

Fire or Explosion in Underground Mines and Tunnels

February 2014

ACKNOWLEDGEMENTS

This material has been developed by WorkSafe New Zealand in collaboration with an independent group of New Zealand, Australian and UK mining experts and practitioners, to ensure that the approach to health and safety in the New Zealand mining industry aligns with international best practice.

In recognition of the valuable contribution made towards the development of this Approved Code of Practice, WorkSafe New Zealand would like to thank the members of the working group and those who provided input and feedback during reviews and consultation.

NOTICE OF APPROVAL

2013 was an exciting and rewarding year as the Government passed and began to implement legislation that brings New Zealand's mining regulatory regime on par with the highest international standards. The unwavering focus has been extending safety and environmental protection measures to ensure that New Zealanders can have confidence in the exploration and development of our valuable mineral resources.

The new regulatory framework for mining came into force in December 2013.

This Approved Code of Practice has been developed to improve health and safety practices and behaviours to reduce workplace accidents and fatalities in the New Zealand mining industry. This outcome will contribute directly to the Government's target of reducing workplace deaths and serious injuries by at least 25 percent by 2020.

The regulatory changes, and the practices outlined in this Approved Code of Practice, will strengthen health and safety performance so that people who work in the New Zealand mining industry are protected when they are at work.

A handwritten signature in black ink, appearing to read 'S. Bridges', with a long horizontal flourish extending to the right.

Hon Simon Bridges
Minister of Labour

FOREWORD

This Approved Code of Practice is a very significant document for New Zealand's underground mining and tunnelling sectors. It gives operators very clear direction on their work in mines and tunnels. No-one in these industries should now be unclear on their responsibilities nor of the regulator's expectations.

In 2012 the report of the Royal Commission on the Pike River Coal Mine Tragedy recommended changes to the mining regulations in New Zealand, and the provision of codes of practice and guidance to assist mining operators to manage their operations safely.

New regulations have now been introduced for the mining industry, based on the specific technical recommendations of the Royal Commission and the Expert Reference Group formed to assist WorkSafe New Zealand in development of the regulations. To manage the major hazards present in mining operations the regulations require mining operations to have Principal Hazard Management Plans and Principal Control Plans as part of their overall Safety Management System.

To assist mine operators in the development of their plans, WorkSafe New Zealand is producing a series of codes of practice to provide technical information on the latest industry good practice. This Approved Code of Practice is part of that series of codes. It has been developed jointly with union and industry members after detailed consultation, and incorporates the latest good practice from Australia and the UK.

I am confident that following the standards in this Approved Code of Practice will assist the New Zealand industry to significantly reduce the risks that workers face in underground mining and tunnelling.



Brett Murray
General Manager, High Hazards and Specialist Services
WorkSafe New Zealand

TABLE OF CONTENTS

01	INTRODUCTION	11
1.1	Background	12
1.2	Purpose	12
1.3	Legal status of this document	13
1.4	Structure of this document	13
1.5	References used in this document	13
02	SCOPE	14
2.1	Operating types to which this Approved Code of Practice applies	15
2.1.1	General	15
2.1.2	Coal mine	15
2.1.3	Metalliferous mine	15
2.1.4	Tunnel	15
2.2	References to mine and tunnel operations and operators	15
2.3	References to roles, responsibilities, training and competencies	15
2.4	References to methane	16
2.5	References to risk appraisal and assessment	16
2.6	Mine plans and schematics	16
03	GENERAL PROVISIONS	17
3.1	Applicable Legislation and Regulations	18
3.2	Mine and tunnel safety management – Requirement for systems and plans	18
3.2.1	Safety Management Systems	18
3.2.2	Hazard Management Systems	18
3.2.3	Principal hazards	18
3.2.4	Principal Hazard Management Plans and Principal Control Plans	19
3.3	Requirement for a Principal Hazard Management Plan for Fire or Explosion	21
3.4	Controlling a hazard – The hierarchy of controls	22
3.4.1	Elimination	22
3.4.2	Isolation	22
3.4.3	Minimisation	23

04 CAUSES OF FIRE AND UNCONTROLLED EXPLOSIONS 24

4.1	Fire or explosion in an underground environment	25
4.2	The properties of fire	26
4.2.1	Open fires	26
4.2.2	Concealed fires	27
4.3	Sources of fuel (flammable, combustible and explosive material)	27
4.3.1	Diesel	27
4.3.2	Timber	27
4.3.3	Plastics and rubber	27
4.3.4	Paper, rubbish and other waste materials	28
4.3.5	Methane	28
4.3.6	Coal and coal dust	28
4.3.7	Sulphide dust	29
4.4	Sources of ignition, fire or explosion	30
4.4.1	Diesel equipment	30
4.4.2	Mechanical equipment	31
4.4.3	Electrical infrastructure and equipment	31
4.4.4	Conveyors	31
4.4.5	Frictional ignitions	32
4.4.6	Hot work	32
4.4.7	Contraband	32
4.4.8	Chemicals	32
4.4.9	Explosives	33
4.4.10	Spontaneous combustion	33
4.4.11	Self-rescuers	33
4.5	Oxygen	33
4.6	Potential for the above to come together	34

05 PLANNING AND ASSESSMENT 35

5.1	Evaluating the likelihood of fire or explosion	37
5.2	Potential for risks	37
5.3	Evaluation of who might be harmed and how	38
5.4	Recording significant findings	39
5.5	Risk assessment and the emergency plan	39
5.6	Reviewing the assessment	39

6.1	Underground fire prevention controls	43
6.2	Explosion Risk Zones (ERZs)	44
6.2.1	Supply of fresh air and assessment of ERZs	45
6.3	Ventilation	47
6.4	Mobile equipment	49
6.4.1	Diesel vehicles	50
6.5	Fixed mechanical plant	50
6.5.1	Hydraulic and lubrication systems	51
6.5.2	Conveyors	53
6.5.3	Prevention of fire on conveyors	55
6.5.4	Compressor systems and pumps	55
6.5.5	Prevention of fire on mechanical equipment	56
6.6	Fixed electrical equipment	58
6.7	Underground infrastructure	58
6.7.1	Explosives magazines	58
6.7.2	Fuel storage, transfer equipment and refuelling bays	59
6.7.3	Workshops	61
6.7.4	Crib rooms	62
6.8	Flammable and combustible substances	62
6.8.1	Flammable gases in metalliferous mines and tunnels	63
6.9	Frictional ignitions	64
6.9.1	Frictional ignition prevention controls	64
6.9.2	Frictional ignition records	65
6.10	Hot work	65
6.10.1	Hot work in metalliferous mines and tunnels	66
6.10.2	Hot work in coal mines	66
6.11	Light metals (or aluminium)	67
6.11.1	Light metal specifications	67
6.11.2	Prohibited use	67
6.11.3	Permitted use	67
6.12	Compressed air	69
6.13	Contraband	69

7.1	General provisions in relation to monitoring	71
7.2	Monitoring of underground ventilation	83
7.2.1	Monitoring of air velocity, quantity and quality	83
7.2.2	Monitoring for the early detection of fire	83
7.2.3	Monitoring for the presence of methane	83
7.2.4	Monitoring of humidity	84
7.2.5	Monitoring of diesel emissions	84
7.2.6	Monitoring for radon	85
7.3	Selection of monitors	85
7.4	Positioning of monitors	86
7.4.1	Positioning of CO monitors or smoke detectors	86
7.4.2	Factors influencing the position of monitors and detectors	86
7.4.3	Positioning of methane monitors	87
7.4.4	Monitors on explosion-protected vehicles energised by a battery or diesel engine	87
7.4.5	Monitors on other explosion-protected mobile plant	87
7.4.6	Monitors on a hydro mining panel	88
7.4.7	Use of portable gas monitors	89
7.4.8	Monitoring where methane drainage is in place	89
7.5	Alarms	89
7.5.1	When alarms warn of the presence of methane	90
7.5.2	When monitoring detects the presence of radon	91
7.6	Inspections	91
7.7	Types of monitors	93
7.7.1	Smoke detectors	93
7.7.2	Carbon Monoxide detectors (ppm)	93
7.7.3	Airflow monitors (m/s)	93
7.7.4	Pressure transducers (Pa or kPa)	93
7.7.5	Tube bundle system	94
7.7.6	Telemetric monitoring	94
7.7.7	Methane monitors (methanometers)	95
7.7.8	Monitors for other gases	95

8.1	Controls to manage the early onset of fire	102
8.2	Firefighting	102
8.2.1	Fire hydrants	103
8.2.2	Fire points in coal mines	103
8.2.3	Fire trucks in metalliferous mines and tunnels	104
8.2.4	Fire hose	104
8.2.5	Fire extinguishers for fixed installations	104
8.2.6	Fire extinguishers for mobile equipment	104
8.2.7	Fixed point fire extinguishers	105
8.3	Testing and examination of firefighting equipment	105
8.3.1	Periodic checks – Monthly	105
8.3.2	Periodic examinations – Annually	105
8.4	Water deluge systems	106
8.5	Fire detection and suppression systems for mobile diesel equipment	106
8.6	Automatic fire detection and suppression systems	107
8.6.1	Areas protected and duration times	107
8.6.2	Manual actuators	107
8.6.3	Automatic actuators	107
8.6.4	Fire suppression interlocks	108
8.6.5	Nozzles, valves, wiring and piping	108
8.6.6	Fire suppression system pressure vessels	109
8.6.7	Foam solution	109
8.6.8	Installation	109
8.6.9	Integrated engine management systems	109
8.6.10	Light vehicles and small diesel plant	110
8.6.11	Tunnel Boring Machines (TBMs)	110
8.7	Dust suppression in underground mines and tunnels	110
8.7.1	Selection of coal mining equipment	110
8.7.2	Sulphide dust explosions (in metalliferous mines and tunnels)	111
8.7.3	Sulphide dust control	112
8.7.4	Development blasting	112
8.7.5	Secondary blasting	112
8.7.6	Open stope blasting (large scale)	112

8.8	Stone dusting in underground coal mines	114
8.8.1	Compliance with these requirements	114
8.8.2	Physical properties of stone dust	114
8.8.3	Spreading of stone dust	114
8.8.4	Dust sampling requirements	116
8.8.5	Dust sampling procedures	116
8.8.6	Colour testing procedures	117
8.8.7	Frequency of dust sampling	118
8.8.8	Dust sample failures	118
8.8.9	Recording of dust sampling results	119
8.8.10	Use of stone dust explosion barriers	120
8.8.11	Explosion barrier design	120
8.8.12	Distributed bag explosion barriers	122
8.8.13	Primary and secondary bag explosion barriers	123
8.8.14	Distributed explosion barriers for hydro mining	128
8.8.15	Conventional stone dust explosion barriers	128
8.8.16	Water trough explosion barriers	130
8.8.17	Ensuring explosion barriers are fit for purpose	131
8.8.18	Water trough explosion barrier installations	131
8.9	Emergency response	132
8.10	Sealing parts of the mine	132

09 NOTIFICATIONS **133**

9.1	Notifications	136
------------	---------------	-----

10 RECORDS **138**

10.1	Stone dusting	147
10.2	Electrical trips	147
10.3	Personnel underground	147
10.4	Firefighting plan	148
10.5	Electronic tracking systems	148

11 REVIEW AND AUDIT **150**

11.1	Review of controls	152
11.2	Review requirements	152
11.3	Audit requirements	152

APPENDIX A **153**

A1	Calculation to determine Effective Temperature	154
A2	Sample fire or explosion risk assessment	156
A3	Sample operating rules on frictional ignition	157
A4	Sample frictional ignition risk assessment	161
A5	Sample plan for the prevention of a frictional ignition in a new heading	162
A6	Sample mine gas chart	165
A7	Methane monitor alarm settings [from the Regulations]	166

APPENDIX B **167**

	Statutory positions and competencies	168
B1	Health and Safety in Employment Act 1992	168
B2	Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013	169

APPENDIX C **174**

C1	Definitions	175
C2	Chemical symbols	177
C3	Standards	178
C4	References	180
C5	Further resources	182

Figures

1	The Fire Triangle	26
2	The Johannesburg Curve	29
3	Location of methane detectors at ERZ/NERZ boundary, and cut off requirements including where NERZ is subdivided	46
4	Methane and CO monitor locations in production panel (forcing ventilation)	96
5	Methane and CO monitor locations in production panel (exhausting ventilation)	97
6	Sample plan showing gas monitoring and dilution doors for a hydro panel	98
7	Minimum extinguisher size for diesel engine rating	104
8	Bags suspended facing the direction of any potential blast wave	121
9	Example for a 3.5m-4.5m high roadway with more than one layer of bags - Section through roadway	122
10	Distribution of bags in a distributed barrier - Plan of worked example 1	125
11	Distribution of sub-barrier bags in a primary barrier - Plan of worked example 2	126
12	Distribution of sub-barrier bags in a secondary barrier - Plan of worked example 3	127
13	Construction of conventional stone dust board	129
14	Spacing of stone dust boards	130
15	Effective Temperature chart	154



01/

INTRODUCTION

- 1.1 Background**
 - 1.2 Purpose**
 - 1.3 Legal status of this document**
 - 1.4 Structure of this document**
 - 1.5 References used in this document**
-

1.1 Background

A new regulatory framework for mining in New Zealand came into force in December 2013.

A set of Approved Codes of Practice and guidance supports the new Regulations. Each of the following Codes contains information to assist a site senior executive in developing the Principal Hazard Management Plans and Principal Control Plans required by the Regulations:

Principal Hazard Management Plans (PHMPs)

- > Ground or strata instability
- > Inundation and inrush of any substance
- > Mine shafts and winding systems
- > Roads and other vehicle operating areas
- > Tips, ponds and voids
- > Air quality
- > Fire or explosion
- > Explosives
- > Gas outbursts
- > Spontaneous combustion in underground coal mining operations
- > Any other hazard at the mining operation identified by the site senior executive as a hazard that could create a risk of multiple fatalities in a single accident, or a series of recurring accidents at the mining operation.

Principal Control Plans (PCPs)

- > Ventilation
- > Mechanical engineering
- > Electrical engineering
- > Emergency management
- > Worker health

This Approved Code of Practice provides information on the content of the **Fire or Explosion Principal Hazard Management Plan**.

1.2 Purpose

The purpose of this Approved Code of Practice is to provide practical guidance to employers, contractors, employees, and all others engaged in work associated with mining, on how they can meet obligations with respect to fire or explosion, under the Health and Safety in Employment Act 1992 (HSE Act) and its associated Regulations. It includes outcomes required and operating procedures where there is an identified hazard that requires fire or explosion controls.

An Approved Code of Practice applies to anyone who has a duty of care in the circumstances described in the Code – which may include employers, employees, the self-employed, principals to contracts, owners of buildings or plant, consultants and any person involved in the operations.

An Approved Code of Practice does not necessarily contain the only acceptable ways of achieving the standard required by the HSE Act. But, in most cases, compliance will meet the requirements of the HSE Act.

Non-compliance with an Approved Code of Practice is not, of itself, an offence, but failure to comply will require an employer and/or principal to demonstrate that they are controlling hazards to a standard equivalent to or better than that required by the Approved Code of Practice.

1.3 Legal status of this document

This Code of Practice has been approved by the Minister under section 20A of the HSE Act. It gives practical advice on how to comply with the law. Following the advice is enough to comply with the law in respect of those specific matters on which the Approved Code of Practice gives advice. Alternative methods to those set out in this Approved Code of Practice may be used in order to comply with the law.

1.4 Structure of this document

The Regulations reproduced in this Approved Code of Practice are from the Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013.

The Regulations and the Approved Code of Practice requirements are accompanied by guidance. This guidance does not form part of the Approved Code of Practice and provides additional information and recommended actions to assist the mine/tunnel operator. Following the guidance is good practice and mine/tunnel operators are free to take other action provided it is to a standard that complies with the HSE Act. WorkSafe NZ inspectors may refer to this guidance as illustrating good industry practice.

While every effort has been made to include and accurately reproduce each Regulation to which this Approved Code of Practice applies, it is the responsibility of the mine or tunnel operator to ensure that the Regulations are read and understood in their entirety to establish whether any additional compliance requirements must be met.

1.5 References used in this document

References in this Approved Code of Practice to other documents do not imply approval by WorkSafe NZ of that document except to the extent necessary to give effect to this Approved Code of Practice.

02/

SCOPE

- 2.1** Operating types to which this Approved Code of Practice applies
 - 2.2** References to mine and tunnel operations and operators
 - 2.3** References to roles, responsibilities, training and competencies
 - 2.4** References to methane
 - 2.5** References to risk appraisal and assessment
 - 2.6** Mine plans and schematics
-

2.1 Operating types to which this Approved Code of Practice applies

This Approved Code of Practice applies to all coal and metalliferous underground mines, and tunnels under construction, that meet the definition in the legislation.^{1 2}

These operating types are defined as below.

2.1.1 General

The content applies to any underground mine, or tunnel under construction, where people are working underground.

2.1.2 Coal mine

The content is specific to underground mines where operations are focused on the exploration or extraction of coal, or metalliferous mines and tunnels where methane is present at levels greater than 0.25%.

2.1.3 Metalliferous mine

The content is specific to underground mines where operations are focused on the extraction of materials other than coal.

2.1.4 Tunnel

The content is specific to tunnels under construction.^{3 4}

Where applicable, and where it does not contradict the legislation or the requirements of this Approved Code of Practice, BS 6164:2011 “Code of Practice for health and safety in tunnelling in the construction industry” may be used as a reference for good practice in the construction of tunnels.

2.2 References to mine and tunnel operations and operators

Where there are references in this Approved Code of Practice to mine and tunnel operations and operators, the meanings applied to each should be as per those outlined in sections 19L, 19M, 19O and 19P of the HSE Act.

2.3 References to roles, responsibilities, training and competencies

The Regulations and this Approved Code of Practice refer to safety critical roles, responsibilities, training and competencies. Mine and tunnel operators are required to ensure they appoint people to carry out key safety critical roles and that people appointed to these roles meet the competency requirements set out in the Regulations.

¹ Health and Safety in Employment Act 1992. Section 19O. Meaning of tunnelling operation
² Health and Safety in Employment (Tunnelling Operations—Excluded Operations) Order 2013
³ Health and Safety in Employment Act 1992. Section 19O. Meaning of tunnelling operation
⁴ Health and Safety in Employment (Tunnelling Operations—Excluded Operations) Order 2013

The Regulations also set out the legal responsibilities for developing Principal Hazard Management Plans and Principal Control Plans. The fulfilment of this requirement may be delegated by the person to whom the legal responsibility is appointed. For example, Regulation 143 outlines the legal responsibilities of the mine operator in relation to the quantity and velocity of air in underground parts of a mining operation. The mine operator may delegate the practical responsibility to the mine manager, however, the mine operator retains the legal responsibility for the requirement being met.

The relevant legislative and regulatory requirements are reproduced in Appendix B of this Approved Code of Practice. See separate guidance that provides more detailed information on the role of management, and requirements in relation to roles, responsibilities and competencies of people employed at underground mines and tunnels.

2.4 References to methane

The Regulations and this Approved Code of Practice refer to methane. References to methane should be taken to include all flammable gases that can be encountered underground such as ethane, propane, carbon monoxide, hydrogen sulphide and hydrogen, which can be present in coal and metalliferous mines, and tunnels.

2.5 References to risk appraisal and assessment

The Regulations and this Approved Code of Practice refer to risk assessments. References to risk assessments should be taken to mean the requirements outlined in Regulations 54 and 55 of the Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013, and in associated standards such as:

- > MDG 1010:2011 “Minerals Industry Safety and Health Risk Management Guideline”;
- > AS/NZS ISO 31000:2009 “Risk Management – Principles and Guidelines”;
- > SA/SNZ HB 436:2013 “Risk Management Guidelines”; and
- > SA/SNZ HB 89:2013 “Risk Management – Guidelines on risk assessment techniques”.

2.6 Mine plans and schematics

Mine plans and schematics are included in this Approved Code of Practice to support some of the Code’s guidance information.

When preparing mine plans, the scale and use of symbols, abbreviations and colours should comply with AS 4368-1996 “Mine plans – Preparation and symbols”.

The accuracy of New Zealand mine plans is also important and should be relative to New Zealand co-ordinates. To ensure accuracy, the co-ordinate system for surveying, mapping and positioning is the “New Zealand Geodetic Datum 2000 – (NZGD2000)”, which should be used with AS 4368-1996 when preparing New Zealand plans.

For more detailed information on the preparation of mine plans and surveying requirements, see the Approved Code of Practice on Surveying.

03/

GENERAL PROVISIONS

- 3.1** Applicable Legislation and Regulations
 - 3.2** Mine and tunnel safety management – Requirement for systems and plans
 - 3.3** Requirement for a Principal Hazard Management Plan for Fire or Explosion
 - 3.4** Controlling a hazard – The hierarchy of controls
-

LEGISLATION

3.1 Applicable Legislation and Regulations⁵

- > *Health and Safety in Employment Act 1992*
- > *Electricity Act 1992*
- > *Hazardous Substances and New Organisms Act 1996*
- > *Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013*
- > *Electricity (Safety) Regulations 2010 and Electricity (Safety) Amendment Regulations 2013.*

REG 60

Consultation

The site senior executive must consult with mine workers and site health and safety representatives about the content of the health and safety management system when—

- (a) preparing the health and safety management system; and
- (b) reviewing the health and safety management system, or any part of it.

ACOP

3.2 Mine and tunnel safety management – Requirement for systems and plans

Part 2 of the Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013 requires all mines and tunnels to have in place formal health and safety management systems.

3.2.1 Safety Management Systems

A **Safety Management System** for a mine or tunnel is the primary means of ensuring safe operations at the site. It brings together a number of procedures and policies to suit the risks and complexity of the site's operations. The Safety Management System should be part of, and integrated with, the overall management system for the mine or tunnel.⁶

3.2.2 Hazard Management Systems

A **Hazard Management System** is part of the Safety Management System. It ensures that hazards are systematically identified and assessed and suitable control measures put in place to mitigate the risks presented by a particular hazard.

3.2.3 Principal hazards

A **principal hazard** is defined as any hazard arising in the underground mine or tunnel that could create a risk of multiple fatalities in a single accident, or a series of recurring accidents, and for which particular processes must be adopted to mitigate the risks presented. Principal hazards have the potential for very serious consequences if not adequately controlled, even though the likelihood of them happening may be low.

⁵ See <http://www.legislation.govt.nz/>

⁶ Ministry of Business, Innovation and Employment. (2013). *Guidance for a Hazard Management System for mines*. Wellington, New Zealand. 7-9.

3.2.4 Principal Hazard Management Plans and Principal Control Plans

For each identified principal hazard, the mine or tunnel operator must have in place a **Principal Hazard Management Plan**, and a **Principal Control Plan**, depending on the type of hazard identified. Both of these plans are elements of the overall Safety Management System.

- (a) A Principal Hazard Management Plan helps the mine or tunnel operator to bring together all of the risks associated with an identified principal hazard at the mine or tunnel and manage the risks in a systematic way. The Principal Hazard Management Plan outlines a suite of controls for the management of the hazard.
- (b) A Principal Control Plan outlines processes that can address a number of principal hazards (for example, ventilation, electrical and mechanical engineering, and emergency management).

Regulation 60 requires consultation with mine workers in the development of the plans. The plans must be reviewed at least every two years, independently audited at least every three years, and be available for review by WorkSafe NZ.

For more detailed information on the relationships between safety systems and plans, and an explanation of their recommended content, see separate guidance.⁷

REG 67

67 General purposes of principal hazard management plans

The general purposes of the principal hazard management plans are to—

- (a) *identify the nature of all principal hazards at any mining operation:*
- (b) *set out the measures that will be used to ensure that all principal hazards are effectively managed.*

REG 85

85 Principal hazard management plan for fire or explosion

(1) *The following matters must be considered in the development of the principal hazard management plan for fire or explosion:*

- (a) *the installation of ventilation control devices to control the supply of ventilation to the underground parts of the mining operation and the means used to ensure that ventilation control devices are not interfered with:*
- (b) *potential sources of flammable, combustible, and explosive materials, both natural and introduced, including gas, dust, fuels, solvents, and timber:*
- (c) *the placement of the main fans, and provision of other devices for a main fan, such as measuring or monitoring devices:*

⁷ Ministry of Business, Innovation and Employment. (2013). *A guide to developing Safety Management Systems for the extractives industry*. Wellington, New Zealand.

- (c) *potential sources of ignition including equipment, static electricity, electricity, spontaneous combustion, lightning, hot work, and other work practices:*
 - (d) *potential for propagation of fire or explosion to other parts of the mining operation:*
 - (e) *the use, presence, and storage of flammable and explosive substances including combustible ore, sulphide dust, coal dust, or methane.*
- (2) *The principal hazard management plan for fire or explosion must include—*
- (a) *a description of the potential sources described in subclause (1)(a) to (c) and of the potential for propagation of fire or explosion:*
 - (b) *procedures for the use, presence, and storage of flammable and explosive substances:*
 - (c) *provision for hot-work procedures, including any restrictions on doing hot work if applicable under Regulation 161:*
 - (d) *provision for live electrical work procedures, including any restrictions on doing live electrical work if applicable under Regulation 195:*
 - (e) *details of the type and location of the systems for prevention, early detection, and suppression of fire (including remote monitoring systems) and of the equipment for firefighting at the mining operation:*
 - (f) *where a gas monitoring system is in place, provision for the use of portable gas detectors fitted with suitable extension probes to monitor the presence of methane in the event that the gas monitoring system, or part of it, fails or becomes non-operational:*
 - (g) *reference to the principal control plan for emergency management and the location of changeover stations, or refuge chambers, where they exist:*
 - (h) *in respect of coal mining operations, the methods that will be used to limit the generation of coal dust, which must include the use of dust suppression systems at coal crushers, coal conveyors, and conveyor transfer points.*
- (3) *In the case of an underground coal mining operation, the principal hazard management plan must also set out the methods that will be used to—*
- (a) *minimise the amount of coal dust resulting from the use of mechanical mining systems:*
 - (b) *minimise the accumulation of coal dust on roadways and on other surfaces in the roadways, and remove accumulations of coal dust from the roadways and other surfaces:*
 - (c) *suppress airborne coal dust and remove it from the workings of the mining operation:*
 - (d) *determine the rate of application of stone dust that is necessary to minimise the risk of a coal dust explosion:*

COAL

- (e) *suppress coal dust explosions and limit propagation of coal dust explosions to other parts of the mining operation:*
- (f) *monitor and take samples of roadway dust, including any stone dust that has been applied, to ensure that the methods outlined in the principal hazard management plan are adequate and sufficiently implemented to prevent and suppress coal dust explosions.*

3.3 Requirement for a Principal Hazard Management Plan for Fire or Explosion

The mine or tunnel operator should ensure that the Fire or Explosion Principal Hazard Management Plan includes a fire protection plan that details the sources of fire, and the controls in place to prevent, monitor and mitigate the outbreak and spread of fire.

The Principal Hazard Management Plan outlines in one formal document the fire or explosion risks present at the mining or tunnelling operation, and all of the activities being undertaken to control the risk of an underground fire or explosion occurring. This ensures the systematic planning and effective implementation of suitable fire or explosion control systems.

When developing the Fire or Explosion Principal Hazard Management Plan, the mine or tunnel operator should include detailed analysis of the following considerations:⁸

- (a) Fire or explosion risks based on:
 - Potential sources of fuel and ignition
 - Locations potentially at risk
 - Impacts of a potential fire or explosion
 - Collection of risk information (eg fire survey).
- (b) Fire prevention controls:
 - Operating and maintenance procedures relating to fire or explosion controls
- (c) Monitoring controls:
 - Inspection programmes
 - Selection and location of monitors
- (d) Mitigation controls:
 - Firefighting equipment, detection and suppression systems (including stone dusting)
 - Emergency procedures
- (e) Hazard reporting procedures
- (f) Records maintenance, and auditing

⁸ See Regulation 85 of the Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013 for all of the content required in a Fire or Explosion Principal Hazard Management Plan.

It is important the Fire or Explosion Principal Hazard Management Plan is developed in the context of the whole Safety Management System, and not in isolation from other Principal Hazard Management Plans and Principal Control Plans that rely on the Fire or Explosion Principal Hazard Management Plan as a control (eg Ventilation, Air Quality, Spontaneous Combustion, Gas Outburst and Mechanical Engineering). This will ensure gaps and overlaps in information and procedures are identified and used in the implementation of suitable controls to minimise the likelihood and potential impacts of a fire or explosion taking place.

Regulation 212 requires that the draft Fire or Explosion Principal Hazard Management Plan should be available for examination by a WorkSafe NZ inspector at least two months before the commencement of underground operations at a mine or tunnel. This includes excavation work where top cover and shaft sinking beyond the top soil is intended, but does not include general civil construction work.

GUIDANCE

3.4 Controlling a hazard – The hierarchy of controls⁹

To take all practicable steps to control a hazard, identifying how to control it must first be planned.

The control hierarchy is outlined in the HSE Act and requires that ‘all practicable steps’ to control each hazard be taken. The HSE Act is very specific about the order in which the appropriate controls for a hazard must be considered.

3.4.1 Elimination

Elimination of the hazard should be the first priority for controlling a hazard as it completely removes the potential harm that the hazard presents.

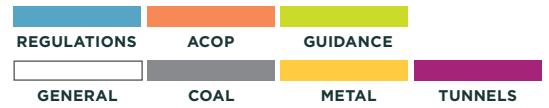
3.4.2 Isolation

Isolation of the hazard provides a barrier that prevents people being exposed to the hazard. The hazard still exists, but people are protected provided that the isolation method is monitored and maintained.

A hazard may be isolated using time or space or in conjunction with other control methods. For example, most workers may be isolated from the hazard, but trained or specialist personnel may be required to access the hazard in order to restore a safe environment.

Isolation of the hazard should only be used as a control method when elimination of the hazard is not practicable.

⁹ Health and Safety in Employment Act 1992. Part 2. Duties relating to health and safety in employment. Duties of employers in relation to hazard management.



3.4.3 Minimisation

Minimisation is the least preferred method to control a hazard. Where practicable steps to eliminate or isolate a hazard are available, to use minimisation as a control contravenes the HSE Act. This is because unlike elimination and isolation, there is still a level of exposure to the hazard.

The HSE Act places duties of care upon duty holders to prevent harm. Minimisation only reduces the risk or actual harm that may result from the hazard.

Where minimisation steps are taken, workers may still be harmed. However the likelihood of harm, and the severity of potential injury, are minimised.

04/

CAUSES OF FIRE AND UNCONTROLLED EXPLOSIONS

RISK APPRAISAL - IDENTIFYING THE HAZARDS

- 4.1 Fire or explosion in an underground environment**
 - 4.2 The properties of fire**
 - 4.3 Sources of fuel (flammable, combustible and explosive material)**
 - 4.4 Sources of ignition, fire or explosion**
 - 4.5 Oxygen**
 - 4.6 Potential for the above to come together**
-

REG 85

85 Principal hazard management plan for fire or explosion

- (1) *The following matters must be considered in the development of the principal hazard management plan for fire or explosion:*
- (a) *potential sources of fire and explosion at the mining operation:*
 - (b) *potential sources of flammable, combustible, and explosive materials, both natural and introduced, including gas, dust, fuels, solvents, and timber:*
 - (c) *potential sources of ignition including equipment, static electricity, electricity, spontaneous combustion, lightning, hot work, and other work practices:*
 - (d) *potential for propagation of fire or explosion to other parts of the mining operation:*
 - (e) *the use, presence, and storage of flammable and explosive substances including combustible ore, sulphide dust, coal dust, or methane.*

REG 100

100 Electrical engineering control plan

- (1) *The electrical engineering control plan must, at a minimum, address the following matters:*
- (b) *the prevention of fires being ignited by electrical energy:*

REG 77

77 Principal hazard management plans for mine shafts and winding systems

- (2) *A principal hazard management plan for mine shafts and winding systems must, at a minimum, provide for the following:*
- (a) *the measures to be used to eliminate, isolate, or minimise—*
 - (i) *the occurrence of fires in a shaft; and*

ACOP

4.1 Fire or explosion in an underground environment

The confined, complex, physical environment underground presents significant risk to mine workers in a fire or explosion.

The site senior executive should ensure that the following influences are taken into consideration when assessing the risk of a fire or explosion taking place underground:

- (a) The surrounding geology.
- (b) The structural layout and composition of the mine or tunnel workings.
- (c) The production methods, procedures, techniques and maintenance of equipment being used.
- (d) The fire safety training of mine workers.
- (e) Communication and information exchange between internal and external stakeholders.

To ensure that fire or explosion risks are adequately controlled, the mine or tunnel manager should ensure that there are in place:

- (i) Good operational procedures.
- (ii) Good maintenance of mechanical, mobile and electrical equipment.
- (iii) Proper storage and clean-up of combustible and flammable liquids.
- (iv) Good safety training.
- (v) Good communication between management, mine workers and WorkSafe NZ.

GUIDANCE

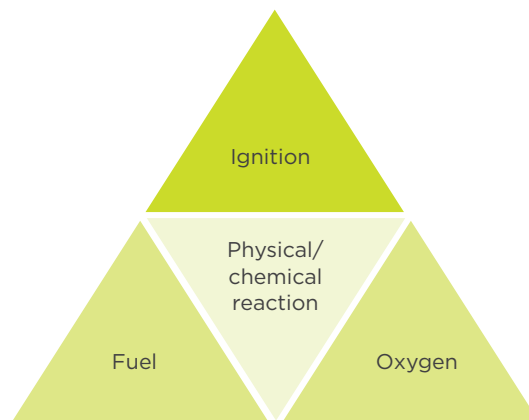


Figure 1 - The Fire Triangle

4.2 The properties of fire

Fire is a combination of chemical and physical changes in which substances interact with each other to release heat, light, smoke and ash.

In order to start, fire requires three main elements - 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 fire-fighting). Flames can be eliminated by cooling or smothering them, removing oxygen, or depriving them of fuel.

In an underground mine or tunnel, if undetected, the by-products of fire may be carried through the workings (such as roadways, or the ventilation system), creating a toxic and potentially explosive atmosphere.

4.2.1 Open fires

Open fires can occur at any location underground where combustible material is present. Equipment, in particular conveyors, electrical infrastructure and vehicles are other common places where a fire may occur. Open fires are usually accompanied by flaming combustion because of the availability of oxygen.

4.2.2 Concealed fires

Concealed fires are difficult to detect underground as they usually occur in inaccessible places such as goafs and sealed workings. Concealed fires are usually caused by spontaneous combustion, which can occur in coal and sulphide ore minerals, and within oily rags, paper or timber.

4.3 Sources of fuel (flammable, combustible and explosive material)

The storage, handling and use of flammable and combustible liquids underground pose a special fire hazard for all mining and tunnelling operations. Mobile equipment is typically diesel-powered, and a large percentage of fires involve the fuel used by these machines. In coal mines, diesel fires are compounded by the presence of coal, coal dust and methane.

Flammable and combustible liquids are often stored underground in most metalliferous mines in limited quantities. In some mines, the main storage facility for diesel fuel, lubricating oil and grease, and hydraulic fluid is underground.

A fire in an underground flammable and combustible liquid storage area is an important consideration in the design of the storage area, as well as the implementation and strict enforcement of safe operating procedures.¹⁰

4.3.1 Diesel

Burning diesel oil (and any plastic or rubber compounds that may come into contact with it) produces gases such as carbon monoxide, carbon dioxide, sulphur dioxide, oxides of nitrogen, hydrogen and hydrogen sulphides.

Diesel is also a key component of ANFO (ammonium nitrate/fuel oil) explosives, which are created when diesel mixes with ammonium nitrate.

4.3.2 Timber

When timber reaches a temperature of about 150°C, the heat decomposes some of the cellulose material that makes up the wood. Some of that decomposed material is released as volatile gases (ie smoke). When the volatile gases are hot enough (about 260°C), the compound molecules break apart, and the atoms recombine with the oxygen to form water, carbon dioxide and other products (ie they burn).

4.3.3 Plastics and rubber

When plastics burn, they rapidly give off gases such as carbon monoxide, carbon dioxide and, if polyurethanes, nylon or polyvinyl chloride PVC, they can give off hydrogen cyanide, hydrochloric and hydrofluoric acid fumes. Phenolic plastics require a higher temperature to burn. Rubber-based compounds in vehicle tyres may also release hydrogen sulphide when heated.

¹⁰ Retrieved from <http://www.ilo.org/oshenc/part-xi/mining-and-quarrying/item/607-fires-and-explosions-in-mines>

4.3.4 Paper, rubbish and other waste materials

Paper ignites at 233°C and quickly burns, which propagates temperature increases in other carboniferous material such as rubbish and waste.

4.3.5 Methane

Methane forms in coal seams as the result of chemical reactions taking place when the coal was buried at depth. Methane occurs in much higher concentrations in coal than other rock types because of the adsorption¹¹ process, which enables methane molecules to be packed into the coal interstices (gaps or spaces) to a density almost resembling that of a liquid.

Methane and other gases stored in the coal seam and the surrounding rock can be released if they are disturbed by mining activity. The total gas flow varies proportionally to how much mining activity disturbs the surrounding rock and coal seam.

Methane is flammable when mixed with oxygen in a wide range of concentrations, but generally between 5-15% methane in air by volume. Gas released from mining activity inevitably mixes with the mine's ventilation air, is diluted and passes through the flammable range. It is therefore critical that methane concentrations in the flammable range are limited in time and location as much as possible, to reduce potential exposure to ignition sources and the risk of explosion. The autoignition temperature of methane is 537°C.

Methane is buoyant and rises in air, and layering of methane can occur in poorly ventilated areas underground. Concentrated methane tends to collect in roof cavities and to layer along the roofs of airways, working faces or goafs. Layering extends the area that can be ignited, and effectively acts as a fuse along which a flame can propagate, igniting a much larger accumulation of gas.

For more detailed information on methane and methane management, see the Approved Code of Practice on Ventilation.

4.3.6 Coal and coal dust

Coal dust is finely divided matter smaller than 100 micrometer (μm) and of low mass. It can remain suspended in air for a relatively long time and is hazardous because it can be carried through the ventilation system for hundreds of metres, gradually falling out at various places along roadways and workings (this is indicated by the Johannesburg curve for respirable dust¹²). In a methane explosion, if enough wind pressure is created, the coal dust is raised into the air and re-distributed, potentially igniting a more deadly secondary coal dust explosion.¹³

COAL

¹¹ See Definitions.

¹² Belle, B. K. (2004, April/June). International Harmonisation Sampling Curve (ISO/CEN/ACGIH): Background and its influence on dust measurement and exposure assessment in the South African mining industry. *Journal of the Mine Ventilation Society of South Africa*. 55.

¹³ Safety in Mines Research Advisory Committee (SIMRAC). (1996, April). *Handbook to reduce the exposure of workers to dust. Final Project*. University of Witwatersrand. Johannesburg, South Africa: Members of the Special Interest Group on Dust and Ventilation. 3/11.

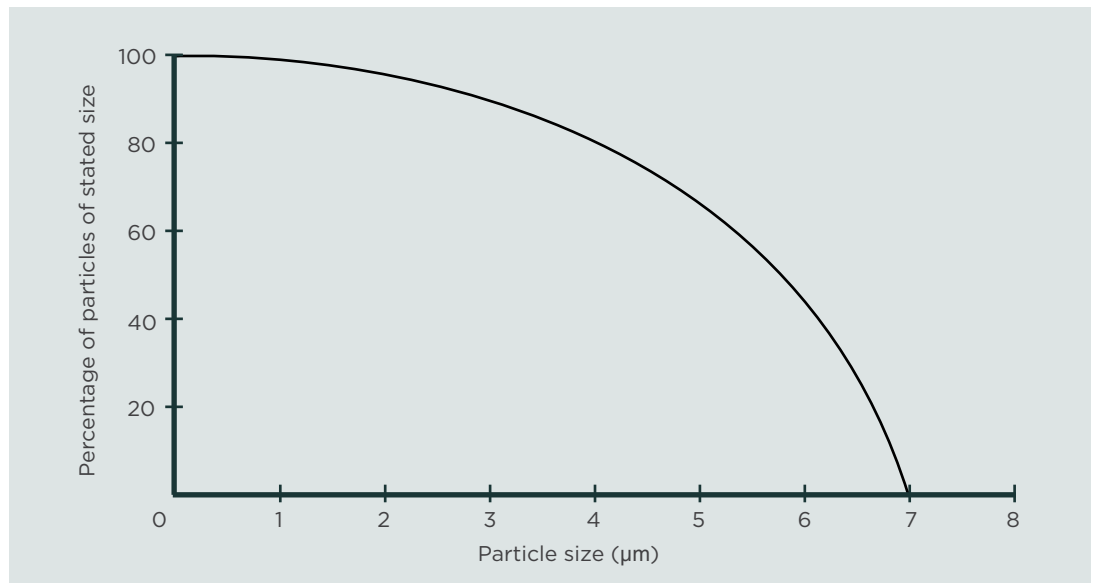


Figure 2 – The Johannesburg Curve

A solid coalface has little danger of igniting because of its small surface area and low porosity. However, when coal is fractured during production, or from roof pressure or faulting, the smaller the particles of coal, the greater the surface area, and the greater the risk of it igniting. Coal dust particles in coal dust explosions are smaller than 240 µm and a minimum dust concentration of approximately 50 g/m³. The most violent explosions take place when coal dust concentrations of 150 to 350 g/m³ are present.

One of the primary controls against coal dust explosions is the spreading of stone dust throughout mine roadways to reduce the potential for the propagation of an explosion.¹⁴ For more detailed information on stone dusting, see section 8.8.

4.3.7 Sulphide dust

In the same way that coal dust may cause a secondary explosion in a coal mine, where there is a source of sulphide material in a metalliferous mine, the dust created during production (eg shotfiring) may act as a source of fuel.

In general, all sulphide dusts of fineness below about 50 µm are flammable and can be ignited by thermal energies well below those commonly generated by shotfiring.

Sulphide minerals oxidise rapidly when broken and exposed to air and, in mining operations where minerals become dispersed as dusts, sparks or heat flash from shotfiring can initiate an explosion.

¹⁴ Department of Natural Resources, Mines and Energy. (2013, August). Review of Queensland underground coal mines' stone dust application and sampling and analysis of roadway dust. *Safety Bulletin 134*. Queensland, Australia.

The flame generated by the detonating blasting agent ignites the sulphide dust generated by the detonation or blast (or dust may be present from prior blasting or other mining activities).

The resulting dust explosion can not only cause considerable damage underground and potentially harm workers, they can also produce large quantities of sulphur dioxide and other noxious gasses that can permeate the underground atmosphere for hours.

Monitoring of atmospheric dust content is vital in controlling sulphide dust explosions, because it can provide dust composition, concentration and size distribution. Monitoring information will also point to the occurrence of ignition events which show up through characteristic changes in chemical composition of the dust.¹⁵

4.4 Sources of ignition, fire or explosion

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

4.4.1 Diesel equipment

Diesel equipment is operated by an internal combustion engine that uses the heat of compression to initiate ignition and burn fuel that has been injected into the combustion chamber. The carbon monoxide content of the exhaust is minimal, which is why diesel engines tend to be used underground.

Fires on diesel-powered mining equipment are caused by leaking high-pressure hydraulic lines that can spray a heated mist of highly combustible liquid onto an ignition source, such as a hot exhaust manifold or turbocharger. Fires on this type of equipment can grow quickly.¹⁶

Underground diesels are frequently turbocharged; having more air in the cylinders allows more fuel to be burned and more power to be produced.

Turbocharging can improve the fuel economy of diesel engines by recovering waste heat from the exhaust, increasing the excess air factor, and increasing the ratio of engine output to friction losses. However, the surface temperature of turbochargers can exceed 500°C during normal operating, rising to beyond 600–700°C following engine shutdown. Irrespective of whether the turbochargers are heat-shielded, the turbocharger's surface temperature is hot enough to ignite fuel or oil when it comes into contact with it.¹⁷ Turbocharged engines can also cause heat and/or sparks if power cables are damaged or crushed.

¹⁵ Department of Industry and Resources. (1997). *Safety Management of Underground Combustible Sulphide Dust Guideline*. WA, Australia.

¹⁶ Retrieved from <http://www.ilo.org/oshenc/part-xi/mining-and-quarrying/item/607-fires-and-explosions-in-mines>

¹⁷ Department of Mines and Energy. (2008, 2 July). Diesel Engine – Turbocharger Fires. *Safety Bulletin 83*. Queensland, Australia.

Poorly maintained diesel engines can produce hot carbon particles in the exhaust system, creating an additional fire hazard. Faulty or binding brakes are known to cause grease fires in wheel hubs, potentially igniting vehicle tyres.¹⁸

4.4.2 Mechanical equipment

Most mechanical equipment used in underground mines and tunnels contains not only fuel sources (eg lubrication oils and greases, and hydraulic fluid) but also ignition sources (eg moving parts, heat and electrical equipment).

In addition to this equipment, maintenance workshops generally contain a variety of tools, materials and equipment (eg degreasing equipment) that are a hazard in any workshop environment.

Fires attributed to mechanical equipment are generally caused by:¹⁹

- (a) Lack of proper maintenance.
- (b) Misuse.
- (c) Removal of bypassing safety features such as diagnostic devices, environmental monitors or thermal trip switches.
- (d) Equipment that has been left running unattended for long periods of time.

4.4.3 Electrical infrastructure and equipment

Electrical infrastructure and equipment such as distribution boxes, cable shafts, vaults, circuit breakers, cables, wires, and transformers can become a source of ignition through sparking or overheating.²⁰ Fire may be caused by short circuits, earthing faults, faulty distribution systems or electrostatic discharges. Electrical equipment operating where methane, sulphide dust or other fire hazards may be present should be closely monitored. As with mechanical equipment, electrical fires may be the consequence of equipment misuse, removal of safety protection, lack of maintenance, or tampering.

4.4.4 Conveyors

By their design, conveyors present a significant fire risk underground because they can carry a fire along their belt length very quickly. There are many types of flame resistant belting available to eliminate or slow the propagation of fire on a conveyor system.

Conveyor fires are usually started by the friction caused when the belt becomes staked at any point and the drive rollers continue to rotate, resulting in high temperatures developing at the drive end. A seized belt roller or return roller may also become red hot from the friction of the belt running over it.

¹⁸ Department of Natural Resources, Mines and Energy. (2004, 30 April). Tyre Fires, Pyrolysis and Explosions. *Safety Bulletin 47*. Queensland, Australia.

¹⁹ Trade & Investment Mine Safety. (2013, November 25). Too many underground fires. *Safety Bulletin No. SB 13-05*. NSW, Australia.

²⁰ Swedish Association of Mines, Metal and Mineral Producers. (2009). *Fire Safety in Mines and Underground Constructions*. Sweden: The Fire Safety Committee of the Swedish Mining Industry's Health and Safety Committee. 18-22.

Additional risk is presented by worn bearings that become red hot. When the bearing casing cracks, hot grease spills onto any nearby surface.

Belts that are misaligned and rub against the conveyor structure or roadway sides, or run through spillage, are also known to cause fires underground.

4.4.5 Frictional ignitions

Frictional ignitions are caused by a spark or very hot stone particle produced as a result of rubbing or impact during coal excavation. The gas released by the fragmenting of the coal coming directly from the seam becomes ignited by heat from the fast-moving cutting machine picks striking against a sandstone or pyritic material.

Additional potential frictional ignition sources may include mechanical clutches, belts or V drives for machinery transmissions.

See the Appendix for more detailed information on the control of frictional ignitions during production.

4.4.6 Hot work

Hot work (or the use of welding and gas-cutting equipment) may propagate fire even in a non-gassy mine, as a result of the hot slag and sparks or burning and grinding produced during this type of work. Combustible materials located near where the work is being carried out are an additional source of fuel.

4.4.7 Contraband

Contraband (or the use or presence of banned materials underground) is difficult to detect due to its concealment, whether intentional or unintentional. Contraband has been known to cause explosions in mines and tunnels. Mine workers may forget that they are wearing a battery-powered watch or hearing aid, or carrying a mobile phone, which may ignite methane in some situations.

Contraband also includes any material that can cause sparks or any material with electric components. See section 6.13 for more detailed information on control of the risks associated with the presence of contraband underground.

4.4.8 Chemicals

Certain chemicals, such as those used in battery acid, chemical anchors, and grouts, paints and solvents, can react to cause excessive heat or create explosive properties. Such chemicals should be stored as recommended by the manufacturer.

4.4.9 Explosives

Explosives, or incandescent particles released during shotfiring, present an obvious hazard in an underground environment, but they can also be an ignition source for suspended dust or hazardous gases (see the previous sections on coal and sulphide dust explosions). Explosives also have the potential to ignite dry wood or other combustible material.

4.4.10 Spontaneous combustion

Spontaneous combustion is a type of combustion that occurs by self-heating (temperature increase) due to exothermic-internal reactions, followed by thermal runaway (self-heating which rapidly accelerates in high temperatures) and finally ignition.²¹

For more detailed information, see the Approved Code of Practice on Spontaneous Combustion.

4.4.11 Self-rescuers

A self-rescuer is a device that provides breathable air to the mine worker wearing it when the breathing of oxygen is impaired, such as during an underground fire. A self-rescuer should be provided to, and carried or worn by, every mine worker entering an underground mine or tunnel.

Oxygen-generating self-rescuers can generate excessive heat when crushed or when the correct initiation process has not been followed and are known to catch fire in some situations.²²

For more detailed information on self-rescuers see the approved code of practice on *Emergency Preparedness in Mining and Tunnelling Operations*.

4.5 Oxygen

The main source of oxygen for an underground fire or explosion is in the general body of air. Unless a fire or explosion occurs in an enclosed space (such as in a sealed goaf, storeroom or within pipe work), the fire will have a ready supply of oxygen as the ventilation system draws air around the mine or tunnel workings.

An explosive atmosphere can be controlled by 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.

²¹ Department of Natural Resources, Mines and Energy. (2012, 20 September). Exposure to toxic gases associated with spontaneous combustion at surface coal mines. Safety Bulletin 120. Queensland, Australia.

²² Trade & Investment Mine Safety. (2005). Self contained rescuer combustion reaction. *Safety Alert.13-05*. NSW, Australia.

Low rates of airflow provide sufficient oxygen to the combustion process, but may not be strong enough to carry fire products away. This creates 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 inbye to 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.

Additionally, other sources of oxygen can be some chemicals or substances that release oxygen when heated (oxidising agents). These include hydrogen peroxide, ANFO (or its main component, ammonium nitrate), bottled oxygen and compressed air in ranges.²³

4.6 Potential for the above to come together

The above fuels, ignition sources and airflows can, in the right condition of coexistence, form a flammable or explosive atmosphere. If undetected, the by-products of fire may be carried throughout the mine or tunnel workings, creating the potential for a deadly atmosphere – either not fit for respiration, or explosive, or both.

²³ Health and Safety Executive (HSE). *The prevention and control of fire and explosion in mines*. Retrieved from <http://www.hse.gov.uk/mining/feguidance.pdf>. 11.

05/

PLANNING AND ASSESSMENT

RISK ASSESSMENT - IDENTIFYING CONTROLS TO MANAGE THE RISK

- 5.1 Evaluating the likelihood of fire or explosion**
 - 5.2 Potential for risks**
 - 5.3 Evaluation of who might be harmed and how**
 - 5.4 Recording significant findings**
 - 5.5 Risk assessment and the emergency plan**
 - 5.6 Reviewing the assessment**
-

REG 54

54 Risk appraisal

The site senior executive must ensure that—

- (a) *a process is in place to systematically identify the hazards to mine workers at the mining operation; and*
- (b) *the process is used when developing, implementing, and maintaining the health and safety management system, including, without limitation, each time the health and safety management system or any aspect of it is reviewed.*

REG 55

55 Risk assessment

(1) *The site senior executive must ensure that—*

- (a) *a process is in place to assess the inherent risk of harm to mine workers from identified hazards at the mining operation and to identify the controls required to manage that risk; and*
- (b) *the process is used when developing, implementing, and maintaining the health and safety management system, including, without limitation, each time the health and safety management system or any aspect of it is reviewed.*

(2) *Nothing in this Regulation limits any specific provision in Parts 3 and 4 relating to the assessment of risks.*

REG 68

68 Content of principal hazard management plans

Each principal hazard management plan must include the following:

- (a) *a statement as to the nature of a principal hazard addressed by the principal hazard management plan:*
- (b) *a description of how all risk assessments will be conducted in relation to the principal hazard:*
- (c) *the results of any risk assessment completed in respect of the principal hazard:*
- (d) *a description of the control measures to be implemented to manage the principal hazard and the risk of harm it presents to the health and safety of mine workers:*
- (e) *a description of how any specific requirements or duties in the Regulations that apply to the principal hazard will be complied with:*
- (f) *a description of the emergency preparedness for the principal hazard:*
- (g) *a description of the roles and their corresponding responsibilities under the principal hazard management plan, including the competencies required to carry out the roles and the details of the responsibilities:*
- (h) *a statement of the periodic review of the principal hazard management plan's continued suitability and effectiveness in managing the principal hazard and the risks related to the hazard at the mining operation, in accordance with Regulation 69:*

- (i) a description of the audit programme in accordance with Regulation 70:
- (j) any other matter required by these Regulations in relation to particular principal hazards.

ACOP

5.1 Evaluating the likelihood of fire or explosion²⁴

The site senior executive should ensure that an evaluation of the likelihood of a fire or explosion occurring is carried out, and adequate measures are in place to eliminate, isolate or minimise the risk of an event occurring. The evaluation should consider:

- (a) The control measures already in place (eg the ability of the ventilation system to dilute any methane, and of any methane drainage system). For more detailed information on methane management, including methane drainage, see the Approved Code of Practice on Ventilation.
- (b) Whether there are any areas of the mine or tunnel where additional control measures are required (eg single-entries).
- (c) Materials used in the construction of the underground workings and infrastructure that present risk.
- (d) The likelihood, and impacts of, any abnormal circumstances that may occur (eg the malfunctioning of ventilation equipment or defects in the methane drainage system).
- (e) The potential consequences of special procedures or events (eg during maintenance work, or when ventilation is reduced).

5.2 Potential for risks

The site senior executive should ensure that any evaluation considers the potential consequences of:

- (a) Any flame, heat or blast wave.
- (b) Oxygen depletion, or the disruption of the ventilation system (eg due to doors being blown open or left open, or due to the buoyancy effects of hot gases affecting airflow).
- (c) Spread and concentrations of toxic and noxious gases and other fire products.
- (d) The distance mine workers are required to travel to a place of safety.
- (e) Reduced visibility underground due to the presence of smoke.

²⁴ Health and Safety Executive (HSE). *The prevention and control of fire and explosion in mines*. Retrieved from <http://www.hse.gov.uk/mining/feguidance.pdf>. 11-13.

5.3 Evaluation of who might be harmed and how

Because the ventilation system circulates air to nearly all places in the mine or tunnel, all mine workers underground are likely to be at some level of risk should a fire break out or an explosion occur.

When assessing the risks associated with a potential fire or explosion, the site senior executive should consider the effects on all mine workers underground at the time, and the level of risk to which each mine worker is exposed.

The assessment should include:

- (a) The number of all mine workers present at the mine or tunnel, and their locations underground.
- (b) The number and designation of all mine workers required to implement the Fire or Explosion Principal Hazard Management Plan, and the availability of adequate equipment and training for those mine workers.
- (c) The specific location of the potential fire or explosion, and whether it is on the intake side or downstream of where mine workers are situated.
- (d) The proximity of all mine workers to the site of the fire or explosion, and the direct effects on those in the immediate area.
- (e) An effective safety checking system to track who is underground at any given time, and where they are working. Special consideration should be given to transient mine workers (eg mobile equipment operators, maintenance staff, officials and management staff), who may be required to travel significant distances underground, and to a number of different locations, during their shift.
- (f) Any other relevant operating plans, including:
 - (i) Any maintenance and calibration programme that the mechanical or electrical superintendent is responsible for.
 - (ii) Equipment available for the protection of mine workers from toxic gases and hazardous substances.
 - (iii) A rockburst or gas outburst plan addressing the protection of mine workers working in, approaching, or travelling through, susceptible zones.
- (g) In the event of reduced visibility or a blocked egress, the availability of an alternative egress or escape route to the surface, or to a refuge chamber, including consideration of:
 - (i) The distance to the nearest refuge chamber or place of safety.
 - (ii) The time it will take to reach the nearest place of safety (taking into consideration factors such as the loss of visibility in smoke-filled roadways).
 - (iii) Egress and routes to safe areas are well-maintained and signposted.

- (h) The provision of self-contained self-rescuers to all mine workers underground, including their type, duration and accessibility, and the provision of training in their use.
- (i) The provision of regular training for all mine workers, to ensure competency in the safe operation of firefighting equipment and in firefighting procedures, where applicable.

5.4 Recording significant findings

The site senior executive should ensure that the details of any evaluation and assessment undertaken are recorded.

The records should meet the requirements outlined in Section 10 Records, and the control measures in place and their supporting operating procedures.

5.5 Risk assessment and the emergency plan

The assessment of suitable control measures should be used to inform the emergency plan for safe evacuation and rescue. For more detailed information about mine evacuation, mine rescue and emergency procedures, see the Approved Code of Practice on Emergency Management.

The site senior executive should ensure that considerations for the emergency management plan include:


- (a) Procedures during a fire or explosion, including the roles and responsibilities of those undertaking fire warden and fire-fighting duties.
- (b) All types of firefighting equipment, and its availability at specific underground locations.
- (c) Emergency arrangements, including a contact list for:
 - (i) Mines Rescue and other emergency services.
 - (ii) Every employer of people working at the mine or tunnel.
 - (iii) WorkSafe NZ's mining inspectorate.

5.6 Reviewing the assessment

The mine or tunnel manager should ensure that the fire or explosion risk assessment is reviewed every two years, or when there is any significant change to the mine or tunnel layout, and its systems, operations or personnel.

The review should consider the effects of:

- (a) Any changes to the mine or tunnel layout, or to production methods, or systems (including natural changes, extensions or conversions).
- (b) Moving activity from one area of the mine or tunnel to another.

- 
- (c) Changes being made to core systems such as ventilation or methane drainage (eg reversing airflow in a particular area).
 - (d) Changes in the amount and type of mobile equipment being used in the mine or tunnel.
 - (e) Relocating plant or equipment from one area of the mine or tunnel to another (eg if a conveyor is moved, firefighting equipment should remain on the intake air side, so it is available at the delivery, drive and loop take up).
 - (f) Changes to the mine operator's management structure or significant personnel changes within the organisation.

06/

PREVENTION CONTROLS

**DEVELOPING, IMPLEMENTING
AND MAINTAINING CONTROLS
TO MANAGE RISK**

- 6.1 Underground fire prevention controls**
 - 6.2 Explosion Risk Zones (ERZs)**
 - 6.3 Ventilation**
 - 6.4 Mobile equipment**
 - 6.5 Fixed mechanical plant**
 - 6.6 Fixed electrical equipment**
 - 6.7 Underground infrastructure**
 - 6.8 Flammable and combustible substances**
 - 6.9 Frictional ignitions**
 - 6.10 Hot work**
 - 6.11 Light metals (or aluminium)**
 - 6.12 Compressed air**
 - 6.13 Contraband**
-

REG 85

85 Principal hazard management plan for fire or explosion

- (1) *The following matters must be considered in the development of the principal hazard management plan for fire or explosion:*
- (a) *potential sources of fire and explosion at the mining operation:*
 - (b) *potential sources of flammable, combustible, and explosive materials, both natural and introduced, including gas, dust, fuels, solvents, and timber:*
 - (c) *potential sources of ignition including equipment, static electricity, electricity, spontaneous combustion, lightning, hot work, and other work practices:*
 - (d) *potential for propagation of fire or explosion to other parts of the mining operation:*
 - (e) *the use, presence, and storage of flammable and explosive substances including combustible ore, sulphide dust, coal dust, or methane.*
- (2) *The principal hazard management plan for fire or explosion must include—*
- (a) *a description of the potential sources described in subclause (1)(a) to (c) and of the potential for propagation of fire or explosion:*
 - (b) *procedures for the use, presence, and storage of flammable and explosive substances:*
 - (c) *provision for hot-work procedures, including any restrictions on doing hot work if applicable under Regulation 161:*
 - (d) *provision for live electrical work procedures, including any restrictions on doing live electrical work if applicable under Regulation 195:*
 - (e) *details of the type and location of the systems for prevention, early detection, and suppression of fire (including remote monitoring systems) and of the equipment for firefighting at the mining operation:*
 - (f) *where a gas monitoring system is in place, provision for the use of portable gas detectors fitted with suitable extension probes to monitor the presence of methane in the event that the gas monitoring system, or part of, fails or becomes non-operational:*
 - (g) *reference to the principal control plan for emergency management and the location of changeover stations, or refuge chambers, where they exist:*
 - (h) *in respect of coal mining operations, the methods that will be used to limit the generation of coal dust, which must include the use of dust suppression systems at coal crushers, coal conveyors, and conveyor transfer points.*
- (3) *In the case of an underground coal mining operation, the principal hazard management plan must also set out the methods that will be used to—*
- (a) *minimise the amount of coal dust resulting from the use of mechanical mining systems:*

COAL



- (b) *minimise the accumulation of coal dust on roadways and on other surfaces in the roadways, and remove accumulations of coal dust from the roadways and other surfaces:*
- (c) *suppress airborne coal dust and remove it from the workings of the mining operation:*
- (d) *determine the rate of application of stone dust that is necessary to minimise the risk of a coal dust explosion:*
- (e) *suppress coal dust explosions and limit propagation of coal dust explosions to other parts of the mining operation:*
- (f) *monitor and take samples of roadway dust, including any stone dust that has been applied, to ensure that the methods outlined in the principal hazard management plan are adequate and sufficiently implemented to prevent and suppress coal dust explosions.*

6.1 Underground fire prevention controls²⁵

The site senior executive should ensure that suitable prevention controls are in place to reduce the likelihood of a fire or explosion occurring. Consideration should be given to:

- (a) Design, construction and installation controls, including:
 - (i) Explosion Risk Zones (ERZs)
 - (ii) Ventilation
 - (iii) Mobile equipment
 - (iv) Fixed mechanical plant
 - (v) Fixed electrical equipment
 - (vi) Underground infrastructure
 - (vii) Flammable and combustible substances
- (b) Operational and maintenance controls, including procedures for:
 - (i) Prevention of frictional ignitions
 - (ii) Hot work
 - (iii) Light metals
 - (iv) Compressed air
 - (v) Contraband

190 Establishment of explosion risk zones

- (1) *The mine operator must ensure that—*
 - (a) *a risk appraisal and risk assessment are conducted to identify the location and type of each explosion risk zone required at the mining operation; and*

²⁵ The Chamber of Minerals & Energy. (October 2004). *Hazard Management Guideline for Underground Fire Prevention*. Part 1 Underground Fire Controls. Version 1. WA, Australia. 9.

REG 191

COAL

REG 192

COAL

ACOP

COAL

(b) explosion risk zones are established for the mining operation.

- (2) The mine operator may temporarily classify any *NERZ* at the mining operation as an *ERZO* or an *ERZ1*.

191 Signposting of explosion risk zones

- (1) The mine operator must ensure that—
- (a) the boundaries of each explosion risk zone at the mining operation are clearly indicated by signage at each boundary; and
 - (b) a plan showing the explosion risk zone boundaries is displayed at the surface of the mining operation where mine workers will see it; and
 - (c) the plan is updated at the end of each shift to reflect any changes to the location of a boundary or boundaries.
- (2) In the event that a temporary change in conditions results in a temporary change in the location of the boundary of an explosion risk zone, the signage required by subclause (1) is not required to be changed if the mine operator ensures that appropriate precautions are taken to control mine workers and mobile plant entering an explosion risk zone affected by the temporary change.

192 Signposting of boundaries between explosion risk zones

If a mine worker or mobile plant can physically move through a boundary between an *NERZ* and an *ERZ1* or between an *ERZ1* and an *ERZO*, the mine operator must ensure that the actual location of the boundary is signposted in each intake airway and vehicle access leading to,—

- (a) in respect of a boundary between an *NERZ* and an *ERZ1*, the *ERZ1*; or
- (b) in respect of a boundary between an *ERZ1* and an *ERZO*, the *ERZO*.

6.2 Explosion Risk Zones (ERZs)²⁶

The mine operator should ensure that:

- (a) A risk assessment is carried out to identify the location and type of each *ERZ* at the mine.
- (b) The *ERZ* boundaries are signposted, and a plan showing the boundaries is displayed at the surface of the mine.
- (c) The plan of the *ERZ* boundaries is updated at the end of each shift to reflect any changes in the boundary locations required to be signposted. The ventilation officer should be responsible for signposting the *ERZ* boundaries.

²⁶ See Definitions.

REG 179	COAL
ACOP	COAL

179 Air across and to working face

The mine operator must ensure that an adequate quantity and velocity of air is delivered across the working face of any production or development place, and within the roadways leading to any working face, to dilute and render harmless any accumulations or layering of methane.

6.2.1 Supply of fresh air and assessment of ERZs

It is a requirement that fresh air (as defined in Regulation 4) is supplied in accordance with Regulation 179.

The mine manager should ensure that:

- (a) Requirements for ERZs are not confused with the requirement for the supply of fresh air. Automatic continuous sampling and monitoring should be used to determine the general body concentration of methane.
- (b) An area is not declared an NERZ if the general body concentration of methane exceeds 0.25% at any time.

The mine operator may classify a NERZ as an ERZ0 or ERZ1. If such a classification is made, the NERZ should be considered to be an ERZ of the type stated in the classifications outlined in the Definitions section of this Approved Code of Practice.

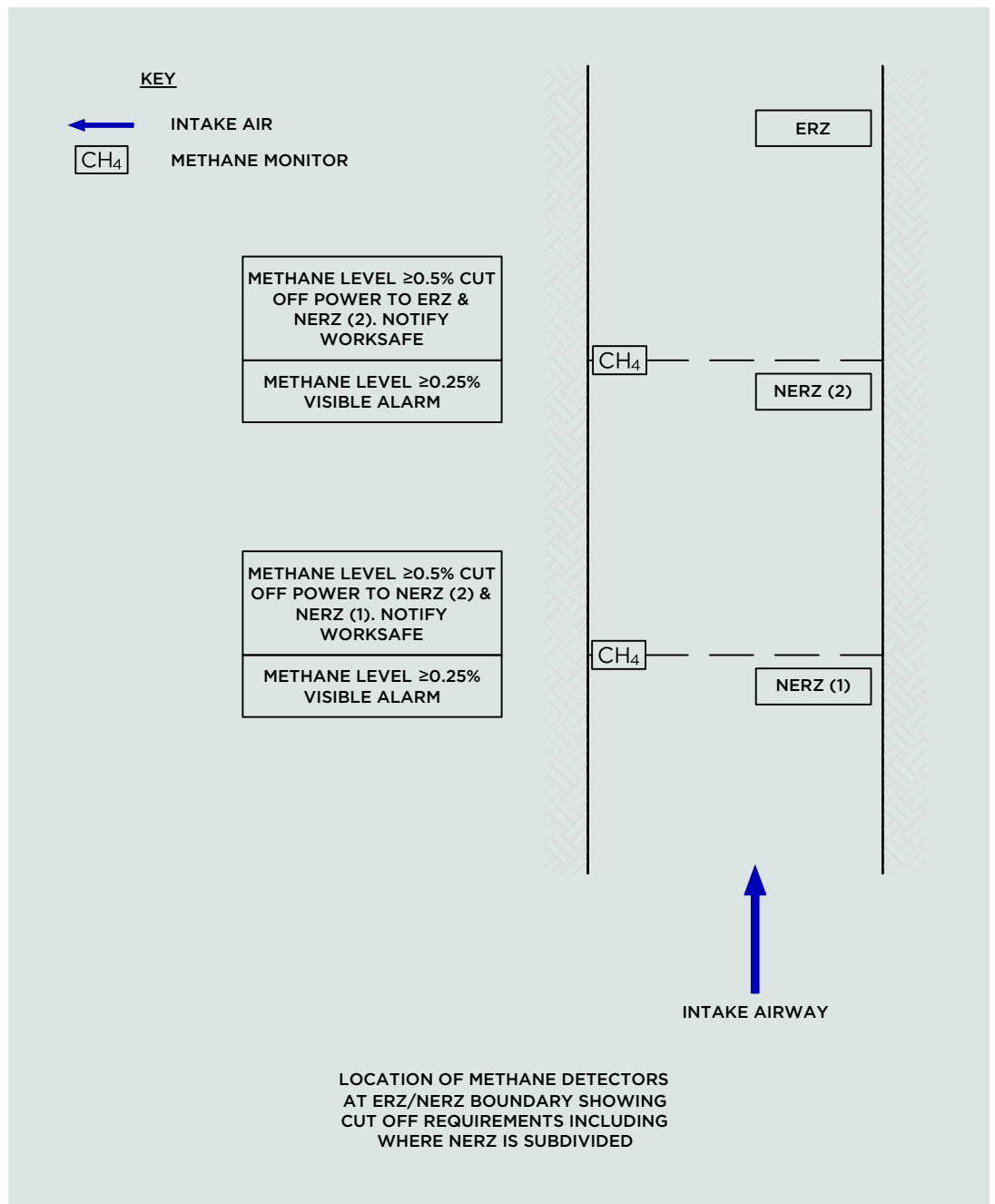


Figure 3 – Location of methane detectors at ERZ/NERZ boundary, and cut off requirements including where NERZ is subdivided

REG 178

COAL

178 Failure of ventilation system

In the event of a failure of the ventilation system to a part or the whole of an underground coal mining operation, the mine operator must ensure that—

- (a) *the supply of electricity to the underground parts of the mining operation, but not the supply to safety-critical equipment, is isolated as soon as reasonably practicable; and*

- (b) every battery-operated mobile plant located in the affected parts of the mining operation is brought out without any delay to—
 - (i) a main intake airway or main intake airways; or
 - (ii) a charging or repair station of suitable fireproof construction that is normally ventilated with intake air; and
- (c) the supply of electricity is not restored until after the ventilation system has been safely restored and a competent person considers it is safe to restore the supply of electricity.

6.3 Ventilation

In the event of ventilation failure in an underground coal mine, the mine operator should ensure that the requirements of Regulation 178 are met. For further information, see the Approved Code of Practice on Ventilation.

98 Mechanical engineering control plan

The mechanical engineering control plan must, at a minimum, address the following matters:

- (a) the standards of engineering practice to be followed at the mining operation regarding mechanical plant and installations throughout their life cycle, including, but not limited to, the following:
 - (i) arrangements for the acquisition and operation of fit-for-purpose mechanical plant and installations:
 - (ii) inspection and testing systems to ensure mechanical plant and installations are and remain safe to operate:
 - (iii) arrangements for the maintenance, repair, and alteration of mechanical plant and installations:
 - (iv) arrangements for the commissioning of mechanical plant and installations and for such commissioning to be documented:
 - (v) the competencies required of mine workers who may deal with mechanical plant and installations during the life cycle of the equipment, plant, and installations at the mining operation:
 - (vi) arrangements for the mine workers installing, commissioning, maintaining, and repairing mechanical plant and installations to be supervised by competent persons:
 - (vii) safe work procedures for mine workers who may deal with mechanical plant and installations during the life cycle of the equipment, plant, and installations at the operation:
 - (viii) the identification, assessment, rectification, and management of defects in mechanical plant and installations:

- (b) *the safe operation of conveyors, winding system, mobile plant, and dredges:*
- (c) *the safety of mechanical plant and installations:*
- (d) *the fitting of appropriate automatic fire suppression and engine or fuel pump shutdown systems to safety-critical equipment and all underground diesel engines:*
- (e) *the fitting of heat detection and automatic trip sensors on safety-critical mechanical components to ensure they stop operating if they may become a danger to health and safety:*
- (g) *the safe use and storage of pressurised fluids (including managing the hazards associated with compressed air and pressurised hydraulic fluids):*
- (h) *means for the prevention, detection, and suppression of fires on mobile plant and conveyors:*
- (i) *the control of diesel engine plant and installations, including the following:*
 - (i) *limiting the number of diesel engines permitted underground in any underground mining operation or tunnelling operation consistent with the safe operation of the mining operation and capacity of the ventilation system to reduce exhaust emissions to an acceptable level:*
 - (ii) *limiting the use of diesel engine plant and installations in the underground parts of an underground coal mining operation to diesel engine plant and installations that are approved for use in an underground coal mining operation:*
 - (iii) *where diesel engines are used on plant underground, the fitting of such plant with steel fuel tanks, automatic fire suppression of adequate delivery means and capacity, and a ready method of battery isolation:*
 - (iv) *the maintenance of explosion-protected plant in an explosion-protected state:*
- (j) *the use of fire-resistant hydraulic fluids in high risk applications underground in an underground mining operation or tunnelling operation:*

REG 156

156 Use of petrol engines prohibited

The mine operator must ensure that no plant with a petrol-driven engine is used underground in the operation.

REG 193

193 Machinery restrictions in explosion risk zones

The mine operator must ensure that—

- (a) *no plant, including mobile plant, or installations powered by electricity that are not explosion-protected are used or located in an ERZO or an ERZ1; and*
- (b) *all mobile plant powered by electricity or a diesel engine used in an NERZ that is not explosion-protected must be fitted with a device that ensures the mobile plant is automatically shut down if it passes beyond an NERZ; and*

COAL

- (c) *no diesel engine is used to power plant, including mobile plant, or installations used or located in an ERZO; and*
- (d) *no diesel engine that is not explosion-protected is used to power plant, including mobile plant, or installations used or located in an ERZ1.*

194 Use of diesel engines in underground coal mining operations

The mine operator must ensure that diesel engines are used to power plant, including mobile plant, or installations in an underground coal mining operation only in accordance with the following requirements:

- (a) *in respect of plant, including mobile plant, and installations located or used in an NERZ, a diesel engine that is not explosion-protected may be used to power the plant or installation only where—*
 - (i) *a risk assessment has been carried out regarding the use of the engine and any risk controls identified by the risk assessment have been implemented; and*
 - (ii) *in respect of mobile plant, an automatic system is in place to ensure that the plant cannot enter an ERZ1 or an ERZO and that system is either fail-safe or includes multiple redundancy devices; and*
 - (iii) *the diesel engine is clearly marked as a non-explosion-protected engine:*
- (b) *in respect of plant, including mobile plant, and installations located or used in an ERZ1, an explosion-protected diesel engine may be used to power the plant or installation only if—*
 - (i) *the diesel engine —*
 - (A) *has been tested by an accredited testing station in accordance with AS/NZS 3584.2:2008 Diesel engine systems for underground coal mines – Explosion protected; and*
 - (B) *is clearly marked with information identifying when the test report was done and by whom; and*
 - (ii) *the diesel engine has been assessed by the engine’s manufacturer as being safe to use in an ERZ1 and is clearly marked with information identifying that the engine has been assessed as safe to use in an ERZ1, when that assessment was done, and by whom.*

6.4 Mobile equipment²⁷

Considerations for mobile equipment that meet the requirements of the Principal Hazard Management Plan for Fire or Explosion are provided in this section. More detailed technical information about underground mobile equipment is provided in the Approved Code of Practice on Mechanical Engineering.

²⁷ The Chamber of Minerals & Energy. (October 2004). *Hazard Management Guideline for Underground Fire Prevention*. Part 2 Underground Fire Controls. Version 1. WA, Australia. 4-20.

COAL

METAL

6.4.1 Diesel vehicles

- (a) The mine manager at an underground coal mine should ensure that all diesel-powered vehicles and equipment used underground complies with the requirements of AS/NZS 3584, including:
 - (i) AS/NZS 3584.1:2008 “Diesel engine systems for underground coal mines, Part 1: Fire protected – Heavy duty”.
 - (ii) AS/NZS 3584.2:2008 “Diesel engine systems for underground coal mines, Part 2: Explosion protected”.
 - (iii) AS/NZS 3584.3:2012 “Diesel engine systems for underground coal mines, Part 3: Maintenance”.
- (b) At all other underground operations, the mine or tunnel manager should ensure that all diesel-powered vehicles and equipment used underground complies with the requirements of AS/NZS 4871.6:2013 “Electrical equipment for mines and quarries – Part 6: Diesel powered machinery and ancillary equipment”, and is fitted with:
 - (i) A steel fuel tank.
 - (ii) An automatic fire suppression system.
 - (iii) A two pole battery isolation and lockout system.
 - (iv) All equipment greater than 125kw is fitted with a fuel isolation system.

6.5 Fixed mechanical plant

Considerations for fixed mechanical plant that meet the requirements of the Principal Hazard Management Plan for Fire or Explosion are provided in this section. More detailed technical information about underground fixed mechanical plant is provided in the Approved Code of Practice on Mechanical Engineering.

The mine or tunnel manager should ensure that fixed mechanical plant is:

- (a) Not able to produce sparks of sufficient energy to ignite a mixture of methane and air.
- (b) Designed so that any maintenance required that involves hot work procedures is minimal. See section 6.10 for more information on hot work procedures.
- (c) If identified as a potential fuel source, fitted with thermal monitoring devices and alarms (as described in Section 8 Monitoring).
- (d) Fitted with temperature monitoring devices and alarms, or thermal overload devices, on equipment such as fans, pumps and compressors.

6.5.1 Hydraulic and lubrication systems

The mine or tunnel manager should ensure that hydraulic and lubrications systems use:

- (a) Steel tanks to hold oil for hydraulic and lubrication systems greater than 20 litres, positioned so that any overflow does not contact a hot surface.
- (b) Steel lines or braided steel hoses.
- (c) Hoses that are:
 - (i) Fire resistant.
 - (ii) Rated for a minimum safety factor of 4 to 1 based on maximum working pressure.²⁸
 - (iii) Securely clamped away from hot surfaces.
 - (iv) Positioned so that they are protected from impact damage.
 - (v) Provided with bulkhead fittings where they pass through bulkheads.
- (d) Filler caps that can be locked or secured.
- (e) Where practicable, low flammability hydraulic fluids (classed as HFDU) should be used.
- (f) Where it is not practicable to use HFDUs, the mine manager should ensure appropriate measures are in place to control the fire risk resulting from standard hydraulic fluid being used.

REG 97

97 Risk assessment in relation to mechanical engineering control plan

The following matters must be considered when developing the mechanical engineering control plan:

- (a) *the hazards presented by mechanical equipment, plant and installations over their lifetime:*
- (b) *the potential for mine workers to be harmed by sources of stored energy, which is energy associated with mechanical equipment, plant, and installations other than electrical energy:*
- (c) *the measures required to prevent the uncontrolled release of stored energy and to prevent the unintended operation of mechanical plant and installations, including mechanical plant and installations restarting on restoration of the supply of electricity:*
- (d) *the potential for, and need to prevent, catastrophic failure of mechanical equipment, plant, or installations:*
- (e) *the potential for, and need to prevent, fires being initiated or fuelled by mechanical equipment, plant, or installations:*

²⁸ MDG 15:2002. Guideline for mobile and transportable equipment for use in mines. 18.

REG 98

- (f) *the potential for, and need to prevent, cutting equipment acting as an ignition source for gas or coal dust explosions:*
- (g) *the potential for, and need to minimise, exposure of mine workers to toxic or harmful materials associated with mechanical plant and installations:*
- (h) *the need for safeguards for mechanical plant and installations to have a probability of failure appropriate to the degree of risk posed by the mechanical plant or installation to which they relate:*
- (i) *in the case of an underground coal mining operation, the potential for, and need to prevent, stored energy providing a source of ignition for gas or coal dust explosions:*
- (j) *any other matter that deals with the safe management of mechanical plant and installations.*

98 Mechanical engineering control plan

The mechanical engineering control plan must, at a minimum, address the following matters:

- (b) *the safe operation of conveyors, winding system, mobile plant, and dredges:*
- (c) *the safety of mechanical plant and installations:*
- (d) *the fitting of appropriate automatic fire suppression and engine or fuel pump shutdown systems to safety-critical equipment and all underground diesel engines:*
- (e) *the fitting of heat detection and automatic trip sensors on safety-critical mechanical components to ensure they stop operating if they may become a danger to health and safety:*
- (g) *the safe use and storage of pressurised fluids (including managing the hazards associated with compressed air and pressurised hydraulic fluids):*
- (h) *means for the prevention, detection, and suppression of fires on mobile plant and conveyors:*
- (i) *the control of diesel engine plant and installations, including the following:*
 - (i) *limiting the number of diesel engines permitted underground in any underground mining operation or tunnelling operation consistent with the safe operation of the mining operation and capacity of the ventilation system to reduce exhaust emissions to an acceptable level:*
 - (ii) *limiting the use of diesel engine plant and installations in the underground parts of an underground coal mining operation to diesel engine plant and installations that are approved for use in an underground coal mining operation:*

REG 124

- (iii) *where diesel engines are used on plant underground, the fitting of such plant with steel fuel tanks, automatic fire suppression of adequate delivery means and capacity, and a ready method of battery isolation:*
- (iv) *the maintenance of explosion-protected plant in an explosion-protected state:*
- (j) *the use of fire-resistant hydraulic fluids in high-risk applications underground in an underground mining operation or tunnelling operation:*
- (k) *the engine management systems used to control diesel pollutants emitted underground in an underground mining operation or tunnelling operation:*
- (l) *the arrangements for hot work to be done safely, including an approval system for hot work to be done if the mining operation is an underground coal mining operation or an underground metalliferous mining operation or tunnelling operation where methane has been detected.*

124 Conveyor belts

- (1) *The mine operator must ensure that, where a conveyor belt or belts are used at the mining operation, the conveyor belt or belts are—*
 - (b) *fitted with an emergency stop system that can be activated at any point along the length of the conveyor belt accessible by any person:*
 - (e) *in the case of an underground metalliferous mining operation or tunnelling operation where no methane has been detected, fitted with certified fire resistant conveyor belting and drum lagging:*
 - (f) *in the case of an underground metalliferous mining operation or tunnelling operation where methane has been detected, or an underground coal mining operation, fitted with certified fire resistant and anti-static conveyor belting and drum lagging.*
- (2) *The mine operator must ensure that a written maintenance programme is in place and is complied with for the maintenance of the conveyor belt to ensure that it complies with subclause (1).*

ACOP

METAL TUNNELS

6.5.2 Conveyors²⁹

The mine or tunnel manager should ensure that:

- (a) Fire resistant materials are used for:
 - (i) Conveyor belting.
 - (ii) Fluids used in hydraulic systems and traction couplings.
 - (iii) Grease used in idler bearings.
 - (iv) Roadways, and at transfer and loading points.

²⁹ Health and Safety Executive (HSE). *The prevention and control of fire and explosion in mines*. Retrieved from <http://www.hse.gov.uk/mining/feguidance.pdf>. 22.

COAL

- (b) Conveyor belts and accessories in an underground coal mine are FRAS rated and compliant with AS 4606-2012 “Grade S fire resistant and antistatic requirements for conveyor belting and conveyor accessories”.
- (c) Conveyors are designed, positioned and aligned so that:
 - (i) Only drums, rollers and idlers manufactured to appropriate standards for the duty required are used. The bearing life should exceed the expected life of the roller or drum shell.
 - (ii) There is sufficient clearance around rollers and idlers so that belts are not rubbing, or coming into contact with any flammable materials.
 - (iii) There is sufficient clearance around, and under, the bottom belts and return rollers to prevent staking or damage to rollers.
 - (iv) The spillage and accumulation of dust is controlled at transfer and loading points and there are facilities in place for safe inspection and cleaning.
 - (v) Brakes are not prone to sticking in the ‘on’ position, or to dust and other contaminants building up in the brake path.
 - (vi) Belts are properly tensioned to avoid slipping.
- (d) Conveyors are fitted with monitors at vulnerable points to detect deterioration or abnormal operation, including:
 - (i) Along the belt length for the detection of misalignment, slip and tear.
 - (ii) Slip monitoring that stops the belt if a slip of 5% or greater is detected.
 - (iii) Temperature monitoring devices and alarms on main bearings.
 - (iv) Smoke detectors and CO monitors on drives and at transfer points.
 - (v) Automatic fire suppression systems are fitted to the conveyor drive and at transfer points.
- (e) Drives, loops, return ends and belt lines are examined regularly for:
 - (i) Flammable materials, including coal dust and coal spillage accumulated within or beneath them.
 - (ii) Pieces of mineral wedged between moving parts and the conveyor structure.
 - (iii) No leakage of lubricant from any drum or idler.
 - (iv) Proper alignment and grading of the belt so that it is not rubbing against the roadside, fixtures and fittings, or any static element of the conveying system.
- (f) Components with failed bearings (ie belt idlers) are replaced or removed until a replacement can be fitted.



- (g) A fire watch is initiated along the whole length of the conveyor after a coal bearing conveyor has been stopped for more than 90 minutes and no later than 3 hours after it has been stopped. Any signs of heating or defects should be addressed immediately.
- (h) Conveyors are cleaned regularly to remove spillage, particularly from beneath belt scrapers, and all parts of the system are accessible for inspection and can be safely cleaned.

6.5.3 Prevention of fire on conveyors³⁰

Belt conveyors have been the most common cause of fires in underground mines over the last twenty years.³¹

Bearing failure, commonly from conveyor idler rollers and drums, has caused the most fires. In most cases, where roller idler sets and bearings fail, it is because they have been subjected to continual loads far in excess of their specified safe working load. The fires tend to be caused by the belt bearing heavily at changes of gradient along the belt line, particularly at the entry and exit points of drives, loop take ups, discharge and return end units.

A burning conveyor belt releases high volumes of smoke, carbon monoxide and other toxic fumes that can quickly pollute the general body of air. As belt fires propagate along a belt in the direction of the airflow, they are difficult to extinguish because the smoke and toxic fumes prevent fire-fighting the advancing front along the belt.

Fire resistant conveyor belts will not ignite by frictional heat when a rotating drum rubs against a stalled conveyor, and flame will not propagate along the belt if part of it is exposed to flame.

Prevention controls include the installation of belt-alignment and motion-sensing switches to detect when the belt is not running correctly, the fitting of smoke- or heat-detection systems in known or frequent ignition zones, the implementation of preventive maintenance programmes, the provision of separate airways to handle all main airflow and putting in place fire-suppressant systems on conveyors. In addition, comprehensive maintenance and inspection plans, as well as emergency plans, should be drawn up, and a specialist in fire prevention should perform a risk assessment for all conveyors.

6.5.4 Compressor systems and pumps

The mine or tunnel manager should ensure that:

- (a) Compressors are located on the surface.

³⁰ Health and Safety Executive (HSE). *The prevention and control of fire and explosion in mines*. Retrieved from <http://www.hse.gov.uk/mining/feguidance.pdf>. 21-22.

³¹ European Commission. (2013). *Early detection and fighting of fires in belt conveyor (Edaffic). Final Report*. Brussels, Belgium.

- (b) Compressors are designed so that in the event of fire the amount of smoke entering the main intake is eliminated.
- (c) Where compressors are installed underground, they are:
 - (i) Installed so that the ventilating current flowing over them is directed into the return.
 - (ii) Fitted with thermal monitoring alarms and devices that stop the compressor when oil pressure overload or high discharge air temperature is detected.
- (d) Flow switches are provided to positive displacement pumps to stop the pump in the event of low flow.

GUIDANCE

6.5.5 Prevention of fire on mechanical equipment³²

Equipment maintenance areas generally contain a variety of other tools, materials and equipment (eg degreasing equipment) that also are a fire hazard in an underground environment.³³

Virtually all underground fires associated with mechanical equipment can be prevented by better maintenance. The most common cause of fire is diesel or hydraulic oil spraying onto hot components when pipes and hoses wear through or burst. Oil does not ignite on its own but needs to be sprayed onto a hot exhaust manifold, a hot turbocharger or onto a worn out and arcing electrical wire. If the engine is turned off, the hydraulic fluid or diesel oil flow generally stops and the fire goes out but in many cases oil soaked dirt and dust or deposits of grease on the equipment provides enough fuel to keep the fire burning. Regular cleaning and maintenance will remove the secondary fire fuel, making it easier to find and fix causes of fires.³⁴

REG 100

100 Electrical engineering control plan

- (1) *The electrical engineering control plan must, at a minimum, address the following matters:*
 - (b) *the prevention of fires being ignited by electrical energy:*
- (2) *In the case of an underground mining operation or tunnelling operation, the electrical engineering control plan must, in addition to the matters in subclause (1), include provision for—*
 - (a) *the design, installation, operation, and maintenance of electrical plant and installations at the mining operation, to minimise the potential impacts from voltage rise due to lightning, static electricity, voltage surges and other transient voltages to within acceptable limits, including—*
 - (i) *the prevention of the ignition of gas by a static charge:*
 - (ii) *the prevention of the effects of lightning being transferred to the underground parts of the mining operation:*

- (3) *In the case of an underground coal mining operation, the electrical engineering control plan must, in addition to the matters in subclauses (1) and (2), provide for—*
- (a) *the prevention of electrical energy acting as an ignition source for gas or coal dust explosions:*
 - (b) *for each explosion risk zone, ensuring the use only of electrical plant and installations, including cables and electrical plant on diesel vehicles, that are appropriate to the explosion risk zone in which they are located or being used:*
 - (d) *the isolation of the supply of electricity to the underground parts of the mining operation, but not the supply to safety-critical equipment, in the event of the following circumstances:*
 - (i) *the presence of methane levels at or above,—*
 - (A) *in an NERZ, 0.5%:*
 - (B) *in an ERZ1, 1.25%:*
 - (ii) *if ventilation falls below the specified quantity set by the electrical engineering control plan:*
 - (f) *the plant and procedures used to ensure that, in the event of a failure of the main ventilation system, the supply of electricity entering the underground parts of the mining operation (other than power to plant or installations that have been designed so that they are incapable of producing heat or sparks sufficient to ignite an explosive atmosphere)—*
 - (i) *is automatically and systematically isolated:*
 - (ii) *is incapable of being restored before the main ventilation system is repaired and restarted:*
 - (iii) *is not restored until a competent person determines it is safe to do so.*

193 Machinery restrictions in explosion risk zones

The mine operator must ensure that—

- (a) *no plant, including mobile plant, or installations powered by electricity that are not explosion-protected are used or located in an ERZO or an ERZ1; and*
- (b) *all mobile plant powered by electricity or a diesel engine used in an NERZ that is not explosion-protected must be fitted with a device that ensures the mobile plant is automatically shut down if it passes beyond an NERZ; and*
- (c) *no diesel engine is used to power plant, including mobile plant, or installations used or located in an ERZO; and*

³² Health and Safety Executive (HSE). *The prevention and control of fire and explosion in mines*. Retrieved from <http://www.hse.gov.uk/mining/feguidance.pdf>. 21-22.

³³ Retrieved from <http://www.ilo.org/oshenc/part-xi/mining-and-quarrying/item/607-fires-and-explosions-in-mines>

³⁴ Retrieved from <http://www.resources.nsw.gov.au/safety/resources/mechanical/information/prevention-of-underground-fires>

- (d) *no diesel engine that is not explosion-protected is used to power plant, including mobile plant, or installations used or located in an ERZ1.*

ACOP

6.6 Fixed electrical equipment

Considerations for fixed electrical equipment that meet the requirements of the Principal Hazard Management Plan for Fire or Explosion are provided in this section. Mine operators should refer to The Electricity Act 2013, and the associated Electricity (Safety) Regulations 2010 under the Act, to ensure obligations are met in respect of fixed electrical equipment underground.

The mine or tunnel manager should ensure that:

- (a) Electrical switchgear is located in a substation where it is protected from unintended contact or damage, including vehicle damage.
- (b) Electrical cables are not located near hydraulic or fuel lines, and are insulated.
- (c) Cables are not hung loosely or untidily, and are not overloaded.
- (d) Electrical trip overloads and earth protection devices are in place.
- (e) Thermistors that cut off the current are provided on electric motors above 22kW.
- (f) Equipment is earthed to prevent the build-up of static electricity.
- (g) There are no non-safety critical electrical installations on the district return of a coalface where methane levels may exceed 1.25%.
- (h) Motors used on the coalface are installed in flameproof enclosures to mitigate the ignition of methane inside the enclosure.
- (i) Oil-filled transformers are not used in underground coal mines.³⁵

COAL

6.7 Underground infrastructure

6.7.1 Explosives magazines

The mine or tunnel manager should ensure that:

- (a) Magazines are located away from main travel ways.
- (b) Floors are constructed in such a way that they are easy to clean spilt product.
- (c) A hose and proper drainage is installed so that spilt product or combustible liquids can be hosed down (eg oil leaking from explosives vehicles).
- (d) A fire hydrant and hose, or automatically-activated deluge system, is installed on the intake side of the magazine.
- (e) Signs are installed at the magazine entrance advising:

METALS

³⁵ Electricity (Safety) Amendment Regulations 2010. Regulation 31. Use of oil-filled and oil-cooled mining electrical equipment prohibited in underground coal mining operation.

- (i) No flames, naked lights or parking of equipment within 8m of explosives.
- (ii) Emergency procedure in case of fire.
- (f) The ventilation of the main magazine has a direct return airway to the primary exhaust.
- (g) The magazine has a sufficient quantity of air passing through it to remove any smoke or fumes.
- (h) Where there is an independent system to ventilate the magazine, there is a means of:
 - (i) Warning mine workers at the entrance to the main magazine in the event that the exhaust system is not functioning.
 - (ii) Warning against entry until the system resumes and is operating normally.
- (i) Housekeeping requirements are established to ensure no rubbish accumulates in the magazine.
- (j) Electrical equipment, including lighting, meets the requirements of T1 AS 2380.1-1989 “Electrical equipment for explosive atmospheres – Explosion-protection techniques – General requirements” and wiring meets the requirements of AS/NZS 3000:2007 “Electrical installations (known as the Australian/New Zealand Wiring Rules)”.
 - (k) Leaky feeder cables, hand-held portable radios and mobile phones do not enter the magazine.

6.7.2 Fuel storage, transfer equipment and refuelling bays

Considerations for fuel storage, transfer equipment and refuelling bays that meet the requirements of the Principal Hazard Management Plan for Fire or Explosion are provided in this section. Mine operators should refer to The Hazardous Substances and New Organisms (HSNO) Act 1996 and its associated Regulations, to ensure obligations are being met in respect of fuel storage, transfer equipment and refuelling bays.

The mine or tunnel manager should ensure that:

- (a) All equipment used to store, transfer or distribute fuel underground meets the requirements of the relevant sections of AS 1940-2004 “The storage and handling of flammable and combustible liquids”, AS/NZS 2229:2004 “Fuel dispensing equipment for explosive atmospheres”, AS 2809.1-2008 “Road tank vehicles for dangerous goods – Explosion protection techniques – General requirements for all road tank vehicles”, and AS 3013-2005 “Electrical installations – Classification of the fire and mechanical performance of wiring system elements”.

- (b) Electrical control systems associated with fuel transfer and storage meet the requirements of AS/NZS 2229:2004 “Fuel dispensing equipment for explosive atmospheres”.
- (c) High voltage reticulation (ie greater than 1kV) does not pass through a fuel storage area.
- (d) Diesel storage tanks (fixed or mobile) meet the requirements of AS 2809.1-2008 “Road tank vehicles for dangerous goods – Explosion protection techniques – General requirements for all road tank vehicles” and AS 1940-2004 “The storage and handling of flammable and combustible liquids”, and are regularly inspected and maintained.
- (e) Where a surface-to-underground fuel delivery pipe is used, it is:
 - (i) Purpose-designed.
 - (ii) Installed in an accurately drilled and surveyed borehole.
 - (iii) Made from stainless steel with a HDPE covering.
 - (iv) Contained in a free draining borehole.
 - (v) Subjected to regular inspection and non-destructive testing.
- (f) Portable fuel containers are only used for transporting fuel when they are secured in holders protecting them from damage when being carried on vehicles.
- (g) There is appropriate signage at the entrance to fuel storage areas advising:
 - (i) Flammable materials are stored inside.
 - (ii) Access to authorised mine workers only.
 - (iii) No flames or naked lights.
 - (iv) No hot work.
 - (v) Engines should be shut down before refuelling.
 - (vi) Emergency procedures in the event of fire.
- (h) Storage tanks, pipe work and fuel transport heavy vehicles entering refuelling bays are earthed in accordance with AS 2809.1-2008 “Road tank vehicles for dangerous goods – Explosion protection techniques – General requirements for all road tank vehicles” to dissipate static electrical charge.
- (i) Permanent fuel storage locations have a floor that is resistant to fuel, can be cleaned, and has bunding and run-off that satisfies AS 1940-2004 “The storage and handling of flammable and combustible liquids”, and meets requirements under HSNO legislation.
- (j) Temporary storage is installed following completion of a risk assessment that evaluates the potential risk for, and suitable controls to minimise the impact of, fuel spills.

- (k) All fuel transfer systems are constructed with non-flammable materials, brass, or non-metallic components and have automatic sealing using fast-fill couplings.
- (l) No vehicle parks in a refuelling bay except to refuel or unload fuel.
- (m) Refuelling bays have facilities to quickly contain or clean-up any fuel spills.
- (n) Rubbish and waste (eg soiled absorbent material) is immediately placed in clearly marked containers and taken to the surface within 24 hours.
- (o) Electrical equipment, including lighting, meets the requirements of T1 AS 2380.1-1989 “Electrical equipment for explosive atmospheres – Explosion-protection techniques – General requirements” and wiring meets the requirements of AS/NZS 3000:2007 “Electrical installations (known as the Australian/New Zealand Wiring Rules)”, as well as requirements under HSNO legislation.
- (p) Permanent storage, supply and refuelling stations have an automatic fire detection and suppression system that meets the requirements of AS 1603.1-1997 “Automatic fire detection and alarm systems – Heat detectors” and AS 1670.1-2004 “Fire detection, warning, control and intercom systems – Systems design, installation and commissioning – Fire”, as well as requirements under HSNO legislation.
- (q) Automatic fire suppression systems have an alarm or other system to alert mine workers in the event of fire, and can be manually activated at a safe distance from the refuelling bay.
- (r) Two hand held extinguishers with a minimum rating of 80BE are provided at an upwind location of temporary fuelling areas.

6.7.3 Workshops

The mine or tunnel manager should ensure that:

- (a) Workshops store a supply of flammable and combustible liquids (eg oils, lubrication and fuel,) limited to the quantity necessary for underground work.
- (b) Combustible liquids are stored in segregated locations that meet the requirements of AS1940-2004.
- (c) Chemicals that can create heat or fumes are stored in a DANGEROUS GOODS store or cabinet.
- (d) A separate location is provided for hot work procedures to be carried out, as outlined in section 6.10.
- (e) There is appropriate signage at the workshop entrance advising:
 - (i) Flammables are stored inside.
 - (ii) No smoking, flames or naked lights.
 - (iii) Hot work in designated areas only.

- (iv) Housekeeping requirements.
- (v) Emergency procedures in the event of fire.
- (f) A sealed waste oil disposal system and suitable containers for other flammable waste are used to minimise spillage.
- (g) Acetylene is not used below ground and is substituted with propane.
- (h) Compressed gases such as propane and oxygen are stored and used in compliance with the requirements of AS 2030.2-1996 "The verification, filling, inspection, testing and maintenance of cylinders for the storage and transport of compressed gases – Cylinders for dissolved acetylene".
- (i) Workshops have the facilities to quickly contain or clean-up fuel spills (eg a hose, absorbent material and fire extinguishers).
- (j) Rubbish and waste (eg soiled absorbent material) is immediately placed in clearly marked bins, which are kept at a distance from any potential ignition source. The bins should be emptied at least weekly.
- (k) Barriers (eg bollards) and designated parking areas separate mobile equipment from flammable or combustible materials and liquids.

6.7.4 Crib rooms

The mine or tunnel manager should ensure that crib rooms are:

- (a) Adequately ventilated.
- (b) Fitted with fire-resistant materials, where practicable.
- (c) Provided with steel rubbish bins, which are emptied daily.

165 Combustible material

- (1) *The mine operator must ensure that any hazards associated with the storage of combustible materials are managed.*
- (2) *Without limiting subclause (1), the mine operator must ensure that flammable materials with a flashpoint of 23°C or lower are not stored underground in the mining operation, unless they are kept in a fireproof room, compartment, or box.*

REG 165

ACOP

6.8 Flammable and combustible substances

This section applies to the use and storage of flammable and combustible substances and materials that generally have a flash point below 23°C, or will easily ignite and support fire.

The mine operator should refer to The Hazardous Substances and New Organisms (HSNO) Act 1996 and its associated Regulations, to ensure obligations are being met in respect of flammable substances.

The mine or tunnel manager should ensure that:

- (a) Fire resistant materials are used underground where practicable, in preference to flammable and combustible substances.

- (b) No flammable or combustible substances and materials (including flammable gases) are stored on, or near, sources of heat or ignition.
- (c) Flammable and combustible substances and materials (including flammable gases) are stored underground in purpose-built, clearly-marked storage areas, which are:
 - (i) Made from fire resistant materials.
 - (ii) Ventilated directly to the return and have suitable fire proof doors.
 - (iii) Protected from collision hazards.
- (d) Store a supply of flammable and combustible substances limited to the quantity necessary for underground work.
- (e) Appropriate signage is displayed advising no naked flames.
- (f) Lighting is clear of all flammable and combustible substances.
- (g) Electrical switchboards are not located near flammable or combustible substance storage areas.
- (h) Hot work procedures are not undertaken in, or near, flammable or combustible substance storage areas.
- (i) Containers used for flammable liquids are clearly labelled, and are purpose-built for transporting flammable liquids.

6.8.1 Flammable gases in metalliferous mines and tunnels

The mine or tunnel manager should ensure that:

- (a) Flammable gases are identified and stored in a well-ventilated area.
- (b) Flammable gases are not decanted underground.
- (c) Flammable gas cylinders are transported and stored in compliance with requirements under HSNO legislation.
- (d) Flash-back arresters are installed on all gas cutting equipment.
- (e) Gas-cutting equipment is used according to the hot work procedures outlined in section 6.10.

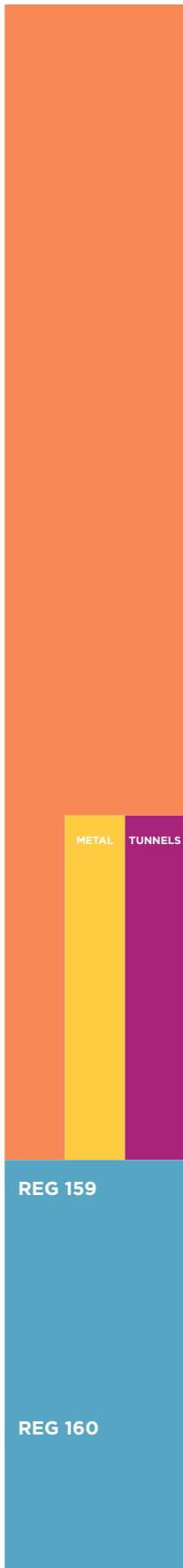
159 Application of Regulations 160 to 162

Regulations 160 to 162 apply to—

- (a) any underground coal mining operation; and
- (b) any underground metalliferous mining operation or tunnelling operation where methane has been detected.

160 Sparks or naked flames

A mine operator of a mining operation to which this Regulation applies must ensure that no device or material, including smoking materials, likely to cause a spark or naked flame is taken into or used in the underground parts of the mining operation.



REG 189

COAL

ACOP

COAL

COAL

189 Compressed air

The mine operator must provide for sufficient electrical bonding and earthing of compressed air equipment, hoses, and pipes that are likely while in operation to develop static electrical charges that are capable of causing an electric shock to a person or a spark.

6.9 Frictional ignitions³⁶

The mine operator at an underground coal mine, or any other mine covered under Regulation 159, should ensure that all risks associated with frictional ignitions are identified and assessed during the development of the Fire or Explosion Principal Hazard Management Plan and the Ventilation Principal Control Plan. For more detailed information on frictional ignitions, see the Appendix.

Hot surfaces and hot sparks are generally the main causes of a frictional ignition. Considerations for the assessment of frictional ignition risks should therefore include:

- (a) Seam characteristics (ie thickness, gas content and composition, and permeability).
- (b) Sources of gas emission.
- (c) Operating factors that may influence gas emission.
- (d) Geological factors that may influence sparking (ie surrounding strata, faults, partings and intrusions).
- (e) Knowledge and historical records of ignitions occurring within the seam.

6.9.1 Frictional ignition prevention controls

When assessing suitable controls for the prevention of frictional ignitions, the mine manager should ensure that considerations include:

- (a) Ventilation in critical places in the mine (ie systems, layouts, quantities and velocities).
- (b) Wet cutting heads, back face flushing sprays.
- (c) Ventilated cutting drums, Hollow Shaft Venturi (HS) or Rotating Air Current (RAC) design.
- (d) Venturi-ventilated roadheaders and continuous miner cutting heads.
- (e) Gas monitoring arrangements.
- (f) Inspections, testing for gas and layering detection.
- (g) Additional equipment (ie air venturis and compressed air fans).
- (h) Dust suppression (ie water sprays, wet drilling, and suitable water pressure and flow to a continuous miner).

³⁶ Safety in Mines Research Advisory Committee (SIMRAC). (1996, January). *Identify methods to reduce the risk of explosions and fire caused by frictional ignition hazards. Final Project.* University of Witwatersrand. Johannesburg, South Africa: Phillips. H. R. 22.



- (i) Cutting picks (ie design and type).
- (j) Cutter picks (ie examination and replacement).
- (k) Mitigation in the event of an ignition taking place (ie fire extinguishers, water hydrants and hoses).
- (l) Procedures to dilute gas accumulations or restore adequate ventilation.

6.9.2 Frictional ignition records

The mine operator should ensure that there is a document maintained that includes the following information as it relates to frictional ignitions:

- (a) A description of the proposed ventilation arrangements (ie fan position and operating range, ventilation ducting layout, and minimum ventilation quantities required).
- (b) Gas make.
- (c) Any arrangements or requirements specific to the area, which are different from, or additional to, the standard arrangements or requirements outlined in the Fire or Explosion Principal Hazard Management Plan.

98 Mechanical engineering control plan

The mechanical engineering control plan must, at a minimum, address the following matters:

- (1) *the arrangements for hot work to be done safely, including an approval system for hot work to be done if the mining operation is an underground coal mining operation or an underground metalliferous mining operation or tunnelling operation where methane has been detected.*

161 Restrictions on hot work

- (1) *The mine operator of an underground coal mining operation must ensure that no hot work is done in an ERZO at any time.*
- (2) *The mine operator of an underground coal mining operation must ensure that no hot work is done in an NERZ or ERZ1 except under an approval system established as part of a mechanical engineering control plan.*
- (3) *The mine operator of any other mining operation to which this Regulation applies must ensure that no hot work is done in the mining operation except under an approval system established as part of a mechanical engineering control plan.*

6.10 Hot work

The Regulations define hot work as any welding, soldering, heating, cutting, grinding, or vulcanising where the surface temperature of the work, or a tool for the work, is likely to exceed 150°C.

METAL TUNNELS

6.10.1 Hot work in metalliferous mines and tunnels

The mine or tunnel manager should ensure that the Fire or Explosion Principal Hazard Management Plan includes procedures for hot work underground including, but not limited to:

- (a) An approval process to commence the work.
- (b) Supervision requirements.
- (c) Competency requirements for mine workers performing hot work. Only approved, authorised and trained mine workers should carry out hot work underground.
- (d) Site preparation.
- (e) Fire precautions, including the provision of firefighting equipment and fire watch for a period of at least one hour after the work has been carried out.
- (f) Areas designated for hot work are:
 - (i) Enclosed to prevent sparks being carried by the ventilation.
 - (ii) Have drop trays that carry hot slag to a wet area, preventing it being dropped onto the floor and igniting loose material or debris.
- (g) Transportation, use and storage of gas cylinders, including that they are:
 - (i) Clearly identified.
 - (ii) Stored and used in an upright position.
- (h) No hot work is permitted in a tunnel under hyperbaric pressure conditions (ie. greater than atmospheric pressure) unless approval has been issued by WorkSafe NZ's Chief Inspector, Extractives.

6.10.2 Hot work in coal mines

The mine operator should ensure that the Fire or Explosion Principal Hazard Management Plan includes procedures for hot work underground including that:

- (a) No hot work is permitted in an underground coal mine unless approval has been issued by WorkSafe NZ's Chief Inspector, Extractives.
- (b) If the work is approved, it will only be carried out in areas that are free of gas.
- (c) When requesting approval from the Chief Inspector, Extractives, the mine operator should address all of the requirements for a metalliferous mine, and:
 - (i) Specify the exact task, duration and location.
 - (ii) Implement a permitting system to control the task.
 - (iii) Ensure continuous supervision by a mine worker authorised by the mine manager is in place.

COAL

- (iv) Ensure continuous gas monitoring with alarms set to activate at 0.25%.
- (v) Ensure the area is fully stone-dusted prior to the work commencing.

6.11 Light metals (or aluminium)

The mine operator at an underground coal mine should ensure that materials, components and equipment made of light metal, or painted or coated with substances containing light metal in metallic form, are prohibited from being taken or used underground.

6.11.1 Light metal specifications

A 'light metal' is defined as aluminium, magnesium, titanium, or an alloy of two or more of these metals, with proportions not exceeding the following limits:

- (a) Total content by weight of the three constituents: 15%.
- (b) Content by weight of magnesium and titanium together: 6%

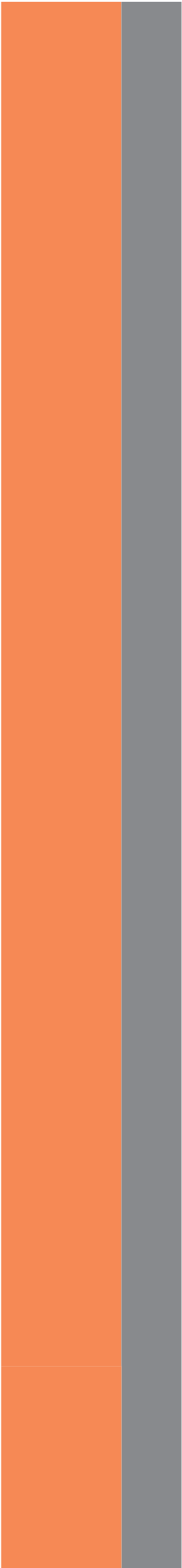
6.11.2 Prohibited use

Equipment, plant, components, materials or any other item made of light metal (including packaging) should not be used or taken underground unless it meets the requirements set out below.

- (a) Fans - Auxiliary and booster fans made of light metal, or with components made of light metal, should not be used underground, except where they form the internal parts of an electric motor and the internal parts of cable connections.
- (b) Fluid couplings - Fluid couplings with casings made of light metal should not be used underground unless they comply with AS/NZS 3584 on diesel-powered vehicles, as outlined in section 6.4.1.
- (c) Coatings and painting - Equipment and its components should not be coated or painted with substances that contain light metals in metallic form.
- (d) Restriction at the working face - Equipment made of light metal or with components or materials made of light metal should not be used, transported, stored or discarded on, or within, 300m of a working face unless they are protected so that there is no possibility of friction or impact.

6.11.3 Permitted use

- (a) Electrical equipment - Electrical equipment containing internal components made of light metal, or painted or coated with substances containing light metal in metallic form may be used underground but they should not be transported, stored or discarded on, or within 300m of a working face unless they are or protected so that there is no possibility of friction or impact.

- 
- (b) Electrical cables with aluminium conductors – Electrical cables with conductors of aluminium may be used underground, but when jointing them into cable couplers, precautions should be taken to avoid friction or impact with the exposed conductors and their coupler contact tubes. Any resulting aluminium debris should be removed from the underground environment.
 - (c) Portable equipment – The following equipment made of light metal may be used underground if there is no alternative available, and subject to the approval of the mine manager:
 - (i) Anemometers and extension handles.
 - (ii) FLP flameproof electronic flash units for underground photography.
 - (iii) Methanometers.
 - (iv) Survey instruments and their telescopic legs (excluding levelling staves).
 - (v) Rescue apparatus.
 - (vi) Scientific apparatus for sampling, measuring and recording.
 - (d) The equipment outlined in (c) above should be used as follows:
 - (i) Existing equipment should continue to be used to the end of their useful lives.
 - (ii) New equipment should be used only where suitable alternatives containing no light metal are not available.
 - (iii) Where practicable, all equipment should be provided with suitable containers or coverings to reduce the risk of friction or impact during transporting. The equipment should be carefully handled to avoid friction or impact and it should not be left unattended on, or within, 300m of the working face.
 - (e) Gas cylinders for air conditioning equipment – Some cylinders used for the transport and storage of refrigeration gases (R12) are fitted with two valves (one to discharge gas and the other to discharge liquid). Labels fitted to the valves, to identify either gas or liquid, may be used underground provided that:
 - (i) Cylinders taken underground are transported in a wooden case, and empty cylinders are returned to the surface in a wooden case immediately after use.
 - (ii) Cylinders stored underground are kept in a secure, purpose-built container.
 - (f) Reflective materials – Reflective sheeting and tape with a light metal content may be used underground provided that:
 - (i) It is attached to a suitable non light metal material.

- (ii) It forms part of a notice or sign, or a sighting object used for surveying.
- (iii) It is reflective tape used to make equipment and hazards more conspicuous.
- (iv) Care is taken to minimise the possibility of friction or impact.
- (g) Diesel-powered vehicles – Certain older types of diesel-powered equipment may contain components (ie fuel-injection pumps, fluid couplings and governors) with light metal content. These components are permitted underground provided they are installed and used so that the possibility of friction or impact is minimised.
- (h) The external light metal surfaces of crankcases, cylinder blocks and sumps of existing and rocker covers, and lubricating oil filter bodies of any engine, may be used underground provided they have had two coats of sprayed metallic zinc and two coats of zinc silicate paint applied by an approved contractor, and the coatings are renewed if found to be damaged when the equipment is examined.
 - (i) All other external components made of light metal should not be used underground.
 - (ii) Where practicable, engine covers should be kept securely in position. Dismantled parts constructed out of light metal should be carefully transported in suitable containers and not left in the mine.

6.12 Compressed air


The mine manager at an underground coal mine should ensure that:

- (a) All reticulated compressed air pipelines are earthed to prevent the build-up of static electricity.
- (b) Any equipment that uses compressed air is anti-static and earthed.
- (c) All hoses used for compressed air equipment are FRAS rated.

6.13 Contraband

The mine manager should ensure that all mine workers entering an underground mine are aware of the risks associated with the presence of contraband in an underground environment.

- (a) Before entering the underground mine, mine workers should be required to declare any of the contraband items listed in section 6.13 (c), and able to collect declared items upon exiting.
- (b) Procedures and information on the use underground of equipment, device or items considered to be contraband should be available and signage clearly visible. This information should include the methane levels at which equipment is prohibited from being used.

- 
- (c) Typical banned substances and materials (in coal mines) should include (but not be limited to):
 - (i) Tobacco products in any form (eg cigarettes, cigars and tobacco ‘pouches’), and smoking paraphernalia (eg devices such as pipes).
 - (ii) Any device that may be used to strike or create an open spark or flame (eg matches or lighters).
 - (iii) Any device or item containing light metal as detailed in section 6.11.
 - (iv) Unless it is a device approved by the mine manager, any item that is:
 - a. Battery-powered, including watches, mobile phones, digital cameras, calculators, hearing aids, torches, and test equipment.

As with electrical equipment, if the level of methane in the general body of the mine reaches 1.25%, all battery-powered equipment should be switched off.

If it is not possible to switch off the equipment, it should be removed from the mine and not taken back underground until a competent mine worker has deemed it safe to do so.
 - b. Made of, or containing, glass (eg bottles).
 - c. Scientific equipment or technology used to monitor or measure.
 - (v) Any item or substance that is illegal or banned on the surface of the mine or tunnel.
 - (d) To support awareness of the risks presented by contraband to the underground environment, the following initiatives should also be considered:
 - (i) The provision of suitable training for all mine workers on types of contraband, the consequences of taking contraband underground, and techniques on how to avoid such circumstances occurring.
 - (ii) Educational poster campaigns and appropriate signage.
 - (iii) Unannounced, random searches of mine workers entering the mine, and records kept of such searches.

07/

MONITORING

**DEVELOPING, IMPLEMENTING
AND MAINTAINING
MEASUREMENT CONTROLS TO
MANAGE RISK**

- 7.1 General provisions in relation to monitoring**
 - 7.2 Monitoring of underground ventilation**
 - 7.3 Selection of monitors**
 - 7.4 Positioning of monitors**
 - 7.5 Alarms**
 - 7.6 Inspections**
 - 7.7 Types of monitors**
-

ACOP

7.1 General provisions in relation to monitoring

The monitoring requirements outlined in this section are generally the same as those included in the Approved Code of Practice on Ventilation. This is because monitoring requirements are an integral part of the Fire or Explosion Principal Hazard Management Plan and the Ventilation Principal Control Plan, and should not be considered in isolation of each other. There may be additional requirements specific to either of these plans, and where this is the case, they are included in addition to the general requirements.

REG 4

4 Meaning of fresh air

A reference in these Regulations to fresh air means that the air—

- (a) *contains not less than 19% by volume of oxygen; and*
- (b) *contains not more than 0.25% methane; and*
- (c) *contains not more than 25 ppm of carbon monoxide; and*
- (d) *contains not more than 5 000 ppm of carbon dioxide; and*
- (e) *contains no other substance at a level that is likely to cause harm to a mine worker over the period that the mine worker is exposed to the substance at the mining operation.*

REG 85

85 Principal hazard management plan for fire or explosion

(2) *The principal hazard management plan for fire or explosion must include—*

- (e) *details of the type and location of the systems for prevention, early detection, and suppression of fire (including remote monitoring systems) and of the equipment for firefighting at the mining operation:*
- (f) *where a gas monitoring system is in place, provision for the use of portable gas detectors fitted with suitable extension probes to monitor the presence of methane in the event that the gas monitoring system, or part of it, fails or becomes non-operational:*

REG 102

102 Ventilation control plan

(1) *The ventilation control plan must, at a minimum, address the following matters:*

- (g) *the means by which heat stress conditions will be monitored and controlled:*
- (2) *In the case of an underground mining operation or tunnelling operation, the ventilation control plan must, in addition to the matters in subclause (1), address the following matters:*
- (d) *the levels of methane at which a methane detector will activate its alarm, and the procedures to be followed when that occurs:*
 - (e) *measures to be taken if the effective temperature in the underground parts of the mining operation exceeds 28°C:*

- (f) *providing for the recording of instances referred to in paragraph (e) as part of the health and safety management system:*
 - (g) *the procedure regarding the action to be taken when monitoring identifies the presence of noxious gases:*
 - (h) *the criteria for determining that ventilation is inadequate in a part or the whole of the underground parts of the mining operation, having regard to the quality, quantity, and velocity of air provided by the ventilation system such that workers must be evacuated from the affected part or the whole of the operation as required by Regulation 149:*
- (3) *In the case of an underground coal mining operation, the ventilation control plan must, in addition to the matters in subclauses (1) and (2), address the following matters:*
- (a) *an assessment of potentially explosive gas contained within the coal seam that is being mined:*
 - (b) *based on the assessment required by paragraph (a), the establishment of a system for the delivery of adequate ventilation that is designed to maintain the concentration of methane below 0.5% of the general body of air in any production area:*
 - (c) *the design, monitoring, and control of the underground ventilation arrangements to ensure that the atmosphere underground in the mining operation is kept within the prescribed limits (including design, monitoring, and control of arrangements required to support air quality, dust, and airborne contaminant management, gas outburst management, spontaneous combustion management, or other hazard management arrangements at the mining operation that are dependent on ventilation):*

142 Measurement of air from fans

- (1) *The mine operator of an underground coal mining operation must ensure that, at least once in every week, a competent person—*
 - (a) *measures the quantity of air being delivered to every working place in the underground parts of the mining operation; and*
 - (b) *determines whether air is being recirculated in the underground parts of the mining operation and takes suitable action to stop any such recirculation.*
- (2) *The mine operator of an underground metalliferous mining operation or tunnelling operation must ensure that, at least once in every month, a competent person—*
 - (a) *measures the quantity of air being delivered to every working place in the underground parts of the mining operation; and*
 - (b) *determines whether air is being recirculated in the underground parts of the mining operation and takes suitable action to stop any such recirculation.*

REG 143

143 Quantity and velocity of air

- (1) *The mine operator must ensure that—*
- (a) *the volume of air passing through an active working face, other than a longwall working face, is not less than 0.3 cubic metres per second for each square metre of normal development cross-sectional area; and*
 - (b) *the volume of air passing through an active longwall working face is not less than 4 cubic metres per second for each metre of extracted height in the face.*
- (2) *The mine operator must ensure, in respect of any underground parts of a mining operation where a mine worker is doing work or may travel, that the air in that part is provided at an adequate quantity and velocity to ensure the mine worker will not be exposed to a concentration of dust that is likely to cause harm to the mine worker.*

REG 144

144 Ventilation fans other than auxiliary fans

The mine operator must ensure that,—

- (b) *each main ventilation fan has the following devices connected to it:*
 - (i) *a pressure gauge that continuously indicates the air pressure; and*
 - (ii) *a device that continuously indicates and records the volume of air passing through the fan; and*
 - (iii) *a device that continuously indicates and records the number of revolutions per minute of the fan; and*
- (c) *each main ventilation fan is fitted with a device that continuously monitors and records the condition of the fan, including the temperature, vibration levels, and static pressure, and that will, when the device detects a significant departure from the fan's normal operating parameters,—*
 - (i) *first, trigger a visible alarm; and*
 - (ii) *following such period of time as will provide a mine worker with a reasonable opportunity to respond to the alarm, isolate the supply of electricity to the fan if no other action has been taken by a mine worker in response to the departure from normal operating parameters; and*
 - (iii) *record the date and time that an alarm is triggered and the supply of electricity is isolated; and*
- (d) *each booster fan installed underground is fitted with a device that continuously monitors and records the condition of the fan, including the temperature, vibration levels, and static pressure, and that will, when the device detects a significant departure from the fan's normal operating parameters,—*
 - (i) *first, trigger a visible alarm; and*

REG 150

- (ii) following such period of time as will provide a mine worker with a reasonable opportunity to respond to the alarm, isolate the supply of electricity to the fan if no other action has been taken by a mine worker in response to the departure from normal operating parameters; and
- (iii) record the date and time that an alarm is triggered and the supply of electricity to the fan is isolated; and
- (e) each of the monitoring devices referred to in paragraphs (c) and (d) is designed and installed so that the part of the device that displays the results of the monitoring is located where it can be easily accessed by a mine worker required to check the condition of the fan; and

150 Quantity of air to be measured

The mine operator must ensure that a competent person measures, at least once in every month, the quantity of air—

- (a) in the main current; and
- (b) in every split; and
- (c) at the commencement of the main return airway; and
- (d) in each ventilating district; and
- (e) at any additional place identified by the mine operator as a hazard.

REG 152

152 Application of Regulation 153

Regulation 153 applies to—

- (a) any underground coal mining operation; and
- (b) any underground metalliferous mining operation or tunnelling operation where methane has been detected.

REG 153

153 Ventilation

The mine operator of a mining operation to which this Regulation applies, must ensure that—

- (a) the percentage of methane in the general body of air in the underground parts of the mining operation where a mine worker is or may be present is not more than 2% by volume; and
- (b) a quantity of fresh air adequate to ensure that paragraph (a) is complied with is circulated throughout the underground parts of the mining operation—
 - (i) before a mine worker enters the underground parts of the mining operation; and
 - (ii) whenever a mine worker is in the mine; and
- (c) there is fresh air at the following places:

REG 157

- (i) *the commencement of an ERZ1:*
- (ii) *every location that is 100 metres outbye of the most inbye completed line of cross-cuts in a panel or of a longwall or shortwall face; and*
- (d) *no air current passes through any stopping, or any unsealed, abandoned, or worked out area, before ventilating or passing through an active working place; and*
- (e) *the total number of mine workers ordinarily present in a ventilation district or ventilation circuit in the mine is kept to a minimum; and*
- (f) *a competent person measures, at least once in every week, the percentage of methane in the main return and split returns.*

157 Fire protection and early warning systems

- (1) *The mine operator must ensure that suitable and sufficient devices are installed in the underground parts of the mining operation to monitor for early signs of fire.*
- (2) *If a device installed as required by subclause (1) detects signs of fire in the underground parts of the mining operation, the device must—*
 - (a) *activate an audible alarm that will warn mine workers in the affected part or parts of the mining operation to escape to a place of safety;*
 - (b) *activate an alarm at the surface of the mining operation.*
- (3) *The mine operator must ensure that suitable and sufficient fire extinguishers are provided beside all high-voltage electrical plant and, if a significant risk of fire exists, beside all other electrical plant.*

REG 158

158 Testing for methane

- (1) *The mine operator must ensure that testing for the presence of methane in the underground parts of the mining operation is carried out—*
 - (a) *as often as practicable; and*
 - (b) *with a suitable device.*
- (2) *The mine operator must ensure that, in respect of the devices used to test for the presence of methane, suitable procedures are in place dealing with—*
 - (a) *their safe use for that purpose; and*
 - (b) *their examination and maintenance; and*
 - (c) *their regular calibration.*
- (3) *The mine operator must ensure that no locked flame safety lamps are taken into or used in the underground parts of the mining operation.*

REG 162

162 Monitoring for methane

The mine operator of a mining operation to which this Regulation applies must ensure that monitoring is carried out continuously at every working face where methane has been detected and a mine worker is present.

REG 164

164 Withdrawal of mine workers when high level of methane present

- (1) *This Regulation applies when the level of methane in the general body of air in a part or the whole of the underground parts of an underground mining operation or tunnelling operation is detected to be 2% by volume or more.*
- (2) *The mine operator must ensure that—*
 - (a) *every mine worker in the affected part or parts of the mining operation withdraws from the affected part or parts including, as the case requires, the whole of the underground parts of the mining operation; and*
 - (b) *the only person who enters the affected part or parts of the mining operation or, as the case requires, any part of the underground parts of the mining operation, is—*
 - (i) *a competent person, to test for the presence of methane; or*
 - (ii) *a mine worker, to inquire into the cause of the presence of the methane or to remove the methane; and*
 - (c) *no other mine worker enters the affected part or parts of the mining operation, or, as the case requires, any part of the underground parts of the mining operation, until a competent person reports to the manager that it is safe to do so.*

REG 176

COAL

176 Continued monitoring of atmospheric conditions underground during emergency

- (1) *The mine operator of an underground coal mining operation must ensure that a system is provided that monitors the atmospheric conditions in the underground parts of the mining operation during an emergency and provides information about those conditions to people on the surface.*
- (2) *The mine operator must ensure that—*
 - (a) *the system incorporates an adequate backup power supply; and*
 - (b) *the components for the system that are installed underground are recognised as being safe to operate in an explosive atmosphere, unless the components are installed in a drift or shaft being driven from the surface in material other than coal.*

REG 180

COAL

180 Sealed goafs

If an underground coal mining operation has a sealed goaf, the mine operator must ensure that appropriate steps are taken to control any hazards that may be presented or caused by the emission of methane and noxious gases from the sealed goaf, including by—

- (a) *preventing intake air from travelling across the face of a permanent seal at the mining operation; or*

- (b) *minimising the risks of inrush and leakage of atmospheric contaminants from sealed goaf areas and abandoned or sealed workings into intake airways, which must include—*
 - (i) *use of no less than a type C seal; and*
 - (ii) *minimising leakage through seals; and*
 - (iii) *preventing damage to seals; and*
 - (iv) *installing a monitoring device in each intake airway on the return side of the seals over which the intake air passes to detect the intake airway's general body concentration of—*
 - (A) *oxygen; and*
 - (B) *carbon dioxide, if it is present behind the seal in a general body concentration greater than 3%; and*
 - (C) *any other gas that is present behind the seal in a quantity and concentration that is likely to create a hazard if it enters the intake airway adjacent to the seal; and*
 - (v) *for longwall workings, installing a monitoring device at the intersection of the longwall face and the intake airway to detect the intake airway's general body concentration of—*
 - (A) *oxygen; and*
 - (B) *carbon dioxide, if it is present behind the seal in a general body concentration greater than 3%; and*
 - (C) *any other gas that is present behind the seal in a quantity and concentration that is likely to create a hazard if it enters the intake airway adjacent to the seal; and*
 - (vi) *ensuring that every monitoring device installed as required by subparagraphs (iv) and (v) triggers an alarm to warn every mine worker who may be affected when a gas required to be detected by the device is present at the predetermined concentration.*

REG 184

COAL

184 Facilities required for sealing*The mine operator must ensure that—*

- (d) *when sealed, the mining operation has facilities allowing the following:*
 - (ii) *monitoring of the atmosphere behind the seal from a safe position; and*

REG 196

COAL

196 Monitoring for methane at the working face*The mine operator must ensure that monitoring for the presence of methane—*

- (a) *is continuous at every working face of the mining operation at which a mine worker is present and is carried out—*
 - (i) *as near to the face as possible; and*

REG 197	COAL
REG 198	COAL
REG 199	COAL

- (ii) at an elevation determined by the principal hazard management plan for fire or explosion; and
- (b) is also carried out when required by Regulation 162.

197 Methane monitors in intake airways

The mine operator must ensure that—

- (a) there is at least 1 methane monitor in each intake airway at the boundary between an NERZ and an ERZ1; and
- (b) every methane monitor located at the boundary between an NERZ and an ERZ1 is visible at the boundary and will,—
 - (i) if the concentration of methane detected in the general body of air at the boundary reaches 0.25% or more, automatically activate a visible alarm; and
 - (ii) if the concentration of methane detected in the general body of air at the boundary reaches 0.5% or more, automatically isolate the supply of electricity to all plant, other than safety critical equipment, in—
 - (A) the ERZ1 and the NERZ; or
 - (B) if the NERZ has been subdivided, the ERZ1 and the subdivided part of the NERZ adjacent to the ERZ1.

198 Methane monitors in return airways

The mine operator must ensure that—

- (a) there is at least 1 methane monitor in each main return airway and in each return airway in a ventilation split; and
- (b) every methane monitor located in a return airway automatically activates a visible alarm at the surface of the mining operation when the concentration of methane detected in the general body of air in the return airway reaches or exceeds the percentage stated in the ventilation control plan as the percentage at which the methane detector activates its alarm; and
- (c) a record is kept of every occasion that the methane monitor activates a visible alarm as required by paragraph (b).

199 Methane monitors on mobile plant powered by battery or diesel engine

- (1) The mine operator must ensure that all mobile plant used in an ERZ1 that is powered by a battery or diesel engine is fitted with a methane monitor that will,—
 - (a) if the concentration of methane detected in the general body of air around the mobile plant reaches 1% or more, automatically activate a visible alarm to warn the operator of the mobile plant; and
 - (b) if the concentration of methane detected in the general body of air around the mobile plant reaches 1.25% or more—
 - (i) automatically shut down the mobile plant; and

- (ii) *in the case of mobile plant powered by a diesel engine, automatically prevent the diesel engine from restarting.*

- (2) *The mine operator must ensure that, in the case of non-explosion protected mobile plant that is powered by a battery or diesel engine and that is fitted with an automatic methane monitor, the mine worker operating the mobile plant immediately parks and shuts down the plant if the methane monitor fails while the mobile plant is in use.*

REG 200

COAL

200 Methane monitors on certain mobile plant powered by electricity through trailing or reeling cable

- (1) *The mine operator must ensure that every coal cutter, continuous miner, tunnel-boring machine, road-heading machine, and longwall shearer used at the mining operation is fitted with a methane monitor that will,—*
 - (a) *if the concentration of methane detected in the general body of air around the mobile plant reaches 1% or more, automatically—*
 - (i) *activate a visible alarm to warn the operator of the mobile plant; and*
 - (ii) *isolate the electricity supply to the cutters:*
 - (b) *if the concentration of methane detected in the general body of air around the mobile plant reaches 1.25% or more, automatically isolate the supply of electricity to the trailing cable or reeling cable supplying the mobile plant.*
- (2) *The mine operator must ensure that every mobile bolting machine, loader, load-haul-dump vehicle, and shuttle car used at the mining operation is fitted with a methane monitor that will,—*
 - (a) *if the concentration of methane detected in the general body of air around the mobile plant reaches 1% or more, automatically activate a visible alarm to warn the operator of the mobile plant; and*
 - (b) *if the concentration of methane detected in the general body of air around the mobile plant reaches 1.25% or more, automatically isolate the supply of electricity to the trailing cable or reeling cable supplying the mobile plant.*

REG 201

COAL

201 Monitoring of other mobile plant powered by electricity through trailing or reeling cable

- (1) *This Regulation applies to any mobile plant of a kind other than that specified in Regulation 200.*
- (2) *The mine operator must ensure—*
 - (a) *that the mobile plant is fitted with a methane monitor that will perform the functions described in Regulation 200(2); or*
 - (b) *that the mobile plant is recognised as being suitable for use in an ERZO by or under the Electricity (Safety) Regulations 2010; or*

REG 202

COAL

- (c) *in any other case, that any mine worker who detects a concentration of methane in the general body of air that reaches 1.25% or more immediately isolates the supply of electricity to the trailing cable or reeling cable supplying the mobile plant.*

202 Auxiliary and booster fans

- (1) *The mine operator must ensure that each auxiliary and booster fan is fitted with a methane monitor and that,—*
- (a) *if the concentration of methane detected in the general of body of air around an auxiliary fan reaches 1.25% or more, the supply of electricity to the auxiliary fan is automatically isolated; and*
- (b) *if the concentration of methane detected in the general body of air around a booster fan reaches 1.25% or more, the methane monitor automatically activates an audible and visible alarm.*
- (2) *The audibility and visibility of the alarm required by subclause (1)(b) must be sufficient to ensure that necessary action will be taken in response to the alarm.*
- (3) *Nothing in this Regulation applies to an auxiliary fan or a booster fan located in a drift or shaft being driven from the surface of a mining operation in material other than coal.*

REG 204

COAL

204 Failure of methane monitoring system

- (1) *This Regulation applies if the methane monitoring system fails or becomes non-operational, affecting a part or the whole of the underground parts of the mining operation, and the mining operation does not have—*
- (a) *a procedure for the use of portable monitors to detect methane; or*
- (b) *a sufficient number of portable monitors to continually monitor the affected part or the whole of the underground parts of the mining operation to the extent necessary to ensure that the levels of methane in the affected part or the whole of the underground parts of the mining operation remain below 2%.*
- (2) *The mine operator must ensure that every mine worker underground is withdrawn to a place of safety.*
- (3) *The mine operator must ensure that no mine worker enters or remains in an unsafe part of the underground parts of the mining operation, except to repair or replace the affected parts of the methane monitoring system.*
- (4) *For the purposes of subclause (3), a part or the whole of the underground parts of the mining operation is unsafe if the concentration of methane in the general body of air in that part or the whole of the underground parts of the mining operation cannot be monitored as required by these Regulations.*

REG 222

222 Examination of mining operations

- (1) *The mine operator must ensure that a competent person—*
- (a) *examines,—*
 - (i) *before the start of each working shift and at suitable times during each working shift, every area of the mining operation where a mine worker is or will be present; and*
 - (ii) *at least weekly, every accessible area of the mining operation, including every area containing barriers, machinery, seals, underground or surface infrastructure, and ventilation stoppings; and*
 - (iii) *at least weekly, every vehicle in the mining operation; and*
 - (iv) *before it is started, any fixed or mobile plant in the mining operation that has been stopped for the preceding 24 hours or longer; and*
 - (b) *takes all practicable steps to eliminate, isolate, or minimise any significant hazard identified during the examination; and*
 - (c) *ensures that all plant examined either is safe or is made safe.*
- (2) *The mine operator must ensure that a written procedure for the conduct of examinations required by subclause (1) is included in the health and safety management system for the mining operation and sets out—*
- (a) *the matters to be covered by the examination; and*
 - (b) *a timetable (subject to the minimum requirements of subclause (1)) for the carrying out of the examinations; and*
 - (c) *the process for recording findings; and*
 - (d) *the process for taking action as a result of findings.*

REG 223

223 Barometer, hygrometer, and thermometer

- (1) *The mine operator of an underground mining operation or tunnelling operation must ensure that—*
- (a) *a barometer and thermometer are placed on the surface of the mining operation in a conspicuous position near the entrance to the underground parts of the mining operation; and*
 - (b) *a hygrometer is available for use in every underground mining operation or tunnelling operation.*
- (2) *The mine operator must ensure that a competent person reads the barometer and thermometer before the examinations required by Regulation 222(1).*

7.2 Monitoring of underground ventilation

The mine operator should ensure that the air supplied to every underground place where mine workers are working meets the requirements of the applicable Regulations, and safe levels, in relation to:

- (a) Air velocity, quantity and composition.
- (b) Fire.
- (c) Methane or noxious gases.
- (d) Humidity.
- (e) Diesel emissions.
- (f) Radon.

7.2.1 Monitoring of air velocity, quantity and quality

The site senior executive should ensure that suitable arrangements are in place to monitor air velocity, quantity and quality, and that any significant changes to the following are investigated immediately:

- (a) Air velocity, quantity and quality at all critical underground locations as required by the ventilation system plan.
- (b) Total air quantity at the main fan, and booster fans.
- (c) Ventilation distribution.

7.2.2 Monitoring for the early detection of fire

The mine or tunnel manager should ensure that:

- (a) Suitable monitors are installed underground to alert all mine workers in the vicinity, and on the surface, of the early onset of fire.
- (b) A monitoring and review process, including visual inspections and regular auditing, is implemented at the mine or tunnel.

7.2.3 Monitoring for the presence of methane

It is a requirement under Regulation 158 that the mine operator must test for methane and under Regulation 162 if methane is detected at any working face that monitoring is continuous.

- (a) To meet this requirement, all mine operators should ensure that monitoring for the presence of methane is undertaken.
- (b) In the event that the presence of methane is detected at an underground metalliferous mine or tunnel at a level of 0.25% or greater, the mine operator should:
 - (i) Establish Explosion Risk Zones as detailed in Regulation 190; and



- (ii) be required to meet the explosion risk requirements as detailed in the Regulations, and as they apply to an underground coal mine, until such time as the methane is reduced to a level below 0.25%; and
 - (iii) immediately notify WorkSafe NZ (ie within 24 hours) of any such re-classification of the underground operation and/or workplace.
- (c) Increasing the ventilation volume to dilute the methane to a level below 0.25% is the simplest method to reduce the presence of methane. The source of the methane should also be investigated to establish whether it will present additional hazards in the future.

7.2.4 Monitoring of humidity

- (a) The shift supervisor should determine underground humidity levels using a hand held whirling hygrometer, or other suitable instrument.
- (b) Effective Temperature (ET) should then be determined by:
 - (i) Use of a hygrometer to find the Wet Bulb (WB) and Dry Bulb (DB) temperatures in a particular section of the mine or tunnel.
 - (ii) Use of an anemometer and watch, to determine the velocity in that particular section of the mine or tunnel.
 - (iii) Plotting all three readings on the ET chart in the Appendix.

7.2.5 Monitoring of diesel emissions

- (a) The site senior executive should ensure that the risks associated with diesel engine emissions and Diesel Particulate Matter are identified and the emissions monitored, and exposure levels are adequately managed and documented in the mine or tunnel's Air Quality Principal Hazard Management Plan. For more detailed information, see the Approved Code of Practice on Air Quality.
- (b) The site senior executive should be aware of, and keep up to date with, new technologies in this area, and the Ventilation Principal Control Plan and/or the Mechanical Engineering Principal Control Plan should include controls and measures that reflect new technological developments. Such controls may include, but are not limited to:
 - (i) The use of Tier 3 and 4 low emission engines
 - (ii) System components to capture or convert diesel pollutants
 - (iii) Ventilation quantities
 - (iv) Maintenance and management systems
 - (v) Traffic management systems
 - (vi) Emission monitoring systems
 - (vii) Exposure monitoring systems

- (viii) Use of personal protective equipment
- (ix) Any other emerging technologies in this area.

7.2.6 Monitoring for radon

- (a) The site senior executive should ensure that monitoring arrangements are in place for the detection of radon.
- (b) As uranium is known to be present in New Zealand³⁷, all mine and tunnel operators should ensure specific monitoring arrangements are in place for its detection.
- (c) Monitoring for radon should be by short term passive dosimeters, which are positioned at specific locations for set periods (usually 7-14 days). At the end of the set period, the dosimeter is sent to an independent testing facility for analysis.
- (d) When the presence of radon is detected, the site senior executive should ensure that arrangements are in place to monitor the levels of radon using short term passive dosimeters or air sampling monitors.

7.3 Selection of monitors

The selection of monitors should be based on suitability for each underground environment and each individual mine or tunnel. The mine or tunnel manager should ensure that there is in place:

- (a) The ability to detect all of the gases outlined in Regulation 4.
- (b) Where required, additional monitors to detect hydrogen sulphide, hydrogen, nitrous oxide, sulphur dioxide, nitrogen and smoke.
- (c) When exposed to a potentially explosive atmosphere, safety critical monitors and detectors.
- (d) Appropriate maintenance and calibration programmes.
- (e) Monitors connected to a control room (where practicable), or some form of automatic alarm system (eg a pager, mobile phone, or RT system) where the underground environment is being continuously monitored for any indication of a contaminated atmosphere.
- (f) Modelling that shows all monitors in the logical sequence created by the airflow and where the pick-up of contaminants starts. See Figure 5 for an example of real time/telemetric monitoring.
- (g) Suitable backup systems that allow data to be continuously transmitted to the surface in the event of a fire or explosion.

³⁷ <http://www.teara.govt.nz/en/radioactive-minerals>

- (h) A system for checking the accuracy of hand held gas monitors at the surface prior to each shift.
- (i) A system for immediately notifying management and the workers representative of any abnormal recordings.
- (j) For each installed tube bundling sampling point, a sampling board with a flow meter arrangement and the minimum flow available at this point so that the sampling point can be checked for accuracy.
- (k) A review process, by the ventilation officer, of any alarms recorded over the month prior and, if necessary, revision of the alarms, either higher or lower.

7.4 Positioning of monitors

7.4.1 Positioning of CO monitors or smoke detectors

Depending on the depth and length of mine or tunnel, and the location of conveyors, electrical equipment, hydraulic systems and the ventilation velocity, the mine or tunnel manager should ensure that monitors are positioned:

- (a) Before the commencement of a working face, unless there is a belt drive sited in that area.
- (b) On the downstream side of any belt drive.
- (c) Against the auxiliary fan, or in a position that will alert mine workers in a blind heading of a fire developing in a part of the mine or tunnel used to supply the blind heading with fresh air.
- (d) In the return from the main working face.
- (e) At the point where return airways form a single tunnel or if multiple main returns, then in each main return.
- (f) At the outlet side of any underground main fan (in a metalliferous mine) or booster fan.
- (g) At any other location where a risk assessment identifies it as a requirement.
- (h) In the flow path as indicated by a smoke test. The smoke test should be carried out prior to installation and again on commissioning.
- (i) To ensure correct positioning is maintained, the tests should be re-taken when there is any significant change in airflow (+/- 20%) at that location.

7.4.2 Factors influencing the position of monitors and detectors

The positioning of CO monitors or tube bundle sample points is critical to the quality of data collected, reported and interpreted.

If a monitor is positioned too close to the potential source/location to be monitored, it may not be in the main airstream so any combustion products may evade the monitor.



If a monitor is positioned too far away from the monitored location, the time it takes for an incident to intensify may be quicker than it takes for contaminated air to travel to where the monitor is positioned.

7.4.3 Positioning of methane monitors

- (a) The mine manager should ensure that methane monitors are installed so that:
 - (i) They meet the minimum location requirements as specified in Regulations 162 and 196-202 inclusive.
 - (ii) Due to the buoyancy of methane, they are positioned so that methane will not pass over the monitor without being detected.
 - (iii) They are clear of obstructions that may cause turbulence and are positioned to ensure they record the reading where the gases are completely mixed.
 - (iv) Power cables and tube bundle tubes are protected from damage and impacts.
- (b) The mine manager should ensure that electrically-powered methane monitors are safety critical and have a back-up system that ensures the monitor to function in the event of a power failure.

7.4.4 Monitors on explosion-protected vehicles energised by a battery or diesel engine

The mine or tunnel manager should ensure that an explosion-protected vehicle energised by a battery or diesel engine is fitted with at least one automatic methane monitor to:

- (a) Detect the concentration of methane around the vehicle.
- (b) Automatically activate a visible alarm to warn the operator when the concentration exceeds 1%; and either:
 - (i) Trip the electricity supply to the machine electrical motors when the concentration exceeds 1.25%; or
 - (ii) Stop the diesel engine when the concentration exceeds 1.25%.

7.4.5 Monitors on other explosion-protected mobile plant

This section applies to explosion-protected mobile plant energised by a reeling or trailing cable.

- (a) The mine or tunnel manager should ensure that the explosion-protected mobile plant is fitted with at least one automatic methane monitor to:
 - (i) Detect the general body concentration of methane around the plant.
 - (ii) Automatically trip the electricity supply to the plant when the concentration exceeds 1.25%.

- (b) The methane monitor should be sited as follows:
 - (i) The methane monitor at the "head end" should be sited as close as possible to the roof within 3.5m of the working face. This should cut off electricity to the machines trailing cable if the level of methane reaches 1.25%.
 - (ii) In any secondary mining process where de-pillaring or floor-coal recovery is taking place, the methane monitor at the "head end" should be sited as close as possible to the roof, no further than 3.5m outbye of the goaf edge, and on the opposite side of the roadway to the ventilation duct. This should cut off electricity to the machines trailing cable if the level of methane reaches 1.25%.

7.4.6 Monitors on a hydro mining panel

- (a) Where developments are located on the intake side of a hydro mining panel, sufficient methane monitors should be located before and after the development roadway to ensure fresh air is supplied to the panel.
- (b) At least two telemetric methane monitors (provided with a digital reader and linked to the high pressure water pump) should be sited no further than 20m from the goaf edge in the return roadway on a hydro mining panel.
- (c) Where primary, secondary and tertiary dilution doors are required, methane monitoring is required in the hydro mining panel when methane accumulation and uncontrolled discharge is predicted. This will allow instant operation of the dilution doors and pressure control of the hydraulic monitor when necessary.
- (d) In a hydro mining panel where no mine workers are working and no equipment is present in the return airway, telemetric methane monitoring is required and should be linked to the operator of the water jets and the control room, so that power to the water jets is tripped before the methane level reaches 2.0%.
- (e) A methane monitoring station should be positioned at the outbye end of the hydro mining district return. This is the most effective location for gathering information for the deputy and the control room as the district methane make will pass this point.

The methane monitors should have duties to:

- (i) Show the rising trend of methane with alarms set at various levels dependant on the legislation requirements; and
- (ii) Trip power to the hydro mining equipment at a set percentage or rate of change; and
- (iii) Allow the operator to control the mining rate and the methane levels.

Power to the hydro mining water jets could be restored as methane reduces to allow production to continue.

- (f) At the outbye end of the hydro mining district return, the methane monitor should be connected to a flashing beacon that initiates at a set level to prevent mine worker or mobile equipment access.

7.4.7 Use of portable gas monitors

Approved, portable gas monitors may be hand held, and are used to provide a continuous reading of the underground atmosphere, and warn with visible and audible alarms when particular levels are reached.

Approved portable gas monitors should be used:

- (a) At each production face where a coal cutter, continuous miner or road heading machine is used to win coal, suspended from the roof; and:
 - (i) Within the distance between the face and the inlet of the ventilation ducting if the face is ventilated in exhausting mode; or
 - (ii) above the general body of a coal cutter, continuous miner or road heading machine in any other ventilation set-up.
- (b) The monitors in (a) (i) and (ii) above should be in place during any work activity associated with production process (including bolting).
- (c) At each hydro monitor face, suspended from the roof above the operator's cab during any work activity.
- (d) At any auxiliary ventilated place where mine workers continuously work during any work activity.
- (e) Any place where a seal is constructed to isolate a goaf or worked out area during any work activity.
- (f) Suitable extension probes should be readily available for use with hand held gas detectors to test for methane layering or accumulations in cavities and voids.

7.4.8 Monitoring where methane drainage is in place

Where a system of methane drainage is in place:

- (a) High reading methanometers should be used in conjunction with standard methane monitors to ensure the early detection of system failure.
- (b) Additional monitors should be installed as part of the methane extraction system design. See the Appendix of the Approved Code of Practice on Ventilation for more detailed information on methane management.

7.5 Alarms

The site senior executive should ensure that there are Standard Operating Procedures (SOPs) in place for monitoring and the response to changes in detected gas (or smoke) levels.

The SOP should require that:

- (a) All monitors are maintained and calibrated according to the manufacturer's specifications, and with the requirements of the Electricity (Safety) Regulations 2010.
- (b) All mine workers are trained in the operation of the monitoring system.
- (c) There are instructions available for all mine workers on the process to be followed, who should be notified above and below ground, and the records to be documented, when a warning or alarm is activated.
- (d) Where continuous monitoring is in place, there is a system for recording the mine worker responsible for controlling the monitoring system.
- (e) Alarms are reset only when a competent mine worker has deemed it safe to do so.
- (f) Alarm data is stored, and can be retrieved at any time, for the review of an alarm activation event, the actions that were taken, and by whom.
- (g) When an alarm is added, removed or changed, a documented process is in place to ensure the mine worker responsible for controlling the monitoring system is notified of the change, and is trained in any new procedures or actions resulting from the change, where required.

7.5.1 When alarms warn of the presence of methane

Methane monitors should alarm at pre-determined levels locally, in the control room, or by automatic notification (where there is no control room).

When higher levels of methane are reached, machines should be automatically shut down and/or the power isolated to the mine. Generally, the alarm and isolation levels are:

- (a) 0.25% to indicate the presence of methane in a NERZ, or in a metalliferous mine.
- (b) 0.5% at the point of transition from an ERZ1 to NERZ.
- (c) 1.0% to warn operators of mobile plant, hydro monitors, coal cutting equipment, or in the general body ventilation, of an increase in methane.
- (d) 1.25% to de-energise or isolate all electrical equipment, excluding safety systems in the affected area.
- (e) 2.0% (or lower, as determined by the mine), to trigger the withdrawal of all mine workers from the affected area to a safe location.
- (f) 4.5% to warn that methane has reached the explosive range (typically, this will occur when monitoring of a recently sealed goaf is in place).
- (g) The withdrawal of mine workers is to be carried out in line with the requirements of Regulation 149.

The regulatory alarm and cut off requirements for methane monitoring are provided in the Appendix.

7.5.2 When monitoring detects the presence of radon

When the presence of radon is detected, it should be controlled in the same way that the presence of other gases are managed, including:

- (a) Dilution of the gas by permanently increasing ventilation quantity.
- (b) Directing the ventilation in the area where radon is being generated to a return airway.
- (c) Sealing the area where radon is being generated.
- (d) If the radon is desorbed from water, by containing the water in pipes, directing the water to returns, or preventing turbulence of the water until it can be contained in pipes.

7.6 Inspections³⁸

- (a) The mine or tunnel manager should ensure that regular inspections of working areas are carried out to:
 - (i) Monitor compliance with the underground ventilation requirements.
 - (ii) Identify sub-standard work practices (behaviours) and conditions (hazards).
- (b) It is the shift supervisor's responsibility on each shift, as part of their inspection duties, to examine all parts of the mine or tunnel that they are responsible for, to ensure that:
 - (i) Fresh air is supplied at the commencement of every section of the workings that has a working face.
 - (ii) The level of methane is no greater than 1.25% in an area classified as ERZ1.
- (c) If the shift supervisor finds the level of methane to be 2% or greater, all mine workers should be immediately withdrawn from the affected area to a safe location, or to the surface, and access to the affected area prevented with a secure barrier or fence. The barrier should be clearly marked with appropriate signage to prevent access.
- (d) No mine worker should enter the affected area until a documented risk assessment has been carried out and a competent mine worker confirmed it is safe to re-enter to:
 - (i) Carry out an inspection/investigation.
 - (ii) Restore or repair the ventilation system.
 - (iii) Save life.
- (e) The mine or tunnel manager should ensure that inspections are time-based and activity-based:

³⁸ The Chamber of Minerals & Energy. (October 2004). *Hazard Management Guideline for Underground Fire Prevention*. Part 2 Underground Fire Controls. Version 1. WA, Australia. 4-20.

- (i) Time-based inspections of all working places on a regular basis (ie shift, daily, weekly or monthly), depending on the level of risk (eg weekly magazine inspections), and that generally involve the use of area-specific or task-specific checklists to record any defects.
 - (ii) Activity-based, or 'on-the-job', inspections undertaken by mine workers or teams on an 'ad hoc' basis. The format for this type of 'dynamic' inspection may vary between operators, but may include 'Time Out', 'Take 5', or 'Positive Attitude Safety System (PASS)' systems. Activity-based systems are usually documented.
- (f) Where time-based inspections are undertaken, the mine operator or site senior executive should ensure that³⁹:
- (i) Mine workers are assigned to inspect specific areas in the mine or tunnel for each shift and for each day of the week (and inspections may include more than one district or section of the mine or tunnel).
 - (ii) Inspections undertaken during a shift are carried out by the same mine worker to ensure assessment continuity. Districts should be of an adequate size so that this can be achieved.
 - (iii) The frequency of inspections takes into consideration changes in the mine or tunnel operation (eg mine workers, equipment, systems and environmental factors). Intervals between inspections should allow for actions to be taken to fix problems identified during a previous inspection.
 - (iv) The frequency of inspections is influenced by schedules and working areas unique to the mine or tunnel operation, and the presence of potential hazards unique to a particular site. Inspection frequencies should be:
 - a. Pre-shift, before work commences.
 - b. At suitable times during the shift, and when mine workers are working alone, at least twice each shift.
 - c. 24 hours (daily), on non-production days.
 - d. At the end of each shift (where continuous working is in place), as part of a pre-shift inspection for the oncoming shift.
 - e. After blasting.
 - f. Weekly.
 - g. Monthly, by the ventilation officer.
 - h. Fire watch inspections, including:
 - 1. When a coal conveyor has been stopped for more than 90 minutes, and no later than 3 hours after it has stopped.
 - 2. Following procedures that require a permit, such as hot work.

³⁹ Health and Safety Executive (HSE). (1993). Approved Code of Practice. *The Management and Administration of Safety and Health at Mines. Management and Administration of Safety and Health at Mines Regulations 1993*. Sheffield, England. 25-29.

7.7 Types of monitors

7.7.1 Smoke detectors

Smoke detectors identify and provide a warning when particles of smoke are detected in a mine atmosphere. There are two types of smoke detectors used in an underground environment:

- (a) Ionisation chambers (which are similar to those used in most residential homes).
- (b) Optical smoke detectors (which are more sensitive to smouldering fires).

Both types of detectors are prone to dust build up and should be cleaned regularly to ensure they function correctly.

7.7.2 Carbon Monoxide detectors (ppm)⁴⁰

Carbon monoxide monitors measure CO levels and sound an alarm before dangerous levels accumulate. CO monitors can detect the onset of fire through spontaneous combustion – events that can both be disguised by the running of diesel-powered vehicles and the use of explosives (which can lead to poisoning of the CO monitors).

The positioning of CO monitors or tube bundle sample points is critical to the quality of the data collected and how it is reported and interpreted.

If a monitor is positioned too close to the potential source/location to be monitored, it may not be in the main airstream resulting in the combustion products evading the monitoring instrument.

If a monitor is positioned too far away, the time it takes for the incident to intensify may be quicker than it takes for the contaminated air to travel to the site of the monitor.

7.7.3 Airflow monitors (m/s)⁴¹

Airflow monitors are used to measure:

- (a) Air velocity of air going into main surface fans.
- (b) Air velocity at the outbye end of the districts.
- (c) Air velocity in an auxiliary ventilation duct or tube (ie pitot tube type).

7.7.4 Pressure transducers (Pa or kPa)⁴²

Pressure transducers are used to measure:

- (a) Static pressure at main surface fans to alarm at +/- 10% of normal pressure.

⁴⁰ See Definitions.

⁴¹ See Definitions.

- (b) The pressure difference across a set of doors usually sited between intake and returns near to the working face. It will give an indication of the pressure variance as operations are carried out on the district.
- (c) The static pressure of an auxiliary fan giving an indication if the fan is operating and if the ducting is damaged or restricted.
- (d) On methane drainage ranges:
 - (i) The vacuum being applied to the district.
 - (ii) The differential pressure across an orifice plate to determine the district flow.
- (e) Across a working panel/roadway where the resistance is known. The quantity can be calculated using the $p=RQ^2$ equation (see the Approved Code of Practice on Ventilation to determine values).

7.7.5 Tube bundle system

A tube bundle system draws air from set points underground via small bore tubing to the surface analyser through a vacuum pump, and provides an accurate analysis of the underground environment.

The further the distance from the mine's outlet, the longer the delay time for the sample to reach the surface. The time delay is not usually a problem as the system gathers historical information from that site, and should the mine lose power underground, the information is still gathered and remains continuous throughout the time of the power outage.

To establish delay times, and to ensure that the system is exhausting from its sample point, a known sample is placed into it and the time taken from introducing the samples to reaching the analyser establishes the delay time. To ensure the system's efficiency, the sample received should be greater than 95% of the known sample introduced inbye.

If this percentage is not achieved there is a leak in the system and the sample is being diluted along its length. The leakage point should be identified and fixed in order that a true district reading and flow is analysed.

7.7.6 Telemetric monitoring

Telemetric monitoring provides real time information, but only while live. Loss of power for any length of time will quickly render the system unreliable.

A combination of telemetric monitoring and tube bundle monitoring will provide the best information to the surface.

⁴² See Definitions.

7.7.7 Methane monitors (methanometers)

Methane monitors, or methanometers, detect the presence of methane gas in a mine or tunnel.

7.7.8 Monitors for other gases

Monitors used to detect other gases that might be present underground (such as radon, hydrogen sulphide, hydrogen, nitrous oxide, sulphur dioxide and nitrogen), include automatic detectors, tube bundle systems, hand held monitors, dosimeters, chemical detector tubes and gas chromatographs.

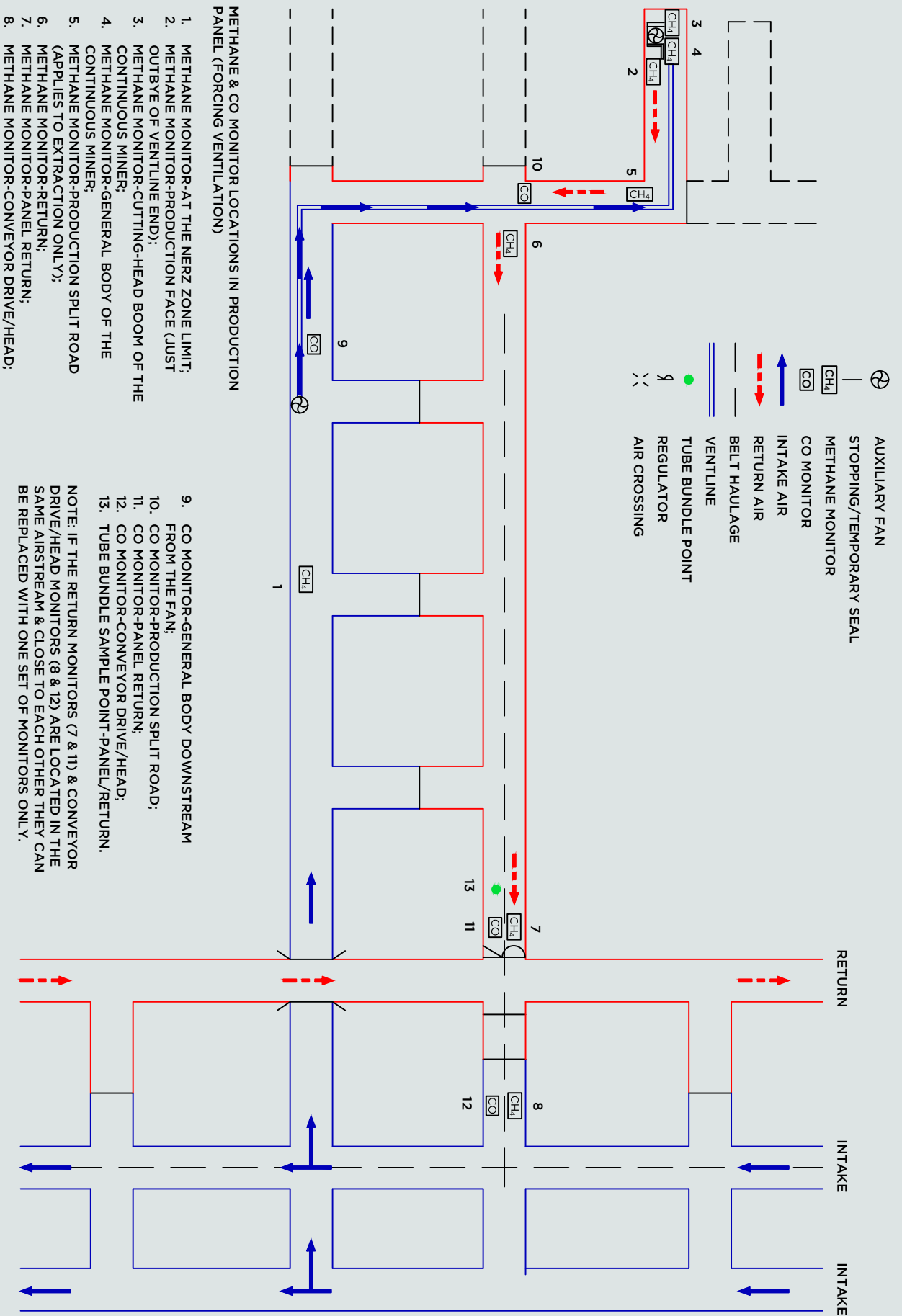


Figure 4 - Methane and CO monitor locations in production panel (forcing ventilation)

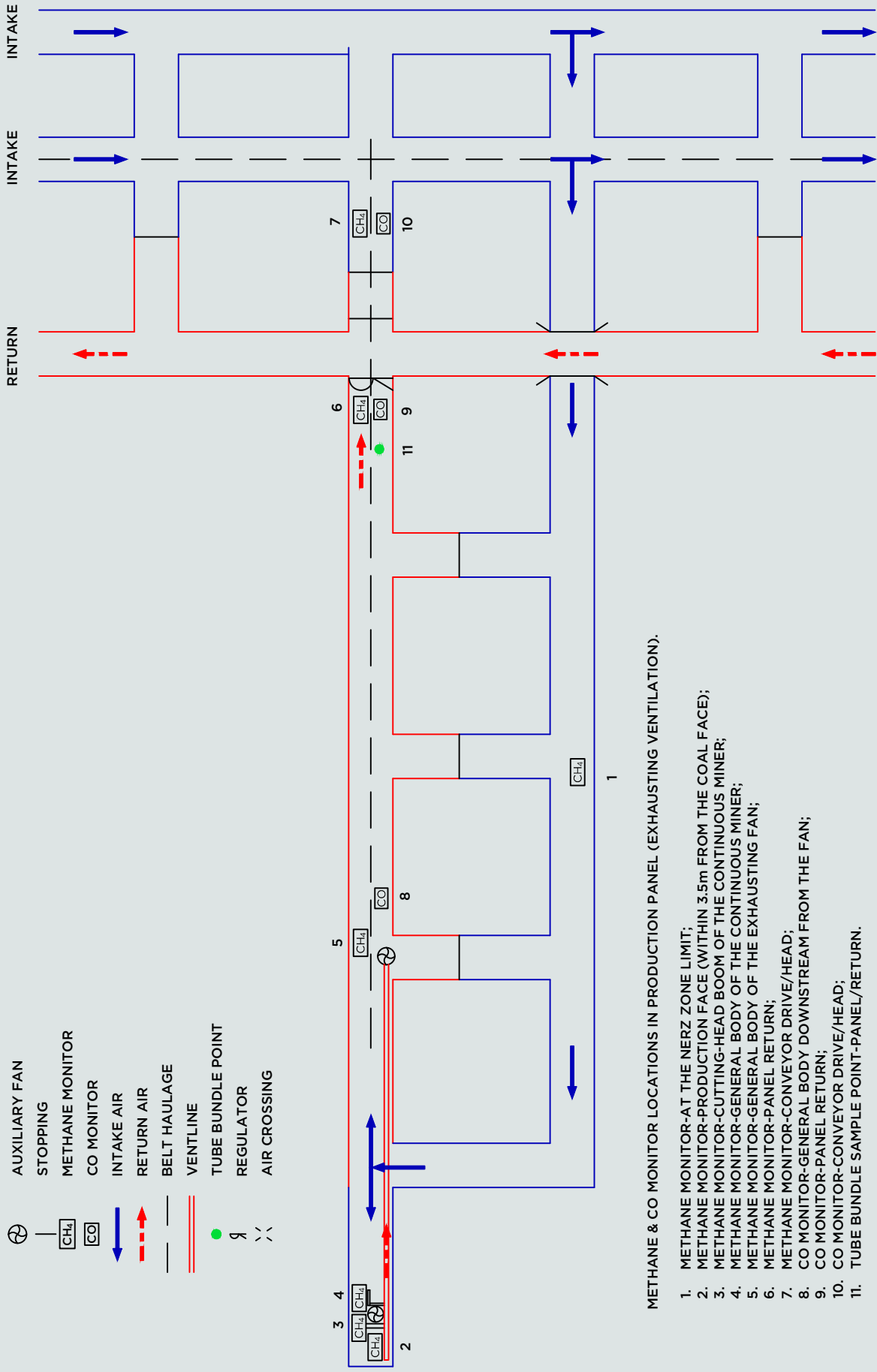


Figure 5 – Methane and CO monitor locations in production panel (exhausting ventilation)

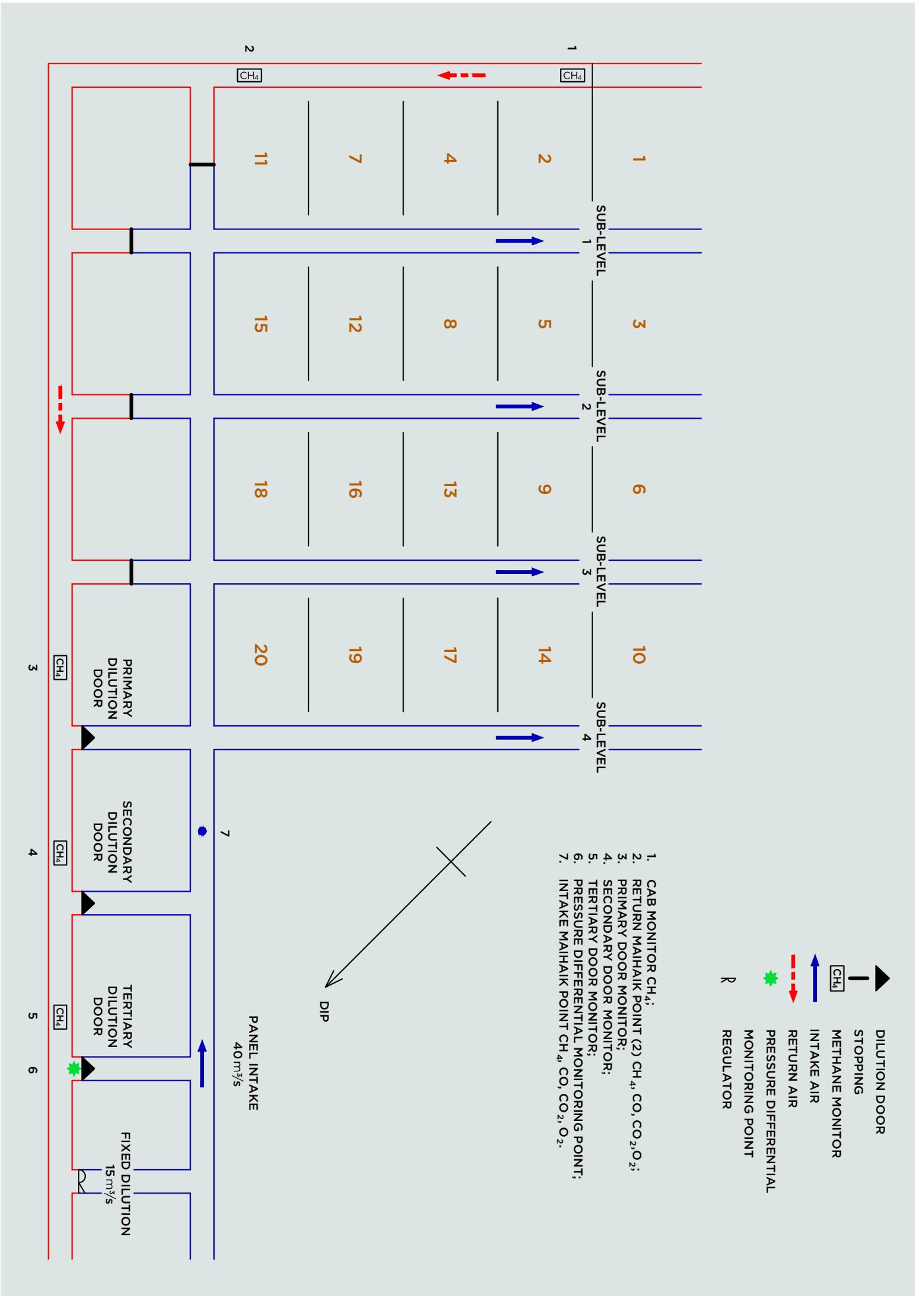


Figure 6 - Sample plan showing gas monitoring and dilution doors for a hydro panel

08/

MITIGATION CONTROLS

**DEVELOPING, IMPLEMENTING
AND MAINTAINING CONTROLS TO
REDUCE RISK CONSEQUENCES**

- 8.1 Controls to manage the early onset of fire**
 - 8.2 Fire-fighting**
 - 8.3 Testing and examination of firefighting equipment**
 - 8.4 Water deluge systems**
 - 8.5 Fire detection and suppression systems for mobile diesel equipment**
 - 8.6 Automatic fire detection and suppression systems**
 - 8.7 Dust suppression in underground mines and tunnels**
 - 8.8 Stone dusting in underground coal mines**
 - 8.9 Emergency response**
 - 8.10 Sealing parts of the mine**
-

REG 85

COAL

85 Principal hazard management plan for fire or explosion

- (3) *In the case of an underground coal mining operation, the principal hazard management plan must also set out the methods that will be used to—*
- (a) *minimise the amount of coal dust resulting from the use of mechanical mining systems:*
 - (b) *minimise the accumulation of coal dust on roadways and on other surfaces in the roadways, and remove accumulations of coal dust from the roadways and other surfaces:*
 - (c) *suppress airborne coal dust and remove it from the workings of the mining operation:*
 - (d) *determine the rate of application of stone dust that is necessary to minimise the risk of a coal dust explosion:*
 - (e) *suppress coal dust explosions and limit propagation of coal dust explosions to other parts of the mining operation:*
 - (f) *monitor and take samples of roadway dust, including any stone dust that has been applied, to ensure that the methods outlined in the principal hazard management plan are adequate and sufficiently implemented to prevent and suppress coal dust explosions.*

REG 98

98 Mechanical engineering control plan

The mechanical engineering control plan must, at a minimum, address the following matters:

- (d) *the fitting of appropriate automatic fire suppression and engine or fuel pump shutdown systems to safety-critical equipment and all underground diesel engines:*
- (e) *the fitting of heat detection and automatic trip sensors on safety-critical mechanical components to ensure they stop operating if they may become a danger to health and safety:*
- (g) *the safe use and storage of pressurised fluids (including managing the hazards associated with compressed air and pressurised hydraulic fluids):*
- (h) *means for the prevention, detection, and suppression of fires on mobile plant and conveyors:*
- (i) *the control of diesel engine plant and installations, including the following:*
 - (i) *limiting the number of diesel engines permitted underground in any underground mining operation or tunnelling operation consistent with the safe operation of the mining operation and capacity of the ventilation system to reduce exhaust emissions to an acceptable level:*

- (ii) *limiting the use of diesel engine plant and installations in the underground parts of an underground coal mining operation to diesel engine plant and installations that are approved for use in an underground coal mining operation:*
- (iii) *where diesel engines are used on plant underground, the fitting of such plant with steel fuel tanks, automatic fire suppression of adequate delivery means and capacity, and a ready method of battery isolation:*
- (iv) *the maintenance of explosion-protected plant in an explosion-protected state:*
- (j) *the use of fire-resistant hydraulic fluids in high-risk applications underground in an underground mining operation or tunnelling operation:*
- (k) *the engine management systems used to control diesel pollutants emitted underground in an underground mining operation or tunnelling operation:*
- (l) *the arrangements for hot work to be done safely, including an approval system for hot work to be done if the mining operation is an underground coal mining operation or an underground metalliferous mining operation or tunnelling operation where methane has been detected.*

REG 105

105 Emergency management control plan

- (1) *The emergency management control plan must, at a minimum, address the following matters:*
 - (m) *provision for all aspects of firefighting, including adequate and compatible firefighting equipment, procedures for firefighting, and training mine workers in firefighting:*
- (2) *In the case of an underground mining operation or tunnelling operation, the emergency management control plan must, in addition to the matters in subclause (1), include provision for ensuring—*
 - (c) *there is adequately maintained equipment at the mining operation that will—*
 - (i) *allow for rapid and continuous rescue operations to take place at the mining operation in conditions of reduced visibility and irrespirable and irritant atmospheres; and*
 - (ii) *assist the escape or safe recovery of any mine worker or other person from a mining operation where necessary; and*

REG 106

106 Testing, etc, of emergency management control plan

- (2) *The mine operator must ensure that the mining operation is provided with adequate resources to—*
 - (b) *keep facilities and equipment regularly inspected and maintained in a fully operational condition.*

REG 157

157 Fire protection and early warning systems

- (4) *The mine operator must ensure that suitable and sufficient devices are installed in the underground parts of the mining operation to monitor for early signs of fire.*
- (5) *If a device installed as required by subclause (1) detects signs of fire in the underground parts of the mining operation, the device must—*
 - (c) *activate an audible alarm that will warn mine workers in the affected part or parts of the mining operation to escape to a place of safety:*
 - (d) *activate an alarm at the surface of the mining operation.*
- (6) *The mine operator must ensure that suitable and sufficient fire extinguishers are provided beside all high-voltage electrical plant and, if a significant risk of fire exists, beside all other electrical plant.*

ACOP

8.1 Controls to manage the early onset of fire

This section provides information on the systems and procedures required to manage the early onset of a fire or explosion. More detailed information is provided in the Approved Code of Practice on Emergency Management. Information specific to the maintenance of systems outlined in this section is provided in the Approved Code of Practice on Mechanical Engineering and the Electrical (Safety) Regulations 2010.

8.2 Fire-fighting

The site senior executive should ensure that the Fire or Explosion Principal Hazard Management Plan provides for:

- (a) The delegation of specific duties to a competent mine worker for the provision, installation and maintenance of firefighting equipment.
- (b) The availability of equipment that is appropriate and sufficient to extinguish any potential fire:
 - (i) Portable fire extinguishers to be located on the intake side of fixed plant or on portable equipment.
 - (ii) Firefighting equipment to be compatible with Mines Rescue and New Zealand Fire Service equipment.
 - (iii) Equipment to be compliant with NZS 4503:2005 “Hand operated fire-fighting equipment”.
- (c) A programme for training mine workers on the purpose and use of portable firefighting equipment.
- (d) The provision and supply of water storage and reticulation:

- (i) An adequate supply of water and efficient means for delivering it promptly at adequate pressure and volume to every place in the mine or tunnel where there are mine workers working, or where mine workers pass going to or from where they will be working.
- (ii) Droppers at junctions to have suitable couplings and adaptors.
- (e) A documented system for inspecting, testing, reporting and replacing any firefighting equipment that is damaged.

8.2.1 Fire hydrants

The mine or tunnel manager should ensure that fire hydrants are provided according to the following requirements:

- (a) Approximately 20m-25m on the intake air side of all conveyor loading and conveyor transfer points, main junctions, workshops, fan houses, crushers, coal breakers and fixed mechanical installations.
- (b) Alongside conveyor systems or where hydrants are considered necessary, such that the distance between the fire hydrants does not exceed 120m.
- (c) In close proximity to each working place, development heading face and at suitable central points in stope and bord & pillar workings.
- (d) The position of each hydrant is clearly marked (eg by a suitably reflective 'Hydrant' sign).

8.2.2 Fire points in coal mines

The mine or tunnel manager should ensure that fire points are provided according to the following requirements:

- (a) Fire points are set up in close proximity to the hydrants described in section 8.2.1.
- (b) Each fire point has a branch pipe or nozzle capable of delivering both a jet and fog pattern.
- (c) Each fire point has fire hoses, couplings and nozzles stored in suitable containers appropriate to their locations, with sufficient lengths of hose to:
 - (i) Reach the extremities of the working face (for fire points in close proximity to each working face, and at suitable central points in stope and bord & pillar workings).
 - (ii) Allow fire-fighters to travel in by while fighting a fire, and reach the next hydrant and fire point.
 - (iii) At least 120m of hose on the intake side of all hydrants not covered by the above requirements.



8.2.3 Fire trucks in metalliferous mines and tunnels

The mine or tunnel manager should ensure that fire trucks are provided as an alternative to fire points, and that:

- (a) The fire truck is not used for any purpose other than to mitigate the consequences of a fire or explosion event at the mine or tunnel.
- (b) Suitable firefighting equipment of sufficient quantities is located on board the fire truck, and the equipment is maintained to an appropriate standard in line with all other firefighting equipment at the mine or tunnel.
- (c) The fire truck is located in close proximity to the mine or tunnel and is at all times equipped, prepared and ready for use.
- (d) A sufficient number of mine workers are trained and competent in the operation of the fire truck.

8.2.4 Fire hose

The mine or tunnel manager should ensure that fire hose are provided according to the following requirements:

- (a) Suitable firefighting hose, compatible with Mines Rescue safety equipment requirements, and designed to withstand a working pressure of 10 bar.
- (b) Where fire hoses are repaired or reduced in length, the minimum length should not be less than 20m per hose.

8.2.5 Fire extinguishers for fixed installations

The mine or tunnel manager should ensure that fire extinguishers for fixed installations are provided according to the following requirements:

- (a) At least two portable fire extinguishers are located close to combustible or flammable store locations or other 'significant risk' areas (eg magazines, refuelling bays, workshops) on the intake airway.
- (b) Areas containing fixed plant have appropriate and sufficient portable fire extinguishers located on the intake airway-side.

8.2.6 Fire extinguishers for mobile equipment

The mine or tunnel manager should ensure that fire extinguishers for mobile equipment are provided according to the following requirements:

- (a) All underground vehicles carry portable fire extinguishers classified as ABE that meet the requirements of NZS 4503:2005 'Hand operated fire-fighting equipment'.

Engine rating	Extinguisher rating	Approx minimum weight (kg)
Up to 200 kW	80 ABE	9kg
More than 200 kW	80 ABE	18kg

Figure 7 - Minimum extinguisher size for diesel engine rating

- (b) More than one portable fire extinguisher may be fitted to a vehicle, however, the combined (extinguishers) rating (see table above) should be equal or greater than that which the vehicle requires.
- (c) At least one appropriately sized portable fire extinguisher (eg 9kg 80 ABE) is installed on all light vehicles, and a minimum of two installed on all heavy vehicles. Such portable fire extinguishers should be within reach of the operator either in, or adjacent to, the driving position.

8.2.7 Fixed point fire extinguishers

The mine or tunnel manager should ensure that fixed point fire extinguishers are fitted underground.

Such fire extinguishers may include dry powder bombs suspended above an installation (ie a static battery-changing facility, temporary diesel storage facility, or conveyor drive).

The dry powder bomb has a quartzoid bulb which will burst at 57°C, discharging the dry powder over the installation in the event of a fire.

These are an effective alternative to portable fire extinguishers for situations when mine workers may not be present to combat the outbreak of fire.

GUIDANCE

ACOP

8.3 Testing and examination of firefighting equipment

The site senior executive should ensure that the testing and examination of firefighting equipment meets the following requirements.

8.3.1 Periodic checks - Monthly

At intervals not exceeding 30 days:

- (a) All hydrants tested for water pressure, flow, and adequate water supply.
- (b) Fire hoses, couplings and nozzles checked.
- (c) External parts of portable fire extinguishers checked for leakage, corrosion, blocked discharge hose or other signs of damage.
- (d) In the case of stored pressure extinguishers, the pressure gauge visually checked for an indication of adequate discharge pressure and flow.
- (e) The external parts of any fixed automatic or manually-operated fire quenching system examined for signs of damage.

8.3.2 Periodic examinations - Annually

At intervals not exceeding 12 months:

- (a) All CO₂ gas cartridges weighed and the cartridge changed if there has been a weight loss exceeding 10%.
- (b) Fire hoses, couplings and nozzles examined.

- (c) All fire extinguishers examined and tested by an approved mine worker.
- (d) All portable liquid CO₂ extinguishers weighed and the extinguisher recharged if there has been a weight loss exceeding 10%.⁴³

GUIDANCE

8.4 Water deluge systems

Water spray installations, or deluge systems, can be fitted around the drives and return end, as well as on the return side of booster fans. These will apply a minimum amount of water at maximum efficiency.

Water spray devices can be operated mechanically by the use of heat sensing devices, which trip the valve – electrically, by smoke sensing devices that cause the operation of trip devices, or remotely, by the use of metron activators that burst the fusible head.

ACOP

8.5 Fire detection and suppression systems for mobile diesel equipment⁴⁴

All mobile diesel equipment should be fitted with effective fire detection and suppression systems, as well as a supply of portable fire extinguishers, to reduce the risk of a fire starting in an engine bay.

When planning the use of a fire detection and suppression system on mobile diesel equipment, the mine or tunnel manager should ensure that:

- (a) No diesel engine operates in an underground mine or tunnel unless it is fitted with portable fire extinguishers, and a suitable fire detection and suppression system with automatic and manual means of activation.
- (b) Firewalls are installed on all underground mobile diesel equipment to separate the engine (ie heat source) from any fuel source (ie oils and diesel) and from the operator's cab.⁴⁵
- (c) Manufacturer-designed, enclosed, brake systems (wet brakes) should be installed on all mobile equipment in an underground coal mine.
- (d) Additionally:
 - (i) Ceramic turbochargers may be used to reduce the surface temperature of the equipment under normal operating conditions.
 - (ii) In underground environments other than a coal mine, mobile diesel equipment may be fitted with enclosed brake systems to reduce the risk of brake failure and fire.

COAL

GUIDANCE

⁴³ NZS 4503:2005 "Hand operated fire-fighting equipment" and SNZ PAS 4509:2008 "New Zealand Fire Service Fire-fighting Water Supplies Code of Practice"

⁴⁴ Department of Industry and Resources. (1997). *Foam Fire Suppression Systems on Mine Vehicles*. WA, Australia. 1-22.

⁴⁵ MDG 15:2002. *Guideline for mobile and transportable equipment for use in mines*. 30.

8.6 Automatic fire detection and suppression systems

8.6.1 Areas protected and duration times

The mine or tunnel manager should ensure that:

- When activated, the system covers all electrical components (especially the starter motor) and hot areas within the engine compartment, including any hydraulic lines, the turbo charger and catalytic converter if fitted in that area, and any adjacent high risk areas.
- The system has a foam tank solution volume that provides for an average discharge rate of 4.1 litres/min/m² or greater, over the fire risk area, for a nominal discharge time of 50 seconds. If the proposed discharge time is less than 45 seconds, the supplier or installer should consult WorkSafe NZ to determine whether this is acceptable.
- Solution volume should not be confused with cylinder capacity.

8.6.2 Manual actuators

The mine or tunnel manager should ensure that:

- A minimum of two manual actuators are installed – one in the cab within easy reach of an operator seated in the normal position, and the other accessible at ground level.
- For pin/strike actuators, there is 200mm clearance above the actuator device to ensure easy access for the operator.
- A device is installed within the cab to warn the operator when the system has been activated (eg an alarm or a pressure gauge indicator to show a fall in pressure). If the pressurised system has not been activated, the pressure indicator should be in the green zone.
- Consideration is given to positioning an actuator at ground level in the vicinity of the battery isolating switch, when this switch is not within 3m of the cabin.
- Consideration is given to the location of the ground level actuator with regards to areas of fire risk.
- Actuating buttons, switches or plungers are a primary colour (ie red, yellow or blue – not green) and have a contrasting background colour.
- The location of actuator devices is indicated with signs that comply with AS 1319-1994 “Safety signs for the occupational environment”.

8.6.3 Automatic actuators

The mine or tunnel manager should ensure that:

- There is a clear indication of the selected mode of operation when the operator is seated in the normal driving position.

- (b) The fire suppression system is capable of being activated automatically by the fire detection and system activation tubing.
- (c) The auto-detect and activation tube is made from a synthetic material designed to melt in the heat of a fire at approximately 150°C, with the resulting pressure drop in the activation circuit initiating the system discharge.

8.6.4 Fire suppression interlocks

The mine or tunnel manager should ensure that when the fire suppression system is activated either manually or automatically:

- (a) The fuel system stops automatically.
- (b) The operator is alerted by a visible and audible warning.

8.6.5 Nozzles, valves, wiring and piping

The mine or tunnel manager should ensure that:

- (a) Nozzles are solid cone, non-aspirating and suitably rated to the operational pressure (aspirating nozzles on a system will need to be evaluated before considered for use).
- (b) While not in use, the nozzles are fitted with blow off caps to ensure the nozzles remain clean and free flowing. Such caps should be of a material that will not melt under extreme engine operating conditions.
- (c) Preference is given to the use of ring main piping, where practicable.
- (d) The discharge valves and piping are compatible with the foam solution used, are suited to the purpose, and meet the design code of the manufacturer of the discharge valve.
- (e) Discharge piping has a continuous fire rating of 1000°C or more and is installed in such a way that the flow of solution is not restricted.
- (f) With any electric remote control actuation system, the hoses and fittings are corrosion resistant.
- (g) Hose ends are compatible with the hose manufacturer's specifications.
- (h) The pipe or hose is installed to the manufacturer's specifications.
- (i) The wiring system on fire suppression equipment has a two hour fire rating.⁴⁶

8.6.6 Fire suppression system pressure vessels

The mine or tunnel manager should ensure that:

- (a) The pressure vessel is designed, manufactured, approved and maintained to an appropriate standard under the duty of care of suppliers and users.

⁴⁶ MDG 15:2002. *Guideline for mobile and transportable equipment for use in mines.* 16.

- (b) The appropriate maximum size cylinder is used wherever practicable, and sized to comply with the nominated discharge and flow rates of the system.
- (c) The purchaser is advised in writing by the supplier, of the standard to which the pressure vessel is designed and of the appropriate standards for inspection, repair and maintenance.
- (d) The pressure vessel is supplied with a hard barrier to prevent over pressurisation (eg a burst disc or pressure relief valve) as required by the cylinder code.
- (e) If the pressure vessel is installed in a horizontal position, the discharge still complies with these minimum standards when it is at an angle of 150° or less below the horizontal.
- (f) The cylinder and syphon tube are designed and fitted to ensure operation of the system should the vehicle roll over.

8.6.7 Foam solution

The foam solution used in the system should be the type of solution recommended by the supplier of the system, and the supplier should nominate the standards and codes to which the foam concentrate complies.

8.6.8 Installation

Fire suppression systems should be installed by the manufacturer or by a mine worker authorised by the manufacturer. Such authorisation should be provided in writing.

8.6.9 Integrated engine management systems

The mine or tunnel manager should ensure that:

- (a) Any fixed fire suppression system is capable of being adapted to activate an engine shutdown, or prevent engine starting, while the system is discharging and when the pressure in the pressure vessel drops to below the minimum operating pressure (eg a drop to 900 kPa).
- (b) When an engine shutdown is activated by the use of the fixed fire suppression system, there is a delay of 5-15 seconds before shutdown to allow the operator time to manoeuvre the machine away from any hazard.
- (c) Where engine shutdown systems are fitted, there is a manual override of the shutdown system that will allow the engine to start and the vehicle to be moved.
- (d) Where an integrated system is used that combines engine shutdown with actuation of the fixed foam device, a sign advising the vehicle operator of the delay period is displayed in the cabin.

8.6.10 Light vehicles and small diesel plant

This section applies to diesel vehicles or plant (such as portable welders/ compressors) rated at below 125kW and not fitted with a turbocharger.

- (a) The mine or tunnel manager should ensure that the foam suppression system discharges at a minimum rate of 4.1 litres/min/m² and has a foam solution charge of 9 litres or more.
- (b) The following specifications are also recommended:
 - (i) A minimum discharge time of 30-45 seconds.
 - (ii) Actuation is by automatic and manual means. Manual operation will be from a single location at ground level, no less than 3m from the driver's point of exit from the vehicle, or on the intake side of the plant.
 - (iii) Remote pressure indication is not required, provided that cylinder mounted pressure indicator is visible from a position at ground level.

8.6.11 Tunnel Boring Machines (TBMs)

In addition to portable fire extinguishers, all TBMs should have the following fire protection systems fitted:

- (a) An automatic fire suppression system that covers all critical parts of the machine, such as electro-hydraulic systems, oil and fuel storage, electrical systems and transformers, and motors.
- (b) A water spray curtain at the outbye end of the machine, where people work on the machine other than for maintenance purposes.
- (c) Visual and audible alarms to alert the onset of fire.

TUNNELS

COAL

8.7 Dust suppression in underground mines and tunnels

8.7.1 Selection of coal mining equipment

The mine or tunnel manager should ensure that:

- (a) The amount of dust generated or released in to the mine ventilation system is minimised at all times.
- (b) In any area where there is a build-up of coal dust, such as at conveyor transfer or loading points, the dust is removed as soon as possible.
- (c) When selecting equipment for coal mining operations, minimising the generation of fine coal dust should be a key consideration.

This may be achieved by using water sprays to suppress dust, or covers and shields (such as on conveyors and at transfer points) to reduce the effects of ventilation and the potential for dust to be carried through the ventilation system and in to the mine workings.

- (d) Other control measures that should be implemented include (but are not limited to):
 - (i) Coal cutters
 - (ii) Conveyor transfer points
 - (iii) Crushers
 - (iv) Truck loading points
 - (v) Drilling
 - (vi) Rubber-tyred vehicles driving directly on coal

Additionally, the use of scrubber fans, the development of suitably sized roadways and effective ventilation systems are ways to minimise the generation of coal dust. For more detailed information on minimising the generation of coal dust, refer to the Approved Code of Practice on Ventilation. For more detailed information on the selection of mining equipment, see the Approved Code of Practice on Mechanical Engineering.

8.7.2 Sulphide dust explosions (in metalliferous mines and tunnels)⁴⁷

In a mine or tunnel where there is ore containing more than 20% pyritic sulphur, there is the potential for a sulphide dust explosion from the blasting of headings or stopes (ie a secondary blast ignited by the shotfiring).

To prevent the occurrence of a sulphide dust explosion, the mine manager should:

- (a) Examine the mineralogy in all areas being mined where the sulphur content of the minerals exceeds 20%.
- (b) Develop procedures, including:
 - (i) Written practices for preventing or confining dust explosions.
 - (ii) Training for mine workers in awareness and precautions.
 - (iii) Firing procedures (such as the location of firing boxes, and evacuation of mine workers).
 - (iv) Ongoing maintenance of dust explosion records, and notifications made to the Chief Inspector, Extractives.
- (c) Control the potential exposure of mine workers to the effects of a dust explosion, by ensuring:
 - (i) The monitoring of SO₂ and H₂S, if present.
 - (ii) Clearance of the mine, or part of the mine, before blasting.
 - (iii) Provision of respirators or SCBA.

⁴⁷ Department of Mines. (1990). Sulphide dust explosion hazard. *Safety Bulletin No. 1*. WA, Australia.

METAL

8.7.3 Sulphide dust control

To control the risk of a sulphide dust explosion, the mine or tunnel manager should ensure there is no accumulation of sulphide dust in the underground workings by:

- (a) Reducing the amount of combustible dust produced during blasting.
- (b) Reducing the temperature and volume of the gases generated from the detonation of high explosives, and preventing ignition of the cloud produced during blasting.
- (c) Removing, or decreasing the amount of, previously deposited dust.
- (d) Before blasting, washing down headings where dust settles after blasting.

8.7.4 Development blasting

The mine or tunnel manager should ensure that:

- (a) No mine workers are working in the proximity of any dust ignition blast that may result from a face being fired.
- (b) All holes are stemmed with inert materials – preferably using limestone dust cartridges.
- (c) A bag of limestone dust is suspended in front of the burn cut.
- (d) The spread of delays used in the blast are minimised.
- (e) Air/water sprays (preferably a bank of two or three) are used at distances of 15m to 45m from the face.
- (f) All inflammable materials are removed from the blast area.
- (g) The dust is watered down and washed away before and after blasting.

8.7.5 Secondary blasting

The mine or tunnel manager should ensure that:

- (a) Secondary blasting is restricted to 'pops' and the holes drilled and charged are stemmed with inert material.
- (b) 'Blister' or 'plaster charges' (such as 'pillow packs') are avoided.
- (c) All pops are fired on the same delay, or with instantaneous detonators.
- (d) The blast area is watered down and air/water curtain sprays are used (as for development blasting).

8.7.6 Open stope blasting (large scale)

The mine or tunnel manager should ensure that:

- (a) All large scale production blasting is detonated electrically from the surface after a complete evacuation and check of the mine.
- (b) All accessible development adjacent to, and connected to, the stope is watered down before the blast.

METAL

METAL

METAL

REG 206	COAL
REG 207	COAL
REG 208	COAL
REG 209	COAL

- (c) Air/water blast sprays are set up in an adjacent connected development to form a water fog.
- (d) Delay scatter for the blast is minimised.
- (e) All inflammable material in the vicinity is removed.
- (f) All charges are stemmed with inert (eg. limestone) dust or water.
- (g) Inert dust is dispersed by charges with the blast.
- (h) The mine is checked thoroughly after the blast for evidence of a sulphide dust explosion. In particular, residual toxic gas should be checked.
- (i) If any evidence of a dust explosion is found, it is reported to WorkSafe NZ.

206 Recording of dust sampling and analysis

The mine operator must ensure that—

- (a) the mine worker in charge of the part of the mining operation where a sample of dust was taken is given notice of the results of the analysis of that sample; and
- (b) a record is kept of the following information for each roadway dust sample taken at the mining operation:
 - (i) the date the sample was taken; and
 - (ii) the location from which the sample was taken; and
 - (iii) the volume and type of incombustible material in the sample; and
 - (iv) the method used to analyse the sample; and
- (c) the results of the analysis of the dust sample, in particular the volume and type of incombustible material content, are marked on a plan of the mining operation.

207 Minimum content of incombustible material in roadway dust

The mine operator must ensure that the content of incombustible material in roadway dust at the mining operation is kept at or above 80% of the volume of the roadway dust.

208 Mine operator must have standard operating procedure for application of incombustible material to roadway

- (1) The mine operator must ensure that a standard operating procedure for the application of incombustible material to roadways is in place to keep the proportion of incombustible material at or above 80% of the volume of roadway dust in every part of the underground parts of the mining operation.
- (2) The standing operating procedure required by subclause (1) must be included in the health and safety management system for the mining operation.

209 Requirements for stone-dusting new roads

The mine operator must ensure that—

- (a) as soon as a 30-metre length of roadway is driven, that entire length is stone-dusted; and

- (b) *each new part of the roadway is stone-dusted within 24 hours of the part being driven.*

ACOP

COAL

COAL

COAL

COAL

8.8 Stone dusting in underground coal mines

Stone dusting is the process of spreading inert, incombustible dust on roadways in an underground coal mine to mitigate the risk of a coal dust explosion taking place. It is effective because the stone dust absorbs heat.

The mine operator at an underground coal mine should ensure efficient arrangements are in place for every length of roadway required to be ventilated, so that any dust on the roadway floor, roof and sides that may be raised into the air contains no less than 80% of incombustible matter.

8.8.1 Compliance with these requirements

It should be the responsibility of the site senior executive to ensure:

- (a) The manufacturer or supplier of the stone dust provides evidence of compliance with the specifications outlined in this document.
- (b) Such evidence should be documented and maintained as part of the mine's records.

8.8.2 Physical properties of stone dust

- (a) The stone dust should be limestone dust.
- (b) It should be light in colour, to allow testing by colour (see section 8.8.6).
- (c) It should contain no more than 3% by mass of free silica.
- (d) It should be dry and free flowing.
- (e) The dust particle size should be:
 - (i) No less than 95% by mass should pass through a 250 micrometre sieve.
 - (ii) Of the dry dust that passes through a 250 micrometre sieve, no less than 60% and no more than 80% by mass should pass through a 75 micrometre sieve.

8.8.3 Spreading of stone dust

(a) Developments

The mine operator at an underground coal mine should ensure that:

- (i) Roadways being driven are stone dusted either:
 - a. Immediately after the completion of each 10 metre length; or
 - b. within 24 hours,
 whichever occurs soonest.

- (ii) The stone dust is spread evenly over the roadway roof, sides and floor. It should be the responsibility of the deputy to ensure that this is carried out.
- (iii) A simple calculation is completed, to estimate the amount of stone dust required compared to the rate of extraction. This should be checked by sampling to ensure the quantity and evenness of spreading meets required standards, as outlined in section 8.8.5.
- (iv) The calculations are reconciled to determine that the calculated amount of stone dust required is not less than the actual amount that is spread underground.

(b) Other areas

The mine operator at an underground coal mine should ensure that:

- (i) The spreading of stone dust achieves a level of at least 80% incombustible matter. It should be the responsibility of the mine manager to ensure the incombustible percentage of the dust is maintained greater than 80%.
- (ii) Although the stone dust itself is not harmful when inhaled in small quantities, the dust made airborne during stone dusting is. For this reason, when stone dusting large areas underground, there should be no mine worker working downstream that may be put at risk.

REG 205

COAL

205 Sampling of roadway dust

- (1) *The mine operator must ensure that—*
 - (a) *dust sampling and analysis is carried out in accordance with this Regulation at no less than the following intervals:*
 - (i) *for a strip or spot sample of dust in an ERZO, at least once a week;*
 - (ii) *for a strip sample of dust in an ERZI, at least once a month; and*
 - (iii) *for a strip sample of dust in an NERZ, at least once every 3 months; and*
 - (b) *the samples of dust are taken by a competent person from the complete perimeter of the roadway and the structures in it, over a length of roadway of at least 45 metres, and by using strip samples; and*
 - (c) *if the dust on the floor of a roadway appears to contain a different content of incombustible material from the dust on the roof and sides of the roadway, the dust on the floor is sampled and tested separately from the dust on the roof and sides of the roadway; and*
 - (d) *each sample of the layer of dust is taken from the layer to a depth not greater than 5 millimetres; and*
 - (e) *if a location is resampled, the individual strips from which dust is taken for a strip sample are not the same as those from which a previous sample has been taken.*

- (2) *The mine operator must ensure that the analysis of dust samples is carried out in an independent testing facility.*
- (3) *In subclause (1), strip sample means the collection of dust from a series of transverse strips of equal width and that are equally spaced not more than 5 metres apart over an area that is at least 1% of the total area sampled.*

8.8.4 Dust sampling requirements

The ventilation officer should ensure that requirements are met for the maintenance of incombustible matter in mine roadway dust, including sampling, sample analysis, and keeping records of analyses. This should include ensuring that:

- (a) A dust zone plan showing all areas that are to be sampled for flammable dust (a zone is a length of roadway of 160m in length). The plan should be easily accessible by all mine officials.
- (b) On a weekly basis, attach to the dust zone plan a list of all areas where analysis has shown roadway dust to contain less than 80%.
- (c) In the event of a failed sample, a review of the stone dusting system is undertaken, and the requirements outlined in section 8.8.8 are met.

8.8.5 Dust sampling procedures

The mine manager should ensure that:

- (a) Samples of dust from the roof and sides (combined) and floor are taken from each roadway zone.
- (b) Samples are taken (where practicable) from the complete perimeter of the roadway and the structures in it, and over a length of road not less than 45m long.
- (c) Samples are gathered by strip sampling whereby the dust is collected from a series of diagonal strips as close as possible to being:
 - (i) equal width and equally spaced;
 - (ii) not more than 5m apart; and
 - (iii) of an aggregate area of no less than 1% of the total area.
- (d) Samples from the roof and sides are taken to a depth not exceeding 5mm, and are tested separately from the dust on the floor.
- (e) Samples from the floor are taken from a depth not exceeding 5mm.
- (f) A sufficient mass of samples are taken so that in the event of a failed colour sample, there is adequate remaining dust to provide to the laboratory.
- (g) The samples are colour tested initially at the mine site, in line with the procedures outlined in section 8.8.6.

ACOP

COAL

8.8.6 Colour testing procedures

The mine manager should ensure that the process for colour testing dust samples at the mine includes:

(a) Equipment

- (i) A sieve of nominal aperture 250 micrometres, that complies with AS 1152-1993 "Specification for test sieves".
- (ii) A supply of clean white paper.
- (iii) A spatula (that is capable of heaping as much dust as possible onto a surface the size of a 10 cent coin).
- (iv) A standard colour sample that is unique to the mine, prepared in compliance with MDG 3006 MRT 5:2001 "Guideline for coal dust explosion prevention and suppression" by an independent testing facility.

(b) Method

- (i) Air-dry the dust sample if necessary. Sieve the sample through the 250 micrometre sieve, and mix the sieved sample thoroughly (but do not grind it).
- (ii) Compare the colour of the mixed sieved sample with the standard colour sample. The comparison should be made under good and even lighting conditions.
- (iii) If there is an obvious difference between the colour of the sample dust and the standard colour sample, it should be recorded that the sample dust is, or is not, lighter in colour than the standard colour sample.
- (iv) If there is no obvious difference in colour, using the spatula, take a small portion of the sample dust, and of the standard colour sample, and place them side by side on clean white paper. Press the portions of dust flat with the spatula to form a smooth surface.
- (v) Examine the portions of dust and record whether the sample is, or is not, lighter in colour than the standard colour sample (or that the two are indistinguishable):
 - a. If the result is lighter than the standard, the sample is determined acceptable as it shows that dust contains more than 80% incombustible material.
 - b. If the result is darker than the standard, the sample is determined unacceptable and should be analysed by an independent testing facility to determine the exact quantity of incombustible materials that is present in the dust.

- c. Immediately following a failed colour sample, the mine manager should make suitable arrangements to spread additional stone dust to the area of the failed result prior to the independent testing facility providing the final result.
- (vi) An independent testing facility should use one of the following methods when determining the quantity of incombustible materials present in the dust:
 - a. Volumetric method;
 - b. Coal ash incombustible analyser method; or
 - c. Chemical method.
- (vii) The laboratory results should be recorded so that the mine manager can easily identify and rectify any deterioration.
- (viii) 5% of all samples should be independently checked using one of the methods listed in 7.8.6 (b) (vi) above.

8.8.7 Frequency of dust sampling

The mine manager should ensure that:

- (a) The frequency for roadway dust sampling is determined by the Explosion Risk Zone:
 - (i) ERZO weekly
 - (ii) ERZ1 monthly
 - (iii) NERZ every third month
- (b) The only exceptions to the above are in the event of a sample failure, or a series of failures, which requires that an area be re-sampled.

8.8.8 Dust sample failures

If analysis results show that the dust sample contains less than 80% incombustible matter, the mine manager should ensure that:

- (a) The area is re-treated with stone dust within 12 hours of the results being advised.
- (b) A record is kept of the date and time when the area was re-treated.
- (c) The area is re-sampled within 24 hours.
- (d) If an area is to be re-sampled, new samples should not be taken from the same area as where previous samples were taken.
- (e) The deputy and the workers representative are advised of the failure.

Persistent sample failures indicate a breakdown of the stone dusting system, which may be caused by:

- (i) An insufficient amount of stone dust being applied to roadways, as outlined above.



- (ii) Lack of intent and competency of the mine worker taking the samples.
- (iii) A malfunction of the cutting regime.
- (iv) A change in the colour of the stone dust, which would require a new standard colour sample being prepared for the mine by an independent testing facility.

8.8.9 Recording of dust sampling results

The mine operator at an underground coal mine should ensure that a record is kept of the following information for each roadway dust sample:

- (a) The date the sample was taken.
- (b) The location from which the sample was taken.
- (c) The incombustible material content of the sample.
- (d) The method used for analysing the sample.

210 Explosion barriers

- (1) *The mine operator must ensure that—*
 - (a) *an explosion barrier is installed and maintained in the part of any roadway in a panel, other than a single-entry roadway, containing a conveyor belt; and*
 - (b) *an explosion barrier is installed and maintained in the part of any return roadway in a panel, other than a single-entry roadway; and*
 - (c) *adequate explosion-suppression measures are installed and maintained in single-entry roadways.*
- (2) *For the purpose of subclause (1), an explosion barrier is taken to be installed in a part of a roadway if the most inbye part of the barrier is in the part of the roadway.*
- (3) *The mine operator must ensure that a risk appraisal and risk assessment are carried out to determine—*
 - (a) *the type of the explosion barriers to be installed as required by subclause (1) that will effectively limit the development of, and contain, an ignition of coal dust or methane; and*
 - (b) *whether any additional explosion barriers need to be installed, and the type and location of those explosion barriers.*
- (4) *The mine operator must ensure that any explosion barriers installed at the mining operation are designed, constructed, and maintained to prevent, as far as is reasonably practicable, a coal dust explosion in one part of the underground parts of the mining operation from propagating to other parts of the mining operation.*

ACOP

COAL

8.8.10 Use of stone dust explosion barriers

Most explosion barriers in New Zealand are constructed from isotropic bags of no smaller than 6kg of stone dust. See sections 8.8.15 and 8.8.16 for information on alternative options to bagged barriers.

- (a) The mine operator at an underground coal mine should ensure a stone dust explosion barrier is installed and maintained in:
 - (i) Any roadway where freshly won coal which is untreated with stone dust is being transported from the working face (excluding hydro mining operations).
 - (ii) Any return within the required distance from the working face.
 - (iii) Single entry roadways.
- (b) The site senior executive should ensure that the design of the explosion barrier will eliminate, as far as is reasonably practicable, a coal dust explosion from travelling through the underground workings.
- (c) Through a risk assessment, and application of suitable mining methods, the site senior executive should determine whether to install:
 - (i) A distributed explosion barrier.
 - (ii) A primary and secondary explosion barrier.
 - (iii) A hydro mining barrier.
 - (iv) Any additional barriers.

8.8.11 Explosion barrier design

Where a bagged explosion barrier is installed, the design of the barrier should include the following:

- (a) Each approved bag contains 6kg of dry stone dust.
- (b) The distance between hooks for the bags in a row should be no less than 0.4m and no more than 1m apart.
- (c) The distance between the bags and the side of the tunnel should be no more than 0.5m, and bags should not touch the side of the roadway or each other.
- (d) For roadways up to 3.5m high, each row should have a single level of bags which are suspended from hooks at no more than 0.5m from the height of the roof.
- (e) For roadways between 3.5m and 4.5m high, the bags should be distributed evenly between two layers, suspended from hooks at 0.5m and 1m from the height of the roof.

COAL

- (f) For roadways between 4.5m and 6m high, the bags should be distributed evenly between three layers, suspended from hooks at 0.5m, 1m and 1.5m from the height of the roof.
- (g) The distance along the roadway between rows of bags should be no less than 1.5m and no more than 3m.
- (h) Unless specified otherwise for a particular barrier type, the total mass of stone dust used in the barrier is 1.2kg/m² of roadway cross section multiplied by the length of the barriers, as specified in this document.
- (i) The total proportion of broken bags should not be more than 5% of the total number of bags in the barrier.



Figure 8 – Bags suspended facing the direction of any potential blast wave

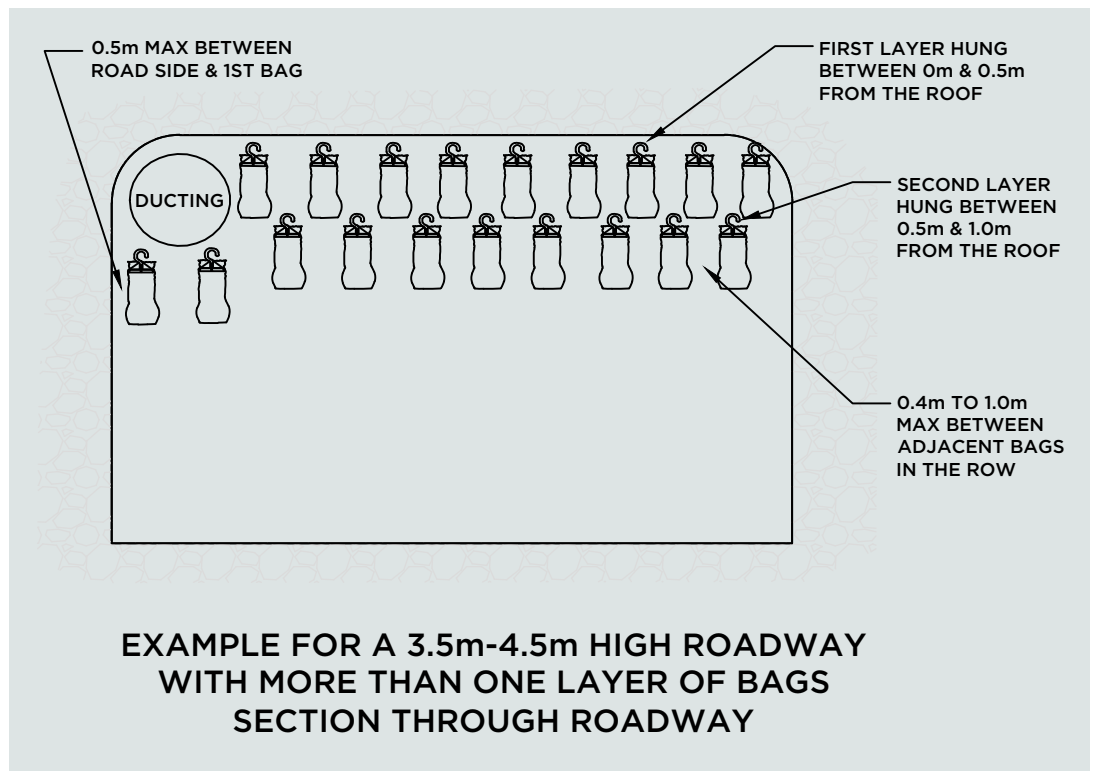


Figure 9 - Example for a 3.5m-4.5m high roadway with more than one layer of bags - Section through roadway

8.8.12 Distributed bag explosion barriers

Where a distributed bag explosion barrier is to be installed:

- (a) The rows of bags are to be maintained as evenly as possible.
- (b) The barrier should consist of rows of bags which are left in place until completion of the mining operations that the barrier is designed to protect.
- (c) The first row of bags should be no closer than 70m, and no further than 120m, from the working face.
- (d) The length of the barrier should be no less than 360m (note this is the distance measurement that is required to calculate total mass of stone dust).
- (e) As the barrier is extended (advancing workings), or the distance from the working face is reduced (retreat workings), the minimum length of the barrier is 360m which should be maintained at all times.



Worked example 1 (see Figure 10)

Roadway volume $5\text{m} \times 3.2\text{m} \times 360\text{m} = 5,760\text{m}^3$
 Stone dust mass required = $5,760\text{m}^3 \times 1.2\text{kg}/\text{m}^3 = 6,912\text{kg}$
 Number of 6kg bags = $6,912/6\text{kg} = 1,152$ bags
 Number of bags per metre = $1,152/360 = 3.2$ bags
 (a) If rows are spaced at 3m, then $3.2 \text{ bags} \times 3\text{m} = 9.6$ bags per row.
 (b) In practice, one row of 10 bags each 3m of roadway length.

8.8.13 Primary and secondary bag explosion barriers

Where a primary and secondary bag explosion barrier is to be installed, the mine manager should ensure that:

- (a) For the primary bag explosion barrier :
 - (i) It should consist of four identical sub-barriers installed over a distance of no less than 100m, and no more than 120m.
 - (ii) The first row of bags should be no closer than 70m and no further than 120m from the working face.
 - (iii) The middle two sub-barriers should be equally spaced between the first and fourth sub-barriers.
 - (iv) To calculate the stone dust mass required, a length of 120m should be used regardless of actual length of the primary barrier.

Worked example 2 (see Figure 11)

Roadway size 5m wide x 3.2m high
 Volume of roadway (for mass of stone dust) $5 \times 3.2 \times 120 = 1,920\text{m}^3$
 Stone dust required $1,920\text{m}^3 \times 1.2\text{kg}/\text{m}^3 = 2,304\text{kg}$
 Number of 6kg bags = $2,304\text{kg}/6\text{kg} = 384$ bags
 Number of bags per sub barrier $384/4 = 96$ bags
 (a) If bags are hung 0.5m from side of roadway and 0.4m apart, then each row can contain 11 bags.
 (b) Each sub-barrier should contain a minimum of 96 bags.
 (c) If each sub-barrier consists of 9 rows of 11 bags, a total of 99 bags will be used.
 (d) If each row is spaced at 1.5m apart, then each sub-barrier will extend over 12m.

- (b) For the secondary bag explosion barrier:
 - (i) It should start no closer than 70m and no further than 120m from the end of the primary barrier.
 - (ii) It should consist of two sub-barriers of an identical length, installed over a distance of no less than 100m and no more than 120m.



- (iii) The volume of stone dust required should be double that required for the primary barrier.
- (iv) When barriers are advanced or retreated, the minimum dimensions should be maintained at all times. This may require an extra sub-barrier being installed before the sub-barrier that is out of distance is removed.

Worked example 3 (see Figure 12)

Mass of stone dust in primary barrier $\times 2 = 2,304\text{kg} \times 2 = 4,608\text{kg}$

Number of 6kg bags $= 4,608/6 = 768$ bags

Number of bags per barrier $= 768/2 = 384$ bags

(a) If the bags are hung 0.3m from the roadway sides and 0.4m apart, then each row can contain 12 bags.

Rows per barrier $= 384/12 = 32$ rows

(b) If each row is spaced 1.5m apart, then each sub-barrier will be 46.5m long.

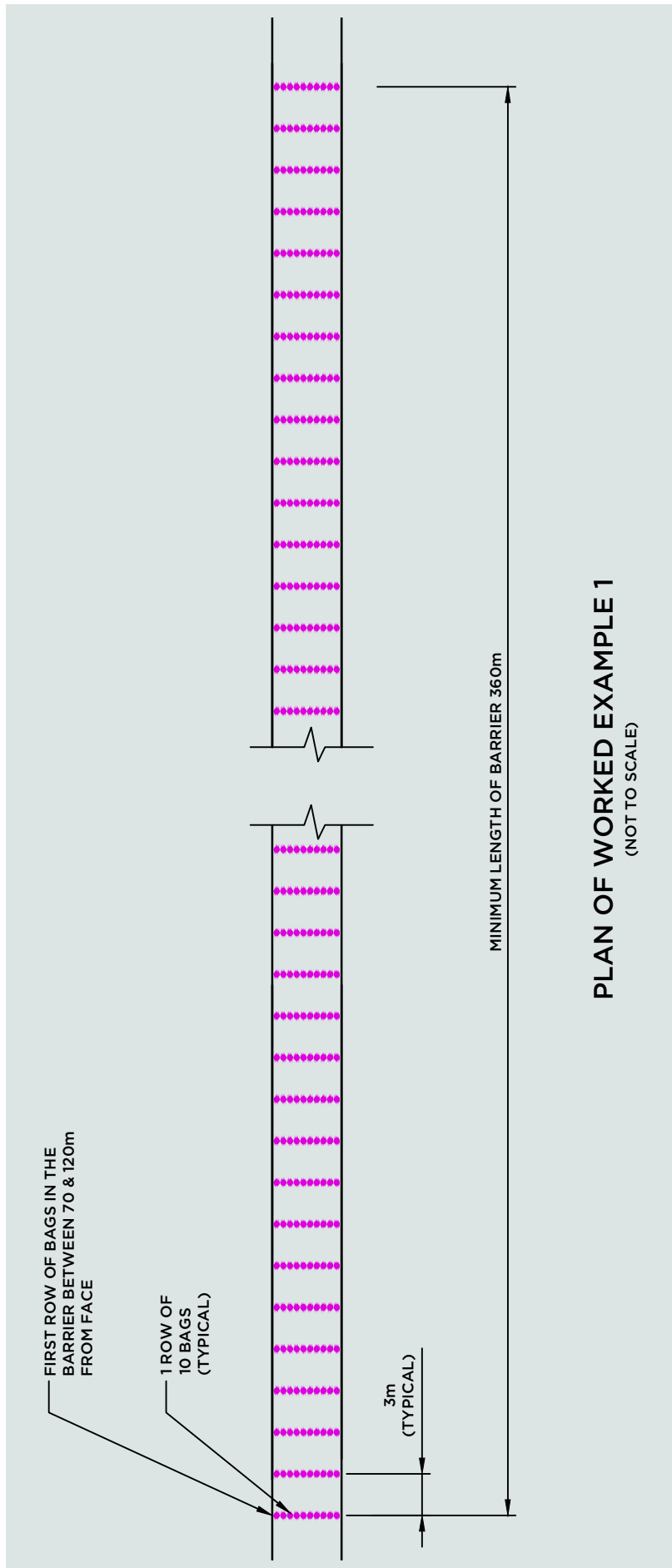


Figure 10 – Distribution of bags in a distributed barrier – Plan of worked example 1



Figure 11 - Distribution of sub-barrier bags in a primary barrier – Plan of worked example 2

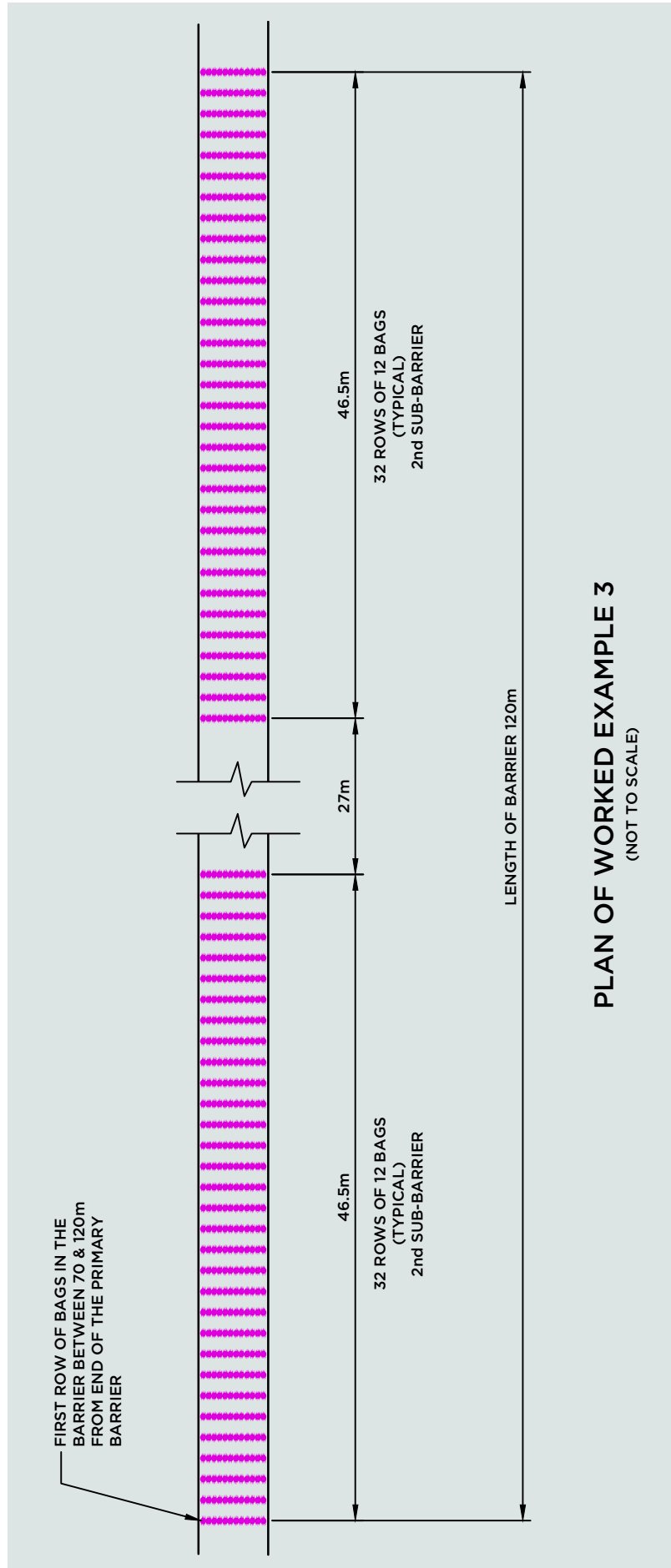


Figure 12 - Distribution of sub-barrier bags in a secondary barrier - Plan of worked example 3



8.8.14 Distributed explosion barriers for hydro mining

Where hydro mining is in operation, and the method of winning and transporting coal is by water, an explosion barrier should be installed so that:

- (a) All roadways that lead away from the working face are installed with the minimum number of barriers.
- (b) In all main roadways, a barrier should be installed at intervals no more than 800m apart.
- (c) The barrier should be constructed in line with the design considerations provided in section 8.8.11, excluding (i).
- (d) Each roadway that is connected to, and within 100m of, the hydro panel production area has a distributed barrier installed.
- (e) The barrier should be no less than 50m long, and installed no closer than 70m, and no more than 120m, from the hydro panel production area.
- (f) To calculate the stone dust mass required, the minimum amount of stone dust per barrier should be no less than 120kg per square metre of the average cross-sectional area of the roadway in which the barrier is constructed.
- (g) Additional barriers should be constructed at distances of no more than 400m apart, and should be left in place and maintained for as long as the area is ventilated, regardless of whether mining operations are taking place.

Worked example 4

Roadway size 5m wide x 3.2m high

Cross-section of roadway (for mass of stone dust) $5 \times 3.2 = 16\text{m}^2$

Stone dust required $16\text{m}^2 \times 120\text{kg} = 1,920\text{kg}$

Number of 6kg bags = $1,920\text{kg}/6\text{kg} = 320$ bags

- (a) If the bags are hung 0.5m from the roadway sides and 0.5m apart, then each row can contain 9 bags

There will be required $320 \text{ bags}/9 \text{ bags} = 36$ rows (rounded up)

- (b) If the rows are spaced 1.5m apart then the barrier will be

$36 \times 1.5\text{m} = 54\text{m}$ long

This meets the minimum requirement of 50m.

8.8.15 Conventional stone dust explosion barriers

Where a conventional stone dust explosion barrier is to be installed, it should be constructed so that:

- (a) It is rectangular, made from timber or sheet metal, and of a height that is no less than 150mm.

- (b) The front and back of the frame is formed from two purlins fixed by cross-pieces so that the frame measures no more than 200mm from front to back edge.
- (c) The frame rest on rigid supports that are fixed on each side of the roadway (the frame itself should not be fixed to the supports).
- (d) Dust boards or trays rest on the frame, aligned in the same direction as the roadway, and which are free to move by purlins placed on their edge so that they can 'roll' and displace the boards or trays if required.
- (e) Barriers should be loaded with no less than 60kg of stone dust per metre of shelf length.
- (f) The distance between two adjacent stone dust boards should be no less than 1.2m and no more than 3m apart.
- (g) The total mass of stone dust per barrier should be no less than the mass required in an equivalent distributed or primary and secondary bag barrier.

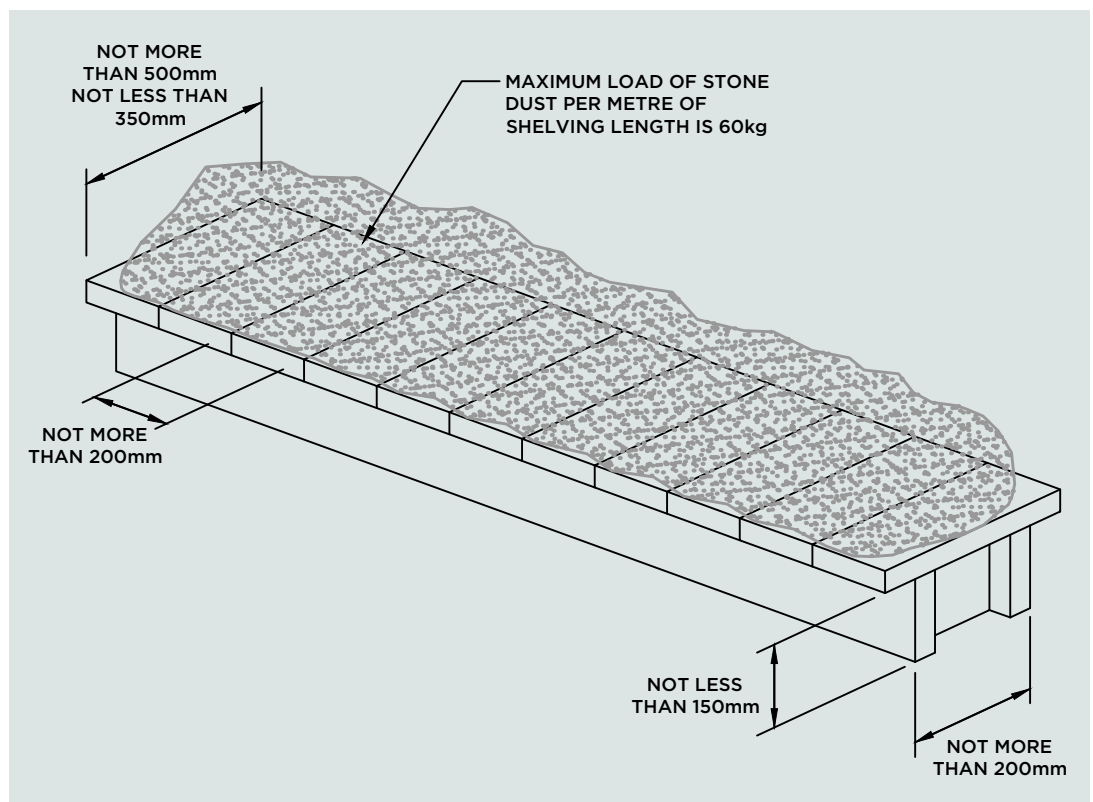


Figure 13 - Construction of conventional stone dust board

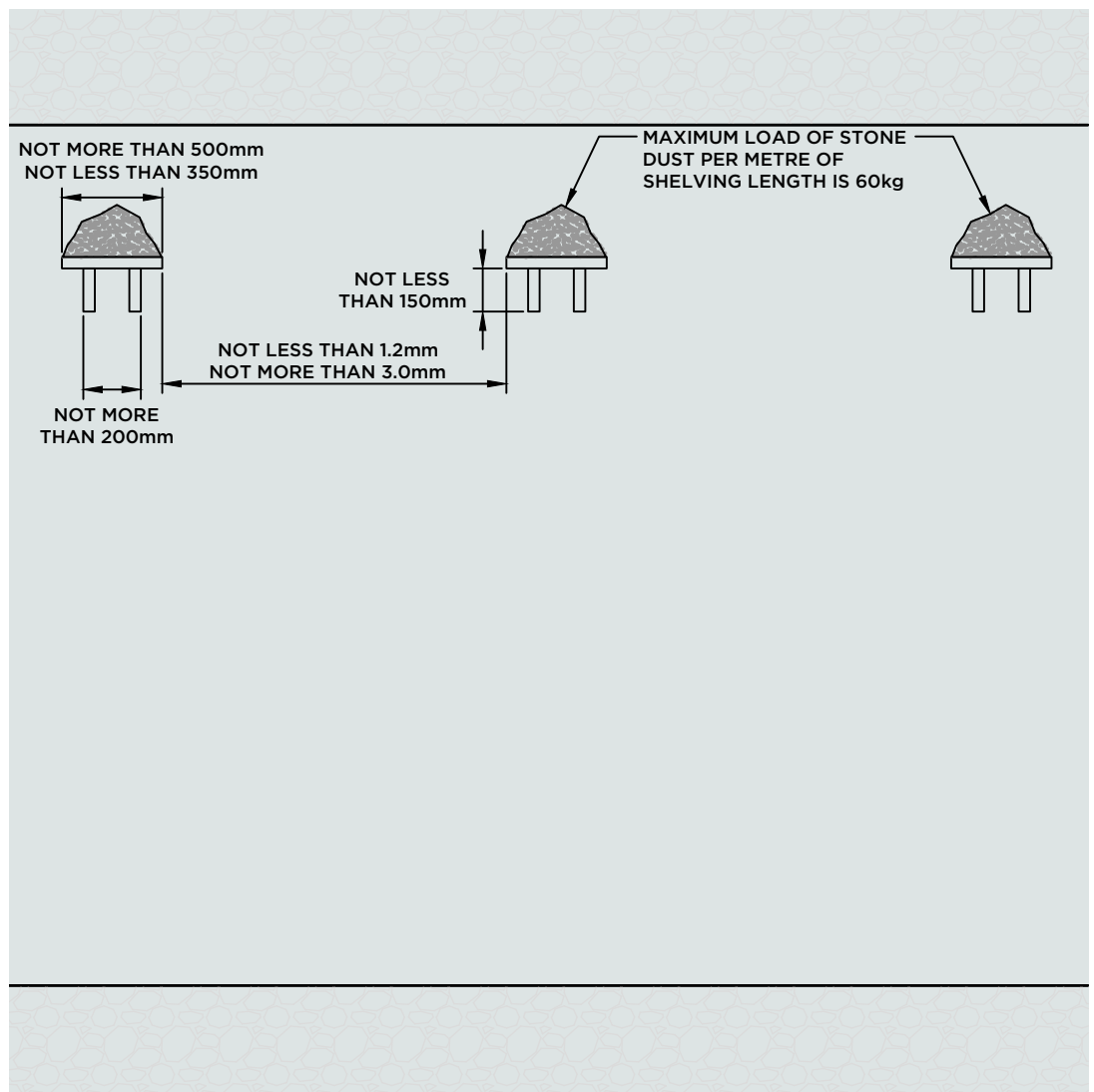


Figure 14 - Spacing of stone dust boards

8.8.16 Water trough explosion barriers

Where a water trough barrier is to be installed, it should be constructed so that:

- (a) Troughs filled with water are rigidly held in support frames or bearers, and form rows at right angles to the roadway direction.
- (b) The troughs are of a type suitable for use with rigid support.
- (c) The frames provide a minimum of shielding to the face of each trough, and the space above them. This is to withstand the maximum impact of a potential wind blast on the face of the trough, and on any water ejected from the top of the trough.
- (d) The frames or bearers are supported in the roadway so that they are not free to move in the direction of the roadway. This is to ensure the troughs are subjected to the maximum possible wind blast in a weak explosion.

- (e) The spacing between rows of troughs is no less than 1.5m between each centre, and where the barrier is a distributed barrier, no more than 3m.
- (f) The distance between the outside rims of the outside troughs in the same row is no less than 65% of the maximum roadway width.
- (g) Within a row, the total distance between troughs, and between the outer troughs and side of the tunnel, is not more than 1.5m. These spaces should be measured at right angles to the roadway direction between trough rims or between trough rims and the rib.
- (h) The troughs are set up with their long sides at right angles to the roadway direction.
- (i) The troughs are placed as low as practicable in the upper third of the roadway.
- (j) A water barrier at all times contains at least 200l/m² of roadway cross-section.
- (k) Troughs of 90l capacity of water, at all times contain a minimum of 80l of water, and 45l capacity troughs at all times contain a minimum of 40l of water.

Refer to MDG 3006 MRT 5:2001 “Guideline for coal dust explosion prevention and suppression” for more detailed information on water trough barriers.

8.8.17 Ensuring explosion barriers are fit for purpose

The mine operator should consult with their explosion barrier suppliers and manufacturers to ensure its design and construction is fit for purpose, in relation to:

- (a) Proven design criteria.
- (b) Results of empirical testing.
- (c) The availability of relevant guidance or technical specifications to support information supplied.

8.8.18 Water trough explosion barrier installations

Until recently, active water trough explosion barriers have not been used in New Zealand. There have been several different designs tested in other countries, and they operate in different ways.

Because active barriers sense the approach of the flame, they can more accurately release suppressant into the path of the flame. They do not rely on the blast to activate them. They provide a very rapid release of extinguishant. Some are powered by explosives, others by compressed gas.

Some types were intended as a replacement for passive barriers. Others are intended to be used on or near the heads of mining machines, and would suppress an ignition at a very early stage.

REG 204

COAL

ACOP

Because of the variety of types, it is necessary that any design which is introduced has its own set of instructions for installation and placement.

204 Failure of methane monitoring system

- (1) *This Regulation applies if the methane monitoring system fails or becomes non-operational, affecting a part or the whole of the underground parts of the mining operation, and the mining operation does not have—*
- (a) *a procedure for the use of portable monitors to detect methane; or*
 - (b) *a sufficient number of portable monitors to continually monitor the affected part or the whole of the underground parts of the mining operation to the extent necessary to ensure that the levels of methane in the affected part or the whole of the underground parts of the mining operation remain below 2%.*
- (2) *The mine operator must ensure that every mine worker underground is withdrawn to a place of safety.*
- (3) *The mine operator must ensure that no mine worker enters or remains in an unsafe part of the underground parts of the mining operation, except to repair or replace the affected parts of the methane monitoring system.*
- (4) *For the purposes of subclause (3), a part or the whole of the underground parts of the mining operation is unsafe if the concentration of methane in the general body of air in that part or the whole of the underground parts of the mining operation cannot be monitored as required by these Regulations.*

8.9 Emergency response

All mine operators must prepare an emergency management PCP (emergency plan) if there is one or more principal hazard at the operation. The mine operator must provide sufficient resources to implement the plan, including training for mine workers. The site senior executive must make the emergency plan available to all mine workers and give a copy to the New Zealand Mines Rescue Service and emergency services.

See the approved code of practice on Emergency Preparedness in Mining and Tunnelling Operations for details on producing and implementing the emergency plan.

8.10 Sealing parts of the mine

For detailed information on the requirements for sealing the mine, and the precautions to be taken when sealing parts of the mine, see the Approved Code of Practice on Ventilation.



09/
NOTIFICATIONS

9.1 Notifications

REG 185

COAL

185 Notice of intention to seal underground coal mining operation

- (1) *The mine operator must give notice to WorkSafe of any intention to seal the whole of the underground parts of the mining operation.*
- (2) *Except in case of emergency sealing, the notice must be given, 1 month in advance of the activity taking place.*
- (3) *The notice must include—*
 - (a) *the proposed locations of the seals to be installed; and*
 - (b) *the proposed sealing procedure; and*
 - (c) *a summary of hazards identified and how they will be managed; and*
 - (d) *any evidence of the presence of an ignition source in a part or the whole of the underground parts of the mining operation; and*
 - (e) *predictions of the rates at which methane and other gases will accumulate in the underground parts of the mining operation; and*
 - (f) *the gas monitoring procedures to be carried out during and after the sealing.*
- (4) *If sealing becomes impracticable in the way in which the procedure was described in the notice provided to WorkSafe, the mine operator must—*
 - (a) *promptly notify WorkSafe of the changes from the initial proposed method of sealing the underground coal mining operation; and*
 - (b) *if the notification under paragraph (a) is not in writing, confirm the notification in writing to WorkSafe as soon as reasonably practicable.*

REG 203

COAL

203 Recording and notification of isolation of electricity supply

- (1) *If the supply of electricity is automatically isolated or mobile plant is shut down as required by any of Regulations 197 and 199 to 202 (except to cutters as required by Regulation 200(1)(a)(ii)), the mine operator must ensure that a record is kept of the date, time, and location of the event.*
- (2) *If the supply of electricity is automatically isolated as required by Regulation 197(b)(ii), the mine operator must ensure that WorkSafe is notified as soon as practicable.*

REG 227

227 Notification of accidents and serious harm

- (1) *For the purpose of section 25(2)(b) of the Act, every accident specified in Schedule 8 is required to be notified to WorkSafe if the accident occurs at a mining operation.*
- (2) *For the purpose of section 25(3)(b) of the Act, the mine operator must notify the following to WorkSafe:*
 - (a) *every accident specified in Schedule 8 if the accident occurs at the mining operation; and*

- (b) every occurrence of serious harm at the mining operation.
- (3) The mine operator must notify the accident or serious harm to WorkSafe by providing the particulars prescribed in Schedule 7 to WorkSafe.
- (4) The mine operator must also provide the particulars of the accident or serious harm, except for personal information about any mine worker, to every site health and safety representative at the mining operation.
- (5) WorkSafe must make the particulars of the accident or serious harm, except for personal information about any mine worker, available to industry health and safety representatives.
- (6) For the avoidance of doubt, a mine operator is not required, in relation to any mine worker, to separately notify the accident or serious harm to WorkSafe on the basis that the mine worker is an employee of or a self-employed person contracted to the mine operator.

229 Notification of high-risk activities

- (1) Before a high-risk activity specified in Schedule 9 is undertaken, the mine operator must ensure that notice of the activity is given to WorkSafe.
- (2) The period of notice to be given is the waiting period specified in Schedule 9 in relation to that activity, or any other longer or shorter period of notice that WorkSafe, by notice in writing, directs.
- (3) The notice must specify—
 - (a) the nature of the high-risk activity; and
 - (b) the intended commencement date of the activity.
- (4) The date that notice is given is the date that the notice is received by WorkSafe.
- (5) WorkSafe may request further information about the activity between the time of the notification of the activity by the mine operator and the expiry of the waiting period.
- (6) The mine operator must ensure that the high-risk activity is not commenced until the period of notice under subclause (2) has expired.

Schedule 8

Notifiable accidents

A notifiable accident is any of the following that occurs at a mining operation:

Fire, ignition, explosion, or smoke

- (1) any outbreak of fire underground involving open flame
- (2) the ignition underground of any gas or dust

- (3) *any accident where mine workers are required to evacuate a part or the whole of the underground parts of an underground mining operation or tunnelling operation because of smoke*
- (4) *the outbreak of any fire on the surface that endangers mine workers on the surface or in the underground parts of the mining operation*
- (5) *any fire on plant, including mobile plant, or a building associated with mining or tunnelling activities*
- (6) *in relation to a coal mining operation, the detection of any spontaneous combustion*

Emergency, escape, and rescue

- (1) *any initiation of the mine emergency plan other than during a planned exercise*
- (2) *use of emergency escape equipment, including self-contained self-rescuers or other breathing apparatus, except during training*
- (3) *failure in use or training of any emergency escape equipment or mines rescue breathing apparatus*
- (4) *any emergency evacuation of a part or the whole of a mining operation*
- (5) *the unplanned unavailability of 1 or more of the emergency escapeways from an underground mining operation or tunnelling operation*
- (6) *any occasion where a mine worker or mine workers are trapped or unable to leave their place of work in a mining operation*

SCHEDULE 9

Schedule 9

High-risk activities

ACOP

9.1 Notifications

The Regulations require WorkSafe NZ to be notified two months prior to the proposed date of commencement of a mining operation. Where a new development is proposed in an existing mining operation, WorkSafe NZ should be notified two months prior to the start of the new development.

A development of an existing mine or tunnel includes (but not exclusively) significant changes to:

- > The physical layout of the mine or tunnel; or
- > Equipment, electrical or ventilation systems.

The notification for a new mining operation, or new development of an existing mine or tunnel, should include (in addition to any regulatory requirement):

- (a) The layout of the development in relation to existing roads and to previous workings.



- (b) The ventilation arrangements for each stage of that development, including air quantities and velocities throughout the development.
- (c) Any gas makes that may affect other workings.
- (d) Any environmental monitoring required by that development.
- (e) Any requirements to be in place for the heading or tunnel breakthrough of that development, such as doors or regulators.
- (f) The ventilation requirements whilst that working area is being equipped.
- (g) The ventilation arrangements for the coal face, including air quantities and any ventilation control system required such as doors, regulators or air crossings.
- (h) The position of any primary and secondary stoppings or bulkheads.
- (i) The tunnelling method to be used and arrangements for the transporting of materials.
- (j) If the tunnelling will require any special arrangements, such as hyperbaric pressure, grouting, or freezing of strata.
- (k) Any methane drainage requirements such as range sizes, and positioning of ranges.
- (l) Any spontaneous combustion prevention work required to be carried out at each stage of the development, such as roadway sealing around the junction area as the heading advances.
- (m) Salvage arrangements for the district after production is complete.
- (n) Final sealing arrangements, if applicable.

10/

RECORDS

- 10.1 Stone dusting**
 - 10.2 Electrical trips**
 - 10.3 Personnel underground**
 - 10.4 Fire-fighting plan**
 - 10.5 Electronic tracking systems**
-

REG 61

61 Maintenance of records of health and safety management system

- (1) *The mine operator must ensure that the following records are kept:*
 - (a) *the current version of the health and safety management system;*
 - (b) *any previous versions of the health and safety management system that applied in the preceding 7 year period;*
 - (c) *records of all reviews and audits of the health and safety management system, or any part of it, that have been conducted in the preceding 7 year period;*
 - (d) *records of any risk appraisal carried out to identify principal hazards at the mining operation as required by Regulation 66(1)(a).*
- (2) *The mine operator must ensure that the records referred to in subclause (1) must be maintained in such a way that—*
 - (a) *the current version of the health and safety management system can be clearly identified; and*
 - (b) *every previous version of the health and safety management system required to be kept is kept as it was while it was current and shows the period during which it was current.*
- (3) *The mine operator must ensure that the records referred to in subclause (1) are made available, on request, to WorkSafe, a site health and safety representative, or an industry health and safety representative.*

REG 62

62 Providing health and safety management system documentation to mine workers

- (1) *The mine operator for a mining operation must ensure that, before a mine worker commences work at the mining operation—*
 - (a) *the mine worker is given a written summary of the health and safety management system for the mining operation; and*
 - (b) *the mine worker is informed of the right to access the current version of the health and safety management system.*
- (2) *The mine operator must ensure that the current version of the health and safety management system is readily accessible by a mine worker at the mining operation.*
- (3) *The mine operator must ensure that a mine worker is given access to—*
 - (a) *the current versions of the principal hazard management plans that are relevant to the work the mine worker is to carry out; and*
 - (b) *the current versions of the principal control plans that are relevant to the work the mine worker is to carry out; and*
 - (c) *the current versions of any other plans or documented processes for the management of hazards that are relevant to the work the mine worker is to carry out.*

REG 63

- (4) *If the health and safety management system is revised under subpart 4, the mine operator must ensure that each mine worker at the mining operation is made aware of any revision that is relevant to work being carried out by that mine worker.*

63 Providing health and safety management system documentation to contractor

- (1) *This Regulation applies to a person who is engaged by the mine operator to provide services where the person's employees or other workers engaged by the person to provide those services will be mine workers in relation to the mine operator.*
- (2) *The mine operator must ensure that the current version of the health and safety management system, and records of all audits and reviews of the health and safety management system, or any part of it, and other audits of the site itself that have been conducted, are made available on request to any person to whom this Regulation applies.*

REG 129

129 Records of first aid provided to mine workers

The mine operator must ensure that records of first aid provided to mine workers who are seriously harmed at the mining operation are kept for at least 7 years after the accident concerned.

REG 144

144 Ventilation fans other than auxiliary fans

The mine operator must ensure that,—

- (b) *each main ventilation fan has the following devices connected to it:*
- (ii) *a device that continuously indicates and records the volume of air passing through the fan; and*
 - (iii) *a device that continuously indicates and records the number of revolutions per minute of the fan; and*
- (c) *each main ventilation fan is fitted with a device that continuously monitors and records the condition of the fan, including the temperature, vibration levels, and static pressure, and that will, when the device detects a significant departure from the fan's normal operating parameters,—*
- (iii) *record the date and time that an alarm is triggered and the supply of electricity is isolated; and*
- (d) *each booster fan installed underground is fitted with a device that continuously monitors and records the condition of the fan, including the temperature, vibration levels, and static pressure, and that will, when the device detects a significant departure from the fan's normal operating parameters,—*
- (iii) *record the date and time that an alarm is triggered and the supply of electricity to the fan is isolated; and*

REG 203

COAL

203 Recording and notification of isolation of electricity supply

- (1) *If the supply of electricity is automatically isolated or mobile plant is shut down as required by any of Regulations 197 and 199 to 202 (except to cutters as required by Regulations 200(1)(a)(ii)), the mine operator must ensure that a record is kept of the date, time, and location of the event.*
- (2) *If the supply of electricity is automatically isolated as required by Regulation 197(b)(ii), the mine operator must ensure that WorkSafe is notified as soon as practicable.*

REG 206

COAL

206 Recording of dust sampling and analysis

The mine operator must ensure that—

- (a) *the mine worker in charge of the part of the mining operation where a sample of dust was taken is given notice of the results of the analysis of that sample; and*
- (b) *a record is kept of the following information for each roadway dust sample taken at the mining operation:*
 - (i) *the date the sample was taken; and*
 - (ii) *the location from which the sample was taken; and*
 - (iii) *the volume and type of incombustible material in the sample; and*
 - (iv) *the method used to analyse the sample; and*
- (c) *the results of the analysis of the dust sample, in particular the volume and type of incombustible material content, are marked on a plan of the mining operation.*

REG 212

212 Giving draft principal hazard management plans and principal control plans to WorkSafe

- (1) *A mine operator must give the following to WorkSafe not less than 2 months before the mining operation commences:*
 - (a) *all draft principal hazard management plans for the mining operation; and*
 - (b) *all draft principal control plans for the mining operation.*
- (2) *Nothing in subclause (1) applies where a mining operation recommences after being suspended.*

REG 213

213 Plans of mining operation

- (1) *The mine operator must ensure that a plan is made of the mining operation as at the date of commencement of the mining operation.*
- (2) *The mine operator must ensure that the plan of the mining operation is reviewed and, if necessary, updated—*
 - (a) *at least once every 3 months in relation to the parts of the plan that identify points of access, egresses, and refuges:*
 - (b) *when there has been a significant modification to the mining operation:*

- (c) *if the mining operation has been suspended, before the mining operation recommences;*
 - (d) *otherwise, at least once every 6 months.*
- (3) *The plan, including any updated plan, must—*
- (a) *be prepared by a mine surveyor using the New Zealand Geodetic Datum 2000 and to a suitable scale; and*
 - (b) *be kept at the site office; and*
 - (c) *be available for inspection at all times at which a mine worker is present at the mining operation.*
- (4) *The mine surveyor who prepares the plan must hold a certificate of competence as a mine surveyor or, in the case of an opencast mining operation or tunnelling operation only, be a licensed cadastral surveyor.*

REG 214**214 Copy of plan of mining operation to be given to WorkSafe**

The mine operator must ensure that a copy of the plan of the mining operation is given to WorkSafe—

- (a) *as soon as practicable after the date of completion of the plan for the first time; and*
- (b) *at intervals of 12 months after that date; and*
- (c) *whenever any significant changes are made to the plan.*

REG 215**215 Copy of plan of mining operation to be available to industry health and safety representative**

The mine operator must ensure that the plan of the mining operation, including any updated plan, is made available, on request, to an industry health and safety representative.

REG 216**216 Plans of ceased mining operation**

- (1) *The mine operator must ensure that, immediately following the suspension or abandonment of the mining operation, a plan is made of the mining operation.*
- (2) *The plan must be—*
- (a) *prepared by a mine surveyor using the New Zealand Geodetic Datum 2000 and to a suitable scale; and*
 - (b) *correct as at the date of suspension or abandonment; and*
 - (c) *copied to WorkSafe.*

REG 217**217 Details to be included in plans**

The mine operator must ensure that the plans, including any updated plans, prepared under Regulations 213 and 216 include such details as exist of—

- (a) every explosion risk zone:
- (b) every area of an underground metalliferous mining operation or tunnelling operation where methane has been detected:
- (c) tenure boundaries:
- (d) the angle of inclination, datum level at the collar, depth and location of every borehole or shaft:
- (e) the direction, extent, and location of every known barrier, fault, intrusive dyke, old workings, washout, water accumulation, or aquifer:
- (f) the floor levels and location of every traverse station:
- (g) the angle of dip, direction, nature, and thickness of every known coal seam:
- (h) the cross and longitudinal sections of every level and lode:
- (i) the horizontal and vertical sections of the ventilation system, including details of—
 - (i) the direction, course, and volume of air flow; and
 - (ii) the location and description of every device used to regulate or distribute air; and
 - (iii) the location of firefighting, rescue, and emergency facilities, including emergency egresses, changeover stations, refuges, and first-aid stations:
- (j) the separation distances between shafts:
- (k) the location of inrush control zones:
- (l) the location of electrical installations, including the route and voltage of all conductors (excluding trailing cables) and the position of all major switchgear:
- (m) water dams, tailing dams, and tip heads:
- (n) areas where spontaneous combustion has occurred, including sealed areas:
- (o) places where hydrocarbons and explosives are stored:
- (p) roads and other key features of the traffic management system within the mining operation:
- (q) any other identified hazards present at or close to the mining operation:
- (r) natural features surrounding the mining operation:
- (s) the location of every device that provides for oral communication between the underground parts of the mining operation and the surface:
- (t) an indication of every location at which it is proposed to develop the mining operation with the next 12 months.

REG 219

219 Mining operation records

- (1) *The mine operator must ensure that mining operations records—*
- (a) *are kept at the site office; and*
 - (b) *are available for inspection by a mine worker or the site senior executive at any time at which a mine worker or the site senior executive is present at the mining operation.*
- (2) *The mining operations records must consist of—*
- (a) *information about the mine operator, including the information provided in the notice given to WorkSafe under Regulation 211:*
 - (b) *information about the appointment of the site senior executive, including the person's name:*
 - (c) *all notifications and reports to WorkSafe under Regulations 211 and 227 to 229:*
 - (d) *the current and all previous plans of the mining operation:*
 - (e) *plans of any abandoned mining operation above, below, or within 200 metres of the boundary of the mining operation, including where any part of an abandoned mining operation is above, below, or within 200 metres of the boundary of the mining operation:*
 - (f) *records of the certificates of competence held by mine workers at the mining operation and any other training or qualifications they have received:*
 - (g) *records of mine workers underground:*
 - (h) *the register of accidents and incidents required under section 25 of the Act and the records kept under Regulation 226:*
 - (i) *the results of examinations performed under Regulation 222:*
 - (j) *statutory notices received from WorkSafe and the responses to those notices, including any remedial action taken as a result of those notices:*
 - (k) *the details of any inspections completed by a site health and safety representative or industry health and safety representative and any actions taken by a site health and safety representative or industry health and safety representative, including any notices issued under sections 19ZF to 19ZH of the Act.*
- (3) *A matter must be kept in the mining operation record for 7 years after the matter is included in the record.*

REG 220

220 Record of mine workers underground

The mine operator must ensure that—

- (a) no mine worker is allowed to enter the underground parts of an underground mining operation or tunnelling operation without the permission of the manager; and
- (b) an accurate record is made of every mine worker's entry into, and exit from, the underground parts of an underground mining operation or tunnelling operation; and
- (c) the record, or a copy of it, is kept at the entry point.

REG 221

COAL

221 Shift reports

(1) The mine operator of an underground coal mining operation must ensure that—

- (a) the underviewer of each shift at the underground coal mining operation completes a written report on—
 - (i) the current state of the workings of the mining operation and plant at the mining operation; and
 - (ii) any material matters that may affect the health and safety of mine workers arising from work done during the shift; and
 - (iii) any hazards or potential hazards identified during the shift; and
 - (iv) the controls (if any) put in place during the shift to manage those hazards; and
- (b) the underviewer communicates the content of the written report to the underviewer of the incoming shift; and
- (c) the content of the written report is communicated to the mine workers on the incoming shift.

(2) The mine operator of a mining operation other than an underground coal mining operation must ensure that—

- (a) the supervisor of each shift at the mining operation completes a written report on—
 - (i) the current state of the workings of the mining operation and plant at the mining operation; and
 - (ii) any material matters that may affect the health and safety of mine workers arising from work done during the shift; and
 - (iii) any hazards or potential hazards identified during the shift; and
 - (iv) the controls (if any) put in place during the shift to manage those hazards; and
- (b) the supervisor communicates the content of the written report to the supervisor of the incoming shift; and

REG 224

- (c) *the content of the written report is communicated to the mine workers on the incoming shift.*
- (3) *If the content of the written report is communicated to the underviewer or supervisor of the incoming shift orally under subclause (1)(b) or (2)(b), the mine operator must ensure that the written report is made available to the underviewer or supervisor of the incoming shift during his or her shift.*
- (4) *A procedure for performing the tasks described in subclauses (1) and (2) must be included in the health and safety management system for the mining operation.*

224 Visits to solitary mine workers

The mine operator of an underground mining operation or tunnelling operation must ensure that—

- (a) *a competent person visits or contacts a mine worker required to be alone in the underground parts of the mining operation at least twice during each shift and at intervals not exceeding 4 hours; and*
- (b) *a record is kept of visits to or contact made with a mine worker as required by paragraph (a).*

REG 226

226 Register of accidents and serious harm

- (1) *The mine operator must record the particulars of the following in relation to any mine worker:*
 - (a) *every accident that harmed (or, as the case may be, might have harmed) the mine worker at the mining operation; and*
 - (b) *every occurrence of serious harm to the mine worker at work, or as a result of any hazard to which the mine worker was exposed while at the mining operation.*
- (2) *For each accident or occurrence of serious harm, the particulars described in Schedule 7 must be recorded in a register of accidents and serious harm maintained by the mine operator.*
- (3) *The mine operator must ensure that a copy of the register is provided to WorkSafe at intervals of not more than 6 months.*
- (4) *For the avoidance of doubt, a mine operator is not required, in relation to any mine worker, to maintain a separate register of accidents and serious harm under section 25(1) or (1B) of the Act.*

REG 228

228 Accident investigations

- (1) *The mine operator must ensure that—*
 - (a) *any accident at the mining operation is investigated; and*
 - (b) *the investigation findings are made available to the mine workers at the mining operation.*

REG 230

- (2) *If the accident is a notifiable accident, the mine operator must ensure that a report of the investigation findings is provided to WorkSafe within 30 days of the date on which the accident occurred.*
- (3) *A procedure for making findings available to workers must be included in the health and safety management system.*
- (4) *Nothing in this Regulation affects section 7(2) of the Act.*

230 Quarterly report to WorkSafe

- (1) *The mine operator must give WorkSafe the information set out in Schedule 10.*
- (2) *The information must be given every 3 months.*

ACOP

COAL

10.1 Stone dusting

The mine operator should ensure that records are kept of the following for a period of three years, or for the period of time that the section of the mine that the record relates to is still in use:

- (a) The date and time that all stone dust was applied.
- (b) Stone dust supply specifications.
- (c) The results of all incombustible material content are recorded on the plan of the mine (as per Regulation 206(c)).

COAL

10.2 Electrical trips

The mine operator should ensure that:

- (a) Records are kept of all trips to the electricity supply caused by:
 - (i) Automatic methane monitors between the zones NERZ - NERZ and NERZ - ERZ1.
 - (ii) Any non-explosion protected vehicle methane monitor.
- (b) Such records should be kept for a minimum of 3 years.
- (c) Such trips should be reported to WorkSafe NZ.

10.3 Personnel underground

The mine or tunnel operator should ensure that:

- (a) A system is in place to record the name and details of every mine worker underground at a mine or tunnel. The records should include each mine worker's approximate location underground.
- (b) A report outlining the above details is able to be provided upon request at any time, including in the event of power failure at the mine or tunnel.

10.4 Firefighting plan

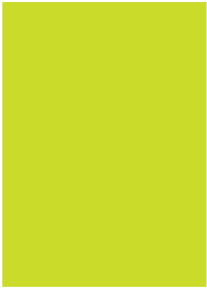
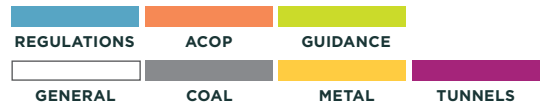
- (a) The firefighting plan should be kept up to date and be available upon request at all times.
- (b) Any change that takes place below ground should be recorded in writing within 24 hours of the change taking place.
- (c) The record should include a diagram showing the change that has taken place.
- (d) The record should be signed by the mine or tunnel manager, acknowledging the change and accepting that the underground fire/explosion plan and the firefighting plan have both been updated accordingly.
- (e) Before any new development starts, a working fire/explosion development plan should be completed and signed by key stakeholders (mine or tunnel manager/supervisor/workers representative). All those working in the area should be able to easily follow this plan.
- (f) Once signed, the plan should be posted in the deployment area (or in a place designated and accessible by all underground workers) and copies provided to the control room.
- (g) The plan should contain the following information:
 - (i) The layout of the development showing water pipes, hydrants, fire points and any refuge chambers or changeover stations. The plan should also show locations of CO and/ or smoke detectors
 - (ii) The firefighting arrangements for each stage of that development, including distances when additional hydrants or monitors are required to be installed.
 - (iii) Items of equipment identified as high potential fire risk
 - (iv) Any other environmental monitoring required by that development.
 - (v) Location of portable fire extinguishers
- (h) The plan and records should be completed in conjunction with the ventilation plan.

GUIDANCE

10.5 Electronic tracking systems

The use of tag board systems and deployment records is a typical method to record mine workers who are underground at any one time. The system requires mine workers to place their own name tag onto a board before entering the underground environment. It is prone to inaccuracies because mine workers might forget to tag on or off or remove the wrong name tag by mistake.

Electronic tracking systems allow each mine worker's cap lamp battery and mobile equipment to be linked to sensors at the mine or tunnel entrance and at key underground locations such as entries to districts or workshops.



Such systems provide real time reporting on locations of underground mine workers, mobile equipment and equipment operators at any one time and can be provided as a safety critical system.

The sensor data can also be used to identify and raise an alarm when the maximum limit of mine workers or mobile equipment is reached in a particular section or district of the mine or tunnel (such as a single entry).

11/

REVIEW AND AUDIT

- 11.1 Review of controls
 - 11.2 Review requirements
 - 11.3 Audit requirements
-

REG 69

69 Review and revision of principal hazard management plans

- (1) *In addition to the requirements of Regulation 58, the site senior executive must ensure that each principal hazard management plan is reviewed at least once every 2 years after the date the principal hazard management plan is approved by the site senior executive.*
- (2) *In addition to the requirements of Regulation 59, the site senior executive must ensure that a principal hazard management plan is reviewed after –*
 - (a) *the occurrence of an accident at the mining operation involving a principal hazard that it was intended to manage;*
 - (b) *a material change in the management structure at the mining operation that may affect the principal hazard management plan;*
 - (c) *a material change in plant used or installed at the mining operation that may affect the principal hazard management plan;*
 - (d) *the occurrence of any other event as provided in a principal hazard management plan as requiring a review of the plan.*
- (3) *Any review of a principal hazard management plan under subclause (1) must include—*
 - (a) *a review of the risk assessment in relation to the relevant principal hazard; and*
 - (b) *a review of all other aspects of the principal hazard management plan.*
- (4) *In addition to the requirements of Regulation 61, the mine operator must ensure that records of all reviews and revisions of principal hazard management plans are kept for at least 12 months from the date on which the mining operation is abandoned.*
- (5) *The mine operator must, on request, provide records relating to a review of a principal hazard management plan to an inspector or a site health and safety representative.*

REG 70

70 Audits of principal hazard management plans

- (1) *The mine operator must engage, and pay for, a competent person to carry out an independent external audit of all principal hazard management plans, ensuring that—*
 - (a) *external audits are carried out once every 3 years after the date the principal hazard management plan is approved by the site senior executive.; and*
 - (b) *the external auditors are independent of the mining operation.*
- (2) *In addition to the requirements of Regulation 61, the mine operator must ensure that records of all audits of principal hazard management plans are kept for at least 12 months from the date on which the mining operation is abandoned.*

11.1 Review of controls⁴⁸

When reviewing controls, the site senior executive (SSE) should ensure that considerations include:

- (a) Parameters and limitations and how they can be checked.
- (b) Verification of the effectiveness of the control.
- (c) The level of maintenance required to ensure the effectiveness of the control, and whether it is included on the maintenance schedule.
- (d) The consequences if the control fails.
- (e) Training/re-training required for mine workers.
- (f) How often the control needs reviewing.
- (g) Whether the hazard for which the control is in place has changed.

11.2 Review requirements

The Fire or Explosion Principal Hazard Management Plan should be reviewed for effectiveness:

- (a) No later than two years after the initial Principal Hazard Management Plan is approved.
- (b) After each audit, if any non-conformances are identified.
- (c) Following an incident.
- (d) When the ventilation system has been found to be inadequate.
- (e) Following changes to the mine or tunnel operating system which may affect the Fire or Explosion Principal Hazard Management Plan.
- (f) At least once every two years.

11.3 Audit requirements

- (a) The review of the Fire or Explosion Principal Hazard Management Plan should be audited internally by a person or people independent of those responsible for developing and implementing the plan.
- (b) An external audit of the Fire or Explosion Principal Hazard Management Plan should be conducted at periods not exceeding three years. The external audit should be carried out by a competent person who is independent of the mining operation and the development and implementation of the Fire or Explosion Principal Hazard Management Plan.
- (c) Details of the above audits should be retained for the life of the mine or tunnel, and be available to a workers representative and WorkSafe NZ upon request.

⁴⁸ Ministry of Business, Innovation and Employment. (2013). *Guidance for a Hazard Management System for mines*. Wellington, New Zealand. 15.

A/

APPENDIX

- A1** Calculate to determine Effective Temperature
 - A2** Sample fire or explosion risk assessment
 - A3** Sample operating rules on frictional ignition
 - A4** Sample frictional ignition risk assessment
 - A5** Sample plan for the prevention of a frictional ignition in a new heading
 - A6** Sample mine gas chart
 - A7** Methane monitor alarm settings [from the Regulations]
-

A1 Calculation to determine Effective Temperature⁴⁹

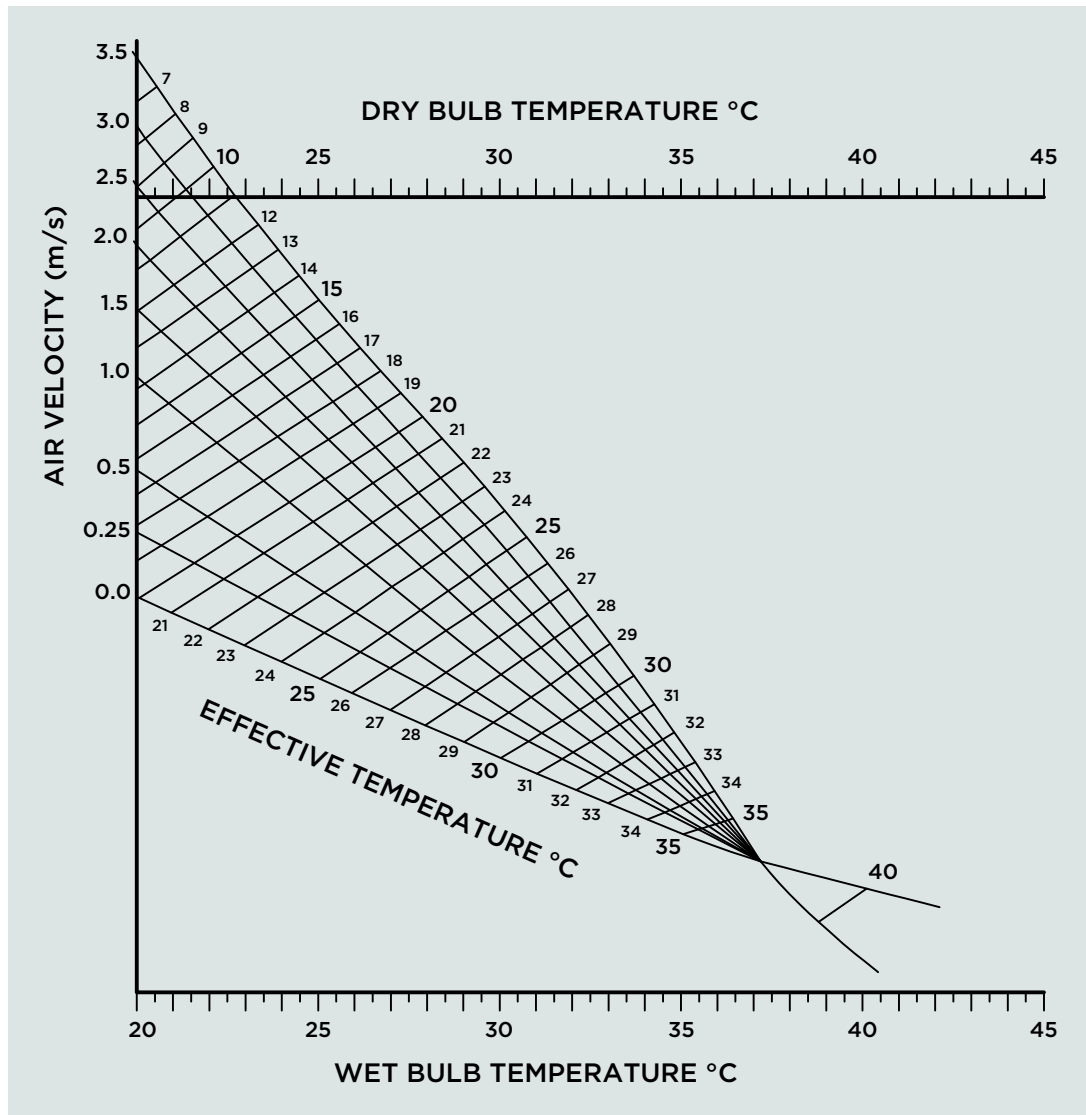


Figure 15 - Effective Temperature (ET) calculation chart

The above chart represents the relationship between the WB temperature, the DB temperature, and air velocity. It is a useful tool for calculating ET. To determine ET, the WB, DB and air velocity figures should be known.

The **DB temperature** is the temperature of the air, measured with a standard thermometer.

The **WB temperature** is measured using a thermometer, the mercury bulb of which is surrounded by a wetted gauze. The effect of the gauze is to saturate the atmosphere locally by evaporation, so the WB temperature is reduced in proportion to the dryness of the air.

⁴⁹ Retrieved from www.hse.gov.uk/mining/effectivetempchart.pdf

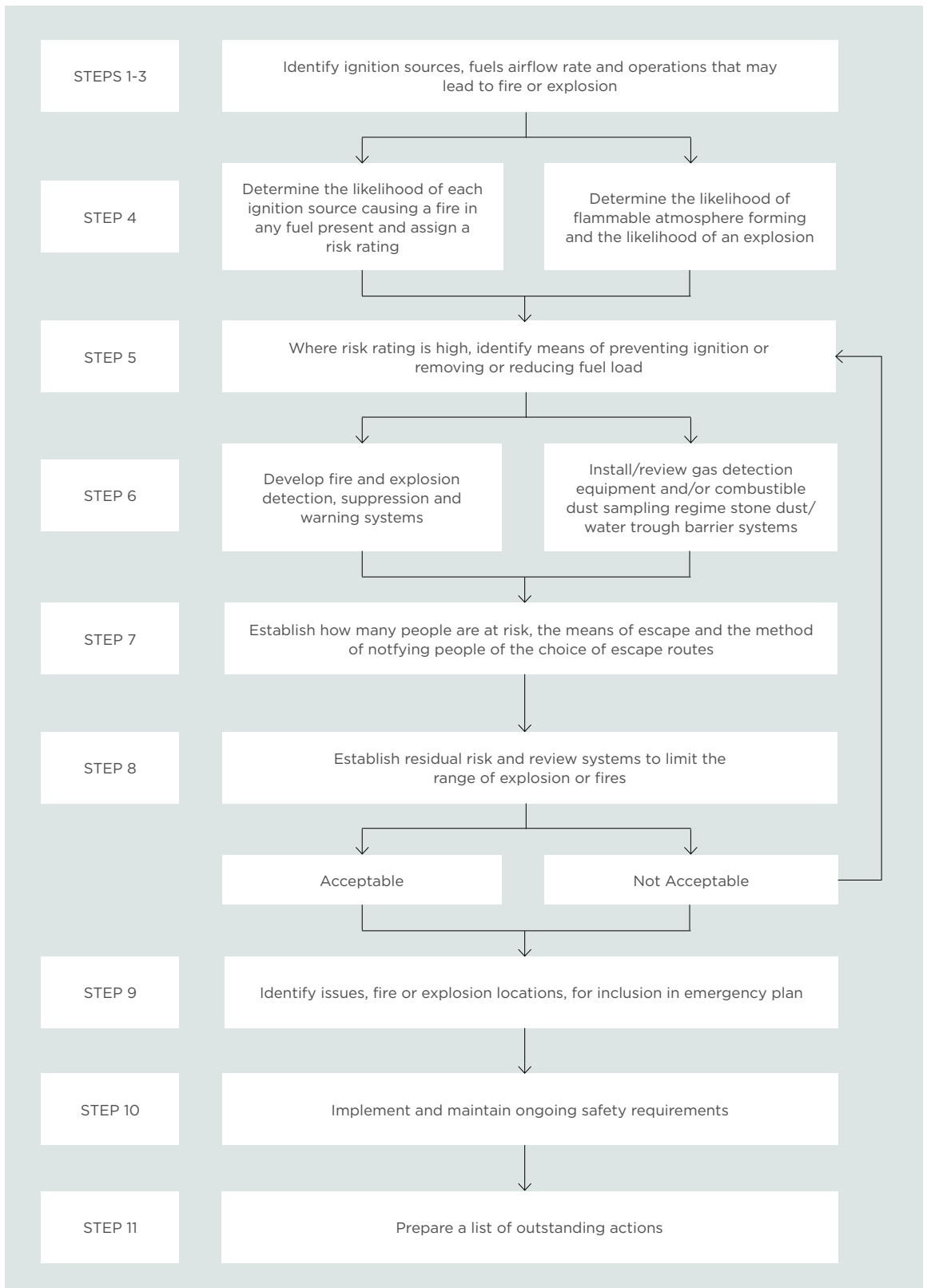
The two temperatures are usually taken simultaneously using a whirling hygrometer. If required, the relative humidity can be calculated from the two temperatures.

The **air velocity** is usually measured using an anemometer and stopwatch. Air velocity produces a wind chill factor, which lowers the apparent temperature, giving a mine worker the sensation of being exposed to a lower temperature than actually being experienced.

The chart is used by drawing a straight line between the points on the upper and lower scales corresponding to the measured DB and WB temperatures. From the point at which the line intersects the curve corresponding to the measured air velocity, the ET can be read off the ET scale.

For example, the ET corresponding to 25°C WB, 29°C DB and an air velocity of 1.5 m/s is 23°C.

A2 Sample fire or explosion risk assessment



A3 Sample operating rules on frictional ignition⁵⁰

Application

- 1 These rules apply to each working face and drivage where machinery is used to cut mineral. They do not apply to hydro mining where a water monitor is used to cut coal.

Interpretation

- 2 'Frictional ignition risk' means the risk of a concentration of methane in the explosive range coinciding with an igniting source caused by frictional heat or sparks from cutting picks.
- 3 'Working face' includes all machine-cut production faces, hydro panel development and bord & pillar operations.
- 4 'Drivage' includes all narrow workings, tunnel developments or small excavations, whether or not in coal seams.
- 5 'Upstream' and 'downstream' refers to the direction, relative to a place, of the movement of air.
 - (a) 'Upstream' means against the direction of movement and towards the source of air reaching that place.
 - (b) 'Downstream' means in the direction of movement of air leaving that place.

The assessment of frictional ignition risk at coal faces and drivages

- 6 Prior to operating any working face or drivage, an assessment should be made by a competent mine worker of the frictional ignition risk.
- 7 The frictional ignition risk assessment should determine:
 - (a) The likelihood of there being an ignition caused by frictional heat or sparks from cutting picks; and
 - (b) the likelihood of:
 - (i) A concentration of methane in the explosive range in the cutting zone either at the working face or the drivage.
 - (ii) An abnormal level of methane (in excess of 1.25%) reaching the working face or drivage from another source on the upstream side.
- 8 The assessment should be revised if there are any changes in circumstances.

Ignition source

- 9 The assessment of the likelihood of an ignition caused by frictional heat or sparks from cutting picks should include:
 - (a) Classification of the Incendive Temperature Potential (ITP) of any strata likely to be encountered in the working face or drivage.
 - (b) The classification should be made by a competent mine worker and should take into account the percentage of quartz in the strata and the existence of any pyrites.

⁵⁰ Health and Safety Executive (HSE). (1993). *The Coal Mines (Owner's Operating Rules) Regulations 1993. Guidance on Regulations*. Surrey, England. 30-36.

10 Where the strata contains quartz, the ITP should be related to the quartz content as follows:

- (a) Rocks containing over 50% quartz - High ITP
- (b) Rocks containing 30% to 50% quartz - Medium ITP
- (c) Rocks containing under 30% quartz - Low ITP

11 Where the strata contains pyrites, an assessment should be made to determine whether its form and presentation qualify it to be assigned a medium or high ITP:

- (a) Massive pyrites, strong highly pyritic bands and ironstone with pyrites - Medium ITP.
- (b) Pyritic sandstones or siltstones including siltstone-seatearths - High ITP.

The combination of a high quartz content rock and pyrites (such as pyritic sandstone) is the most incendive type of rock likely to be encountered in coal mines. The relative ITPs of pyrites and related minerals can sometimes be difficult to determine. If uncertain, the classification should be a High ITP.

12 Rocks classified as either Medium or High ITP should be considered as having the potential to ignite methane as a result of the action of cutting picks.

13 An ITP classification is not required if the mine operator elects to classify a working face or drivage as having Medium or High ITPs for the purposes of a risk assessment.

Methane

14 The assessment of an abnormal level of methane (in excess of 1.25%) at the working face or drivage should be made by a competent mine worker and should include an evaluation of:

- (a) The expected release of methane at the face or drivage resulting from mining operations, and consideration of sudden emissions or bleeders.
- (b) The minimum quantity and velocity of air required to ensure compliance with statutory ventilation requirements in the general body of air and in the cutting zone. The evaluation should include:
 - (i) The prevention of methane layering.
 - (ii) The prevention of methane in the explosive range accumulating near cutting picks.
 - (iii) Methane emission from the goaf and at the downstream end of the face.
 - (iv) The requirement for methane drainage,;
 - (v) The likelihood of methane from the upstream side reaching the face or drivage.

Assessment report

15 The mine worker responsible for carrying out the frictional ignition risk assessment should prepare a written report which includes:

- (a) The methodology of the assessment and details of the results.

- (b) A statement as to whether any hazard is identified and the nature of the hazard.
- (c) For any hazard identified, its location and any mine workers at risk.
- (d) The signatures of the mine worker who carried out the assessment and the manager to confirm agreement with the assessment.

Frictional ignition rules

- 16 The site senior executive should prepare written procedures to reduce the risk of a frictional ignition of methane. These should include:
- (a) The minimum air quantity and velocity at selected locations for the district or drivage, including the cutting zone.
 - (b) A requirement to use portable methane detectors at suitable locations and, where practicable, to use continuous methane monitoring systems with automatic electrical cut-offs to the cutting machine.
 - (c) Devices or equipment on board any cutting machine that provide a minimum air flow to the cutting zone. Where such devices are water-powered, the minimum water pressure and flow necessary to achieve the required minimum air flow should be stated, and the equipment should alert the operator when the minimum pressures and flows are not being attained.
 - (d) Interlock devices on cutting machines to prevent operation of the cutting element in the event of a shortfall in air flow at any local ventilation device, or a shortfall in water pressure or flow where devices are water-powered.
 - (e) The type and position of local ventilation devices to be fitted to the cutting machine with details of the minimum water pressure and flow requirements.
 - (f) The type of picks to be used on the cutting machine that is best suited to limit frictional ignitions.
 - (g) On-board fire-fighting arrangements on the cutting machine, or the provision of other fire-fighting facilities that are readily available and in close proximity to the machine at all times.
 - (h) The type and location of any other device to be used either on any cutting machine or at any strategic points where a machine might operate, to assist with the dilution of methane in or around the cutting zone (eg compressed air venturis, on-board fans, air curtains).
 - (i) Monitors that automatically cut off the electricity supply on the working face or drivage before a concentration of methane from upstream exceeding 1.25% reaches a source of frictional ignition risk.
 - (j) A plan illustrating the arrangements, equipment and requirements.
 - (k) A statement of any operational precautions to be taken by a designated mine worker to reduce the risk of a frictional ignition. This should include the maintenance of the cutting horizon and examination and replacement of blunt, damaged or missing picks.

- (l) A statement of the duties of mine workers appointed by the manager regarding the planning, organisation, control, monitoring, review and maintenance of the protective and preventive measures introduced to reduce the risk of a frictional ignition.
- (m) Arrangements for safely moving any cutting machine to a position where maintenance or repair can be safely undertaken.
- (n) Prohibited operations.

17 The mine workers appointed to undertake the procedures should be supplied with a copy of them in writing and training in their application.

Immediate procedures following a frictional ignition incident

18 If an ignition occurs and the flame cannot be extinguished immediately, the mine's emergency procedure should be put into operation immediately.

19 In a drivage where a fire cannot be extinguished immediately, all mine workers should be withdrawn and the drivage fenced off. Electrical power should be isolated to all equipment in the drivage. The ventilation of the drivage should be maintained subject to instructions from a senior official at the mine.

Notification and investigation of frictional ignition incidents

20 An ignition of methane is an incident which is required to be reported to WorkSafe NZ's Chief Inspector, Extractives. In addition to any investigation carried out, the site senior executive should:

- (a) Ensure any mine worker designated by the mine operator to be notified of such incidents is informed.
- (b) Arrange for a competent mine worker to visit the site of the ignition so that rock samples can be taken and a record made of location of the incident (or as close as is possible). The mine worker should:
 - (i) Provide a preliminary report based on the record; and
 - (ii) after the samples have been examined in detail, prepare a final report.

21 The preliminary and final reports should be submitted to the site senior executive and any other mine worker designated by the mine operator to undertake an investigation into the incident.

A4 Sample frictional ignition risk assessment

FRICTIONAL IGNITION RISK ASSESSMENT FOR A MECHANICALLY CUT DRIVAGE, ROADHEAD, RIPPING OR SCOUR

MINE:

SEAM:

LOCATION:XXXX HEADING

1. INCENTIVE TEMPERATURE POTENTIAL ASSESSMENT.

The ITP classification is HIGH/MEDIUM/LOW:

2. ASSESSMENT OF THE POTENTIAL HIGH LEVELS OF METHANE IN THE CUTTING ZONE OR OF ABNORMAL LEVELS REACHING DRIVAGE, ROADHEAD, RIPPING OR SCOUR.

2.1 There is a possibility of methane being present in the cutting zone at a concentration at which an ignition could occur.

2.2 There IS/IS NOT[†] a likelihood of methane in excess of 1% from other sources on the upstream side reaching the drivage, roadhead, ripping or scour.

3. OVERALL ASSESSMENT OF THE RISK OF A FRICTIONAL IGNITION OCCURRING

The risk is HIGH = by virtue of 1 and 2 above.

4. EMPLOYEES ESPECIALLY AT RISK

People working at or near the face of the drivage, roadhead, ripping or scour.

[†]Delete as applicable.

SIGNED ASSESSOR DATE / /

SIGNED ASSESSOR DATE / /

A5 Sample plan for the prevention of a frictional ignition in a new heading

Mine:

Seam:

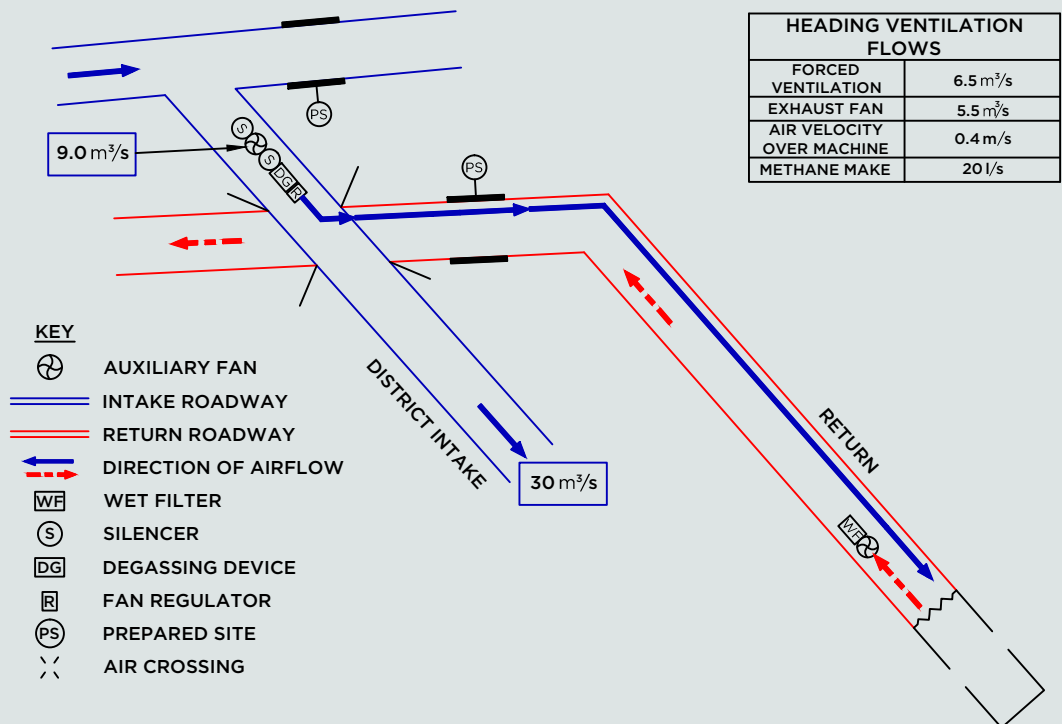
Location:

Type of Machine: Joy 12 ED 15 continuous miner

Heading/Roadway Dimensions: Roof bolted 5.8m x 4m

Proposed Heading Length: 500m

A. Sketch showing heading location, position of auxiliary fans and the proposed minimum air quantities and typical velocities.



B. Type of Auxiliary Ventilation Provided: Forcing/Exhaust overlap

C. Type/Size of Auxiliary Fan(s) and Ducting:

Main Auxiliary Fan: 90 kW Carter Howden

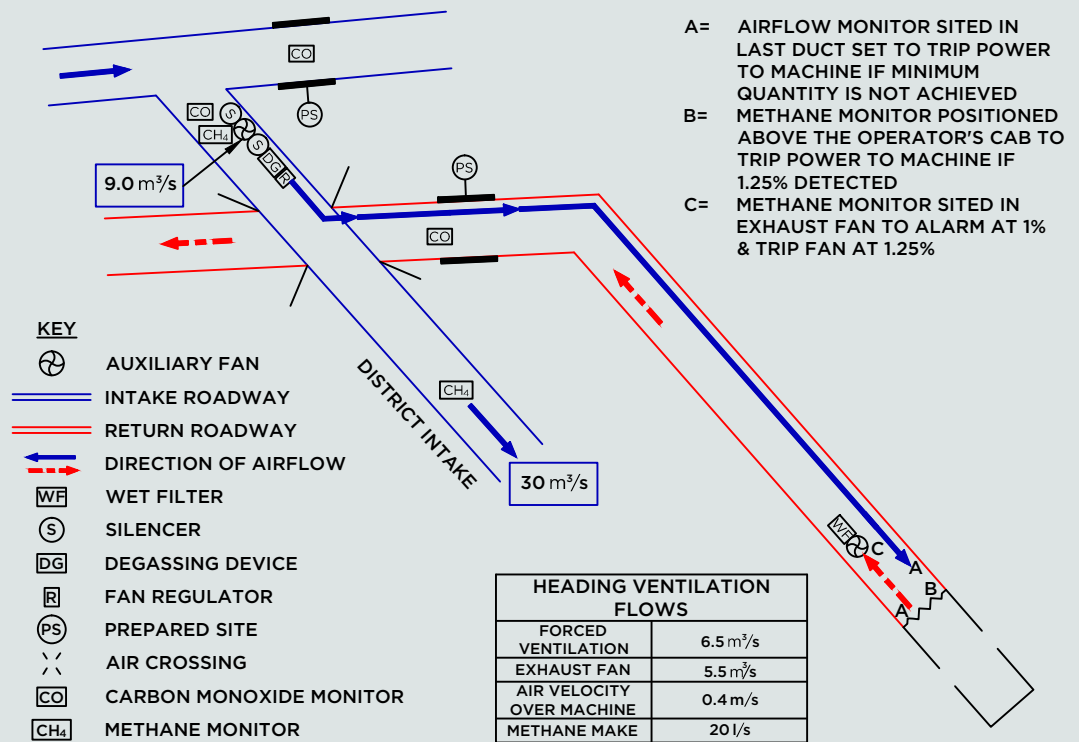
Overlap Auxiliary Fan: 56 kW Carter Howden

Main Ventilation Duct: 1066mm flatlay

Overlap Ventilation Duct: 610mm SR duct

- D. Estimation of the make of methane expected: **20 l/s**
- Proposed minimum airflow to face of heading: **5.50 m³/s (Exhaust)**
- Proposed minimum airflow to force duct end: **6.50 m³/s (Force)**
- These figures should be specified taking into account the need to prevent layering of methane, both in the vicinity of the face of the drive, in the overlap zone and in the roadway itself.
- E. The main force/exhaust overlap systems, maximum and minimum distance from force duct end to the face of the drive:
- From: **25m** To: **15m**
- F. The devices to provide additional air velocity to the cutting zone are:
- Boom Type Machines**
- Boom-mounted Water Venturis: **YES/NO/NA**
- Boom-mounted Compressed Air Venturis: **YES/NA**
- Other (Specify):
- Matt Type Machines**
- Hollow Cone Sprays: **YES/NO/NA**
- Other (Specify):
- G. Additional equipment to prevent/suppress a frictional ignition:
- External Water Sprays: **YES/NO/NA**
 - Water to Cutter Picks: **YES/NO/NA**
 - External Airmover: **YES/NO/NA**
 - Coanda Air Curtain: **YES/NO/NA**
- H. The means provided to combat frictional ignitions are:
- Fire extinguishers: **YES/NO**
- Wander Hose: **YES/NO**
- Mains Firefighting Hose: **YES/NO**
- Other (Specify):
- I. Minimum flow and pressure to apron and boom mounted 16 sprays:
- Flow: **35 l/m** Pressure: **191 psi** Bar: **13**
- J. Maximum flow and pressure to apron and boom mounted 16 sprays:
- Flow: **42 l/m** Pressure: **213 psi** Bar: **14.5**
- K. The type of pick to be used: Point attack
- L. The type and orifice size of spray nozzle to be fitted for dust suppression.

M. A sketch plan showing the location and type of any monitoring transducers, including details of protection equipment installed for series ventilated places including warning, alarm and trip levels.



Signed: Date:

A6 Sample mine gas chart

Symbol	Legal Limits	Detection Method	Relative Density	Flammable and Explosive Limits	Physical properties	Occurrence in mines	Effect on People
Hydrogen	H ₂ None	GC	0.07	4 – 74% explosive range; Ignition temperature 580-590° C	Colourless Odourless Tasteless Non-toxic	Mine fires and explosions Battery charging Spontaneous combustion	Will not support life but no effect as long as enough oxygen present
Methane	CH ₄ 1.25% - Electricity off, shuffling ceases, diesels prohibited 2% Men withdrawn from the area	Electronic TBS GC	0.55	0 – 5% will burn at source of ignition with intensity of flame increasing as level of CH ₄ increases 5 – 15% explosive range 15 – 100% – will burn and become explosive on dilution with oxygen 7.5% – most easily ignited 9.5% – most explosive 600 – 750° C ignition temperature	Non-toxic	Methane is liberated through newly won coal, outbursts, blowers, and is found in cavities, behind seals, in unventilated headings, layering and open goafs	Slight anaesthetic effect Will not support life and has ill no effect as long as enough oxygen is present
Nitrogen	N ₂ None	GC or measure all other gases – remainder is N ₂	0.97	Non – flammable (inert)	Colourless Odourless Tasteless Non-toxic	79% by volume in normal air	Will not support life but no effect as long as enough oxygen present
Carbon Monoxide	CO TWA 25ppm Ceiling 400ppm STEL 50ppm = 60min 100ppm = 30min 200ppm = 15min Only once per day	TBS CRT GC	0.97	12.5%- 74% Explosive range and has an ignition temperature of 605°C 29% most explosive Burns with a blue flame to form CO ₂ Product of incomplete combustion	Odourless Tasteless Toxic	Mine fires and heatings Explosions Shooting Diesel exhausts	Displaces the oxygen in the blood forming carboxyhaemoglobin CO has a 300-1 preference rate over oxygen CO is cumulative in its effect
Oxygen	O ₂ 19% Minimum	Electronic TBS CRT GC	1.11	Accelerates combustion and increases the flammability of substances 12.5% – flaming combustion ceases 2.0% – all combustion including smouldering ceases	Colourless Odourless Tasteless Non-toxic	20.9 % by volume of normal air	16% – breathing becomes laboured < 10% – dangerous to man
Hydrogen Sulphide	H ₂ S TWA 10ppm STEL 15ppm	Electronic CRT GC	1.18	4.5- 45% explosive range Burns to form SO ₂	Colourless Rotten egg smell Sweet taste Soluble in water Toxic	Decomposition or rotting of animal or vegetable matter containing sulphur, Shooting in high sulphur coal Forms in stagnant water	Deadens the sense of smell Irritates eyes and respiratory tract Narcotic effect on the central nervous system
Carbon Dioxide	CO ₂ TWA 0.5% STEL 3.0%	Electronic TBS CRT GC	1.53	Non – flammable Product of complete combustion	Colourless Pungent smell Soda water taste Soluble in water Non-toxic except in high concentrations	Oxidation of coal, breathing of persons, shooting, diesel exhaust In some coal seams it is an outburst gas	Will not support life Asphyxiation due to the lack of oxygen Increased respiratory rate by 50% @ 2% CO ₂ and 100% @ 3% CO ₂
Nitrogen Dioxide	NO ₂ TWA 3ppm STEL 5ppm	Electronic CRT GC	1.6	Non – flammable	Reddish/brown colour Acid smell Acid taste Soluble in water forming nitric acid Toxic	Diesel exhausts Shooting using nitro-glycerine based explosives	Irritates eyes and respiratory tract Causing violent coughing Delayed bronchitis and pneumonia develops. Low concentrations (4ppm) will anaesthetise the nose.
Sulphur Dioxide	SO ₂ TWA 2ppm STEL 5ppm	Electronic CRT GC	2.26	Non – flammable	Colourless Sulphur smell Acid taste Soluble in water forming sulphuric acid Toxic	Burning of high sulphur coal and rubber Diesel exhausts	Irritates eyes and respiratory tract Causing violent coughing Delayed bronchitis and pneumonia develops

KEY: Electronic = Hand held detectors and telemetric systems GC = Gas Chromatography CRT = Chemical Reaction Tube TBS = Tube Bundle System

A7 Methane monitor alarm settings [from the Regulations]

Methane level %	Where	Indicates/Required Action	Reg No
≤ 0.25	Anywhere	Definition of fresh air	4
≤ 0.25	Must have fresh air at commencement of ERZ1	Requirement	153(c)(i)
≥ 0.25	Between NERZ and ERZ1	Automatically activate a visible alarm.	197(b)(i)
≥ 0.5	In a NERZ	Isolate the supply of electricity underground except to safety-critical equipment.	100(3)(d)(i)(A)
≥ 0.5	At the boundary between a NERZ and ERZ1	Automatically isolate the supply of electricity to all plant, except safety-critical equipment, in the ERZ1 and NERZ; or, if the NERZ has been subdivided, in the ERZ1 and the subdivided part of the NERZ adjacent to the ERZ1.	197(b)(ii)
≥ 1.0	General body of air around mobile plant in an ERZ1 powered by a battery or diesel engine	Visible alarm to warn operators of the mobile plant.	199(1)(a)
≥ 1.0	General body of air around mobile plant powered by electricity through trailing or reeling cable	Visible alarm to warn operators of the mobile plant.	200(1)(a)(i) and 200(2)(a) and 201(2)
≥ 1.0	General body of air around cutting plant powered by electricity through trailing or reeling cable	Automatically isolates the electricity supply to the cutters	200(1)(a)(ii)
≥ 1.25	General body of air around mobile plant in an ERZ1 powered by a battery or diesel engine	Automatically shut down the mobile plant, and in the case of diesel engines automatically prevent a restart.	199(1)(b)
≥ 1.25	General body of air around mobile plant powered by electricity through trailing or reeling cable	Automatically isolate the supply of electricity to the trailing or reeling cable supplying the mobile plant.	200(1)(b) and 200(2)(b) and 201(2)
≥ 1.25	General body of air around an auxiliary fan	Automatically isolate the supply of electricity to the fan	202(1)(a)
≥ 1.25	General body of air around a booster fan	Automatically activate an audible and visible alarm	202(1)(b)
≥ 1.25	In an ERZ1	Isolate the supply of electricity underground except to safety-critical equipment	100(3)(d)(i)(B)
≤ 2.0	Where a mine worker is or may be present	Maximum per cent in the general body of air	153(a)
≥ 2.0	An affected part or parts of the mining operation	Withdrawal of all workers in the affected area	164(2)(a)

Green = no action required **Orange** = alarm **Red** = action required

NOTE: This table is a summary of the requirements. Refer to the full regulations for complete regulatory requirements.



B/
APPENDIX

Statutory positions and competencies

- B1 Health and Safety in Employment Act 1992**
 - B2 Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013**
-

Statutory positions and competencies

B1 Health and Safety in Employment Act 1992

SECTION 19L

19L Interpretation

In this Act,—

mine operator means,—

- (a) *in respect of a mining operation carried out under a permit granted under the Crown Minerals Act 1991,—*
 - (i) *the person appointed by the permit operator to manage and control the mining operation; or*
 - (ii) *the permit operator, if no such person has been appointed:*
- (b) *in respect of a mining operation (not being a mining operation described in paragraph (a)) carried out under a licence or other permission,—*
 - (i) *the person appointed to manage and control the mining operation by the person who holds the licence or other permission to carry out mining operations; or*
 - (ii) *the person who holds the licence or other permission to carry out mining operations, if no such person has been appointed:*
- (c) *in any other case,—*
 - (i) *the person appointed to manage and control the mining operation by the owner of the land where the mining operation is being carried out; or*
 - (ii) *the owner of the land where the mining operation is being carried out, if no such person has been appointed*

mine worker means a person who works in a mining operation, either as an employee or as a self-employed person

site senior executive means the person appointed as the site senior executive by the mine operator

SECTION 19M

19M Meaning of mining operation

In this Act, mining operation—

- (a) *means the extraction of coal and minerals and the place at which the extraction is carried out; and*
- (b) *includes any of the following activities and the place at which they are carried out:*
 - (i) *exploring for coal:*

- (ii) *mining for coal or minerals:*
 - (iii) *processing coal or minerals associated with a mine:*
 - (iv) *producing or maintaining tailings, spoil heaps, and waste dumps:*
 - (v) *the excavation, removal, handling, transport, and storage of coal, minerals, substances, contaminants, and wastes at the place where the activities described in subparagraphs (i) to (iv) are carried out:*
 - (vi) *the construction, operation, maintenance, and removal of plant and buildings at the place where the activities described in subparagraphs (i) to (iv) are carried out:*
 - (vii) *preparatory, maintenance, and repair activities associated with the activities described in subparagraphs (i) to (iv); and*
- (c) *includes—*
- (i) *a tourist mining operation:*
 - (ii) *a tunnelling operation; but*
- (d) *does not include—*
- (i) *exploring for minerals:*
 - (ii) *an alluvial mining operation:*
 - (iii) *a mining operation wholly on or under the seabed on the seaward side of the mean high-water mark:*
 - (iv) *a quarrying operation.*

B2 Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013

Site Senior Executive

7 Appointment of site senior executive

- (1) *The mine operator of a mining operation must appoint a site senior executive for that mining operation.*
- (2) *Subject to regulation 10, a mine operator that has more than 1 mining operation may appoint a person to be the site senior executive for more than 1 mining operation.*

8 Competency requirements for appointment as site senior executive

- (1) *The mine operator and the site senior executive must ensure that the site senior executive holds a current certificate of competence as a site senior executive and any other certificate or competency required by subclause (2).*
- (2) *In addition to the requirements of subclause (1),—*

REG 7

REG 8

- (a) *if appointed for an underground coal mining operation, the site senior executive must hold a current certificate of competence as—*
 - (i) *a first-class coal mine manager; or*
 - (ii) *if not more than 5 mine workers ordinarily work underground at the underground coal mining operation at any one time, a coal mine interviewer;*
 - (b) *if appointed for an underground metalliferous mining operation, the site senior executive must hold a current certificate of competence as—*
 - (i) *a first class mine manager; or*
 - (ii) *if at least 3 but not more than 10 mine workers ordinarily work underground at the underground metalliferous mining operation at any one time, an A-grade tunnel manager; or*
 - (iii) *if fewer than 3 mine workers ordinarily work underground at the underground metalliferous mining operation at any one time, an A-grade tunnel manager or B-grade tunnel manager;*
 - (c) *if appointed for a tunnelling operation, the site senior executive must have successfully completed any additional competencies prescribed by WorkSafe under regulation 34(d) for a site senior executive of a tunnelling operation.*
- (3) *Subclause (2)(a) does not apply during any period of time where the only activities at the mining operation are those described in regulation 16(2).*
 - (4) *If there is disagreement between the mine manager and the site senior executive in relation to any operational matter at the mining operation, the manager's view prevails if the site senior executive does not hold a relevant certificate of competence as a manager or holds a lower certificate of competence than the manager (of the relevant certificates of competence in regulation 35(b) to (j) applicable to the particular type of mining operation).*
 - (5) *Nothing in subclause (4) limits or affects the application of the Act to any matter arising at the mining operation.*

REG 11**11 Mine operator must ensure site senior executive has sufficient resources**

The mine operator must ensure that the site senior executive has sufficient resources and authority to perform his or her functions, duties, and powers under the Act and these regulations.

Manager**13 Manager of mining operation**

The mine operator of a mining operation must appoint a person to—

- (a) *manage the mining operation; and*

REG 13

REG 16

- (b) *supervise the health and safety aspects of the mining operation on every day on which any mine worker is at work.*

16 Manager must hold certificate

- (1) *The mine operator or, as the case may be, the quarry operator or alluvial mine operator, and the manager must ensure that the manager holds a current certificate of competence specified in regulations 17 to 22 for the kind of mining operation or quarrying operation or alluvial mining operation to which the manager is appointed.*
- (2) *Subclause (1) does not apply to—*
 - (a) *any operation in which any activity is carried out pursuant to a prospecting licence or an exploration licence granted under the Mining Act 1971 or a coal prospecting licence granted under the Coal Mines Act 1979 or a prospecting permit or an exploration permit granted under the Crown Minerals Act 1991, being in each case a licence or permit in force; or*
 - (b) *any operation in which any exploratory activity is carried out by machinery for the purpose of ascertaining whether a mine or quarry may be worked.*

Other safety-critical roles

26 Electrical superintendent

- (1) *The site senior executive of a mining operation must appoint an electrical superintendent for the mining operation if an electrical engineering principal control plan is in place, or required to be put in place, at the mining operation.*
- (2) *The site senior executive and the person appointed as an electrical superintendent must ensure that the person holds a current certificate of competence as an electrical superintendent.*

27 Mechanical superintendent

- (1) *The site senior executive of a mining operation must appoint a mechanical superintendent for the mining operation if a mechanical engineering control plan is in place, or required to be put in place, at the mining operation.*
- (2) *The site senior executive and the person appointed as a mechanical superintendent must ensure that the person holds a current certificate of competence as a mechanical superintendent.*

28 Mine surveyor

- (1) *The site senior executive of an underground mining operation or tunnelling operation must appoint a mine surveyor for the operation.*

REG 26

REG 27

REG 28

REG 29

- (2) *The site senior executive and the person appointed as a mine surveyor at an underground mining operation must ensure that the person holds a current certificate of competence as a mine surveyor.*
- (3) *The site senior executive and the person appointed as a mine surveyor at a tunnelling operation must ensure that the person holds a current certificate of competence as a mine surveyor or is a licensed cadastral surveyor.*
- (4) *In considering any appointment of a mine surveyor, the site senior executive must consider—*
 - (i) *the education, knowledge, and experience of the person, having regard to the type and size of the mining operation and the nature and complexity of the technology used at the mining operation; and*
 - (ii) *the fitness and capacity of the person to exercise the skills required as a mine surveyor.*
- (5) *Unless expressly authorised by WorkSafe, no underground mining operation or tunnelling operation may operate for longer than 28 days without a person holding the position of mine surveyor.*

29 Ventilation officer

- (1) *The site senior executive of a mining operation must appoint a ventilation officer for the mining operation if a ventilation control plan is in place, or required to be put in place, at the mining operation.*
- (2) *The site senior executive and the person appointed as a ventilation officer must ensure that the person holds a current certificate of competence as a ventilation officer.*

REG 30

30 Underviewer

- (1) *The site senior executive of an underground coal mining operation must appoint an underviewer for each production shift at the mining operation.*
- (2) *Subject to subclause (3), the site senior executive and the person appointed as an underviewer must ensure that the person holds a current certificate of competence as a first-class coal mine manager or an underviewer.*
- (3) *WorkSafe may at any time give notice to the site senior executive that the person appointed as underviewer must hold a current certificate of competence as a first-class coal mine manager.*
- (4) *The site senior executive must ensure that an underviewer is present at each production shift at the mining operation.*

31 Supervisor

- (1) *The site senior executive of a mining operation other than an underground coal mining operation must appoint a supervisor for each production shift.*
- (2) *The site senior executive and the person appointed as a supervisor of an underground metalliferous mining operation must ensure that the person holds a certificate of competence as a B-grade tunnel manager, an A-grade tunnel manager, or a first-class mine manager.*
- (3) *The site senior executive and the person appointed as a supervisor of a tunnelling operation must ensure that the person holds a current certificate of competence as a B-grade tunnel manager or an A-grade tunnel manager.*
- (4) *The site senior executive and a person appointed as a supervisor of an opencast coal mining operation must ensure that the person holds a current certificate of competence as a B-grade opencast coal mine manager or an A-grade opencast coal mine manager.*
- (5) *The site senior executive and a person appointed as a supervisor of an opencast metalliferous mining operation must ensure that the person holds a current certificate of competence as a B-grade quarry manager, an A-grade quarry manager, or a first-class mine manager.*
- (6) *Despite subclauses (2) to (5), WorkSafe may at any time give notice to the site senior executive that the person appointed as supervisor must hold a certificate of competence of one of the kinds described in regulation 35(b) or (d) to (j).*
- (7) *The site senior executive must ensure that a supervisor is present at each production shift at the mining operation.*

32 Other workers required to hold certificates

The site senior executive of a mining operation must take all practicable steps to ensure that a worker required to carry out the duties normally associated with a coal mine deputy or a winding engine driver holds a current certificate of competence issued in accordance with these regulations.



C/

APPENDIX

- C1** Definitions
 - C2** Chemical symbols
 - C3** Standards
 - C4** References
 - C5** Further resources
-

C1 Definitions

Adsorption – the process in which atoms, ions or molecules from a substance (it could be gas, liquid or dissolved solid) adhere to a surface of the adsorbent.

Blind heading – a single entry roadway or tunnel with no exit.

Continuous miner – usually an electric/hydraulic machine used to cut and load out coal in the development of roadways in coal mines.

REG 3

COAL

Interpretation

Explosion Risk Zone (ERZs)

ERZO means:

- (a) *an underground coal mining operation, or any part of it, where the general body concentration of methane is known to be, or is identified by a risk assessment as likely to be, greater than 1.25%:*
- (b) *any part of an underground coal mining operation that is an ERZ1 or a NERZ if the general body concentration of methane in that part of the mining operation becomes greater than 1.25%:*
- (c) *an area of an underground coal mining operation that is classified by the mine operator as an ERZO under Regulation 190*

ERZ1

(a) *means:*

- (i) *an underground coal mining operation, or any part of it, where the general body concentration of methane is known to be, or is identified by a risk assessment as likely to be, greater than 0.25% but not more than 1.25%; or*
- (ii) *an area of underground coal mining operation that is classified by the mine operator as an ERZ1 under Regulation 190; and*

(b) *includes:*

- (i) *a workplace where coal or other material is being mined (except where the work is undertaken in a shaft or roadway driven from the surface in material other than coal or between seams predominantly driven in material other than coal) other than by brushing in an outbye location:*
- (ii) *a place where adequate standards of ventilation in relation to methane cannot be assured taking into account abnormal circumstances in the mining operation:*



- (iii) *a place where connections, or repairs, to a methane drainage pipeline are being carried out:*
- (iv) *a place where holes are being drilled underground in the coal seam or adjacent strata for exploration or seam gas drainage:*
- (v) *a place, in a panel, other than a longwall panel that is being extracted, inbye the panel's last completed cut-through:*
- (vi) *a goaf area:*
- (vii) *each place on the return air side of any of the places in subparagraphs (i) to (vi), unless the place is an ERZO:*
- (viii) *any development heading.*

NERZ or negligible explosion risk zone, means:

- (a) *an underground coal mining operation, or any part of it, where the general body concentration of methane is demonstrated by means of continuous and recorded monitoring to be less than 0.25%; or*
- (b) *any part of an underground coal mining operation that is submerged by water*

g/m³ - grams per cubic metre.

Goaf - an area of a mine where the coal or ore has been mined or extracted and no ground support has been installed.

Inbye/Outbye - from any point in the mine, inbye of that location is in the direction of the working face, and outbye of that location is in the direction away from the working face, typically heading 'out of the mine'.

MDAs (Multi Discriminating Alarms) - used to differentiate between transient peaks caused by diesel engines and genuine increase in CO caused by fire and spontaneous combustion.

l/s - litres per second.

m/s - metres per second.

m³/s - cubic metres per second.

Pa or kPa - pascal or kilopascal.

ppm - parts per million.

TBM - Tunnel Boring Machine.

C2 Chemical symbols

CH₄ - Methane

CO - Carbon Monoxide

CO₂ - Carbon Dioxide

H₂ - Hydrogen

H₂S - Hydrogen Sulfide

N₂ - Nitrogen

O₂ - Oxygen

SO₂ - Sulphur Dioxide

C3 Standards

AS 1152-1993 “Specification for test sieves”

AS 1319-1994 “Safety signs for the occupational environment”

AS 1603.1-1997 “Automatic fire detection and alarm systems – Heat detectors”

AS 1670.1-2004 “Fire detection, warning, control and intercom systems – Systems design, installation and commissioning – Fire”

AS 1940-2004 “The storage and handling of flammable and combustible liquids”

AS 2030.2-1996 “The verification, filling, inspection, testing and maintenance of cylinders for the storage and transport of compressed gases – Cylinders for dissolved acetylene”

AS 2380.1-1989 “Electrical equipment for explosive atmospheres – Explosion-protection techniques – General requirements”

AS 2809.1-2008 “Road tank vehicles for dangerous goods – Explosion protection techniques – General requirements for all road tank vehicles”

AS 3013-2005 “Electrical installations – Classification of the fire and mechanical performance of wiring system elements”

AS 4368-1996 “Mine plans – Preparation and symbols”

AS 4606-2012 “Grade S fire resistant and antistatic requirements for conveyor belting and conveyor accessories”

AS/NZS 2229:2004 “Fuel dispensing equipment for explosive atmospheres”

AS/NZS 3000:2007 “Electrical installations (known as the Australian/New Zealand Wiring Rules)”

AS/NZS 3584.1:2008 “Diesel engine systems for underground coal mines, Part 1: Fire protected – Heavy duty”.

AS/NZS 3584.2:2008 “Diesel engine systems for underground coal mines, Part 2: Explosion protected”.

AS/NZS 3584.3:2012 “Diesel engine systems for underground coal mines, Part 3: Maintenance”.

AS/NZS 4871.6:2013 “Electrical equipment for mines and quarries – Part 6: Diesel powered machinery and ancillary equipment”

AS/NZS ISO 31000:2009 “Risk management – Principles and guidelines”

BS 6164:2011 “Code of Practice for health and safety in tunnelling in the construction industry”

LINZS25000 “Standard for New Zealand Geodetic Datum 2000”

MDG 15:2002 “Guideline for mobile and transportable equipment for use in mines”

MDG 1010:2011 “Minerals industry safety and health risk management guideline”

MDG 3006 MRT 5:2001 “Guideline for coal dust explosion prevention and suppression”

NZS 4503:2005 “Hand operated fire-fighting equipment”

SA/SNZ HB 89:2013 “Risk Management – Guidelines on risk assessment techniques”

SA/SNZ HB 436:2013 “Risk Management Guidelines”

SNZ PAS 4509:2008 “New Zealand Fire Service Fire-fighting Water Supplies Code of Practice”

C4 References

Belle. B. K. (2004, April/June). International Harmonisation Sampling Curve (ISO/CEN/ACGIH): Background and its influence on dust measurement and exposure assessment in the South African mining industry. *Journal of the Mine Ventilation Society of South Africa*.

Belle. B., Carey. D., Robertson. B. (2012). *Prevention of frictional ignitions in coal mines using chilled water sprays*. Paper presented at the 12th Coal Operators' Conference. The University of Wollongong & the Australasian Institute of Mining and Metallurgy. Australia. Retrieved from <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=2066&context=coal>

The Chamber of Minerals & Energy. (October 2004). *Hazard Management Guideline for Underground Fire Prevention*. Part 1 Underground Fire Controls. Version 1. WA, Australia.

The Chamber of Minerals & Energy. (October 2004). *Hazard Management Guideline for Underground Fire Prevention*. Part 2 Underground Fire Controls. Version 1. WA, Australia.

Department of Industry and Resources. (1997). *Foam Fire Suppression Systems on Mine Vehicles*. WA, Australia.

Department of Industry and Resources. (1997). *Safety Management of Underground Combustible Sulphide Dust Guideline*. WA, Australia.

Department of Mines. (1990). Sulphide dust explosion hazard. *Safety Bulletin No. 1*. WA, Australia.

Department of Mines and Energy. (2008, 2 July). Diesel Engine – Turbocharger Fires. *Safety Bulletin 83*. Queensland, Australia.

Department of Natural Resources, Mines and Energy. (2004, 30 April). Tyre Fires, Pyrolysis and Explosions. *Safety Bulletin 47*. Queensland, Australia.

Department of Natural Resources, Mines and Energy. (2012, 20 September). Exposure to toxic gases associated with spontaneous combustion at surface coal mines. *Safety Bulletin 120*. Queensland, Australia.

Department of Natural Resources, Mines and Energy. (2013, August). Review of Queensland underground coal mines' stone dust application and sampling and analysis of roadway dust. *Safety Bulletin 134*. Queensland, Australia.

European Commission. (2013). *Early detection and fighting of fires in belt conveyor (Edaffic)*. Final Report. Brussels, Belgium.

Health and Safety Executive (HSE). (1993). *The Coal Mines (Owner's Operating Rules) Regulations 1993. Guidance on Regulations*. Surrey, England.

Health and Safety Executive (HSE). (1993). Approved Code of Practice. *The Management and Administration of Safety and Health at Mines. Management and Administration of Safety and Health at Mines Regulations 1993*. Sheffield, England.

Health and Safety Executive (HSE). *The prevention and control of fire and explosion in mines*. Retrieved from <http://www.hse.gov.uk/mining/feguidance.pdf>

Ministry of Business, Innovation and Employment. (2013). *Guidance for a Hazard Management System for mines*. Wellington, New Zealand.

Ministry of Business, Innovation and Employment. (2013). *A guide to developing Safety Management Systems for the extractives industry*. Wellington, New Zealand.

Safety in Mines Research Advisory Committee (SIMRAC). (1996, January). *Identify methods to reduce the risk of explosions and fire caused by frictional ignition hazards*. Final Project. University of Witwatersrand. Johannesburg, South Africa: Phillips. H. R.

Safety in Mines Research Advisory Committee (SIMRAC). (1996, April). *Handbook to reduce the exposure of workers to dust*. Final Project. University of Witwatersrand. Johannesburg, South Africa: Members of the Special Interest Group on Dust and Ventilation.

Swedish Association of Mines, Metal and Mineral Producers. (2009). *Fire Safety in Mines and Underground Constructions*. Sweden: The Fire Safety Committee of the Swedish Mining Industry's Health and Safety Committee.

Trade & Investment Mine Safety. (2005). Self contained rescuer combustion reaction. *Safety Alert.13-05*. NSW, Australia.

Trade & Investment Mine Safety. (2013, November 25). Too many underground fires. *Safety Bulletin No. SB 13-05*. NSW, Australia.

www.legislation.govt.nz

www.ilo.org/oshenc/part-xi/mining-and-quarrying/item/607-fires-and-explosions-in-mines

www.resources.nsw.gov.au/safety/resources/mechanical/information/prevention-of-underground-fires

C5 Further resources

Standards

AS 4242-1994 “Earth-moving machinery and ancillary equipment for use in mines – Electrical wiring systems at extra-low voltage”

AS/NZS 1715:2009 “Selection, use and maintenance of respiratory protective equipment”

AS/NZS 1716:2012 “Respiratory protective devices”

BS EN 14591-2:2007 “Explosion prevention and protection in underground mines. Protective systems. Passive water trough barriers”

References

Health and Safety Executive (HSE). (1979). *The law relating to safety and health in mines and quarries*. (3rd Ed. Part 2. Section A). United Kingdom.

Ministry of Business, Innovation and Employment. (2013). *People Come First. Building a strong health and safety culture in New Zealand mines, quarries and tunnels*. Wellington, New Zealand.

Ministry of Business, Innovation and Employment and the Institute of Directors in New Zealand (Inc). (2013). *Good Governance Practices Guideline for Managing Health and Safety Risks*. Wellington, New Zealand.

The Mines Miscellaneous Health and Safety Provisions Regulations 1995 (as amended by The Management of Health and Safety at Work 1999). United Kingdom.

Williamson. J. J. (1958). *General fire hazards and fire prevention*. Fourth Ed. London, England: Sir Isaac Pitman & Sons.

ISBN 9780478425093 (Online)

ISBN 9780478425086 (Print)

First published February 2014. Updated February 2015. Amended September 2016.

PO Box 165, Wellington 6140, New Zealand



Except for the logos of WorkSafe New Zealand, this copyright work is licensed under a Creative Commons Attribution-Non-commercial 3.0 NZ licence. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc/3.0/nz/>

In essence, you are free to copy, communicate and adapt the work for non-commercial purposes, as long as you attribute the work to WorkSafe New Zealand and abide by the other licence terms.

WorkSafe New Zealand

Level 6, 86 Customhouse Quay

PO Box 165

Wellington 6140

Phone: +64 4 897 7699

Fax: +64 4 415 4015

0800 030 040

www.worksafe.govt.nz

[@WorkSafeNZ](https://twitter.com/WorkSafeNZ)

ISBN 9780478425093 (Online)

ISBN 9780478425086 (Print)