fittings
AS 2792-1992	Fire hose - Delivery layflat
AS 2941-2013	Fixed fire protection installations - Pumpset systems
AS 3780:	The storage and handling of corrosive substances
AS 3786-2023	Smoke alarms (ISO 12239: 2021 MOD)
AS/NZS 3833:	The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers
AS/NZS 4024.3610	Conveyors - General requirements
AS 4041-2006	Pressure piping
AS 4587-2020	Water mist fire protection systems - System design
AS 4587-2020	Water mist fire protection systems - System design, installation, and commissioning

AS/NZS 4680:2006 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

AS/NZS 4792:2006 Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process

AS/NZS 4871 series Electrical equipment for mines and quarries – Parts 1 to 6

AS 5062-2022 Fire protection for mobile and transportable equipment

AS ISO 31000:2018 Risk Management Guidelines

AS/NZ ISO 45001: 2018 Occupational Health and Safety Management Systems – Requirements with guidance for use

AS/NZS 60079.10.1: Explosive atmospheres — Classification of areas — Explosive gas atmospheres (IEC 60079-10-1, Ed.1.0 MOD)

AS/NZS 60079.10.2: Explosive atmospheres — Classification of areas — Combustible dust atmospheres.

Other standards

NFPA15 National Fire Protection Association Code - Standard for Water Spray Fixed Systems for Fire Protection

NFPA 120 National Fire Protection Association Code Standard for Fire Prevention and Control in Coal Mines

NFPA 121 National Fire Protection Association Code - Standard on Fire Protection for Self-Propelled and Mobile Surface Mining Equipment

NFPA 122 National Fire Protection Association Code - Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities

NFPA 1620 National Fire Protection Association Code – Pre Incident Planning

ASTM A35 Standard for metal pipes

ASTM A135 Standard for electric resistance welded steel pipe

Building Code of Australia Australian Building Codes Board www.abcb.gov.au

Safety Bulletins

SB22 - -13 - Fires on battery powered tools increase

SB22- 12 - Fires occurring on mobile manufacturing unit trucks

SB22 – 09 - Mobile plant and vehicle fires associated with diesel exhaust treatment

SB21 – 11 - Fires occur after servicing mobile plant

SB21 - -01 - Fires occur while refuelling plant

SB18- - 02 - Fire suppression system fails to discharge

SB19 – 12 - Spontaneous combustion of rubber fines

SB19 – 14 - Conveyor pulley failures cause fires

SB18 – 14 - Preventing fires on mobile plant

SB18- 04 - Fires on surface drill rigs

SB18 – 02 - Mines and preparing for fires

SB16 – 02 - Exploding lead acid batteries

SB15 – 03 - Fires ignite while refuelling mobile plant with quick-fill fuel systems

SB13 – 05 - Too many underground fires

SB08 – 07 - Failure of fire suppression system on rear dump truck

Safety Alerts

SA20 – 10 - Anti static material in underground coal mines

SA18 – 08 - Underground fire initiates emergency response

SA18-04 - Workers withdrawn after methane frictional ignition

SA11 – 12 - Ignition of gas leads to underground fire

Resources Regulator reports on fires

Fires on mobile plant quarterly reports

Other information

Hansen R, Pre-incident planning of fires in underground hard rock mines: old and new risks AJEM Oct 2021

NSW Fire safety guideline – Access for fire brigade vehicles and firefighters

NSW Fire safety guideline – Compatible storz hose connections

NSW Fire safety guideline for tactical fire plans

NSW Fire safety Emergency services information package and tactical fire plans

Appendix B – Examples checklists

Note: the examples in Appendix B are extracted from MDG 1032

Example table of considered areas underground coal mine

Area of mine	Considerations (not an exhaustive list)
Development	Conveyor
	Mobile Electrical Equipment
	Fixed Electrical Equipment e.g., TX DCB Aux fan
	Diesel vehicles
	Cutting and welding
	Face Equipment
	Chemicals
	Drill rigs
	Gas drainage
	Compressed air
	Coal
	Portable electrical apparatus
	Air driven equipment
	Contraband
	Atmosphere
	Coaldust
Longwall	Conveyor
	Mobile Electrical Equipment
	Fixed Electrical Equipment e.g., TX DCB Aux fan
	Diesel vehicles
	Cutting and welding
	Face Equipment
	Chemicals
	Drill rigs
	Gas drainage
	Hydraulics
	Compressed air
	Coal
	Portable electrical apparatus
	Air driven equipment
	Contraband
	Atmosphere
	Coaldust

Area of mine	Considerations (but not limited to)
Outbye Areas	Conveyor
	Mobile Electrical Equipment
	Fixed Electrical Equipment e.g., TX DCB Aux fan
	Diesel vehicles
	Cutting and welding
	Battery charging station
	Chemicals
	Drill rigs
	Gas drainage
	Compressed air
	Workshop
	Fuel pods
	Service bay
	Reticulation cables
	Rail vehicles
	Coal
	Portable electrical apparatus
	Air driven equipment
	Contraband
	Atmosphere
	Coaldust
Goafs and Sealed areas	Atmosphere
	Coal and coal dust
Drifts and shafts	Conveyor
	Mobile Electrical Equipment
	Fixed Electrical Equipment e.g., TX DCB Aux fan
	Diesel vehicles
	Cutting and welding
	Chemicals
	Gas drainage
	Compressed air
	Reticulation cables
	Rail vehicles
	Coal
	Portable electrical apparatus
	Air driven equipment
	Contraband
	Atmosphere
	Coaldust
Surface	Conveyor

Area of mine	Considerations (but not limited to)
	Mobile Electrical Equipment
	Fixed Electrical Equipment
	High voltage switch yard
	Diesel vehicles
	Cutting and welding
	Chemicals
	Gas drainage plant
	Compressed air and compressors
	Reticulation cables
	Rail vehicles
	Coal
	Workshop
	Air driven equipment
	Contraband
	Atmosphere
	Coaldust
	Explosives magazine
	Winders
	Bushfires
	Hazardous materials stores
	Coal stockpiles
	Reclaim Tunnel
	Coal Bins
	Rail Receival Terminal
	Preparation plant
	Mine ventilation fans
	Surface buildings
	Car Park

Example table of considered areas open cut mine

Area of open cut	Considerations (but not limited to)
Car park	Mobile equipment
	Chemicals
Office Buildings	Fixed electrical equipment
	Contraband
	Chemicals
Preparation Plant	
Road network	
Open Cut	
Stockpiles	
Reclaim Tunnel	
Coal Bins	
Rail Receival Terminal	
Overland conveyor system	
Workshop	
Hazardous materials store	
Explosives magazine	

Underground coal risk results table example

Note:

1. All these events are situations that have the capacity to cause a fire.
2. The example used are those events that may occur in a Face zone
3. This table may be expanded to include a risk assessment of all areas of the underground mine. (e.g., travelling roads, returns, sealed areas, drifts etc.)

Consideration to be given to the fire risk potential of conveyor belt systems.

(A) Underground Fires in Development Face Zone										
Ref	Potential Fire Risk Areas of the mine / Plant[1]		Ignition Source	Fire Risk Scenarios (what/how/when can it happen?)[4]		P	C	Risk to health and safety of people, (property, production, environment)	Proposed Controls	New RR
	Face Zone Conveyors			Frictional heating						
	Face Zone Conveyors			Overheating of motors						
	Face Zone Conveyors			Cables overheating						
	Face Zone Conveyors			Electrical arcing						
	Face Zone Conveyors			Static electrical discharge						
	Mobile Electrical Equipment			Overheating of motors						
	Mobile Electrical			Cables overheating						
	Equipment									
	Mobile Electrical Equipment			Electrical arcing						
	Mobile Electrical Equipment			Impact damage compromises fire-safe integrity of apparatus						

	Fixed Electrical Equipment			Impact damage compromises fire-safe integrity of apparatus						
				Electrical arcing						
				Chemicals						
				Overheating of motors						
				Cables overheating						
				Heated surfaces						
	Diesel vehicles			Overheating of motors						
	Diesel vehicles			Impact damage compromises fire-safe integrity of apparatus						
	Diesel vehicles			Frictional heating of brakes and other components						
				Methane present						
	Cutting and welding			Methane present						
	Cutting and welding			Coal dust present						
	Face equipment			Frictional sparking						
				Impact damage compromises fire-safe integrity of apparatus						
				Electrical arcing						
				Overheating of motors						
				Cables overheating						
				Frictional heating						
				Heated surfaces						
	Chemical reaction (polymer)			Ignition of chemical						
	Drill rigs			Frictional sparking						
				Impact damage compromises fire-safe integrity of apparatus						
				Electrical arcing						

				Overheating of motors						
				Cables overheating						
				Frictional heating						
				Heated surfaces						
	Gas drainage			Impact damage						
				Methane present						
	Compressed air			Frictional heating						
				Static electricity causes arcing and sparking						
	Coal			Spontaneous combustion						
				Heated surfaces						
				Frictional heating						
	Portable electrical apparatus			Impact damage						
				Electric arcing						
				Overheating of motor						
				Cables overheating						
	Air driven equipment			Overheating of motor						
				Static electrical discharge						
				Frictional heating						
				Frictional sparking						
	Contraband			Naked flame						
				Arcing						
	Atmosphere			Methane						
	Coal dust			Frictional sparking						
				Shotfiring						
				Electrical arcing						
				Overheating of motors						
				Cables overheating						
				Frictional heating						
				Heated surfaces						

Appendix C – Case studies

1980 Cobar CSA mine fire

On 12 October 1980, three miners died in a fire at the CSA Mine in Cobar, Central Western NSW. They were in the mine shaft's person-riding cage, removing old concrete delivery pipes.

Coroner Schreiner believed that hot metal, slag, or sparks falling down the shaft ignited flammable material below the cage, such as old cement bags and 'hydrocarbons' on the shaft walls.

The fire sent flames up the shaft walls, fed by hydraulic oil or diesel fuel which had leaked from galvanised pipes in the shaft. The fire was further fuelled by the acetylene the men were carrying.

The coroner discovered that a fire had occurred a week earlier in the same shaft when a different crew was working on removing the old concrete pipes. In this instance, no workers were injured. The fire was reported to management and the mine's management conducted an inspection on 7 October to investigate. It seemed to have been caused in the same way.

The manager of the mine reported this fire to headquarters in Broken Hill, categorising it as "minor". The coroner found that information about this fire was missing from the report shared with the Broken Hill Mine Safety Inspector and an inspection by a Mine Inspector could not be arranged before the fatal incident on 12 October.

The coroner said the tragedy demonstrates the dangers caused by sending fuel and oil underground by means of pipes in a shaft used for other purposes. The difficulty in detecting leaks is a major one. The coroner made no formal recommendation, however, suggested the mine properly washes down the shaft n before removal of any further pipes.

This incident highlights the need to undertake suitable risk assessments and proper investigation of incidents (such as the previous fire) to identify causes, review control measures and apply appropriate risk controls as currently required by legislation.

This incident claimed the lives of 3 people

1965 Bulli colliery fire

On 9 November 1965, four underground miners lost their lives at Bulli Colliery, located on the South Coast of NSW. The mine belonged to Australian Iron & Steel, a subsidiary of BHP.

A pocket of gas which ignited in a panel a few hundred metres from the main shaft caused the fire.

The investigation report found that there had been intermittent outbreaks of Illawarra Bottom Gas (IBG) detected on the days leading to the fire, as well as on the day of the fire. IBG is a combination of noxious gas (e.g., carbon monoxide) and methane.

In his report, Honour, Judge A. J. Goran Q.C., Court of Coal Mines Regulation indicated that wood had lodged in the braking system of a shuttle, caught fire, and ignited the gas.

Three of the four miners died in shunt where the fire had started, and the fourth miner died slowly of noxious gas poisoning more than an hour after the fire began. One trapped miner escaped by running through the fire, suffering severe burns to his body.

Miners were left underground when the fire started, marshalled in muster areas to allow rescue teams to use the transport system to enter the mine. Judge Goran found they were not at risk and were eventually brought to the surface.

The 200 workers at the mine did not carry self-rescuers.

Mines rescue, mine staff and mines inspectors carried out the rescue and firefighting operation co-ordinately. Mines rescue used breathing apparatus that lasted two hours, requiring a rotating process. The search for the missing miners and firefighting continued for over 24-hours, even though suitable firefighting equipment was not available at the mine and had to be transported in.

In the Report of Inquiry, Judge Goran stated that mine management had tolerated concentrations of noxious gas. He also noted that the competence of the deputies to take gas reading was low. He recommended mine inspectors undertaking an assessment under actual conditions. He also found the mine's ventilation method to deal with gas to be ineffective and improvised. The provision of foam and other firefighting equipment available was also inadequate.

The Report of Inquiry recommended significant improvements be made to the *Coal Mines Regulations Act* to ensure appropriate ventilation, stringent and continuous gas monitoring and detection, and the compulsory carrying of self-rescuers.

This incident claimed the lives of 4 people