



**NSW
Resources
Regulator**

FACILITATOR GUIDE

LEARNING FROM DISASTERS

Program 1: One-hour induction training program for mine workers

Document control

Published by NSW Resources Regulator

Title: Facilitator guide: Learning from disasters – program 1: One-hour induction training program for mine workers

First published: July 2019

Authorised by: Executive Director, NSW Resources Regulator

CM9 reference: DOC19/32566

AMENDMENT SCHEDULE

Date	Version	Amendment
July 2019	1	Original version
April 2020	2	Updated fatalities data and link to feedback surveys
August 2020	3	Updated timeline of NSW mining disasters on p15 (slide 3) and correction of fatalities data on p19 (slide 5)

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Foreword

The NSW Resources Regulator is committed to supporting the health and safety of those working in the mining industry through the development and distribution of relevant and flexible learning and development programs.

As part of our commitment we have collaborated to develop three flexible training programs for delivery by suitably qualified facilitators, that specifically incorporate the findings from investigations and independent reviews of mining incidents that have involved fatalities and serious injury, or where the circumstances that occurred presented a significant risk of injury or death to workers or the wider community.

The three training programs are as follows:

- Program 1: 1-hr induction or refresher training program for mine workers
- Program 2: 2-hr program for practising certificate holders – quarry managers with specified mine restrictions conditions
- Program 3: One-day program for holders of practising certificates for any class of mine to satisfy their maintenance of competence condition.

The case studies selected have been deliberately designed to represent all mining contexts. This reinforces to all stakeholders that the risk of fatality or serious injury occurs in all parts of the mining sector. It requires everyone to remain vigilant and proactive in meeting their responsibilities. For this reason, Programs 2 and 3 have been integrated into the requirements to maintain competence, where relevant, as part of the *Maintenance of competence scheme for practising certificates*.

Learning from experience, preventing devastating reoccurrences and improving the health and safety of all working in this industry is a profound way of acknowledging and recognising all those who have been impacted by mining safety incidents throughout history.

Anthony Keon
Executive Director
NSW Resources Regulator

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1. Introduction

This Facilitator Guide is designed to help you to prepare for and facilitate health and safety learning programs for people working in the mining sector.

Acknowledgements

Special thanks to Professor Michael Quinlan for the use of his text, *Ten Pathways to Death and Disaster*, Federation Press (2014) as part of developing this program.

Many thanks to:

Mark Parcell of the Mine Safety Institute Australia for his input and the use of the content from the DVD *Pike River, A failure to learn (2014)* and the *MSIA Coal Mine Disaster Recommendations Report (2017)*;

Rob Cunningham, Mining Operations Manager, Northparkes Mines, Parkes NSW;

The Resources Regulator would like to thank the team the Mine Safety Advisory Council and the Mining and Petroleum Competence Board for their input into the case study selection.

Interpretation of the term disaster

The traditional definition of 'disaster' in Australia describes incidents involving three or more deaths. While some incidents in the case studies clearly exceed that number of fatalities, for the purpose of this training package, the term is interpreted and used more broadly to reference significant threats to safety where a fatality may or may not have occurred but the risk presented was critical. Certainly for the colleagues, friends and families involved, every single death is a disaster.

Integration of organisational safety policies and procedures

This program is designed to enable the inclusion of the relevant individual organisational policies and procedures that will enhance and supplement the learning as part of the workshops. Each of the sessions in the suite can be supplemented and expanded to incorporate key parts of individual organisational risk management frameworks to maximise the learning and development opportunity. For example, facilitators can lead the reviewing of specific organisational hazard management plans while discussing the legislated principal hazards.

Workshop activities

There are session activities designed to make the program more interactive for participants. Facilitators are encouraged to use the activities flexibly to generate discussion from all involved on the strategies to learn the lessons of the past and implement robust work health and safety management systems throughout their workplaces.

Ten pathways to death and disaster

To assist those undertaking this learning package, we have integrated Professor Michael Quinlan's framework which identifies consistent patterns underpinning major safety incidents. This will assist in identifying key areas of risk at a specific organisational level and is aimed at driving proactive responses.

The framework indicates that the vast majority of major safety incidents in mining (and other high-risk industries) entailed at least three of these pattern deficiencies and many exhibited five or more.

Significantly, Professor Quinlan's research indicates that there is little to differentiate the failures that led to a single death or multiple deaths. Similar research on human disasters in the workplace has highlighted that proactive efforts to capture and treat near miss events in a similar way to fatalities or serious injuries supplements organisational risk resilience.

Pattern failure

Professor Quinlan systematically analysed 24 mine disasters and fatal incidents in five countries (Australia, Britain, Canada, New Zealand and the USA) since 1975. His research concluded that there are 10 pattern causes which repeatedly recur in these incidents, namely:

- **Engineering, design and maintenance flaws.** Latent flaws originating from decision making by the mine operator and in some cases expert consultants, with technologies that were not overly complex or deficient. In most cases the flaws were known or should have been detected before the incident.
- **Failure to heed warning signs.** In some cases prior warnings or causes for alarm were ignored. Problems with regard to well-known hazards were ignored, overlooked or withheld. Prior incidents were not fully investigated, nor had they triggered a risk assessment. Warning signs had been ignored or had not been recognised.
- **Flaws in risk assessment.** Failures in risk assessments or even the failure to conduct risk assessments in a meaningful way. Risk assessments should not be generic and need to be informed by knowledge of the hazard being addressed, suitable control measures, monitoring and revision.

- **Flaws in management systems.** Management systems failed to deliver effective control of well-known hazards. Safety Management Systems were full of gaps, biases and a preoccupation with Key Performance Indicators (KPIs) or changes in work organisations.
- **Flaws in system auditing.** Failure in auditing or monitoring to verify that controls and safe work practices were in place. This failure to audit meant unsafe conditions and bad decisions were overlooked or not corrected.
- **Economic/reward pressures compromising safety.** Pressure due to financially troubled operations. Production overly focused on operations through substantial bonuses and incentives. These may have contributed to a number of disasters.
- **Failures in regulatory oversight.** Serious non-compliance with existing regulations, gaps in regulatory frameworks and lack of regulatory oversight and inspection have all been identified as causes.
- **Worker/supervisor concerns that were ignored.** The concerns of workers and others were not considered or were ignored. Workers did not appear to have been meaningfully consulted.
- **Poor worker/management communication and trust.** Effective communication and the trust (not to be confused with harmony) that flows from it was missing. This would have enabled dialogue on critical safety issues. Poor relationships between managers and workers feature in many investigations as there were no constructive communication processes in place.
- **Flaws in emergency and rescue procedures.** Emergency and rescue play a role in mitigating escalation, enabling withdrawal or rapid evacuation. In many inquiries this was found to be deficient.

Support services

Facilitators should be mindful that the content of this program can be quite distressing for some participants. The videos and photos can be particularly confronting for some in the room. There are two prompts in the sessions that list support services available for any participants who may wish to seek assistance if they are adversely affected by the program content.

Recommended facilitator qualifications

This program has been designed to enable stakeholders throughout the mining industry to deliver the session and facilitate constructive discussion on health and safety management **either** in-house by a competent person **or** by utilising the services of a training organisation.

The program should be delivered by a person who has appropriate technical and/or educational ability, experience and qualifications relevant to the course. The facilitator should be competent and confident to lead a discussion and respond to questions around work health and safety risks in mining. It is preferable for the facilitator to hold workplace training qualifications such as the Certificate IV in Training and Assessment, however, this is not compulsory.

The learning environment must be appropriate, safe and adequately resourced.

2. Course overview

The goal of this course is to enable participants to understand the common factors that cause significant health and safety incidents in a mining environment. The program is designed so that mine workers are aware that mining disasters have occurred in the class(es) of mines they are working in and are aware of the consequences for workers involved.

In addition, this program aims to ensure that mine workers are aware that the learnings from mine disasters are now applied as part of NSW WHS laws and regulations applying to mines and petroleum sites.

Finally, this program seeks to raise awareness and support workers to be vigilant in their thoughts and actions to prevent mining disasters as part of mines' safety management systems and activities.

Target audience

Induction training for new entrants to the mining industry and/or people requiring work health and safety refresher training across all forms of mining.

Learning objectives

When participants complete this course they will be able to:

- Recognise recurrent patterns of failure linked to significant work health and safety incidents across the mining industry
- Identify a principal hazard at their own site
- Identify factors at their own sites that impact on risks to health and safety.

Materials and equipment

MATERIALS	EQUIPMENT
For the Instructor: <ul style="list-style-type: none"> ■ PowerPoint® Slides ■ Scenarios ■ Course evaluation form 	For the Instructor: <ul style="list-style-type: none"> ■ Flip charts and paper ■ Whiteboard and markers ■ Laptop ■ LCD projector ■ Speakers for videos that accompany case studies

Class preparation checklist

TASK	✓
Obtain and test LCD projector and personal computer	
Obtain whiteboard or flip chart and markers	
Obtain and test PowerPoint file (PDW-PPT)	

Classroom setup and equipment

Arrive early to setup the classroom:

- Arrange tables for groups of four.
- Provide a flip chart and easel or whiteboard for the facilitator to record responses from the group.

3. Course instruction

Workshop schedule

TASKS	SLIDE #	SUGGESTED TIME (MINS)
Introduction to program and learning outcomes	1-2	2
NSW mining disasters; work-related fatalities; support services	3 - 6	3
Facilitator led outline of framework of recurrent failures: Professor Michael Quinlan's Ten Pathways to Death and Disaster	7	2
Case study: Aberfan mining disaster	8 - 12	3
Discussion activity 1 Principal hazards; What are the principal hazard risks in your workplace? Are there any hazards that are not specifically listed here?	13 - 14	10
Case study: Pike River mining disaster	15 - 18	14
Case study review – (1 case study chosen by facilitator to review and discuss in detail) <i>NB: Due to the one hour duration of this program, it is recommended that only one case study is reviewed and discussed in detail. However, it is recommended the facilitator covers off on the remaining seven case studies briefly to create awareness of other types of mine disasters included in this training package. The PowerPoint slides for the remaining case studies could be interspersed throughout the day as determined by the facilitator.</i>	19 - 28	10
Facilitator led outline on legislated responsibilities for safety on mine sites	29 - 32	3
Learning the Lessons - Discussion activity 2	33	10
Program close – Pathways to success; next steps; acknowledging workers that have lost their lives; questions, acknowledgements, further references and feedback	34-40	3
Total		60 minutes

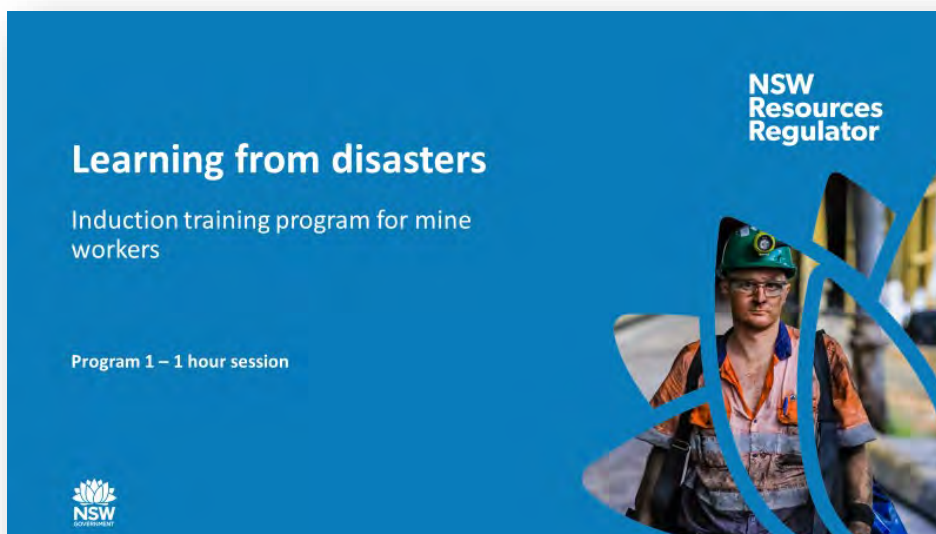
Instructions and speaking notes

Suggested actions and scripts for the instructor are provided below as well as instructions on when and how to use the discussion activities. The notes are also contained in the notes section of the PowerPoint presentation – *Learning From Disasters – Program 1*.

Use these materials as you prepare for your session to the guide you during the workshop.

Slides 1-2

*Suggested
time: 2 min*



Facilitator/key points:

Welcome the participants and introduce yourself (if you are new to the group).

This is an introductory program in a series of health and safety packages.

The focus of the session is on generating discussion, within the limited time frame, on the need for all in the workplace to remain vigilant in identifying and managing hazards associated with working in a high risk industry.

Analysing previous incidents provides a valuable opportunity to identify common pathways that lead to fatalities and serious health and safety incidents in the mining industry.

Acknowledge with participants that the content of the material can be distressing and that attendees may know, or even have been involved, in the fatalities or serious incidents that are being discussed or similar events. This can be traumatic for participants to discuss. Remind participants that should they feel uncomfortable with the information being discussed they should remove themselves. An additional support slide is included just prior to the case studies.

The session will identify 10 recurrent failures that have been researched and analysed by Professor Michael Quinlan, and others, as a result of major disasters in the mining industry across Australia and internationally. Although some of the events mentioned are historical – unfortunately many of the themes and causes are as relevant today as they were then.

Learning outcomes

- Recognise recurrent patterns of failure linked to significant work health and safety incidents across the mining industry.
- Identify a principal hazard at your site.
- Identify factors at your own site that impact on risks to health and safety.

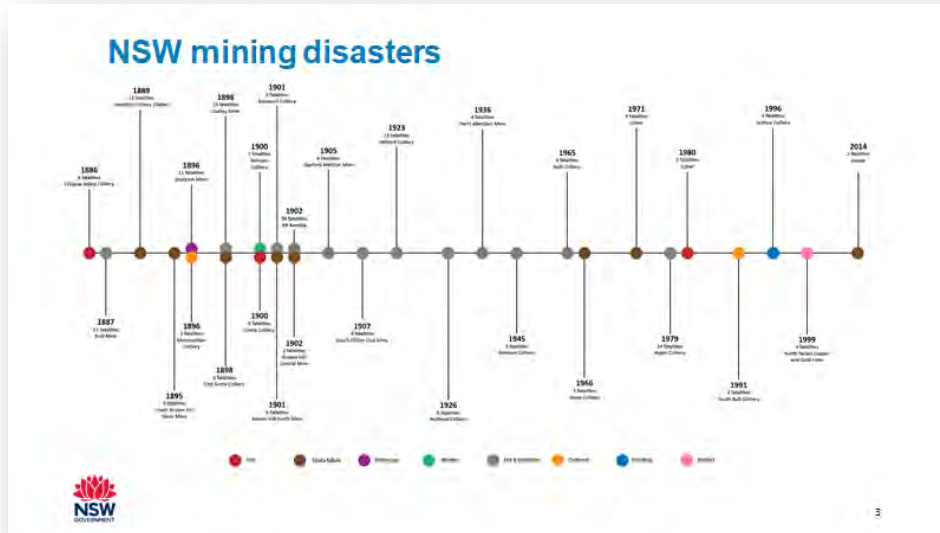


Facilitator/key points:

List the learning outcomes as described.

Slides 3 - 6

Suggested
time: 3 min



Facilitator/key points:

As you can see from the table, there have been a number of major mining disasters in NSW since the late 1800s.

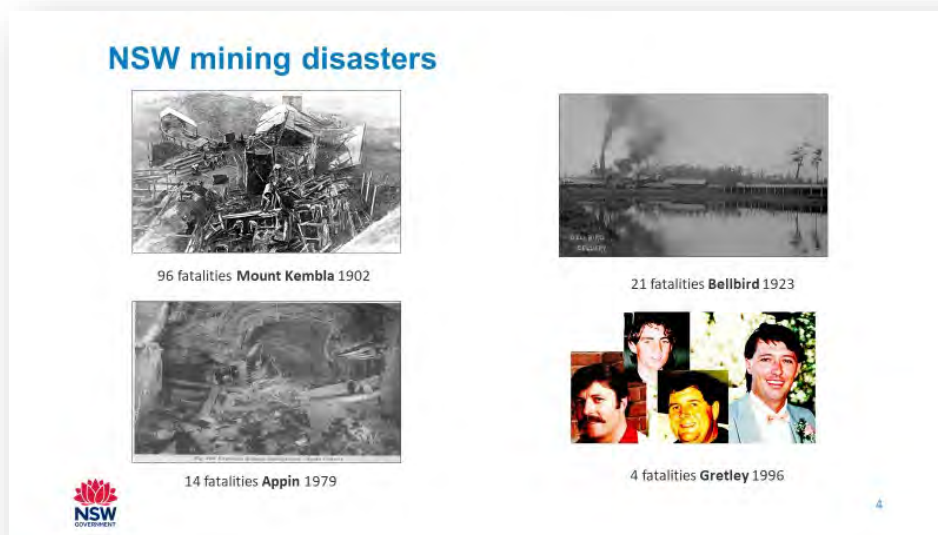
These include the:

- Bulli Mine explosion in 1887 with **81 fatalities**
- Dudley Mine Explosion in 1898 with **15 fatalities**
- Mt Kembla Explosion in 1902 with **96 fatalities**
- Bellbird Colliery explosion in 1923 with **21 fatalities**
- Appin Colliery explosion in 1979 with **14 fatalities.**

And in more recent times the:

- *Gretley Colliery flooding in 1996 with **4 fatalities;** and
- *Northparkes Copper and Gold mine airblast in 1999 with **4 fatalities**
- Austar rib/sidewall burst in 2014 with **2 fatalities.**

Notes: *denotes a case study around that incident has been provided as part of this learning package.



Facilitator/key points:

Note: The following information is background information for the Facilitator. It is not intended to be speaking points.

Mount Kembla 1902 – 96 fatalities

The Mount Kembla mine disaster was the worst post-settlement peace-time disaster in Australia, until the 2009 Black Saturday bushfires in Victoria. Mount Kembla was an underground coal mine in the Illawarra region of NSW.

On 31 July 1902, a large section of the unsupported roof in a goaf collapsed, pushing air and methane gas into the main tunnel. The rush of air and gas stirred up the coal dust clinging to the roof and walls of the workings and suddenly came in contact with a naked light. The gas ignited and, combined with the now airborne coal dust, set off the initial explosion that blew down the main tunnel with such force it took everything in its path. This initial explosion set off a series of explosions giving the miners no warning and no chance to escape. The explosion produced odourless carbon monoxide gas that filled the tunnels, accounting for more loss of life than the explosion itself.

The Royal Commission stated that only the substitution of safety lamps for flame lights could have saved the lives of the 96 victims.

The hazards that existed at Mt Kembla are present at many underground coal mines today. Mine operators have an obligation to manage risks to workers through the conduct of risk assessments,

where controls must be implemented for identified hazards through the implementation of the hierarchy of controls.

Legislation prescribes matters that must be considered in implementing controls for gas and ventilation, fire, explosion (including explosion suppression), emergency management and training of workers. Explosion protected equipment must be used in areas where gas is likely to be present and real-time monitoring systems provide mine operators with a continuous stream of data that allows for a proper understanding of the condition of a mines' atmosphere at all times.

Bellbird 1923 – 21 fatalities

On 1 September 1923, explosions and fires underground killed 20 men at the Bellbird Colliery near Cessnock, NSW. Another man died in the rescue attempt, bringing the death toll to 21. The 21 victims left behind 38 children.

Inquests were unable to explain the cause of the fire. However, some accounts were critical of many unsafe work practices, including smoking in the mines, unreliable emergency phone lines and lack of hazard reporting and control. Some workers did not even have safety lamps.

Fifteen bodies were recovered from the site by rescue parties in the immediate aftermath of the explosion. The Coroner found the victims died from carbon monoxide poisoning.

In 1924, trained volunteer rescue teams using Proto breathing apparatus recovered the bodies of the six entombed miners. This demonstrated the value of a professional approach to mines rescue and advanced the cause of mines' rescue stations. This disaster is considered to be the catalyst for the formation of the Mines Rescue Service in NSW in 1925.

Today, Coal Services Mines Rescue continues to provide training for rescue brigades-men in underground coal mines and has rescue stations in major coal fields in NSW. The mine safety legislative framework requires self-rescuers be carried by workers underground and self-contained breathing apparatus to be available along with suitable firefighting equipment for first response underground. Emergency escape systems and emergency management plans are also required.

Appin 1979 – 14 fatalities

On 24 July 1979 at the Appin Coal Mine on the NSW South Coast, an explosion, three kilometres from the pithead and 600 metres underground, killed 14 mine workers. The first three mine workers were killed by the explosion, while 11 mine workers died from carbon monoxide poisoning.

Judge Goran concluded that a methane explosion initiated a coal dust explosion following an accumulation of methane resulting from a flawed ventilation change and that the explosion began by an ignition in the fan starter-box and not the deputy's safety lamp as initially speculated.

Judge Goran's report called for electronic monitoring of gasses including portable devices for deputies and reinforced the need to have effective ventilation changeover practices including the need to cut the power to equipment during ventilation changeover and the necessity for an interlocking circuit to cut power to equipment if the auxiliary fan stops. It also recommended that ventilation officers be appointed. The issues identified in Judge Goran's report are addressed by the current legislative framework.

Gretley 1996 – 4 fatalities

On 14 November 1996, four workers at the Newcastle Wallsend Coal Company's Gretley Colliery were killed as a result of an inrush of water from old workings.

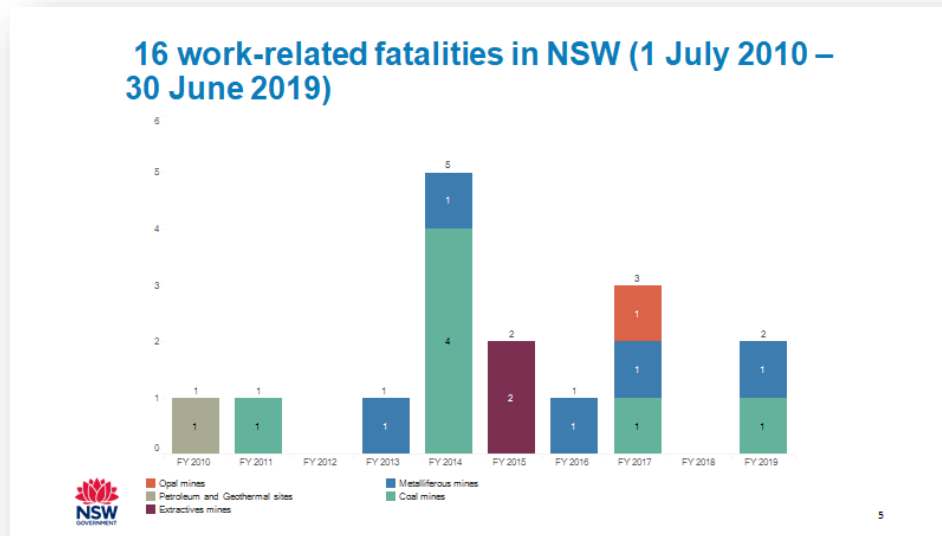
The men were part of a crew of eight who were in the process of developing a roadway in an area of the mine, operating a continuous mining machine. Suddenly, with tremendous force, water rushed into the heading from a hole in the face made by the continuous miner. The machine, weighing between 35 and 50 tonnes, was swept 17 metres back down the heading where it jammed against the sides. The four men were engulfed by the water, swept away and drowned. The remaining team members were in the crib room a short distance away, which also flooded.

The water came from the long-abandoned mine at the Young Wallsend Colliery, which was full of water. The water extended to the surface through the mine shafts, significantly increasing the water pressure.

Justice Staunton prepared a report of a formal investigation. He accepted that many individuals within the mining industry assumed before the inrush that the 50 metre Borehole Rule in clause 9 of the Coal Mines Regulation (Methods and Systems of Working – Underground Mines Regulation 1984) offered adequate protection against inaccurate plans.

However, the errors in the Gretley plan were between 100 – 200 metres. The inquiry found the department, the mine operator and the mine surveyor all failed to identify the errors in the old workings. They each should have made efforts to confirm the accuracy of the old plan but failed to do so. There were also failings by mine deputies and the mine under-manager to properly investigate the source of water in the mine in the days and weeks prior to the inrush.

The current legislative framework requires certain actions by mine operators to identify and control inrush hazards. The mine operator must also prepare and implement a principal mining hazard management plan if it identifies an inrush or inundation principal mining hazard is present.



Facilitator/key points:

From 1 July 2010 – 30 June 2019, there were 16 mining incident related deaths in NSW.

Facilitator should reinforce that all stakeholders in the industry need to be aware that the risk of fatality and serious injury occurs in all parts of the mining sector which requires everyone to remain vigilant and proactive in meeting their responsibilities.

Learning from experience, preventing devastating reoccurrences and improving the health and safety of all working in this industry is a profound way of acknowledging and recognising all those who have been impacted by mining safety incidents throughout history.

Support services available

Due to the potentially distressing nature of the video clips and content of the program, please note the following contact information for support services:

Beyond Blue: Phone: 1300 22 4636 (24 hours)

Web chat also available between 3pm and midnight at www.beyondblue.org.au

Lifeline: Phone: 13 11 14 (24 hours)

Web chat also available between 7pm and midnight at www.lifeline.org.au

Internal organisational welfare and support services



Facilitator/key points:

Prior to commencing the case studies and using any of the media or information, remind participants of the support services available to them should they find the content disturbing.

Slide 7

Suggested time: 2 min

Professor Michael Quinlan – Ten pathways to death and disaster



Facilitator/key points:

This is an overview slide outlining the key pathways identified by Professor Quinlan. Further background information on Professor Quinlan is located in the *'Introduction'* section of this Facilitator Guide.

Advise participants that research by several groups and individuals on fatalities and major safety incidents in mining over many years **continues** to identify these themes.

The themes are relevant in all mining contexts and in incidents involving both single and multiple fatalities.

Facilitators will need to ensure they do prior research and reading on the ten (10) pathways model so that they clearly understand the importance and relevance of each pathway

Slides 8- 12

*Suggested
time: 3 min*



Facilitator key/points

This video of the Aberfan disaster is provided to set the scene for the training and provide context about the devastating impact mining disasters can have on a community. More information on the Aberfan case study is provided in the *'Case study information for facilitator'* section of this guide.

NB: Do not show this video here if the Facilitator has chosen the Aberfan case study to review and discuss in detail as part of the case study review activity. Instead, show this video as part of the case study review section of the training.

Case study: Aberfan, UK

21 October 1966

Principal Hazard – (i) Ground or strata collapse

Pattern of failure:

1. Design engineering and maintenance flaws

Failure to recognise debris pits as structures requiring maintenance.

2. Failure to heed clear warning signals

Previous debris slides occurred at Aberfan in 1944 and 1965.

Rainfall in 3 weeks prior resembled 1944 experience.

Slippage occurred day prior and day of the incident which should have triggered early warning system.

3. Flaws in risk assessment

Little or no risk management around debris tip management.



Fatalities: 144 (116 children)



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Case study: Aberfan, UK

Pattern of failure:

4. Flaws in work health and safety management system

Lack of training and no accountability or responsibility of management to develop and maintain a safety system.

5. Flaws in system auditing

Failure to audit and inspect.

6. Economic/reward pressures compromising safety

It was argued that the costs involved in removing debris tips may have undermined worker positions.



Fatalities: 144 (116 children)



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Case study: Aberfan, UK

Pattern of failure:

7. Failures in regulatory oversight

Role of the Inspectorate was only focused on safety of the miners. Lack of legislative imperatives to inspect or manage debris pits.

8. Worker, consultant and supervisor concerns prior to incident

Failure by the engineers to communicate with staff or around attendances or concerns raised.



Fatalities: 144 (116 children)



11

Case study: Aberfan, UK

Pattern of failure:

9. Poor management, worker communication and trust

Evidence of failure to share information on concerns or relevant incidents from local borough and workers.

10. Flaws in emergency procedures and resources

Poor communication systems on site negated possibility of last minute warning being given to Aberfan village.



Fatalities: 144 (116 children)



12

Slides 13 - 14

*Suggested
time:*

10 min



Principal hazards in mining environments

- (i) ground or strata failure
- (ii) inundation or inrush of any substance
- (iii) mine shafts and winding systems
- (iv) gas outbursts
- (v) spontaneous combustion
- (vi) subsidence
- (vii) roads or other vehicle operating areas
- (viii) air quality or dust or other airborne contaminants (e.g. dust)
- (ix) fire or explosion
- (x) a hazard identified by the mine operator under clause 34 of the WHS Regulations

References: Work Health and Safety Regulation 2017 Part 3.1 (cl 34)
Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 – Part 1 (cl 5)

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Facilitator key/points:

Familiarise participants with the principal hazards **as outlined in the legislation.**

Remind participants that these principal hazards are now in legislation *because* of their link to previous work, health and safety incidents. The current regulatory framework reflects the evolution of the industry in response to past experience.

The facilitator is encouraged to explain that in many sites there may be several principal hazards that the management team will need to recognise and these hazards will be managed through the development, implementation, monitoring, evaluation and review of risk control strategies.

Lead the discussion on the hazards identified with the group with the objective of sharing experiences and strategies that various mine sites are adopting to manage their principal hazards.



Discussion activity #1 **Principal hazards**

- In groups consider what the principal hazard risks in your workplace are from the legislated list.
- Are there any hazards that are not specifically listed here?

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Facilitator/key points – Group based activity

Use the Activity Worksheet provided in the ‘Participant Resources’ section of this guide.

Ask participants to discuss and identify how many of the legislated principal hazards they encounter in their workplace. Feedback the discussion where possible.

Encourage them to consider any other hazards that may **not be listed** such as confined spaces, working at heights or fatigue management for example.

Facilitator will ensure that participants are provided with the opportunity to identify and discuss other hazards (clause x) which mine sites are recognising and including in their Principal Hazard Management Plans.

Suggested questions to generate discussion could include:

How are mine sites currently identifying principal and other hazards?

What tools or strategies are used? Is the workforce (both management, employee and contractor) encouraged to pro-actively identify hazards or near miss situations?

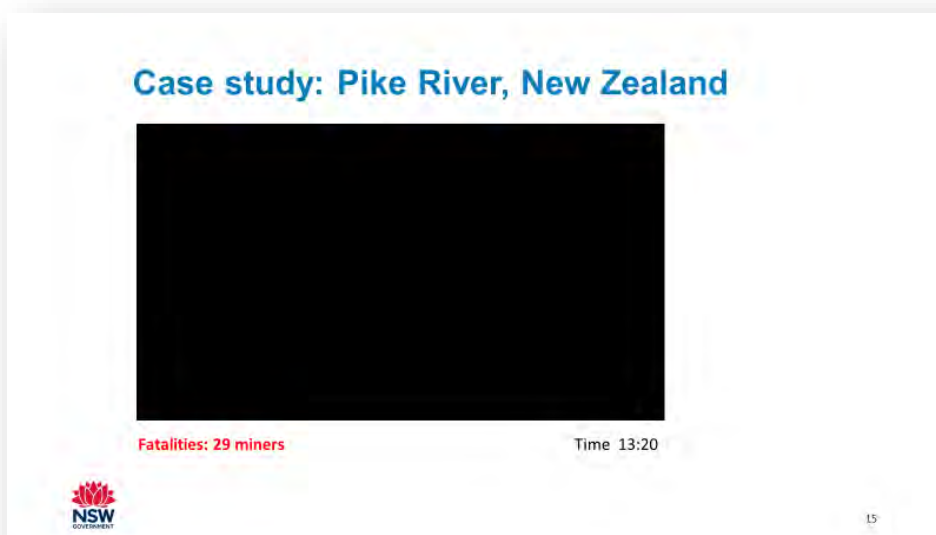
Are the mine sites using lead or lag indicators in relation to hazard management? Are the hazard management strategies being led by operational or WHS management areas?

Have certain hazards been normalised in your mine sites?

Slides 15 -
18

*Suggested
time:*

14 min



Facilitator/key points:

This video of the Pike River disaster is provided to set the scene for the training and provide context about the devastating impact mining disasters can have on a community. More information on the Pike River case study is provided in the '*Case study information for facilitator*' section of this guide.

NB: Do not show this video here if the Facilitator has chosen the Pike River case study to review and discuss in detail as part of the case study review activity. Instead, show this video as part of the case study review section of the training.

Case study: Pike River, New Zealand

19 November 2010 - Principal Hazard – (ix) Fire/explosion

Pattern of failure:

1. Design, engineering and maintenance flaws

Decision to use hydro mining and the positioning of the main mine ventilation fan.

2. Failure to heed clear warning signals

Failure to respond to trends in atmospheric pressure and methane levels.

3. Flaws in risk assessment

Failure to risk assess hydro mining or UG main mine ventilation fan.

4. Flaws in management systems

Failure to maintain safety critical systems – stone dusting, ventilation, equipment.



Fatalities: 29 miners



16

Case study: Pike River, New Zealand

Pattern of failure:

5. Flaws in system auditing

No proper OHS audits conducted.

6. Economic/reward pressures compromising safety

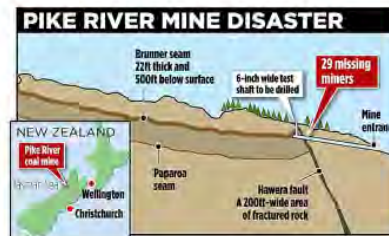
Production pressure/cost cutting compromising safe work practices and incentive pay systems encouraging unsafe work practices.

7. Failures in regulatory oversight

Insufficient/inadequately trained or supervised inspectors.

Inadequate/poorly targeted enforcement.

Flaws in legislation – standards, reporting requirements, sanctions, workers rights.



Fatalities: 29 miners



17

Case study: Pike River, New Zealand

Pattern of failure:

8. Worker, consultant and supervisor concerns prior to incident

Failure to respond to supervisor, consultant and worker concerns about safety.

9. Poor management, worker communication and trust

Poor management response to worker, supervisor and union concerns leading to non-productive relationships.

10. Flaws in emergency procedures/resources

No second egress.

Unsatisfactory emergency response procedures post incident.



Fatalities: 29 miners



18

Slides 19 – 28

*Suggested
time for one
case study:
10 minutes*

Case study review



Facilitator/key points:

Note: For the full suite of slides available please go to the ‘PowerPoint slides for case studies’ section of this guide (section 4).

All the case studies have been provided as part of this training package. Facilitators should select the slides that relate to a case study **relevant to your work environment**. Use the points on the relevant


PowerPoint slides and the information contained within the case study section of this Facilitator Guide to generate discussion. Case study summaries are available in the 'Case study information for facilitator' section of this guide (see section 4).

Where case studies contain videos these will take longer to discuss and will impact on the time available for activities.

NB: Due to the one hour duration of this program, it is recommended that only one case study is reviewed and discussed in detail. However, it is recommended that the Facilitator covers off on the remaining seven case studies briefly to create awareness of other types of mine disasters included in this training package. The PowerPoint slides for the remaining case studies could be interspersed throughout the day as determined by the Facilitator.



Slides 29 -
32

*Suggested
time: 3 min*

Responsibilities for safety on mine sites 

The legal framework for safety as it applies to:

- Mine Operators
- Contractors
- Workers



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Responsibilities for safety on mine sites – mine operators

The Operator who is the primary PCBU on site must ensure:

- Provision and maintenance of a workplace **without risk to health and safety**
- Provision and maintenance of **safe plant and structures**
- Provision and maintenance of **safe systems of work**
- **Safe use, handling, and storage** of plant, structures and substances
- Provision of **adequate facilities** for welfare at work
- Provision of **information, training, instruction or supervision**
- The **monitoring** of the health of workers and conditions at the workplace

Reference: S. 19 NSW Work Health and Safety Act 2011 No 10 – primary duty of care (PCBUs)



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Responsibilities for safety on mine sites – contractors

- The contractor must **provide** all relevant information to the operator to enable the operator to identify risks associated with proposed operations
- There are **two options** on how a contractor interacts with the mine's Safety Management System (SMS)

Option 1:

- Contractor **prepares** a Health & Safety Management Plan and **provides** it to operator
- Operator **reviews** Plan and gives **written notice** to contractor that it is consistent with the SMS of the mine

Option 2:

- Contractor **reviews** the relevant parts of the mine's SMS.
- Contractor gives operator **written notice** they have reviewed SMS and that it is consistent with the contractors arrangements for managing health & safety as per clause 9 of WHS(MPS) Regulations & WHS laws



References: cl. 21 and cl. 22 of the NSW Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 and S. 46 of the WHS Act 2011 (Consultation)

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Responsibilities for safety on mine sites – workers

- **Take reasonable care** for your own health and safety
- **Take reasonable care** that your actions **or** your failure to act do not adversely affect the health and safety *of others*
- **Comply** with any reasonable instruction that allows the mine manager or operator to comply with the Act
- **Co-operate** with any reasonable safety policy or procedure



Reference: S. 28 of NSW Work Health and Safety Act 2011

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Facilitator/key points:

These slides are to remind participants that this is the legislated framework that outlines the **shared responsibility and obligations** of everyone involved in the mining sector to ensure the health and safety of all those working in the industry. Many of the incidents involving fatalities/injuries or the exposure to serious risk highlighted failures at **all levels** of the specific organisation.

The Facilitator will provide detailed information on each duty holder and the range of accountabilities and responsibilities each needs to meet to discharge their duties under the NSW WHS laws and regulations.

The Facilitator should identify the links to the ten (10) pathways model to relevant duties identified in the legislation as they work through each point and duty holder slide.

Discussion should be encouraged as this section of the presentation will allow participants to contextualise their job roles with current workplace situations and promote discussion on possible solutions to overcoming pathway issues.

Relationship with the WHS Act

The WHS (Mines and Petroleum Sites) Act 2013 is to be construed with, and as if it formed part of the WHS Act 2011, and the regulations under this Act are to be construed with, and as if it formed part of the WHS regulations. See section 4 of the WHS (Mines and Petroleum Sites) Act 2013.

Slide 33



*Suggested
time:*

10 min



Discussion activity #2 Learning the lessons

- In groups reflect on the case study and Professor Quinlan's 10 pathways.
- Discuss and identify two (2) of any of Quinlan's pathways that **you believe present the greatest risk of a safety failure in your workplace.**



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Facilitator/key points:

Use the Activity Worksheet in the Participant Resources area and ask the participants to reflect in their groups on which of the pathways they feel their workplace could improve on.

For example, are risk assessments being completed thoroughly and accurately? Are warning signals being routinely collected, analysed and acted upon? How constructive is the consultation and communication between workers and management?

Following that reflection, ask participants to discuss and prioritise what two (2) key actions they believe would improve health and safety outcomes in the future at their location.

For example, prompts could include improving communication channels between management and staff relating to raising and managing WHS concerns or reviewing and updating on site emergency response procedures.


Option: this activity may be discussed in a group using a whiteboard to reduce the time required.

Slides 34 -
39

*Suggested
time: 3 min*

Pathways to success

- An effective regulatory framework
- Leadership and commitment from the mine operator and officers that builds confidence and trust
- Effective health and safety management systems
- Development and maintenance of successful communication systems across all levels of the organisation
- Proactive and positive risk and hazard management processes that are embedded by everyone throughout the organisation
- High levels of emergency management across prevention, preparation and response





Facilitator/key points:

The facilitator should work through this list and identify the positive pathways to reduce the risk of a serious safety incident. Ask participants if they believe there are any other pathways or features of organisations that enjoy optimal work health and safety outcomes.

Next steps

Is your mine prepared for a disaster?



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Facilitator/key points:

The facilitator should recap on the major themes of the presentation and how those participating are able to contribute to improved safety outcomes going forward.

Conclusion and questions. Thank participants for their attendance at the program and draw attention to the final slide which includes additional resources.

The patterns of failure help to explain fatalities and serious injuries and confirm why poor safety cultures are a symptom of failure in WHS regimes and priorities.

Given the length of time since the last disaster, the industry is entering a dangerous period of potential complacency and everyone operating in this high risk sector must remain vigilant.

Previous downturns in the industry have led to job insecurity and industry/corporate restructuring. Organisations are constantly changing structures and introducing new technology which, if not managed effectively, could lead to disaster. Other risk factors can include, for example a significant increase in the use of subcontracted staff over a short period of time who may not be as familiar with the site and/or frequent changes to key management positions.

Encourage all participants, particularly those with statutory responsibilities how they will ensure that the messages and lessons from the ten (10) pathways analysis are passed on to their workforce.

Close with a series of confronting questions:

- Is your mine prepared for a disaster?
- What have you done to prepare?

Acknowledging the 17 people who died in work-related accidents in the NSW resources industry (1 July 2008 – 30 June 2018)

Darren Burgess, 48	Mark Daniel Galton, 50
David Hurst Oldknow, 59	James Leo Hern, 26
Daniel Gregory Hill, 34	Judith Liehr, 49
Bruce Henry Austin, 57	Ryan Anthony Messenger, 25
Peter Thomas Jones, 53	Lee William Peters, 28
Jeremy Mathew Junk, 41	Mark Siegel, 52
Ingrid Forshaw, 38	Stephen Craig Norman, 53
Jamie Mitchell, 49	Mark Brilley, 36
Phillip Grant, 35	



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Facilitator/key points:

Learning from experience, preventing devastating reoccurrences and improving the health and safety of all working in this industry is a profound way of acknowledging and recognising all those who have been impacted by mining safety incidents throughout history.

Support services available

Due to the potentially distressing nature of the video clips and content of the program, please note the following contact information for support services:

Beyond Blue: Phone: 1300 22 4636 (24 hours)
Web chat also available between 3pm and midnight at www.beyondblue.org.au

Lifeline: Phone: 13 11 14 (24 hours)
Web chat also available between 7pm and midnight at www.lifeline.org.au

Internal organisational welfare and support services



Facilitator/key points:

Remind all participants of the support services available should they find the content distressing.

Acknowledgements

Special thanks to the following for their contribution in developing this package:

- Rob Cunningham, Mining Operations Manager, Northparkes Mine
- Professor Michael Quinlan
- Mark Parcell - Mine Accident and Disaster Database
- Radio New Zealand
- Sonya Rockhouse
- Anna Osborne



More information

Several texts and presentations focused on reviews of disasters and work health safety culture and leadership were used to inform this presentation including:

Australasian Mine Safety Journal - www.amsj.com.au

Hopkins, Professor Andrew Hopkins (Australian National University)

Hudson, Professor Patrick (Delft University, The Netherlands)

Mine Accident and Disaster Database www.mineaccidents.com.au

Mine Safety Institute of Australia, DVD – 'A failure to learn' (2014) DVD (Copies of the full DVD are available from www.PikeRiverDVD.com)

Mine Accident and Disaster Database www.mineaccidents.com.au

MSIA Coal Mine Disaster Recommendations Report (2017) <https://www.minesafetyinstitute.com.au/>

Statutory function description <https://www.resourcesandgeoscience.nsw.gov.au/miners-and-explorers/safety-and-health/topics/statutory-functions>

Quinlan, M. (2014) Ten Pathways to Death and Disaster: Learning from fatal incidents in mines and other high hazard workplaces, Federation Press, Sydney.

Reason, Dr James (University of Manchester)

Safework Australia <http://www.safeworkaustralia.gov.au>

Further information on NSW mining disasters is available on the NSW Resources Regulator website.



Facilitator/key points:

Highlight the research available in this area and point out the Resources Regulator's Learning from disasters website URL.

4. Case studies

Eight case studies were selected to cover underground, surface, metalliferous and quarrying contexts.

There have been many seminal events in the history of mining activity around the world that have shaped the industry dating back to 1812. For example, the Felling Colliery Explosion in the United Kingdom which resulted in the formation of the Sunderland Society and ultimately the development of the flame safety lamp. This incident became the catalyst for the use of science to solve mining problems and early attempts to improve ventilation.

Catastrophic disasters continued to occur throughout the 19th and 20th centuries including the Aberfan* Tip slide in Wales which killed 144 people including 116 children in their classrooms at school. This tragedy led to the Report by Lord Alfred Robens (1972) and the subsequent far reaching reform of workplace health and safety in the United Kingdom and Australia.

Disasters prior to 1970 focused primarily on a mining environment characterised by non-mechanised, manual labour with limited gas detection and hazard monitoring. The Australian disasters of the 1970s of Box Flat (1972), Kianga (1975) and Appin (1979) for example led to improved technology for gas monitoring, combustibility and remote monitoring.

The disasters of the 1990s led to the adoption of risk management and principal hazard management plans being integrated into mining practice. The incidents included the South Bulli Outburst (1991), Moura #2 (1994), Gretley* (1996) and Northparkes* (1999).

The Pike River, NZ* disaster in 2010 was a stark reminder of how important it is to take the lessons of the past seriously. The Royal Commission investigation identified, in relatively recent times, more evidence of poor health and safety systems and processes, as well as consistent patterns of behaviour that perpetuated a poor risk management culture.

Underground mining v surface mining

Historically, larger numbers of fatalities around single events have occurred as part of underground mining disasters. However single and multiple fatalities also continue to occur regularly, and in significant numbers, in both mining environments. From 1 July 2008 – 30 June 2018 there were 17 mining incident related deaths in NSW.

*Notes: *denotes a case study around that incident has been provided as part of this learning package.*

The following case studies **may be selected and used interchangeably** for each of the different sectors. They include information on:

- human and organisational factors
- critical controls
- patterns of failures causing mining incidents.

We encourage facilitators to select the most suitable and relevant for their individual participants.

Case study instructions

The case study information has been sourced from independent inquiries, coronial matters and recognised work, health and safety experts.

Additional reading sources have been suggested and facilitators are encouraged to source that material prior to conducting the session.

The participant resources section of this guide contains an abbreviated version of the case studies to generate class discussion.

All the case studies have been provided as part of this training package. Facilitators should select the slides that relate to a case study **relevant to your work environment**. Use the information contained within the case study section of this guide to generate discussion.

NB: Due to the one hour duration of this program, it is recommended that only one case study is reviewed and discussed in detail. However, it is recommended that the facilitator covers off on the remaining seven case studies briefly to create awareness of other types of mine disasters included in this training package. The PowerPoint slides for the remaining case studies could be interspersed throughout the day as determined by the facilitator.

Videos

Some of the case studies incorporate videos to assist in outlining the factors that led to the disaster or fatality.

Suggested time for one case study: 10 minutes

Where case studies contain videos these will take longer to discuss and will impact on the time available for activities.

Case studies available

DATE	LOCATION	MINING CONTEXT
21 October 1966	Aberfan, UK	Underground coal – tailings collapse
14 November 1996	Gretley Colliery, NSW	Underground coal
24 November 1999	North Parkes Mine, Parkes NSW	Underground metalliferous
21 February 2010	Cadia East Mine, Orange NSW	Underground metalliferous
19 November 2010	Pike River Colliery, New Zealand	Underground coal
30 November 2013	Ravensworth Mine, Hunter Valley, NSW	Surface coal mining
27 August 2014	Cudal Limestone Quarry, Cudal, NSW	Quarry mining
6 June 2015	Moolarben Coal Operations, Ulan, NSW	Surface coal mining

Case study information for facilitator

Case study – Aberfan, United Kingdom

Date	21 October 1966
Location	Merthyr Vale Colliery, Glamorgan, South Wales (UK)
Principal Hazard NSW Mining Legislation	(i) ground or strata failure (ii) inundation or inrush of any substance
Incident details	<p>The Aberfan disaster was a catastrophic collapse of a colliery spoil tip in the Welsh village of Aberfan, near Merthyr Tydfil, on 21 October 1966, killing 116 children and 28 adults.</p> <p>It was caused by a build-up of water in the accumulate rock and shale, which suddenly started to slide downhill in the form of slurry.</p> <p>Over 40,000 cubic metres of debris covered the village in minutes, and the classrooms at Pantglas Junior School were immediately inundated, with young children and teachers dying from impact or suffocation.</p> <p>Many noted the poignancy of the situation: if the disaster had struck a few minutes earlier, the children would not have been in their classrooms, and if it had struck a few hours later, the school would have broken up for half-term.</p> <p>Great rescue efforts were made, but the large numbers who crowded into the village tended to hamper the work of the trained rescue teams and delayed the arrival of mineworkers from the Merthyr Vale Colliery. Only a few lives could be saved in any case.</p> <p>The official inquiry blamed the National Coal Board (NCB) for extreme negligence. Parliament soon passed new legislation about public safety in relation to mines and quarries.</p>
Human and organisational factors	<p>With few exceptions, regulators, government, the mine workers and the public had built a perception that the tip did not represent a risk to the community and efforts to manage risk were directed elsewhere.</p> <p>Some members of the public had made complaints about the tip but the major concern had focused around the dumping of very fine material into the tip rather than the size of the dump. These protests were largely withdrawn when it was agreed not to dump any further fine waste on the tip.</p>

	<p>Men were given tasks and held accountability that they were not competent to undertake.</p> <p>A culture of poor communication and accountability existed within both the council and the NCB.</p> <p>The NCB was aware of existence of spring underneath Aberfan mine tip yet failed to take action.</p>
<p>Critical controls</p>	<ul style="list-style-type: none"> ■ System to engineer and design debris pits ■ System to ensure monitoring and maintenance of debris pits ■ Systems to communicate information within organisation ■ Effective oversight by the regulator (NCB) – there was no policy that related to mine tips and had failed to take action in regard to pervious debris slides and minor slips leading up to the incident. ■ System of Training and Competency
<p>Patterns of failure</p>	<p>1. Design, engineering and maintenance</p> <p>Failure to recognise debris pits as structures requiring maintenance</p> <p>2. Failure to heed clear warning signals</p> <p>Previous debris slides at Aberfan had occurred (1944, 1965). Rainfall in 3 weeks prior resembled 1944 experience. Slippage occurred day prior and day of the incident which could have triggered early warning system.</p> <p>3. Flaws in risk assessment</p> <p>Little/no risk management around debris tip management</p> <p>4. Flaws in work health and safety management system</p> <p>Lack of training and no accountability or responsibility of management to develop and maintain a safety system.</p> <p>5. Flaws in system auditing</p> <p>Failure to audit and inspect the structure of debris pit</p> <p>6. Economic/reward pressures compromising safety</p> <p>It was argued that the costs involved in removing debris tips may have led to job losses.</p> <p>7. Failures in regulatory oversight</p>

	<p>Role of the Inspectorate was only focused on mining underground.</p> <p>No legislative imperative to inspect or manage debris pits.</p> <p>Little technical knowledge and no requirement to undertake risk management of debris pits.</p> <p>8. Worker, consultant and supervisor concerns prior to Incident</p> <p>Failure by the engineers to communicate with staff or around attendances or concerns raised.</p> <p>9. Poor management/worker communication/trust</p> <p>Evidence of failure to share information on concerns or relevant incidents from local borough and workers</p> <p>10. Flaws in emergency procedures/resources</p> <p>Poor communication systems on site negated possibility of last minute warning being given to Aberfan village.</p>
References	<p>http://aberfan.walesonline.co.uk/</p> <p>http://www.mineaccidents.com.au/mine-accident/119/aberfan-disaster-1966</p> <p>Source: Aberfan Tribunal Report</p> <p>Additional material: “Drift into Failure” Sidney Dekker (2011)</p>

Case study – Gretley Colliery, Hunter Valley, NSW

Date	14 November 1996
Location	Gretley Colliery, Hunter Valley, NSW
Principal Hazard NSW Mining Legislation	(ii) inundation or inrush of any substance
Incident details	<p>At about 5.30 am employees of The Newcastle Wallsend Coal Company Pty Limited were engaged in work on the night shift.</p> <p>Four men from a team of eight were in the process of developing a roadway (known as C heading) in an area of the mine called 50/51 panel, operating a continuous mining machine. The remaining four members of the team were in a crib room a little distance away.</p> <p>Suddenly, with tremendous force, water rushed into the heading from a hole in the face made by the continuous miner. That machine, weighing between 35 and 50 tonnes, was swept some 17.5 metres back down the heading where it jammed against the sides. The four men were engulfed by the water, swept away and drowned.</p> <p>The remaining team members survived the disaster by reason of being in the crib room, which itself was flooded.</p>
Human and organisational factors	<p>Individuals and the organisation failed to recognise subtle warning signs.</p> <p>The Mine Surveyor was new to role and did not sufficiently question the accuracy of plans of adjacent workings provided by the NSW Government and Mine Subsidence Board.</p> <p>The Undermanager failed to respond to concerns raised by the Deputy or to investigate further when reports of water ingress were noted on inspection reports.</p> <p>The Regulator failure to question absence of risk assessment.</p> <p>Cost pressures were involved around dewatering the adjacent workings and the perception existed that approval for implementation of dewatering methods would not be granted.</p> <p>Additional risk controls were due to be implemented but were not initiated in time to prevent the inrush (Drilling Ahead process).</p>

Critical controls	<ul style="list-style-type: none"> ○ Geo-technical data and systems of analysis ○ Inspection and monitoring arrangements ○ Training and competency of statutory processes for statutory roles ○ Systems of communication of information between shifts ○ Regulator over sight in relation to approvals for extraction
Patterns of failure	<p>Pathway 1 Design engineering and maintenance flaws</p> <p>Flawed maps of workings</p> <p>Pathway 2 Failure to heed clear warning signals</p> <p>Evidence of abnormal water prior to incident</p> <p>Pathway 3 Flaws in risk assessment</p> <p>Failure to assess risk of inrush</p> <p>Pathway 7 Failures in regulatory oversight Inadequate/poorly targeted enforcement activity</p>
References	<p>Report of a formal investigation under Section 98 of the Coal Mines Regulation Act 1982 by His honour Acting Judge J.H. Staunton (July 1998)</p> <p>https://trove.nla.gov.au/work/8874656?q&versionId=46593902</p> <p>“Ten Pathways to Death and Disaster”, Michael Quinlan (2014)</p> <p>“Lessons from Gretley: Mindful Leadership and the Law”, Andrew Hopkins (2007)</p>

Case study – Pike River Mine, New Zealand

Date	19 November 2010
Location	Pike River Mine, Greymouth, South Island, New Zealand
Principal Hazard NSW Mining Legislation	(ix) Fire or explosion
Incident details	At 3.45pm there was an underground explosion at the Pike River coal mine resulting in 29 fatalities.
Human and organisational factors	<p>The cost of the mine development had exceeded its budget.</p> <p>Mine production had failed to meet the anticipated targets and the commitments given to stakeholders resulting in production pressure to complete unsafe work.</p> <p>The company ignored advice regarding risks associated with placing a main mine ventilation fan underground.</p> <p>High rates of staff turnover and inability to attract and retain skilled staff compromised safety systems.</p> <p>Lack of appropriate resources related to WHS systems and auditing.</p>
Critical controls	<ul style="list-style-type: none"> ○ Introduction to site process ○ Regulatory and legislative over-sight regarding 2nd egress ○ Regulatory and legislative over-sight regarding main ventilation fan location ○ Risk management controls for hydro mining technique ○ Mine systems to prevent prohibited items/contraband UG
Patterns of failure	<p>Pathway 1 Design, engineering and maintenance flaws</p> <p>Hydro mining and main mine ventilation fan</p> <p>Pathway 2 Failure to heed clear warning signals</p> <p>Failure to respond to trends in atmospheric pressure and methane levels</p> <p>Pathway 3 Flaws in risk assessment</p> <p>Failure to risk assess hydro mining or UG main mine ventilation fan</p> <p>Pathway 4 Flaws in management systems</p> <p>Failure to maintain safety critical systems – stone dusting, ventilation, equipment</p>

	<p>Failure 5 Flaws in system auditing</p> <p>No proper OHS audit</p> <p>Pathway 6 Economic/reward pressures compromising safety</p> <p>Production pressure/cost cutting compromising safe work practices + incentive pay systems encouraging unsafe work practices</p> <p>Pathway 7 Failures in regulatory oversight</p> <p>Insufficient/inadequately trained or supervised inspectors</p> <p>Inadequate/poorly targeted enforcement</p> <p>Flaws in legislation – standards, reporting requirements, sanctions, workers’ rights</p> <p>Pathway 8 Worker, consultant and supervisor concerns prior to incident</p> <p>Supervisor, consultant and worker concerns at Pike River</p> <p>Pathway 9 Poor management/worker communication/trust</p> <p>Poor management response to worker, supervisor and union concerns</p> <p>Pathway 10 Flaws in emergency procedures/resources</p> <p>No second egress</p>
References	<p>Final Report Pike River Royal Commission (30 October 2012) http://pikeriver.royalcommission.govt.nz/Final-Report “Ten Pathways to Death and Disaster”, Michael Quinlan (2014)</p>

Case study – Cadia East Mine, Orange NSW

Date	21 February 2010
Location	Cadia East Mine, Orange NSW
Principal Hazard NSW Mining Legislation	(ii) inundation or inrush of any substance
Incident details	<p>An inrush of mud and water from an almost completed ventilation shaft partially flooded the underground workings. The ventilation shaft was being formed by raise boring.</p> <p>The inrush material travelled 814m along a roadway to the top of a second ventilation shaft where it continued to fall 375m down a shaft to a second level in the mine.</p> <p>The inrush pushed a 57 tonne manned bogger (front end loader) for 30 – 40m along a roadway and pushed a 5.7m tonne unmanned mini excavator an unknown distance along a roadway.</p> <p>Although no one died seven people were directly exposed to the risk of serious injury or death.</p> <p>“The dried mud left on the walls by the inrush was, in places, higher than a person. The height of the flow and the force would have had serious consequences for anyone caught in its path.” (P. 20)</p> <p>“The inrush was the result of an excessive build-up of reamed cuttings choking the raise bore shaft at its base and the subsequent build up of water and cuttings in the shaft bursting out from the bottom of the shaft.” (P. 33)</p>
Human and organisational factors	<p>Supervisors failed to recognise or respond to the increased evidence of water in the hours leading up to the incident.</p> <p>The organisation made the decision not to drill telltale holes.</p> <p>The risk assessment process failed to effectively identify the scope of risks associated with the activity.</p>
Critical controls	<ul style="list-style-type: none"> ○ Training and competency management system for supervisors ○ Inspection and Monitoring arrangements ○ Safety Management System monitoring and review process

<p>Patterns of failure</p>	<p>Pathway 1 Design, engineering and maintenance flaws</p> <p>Tell-tale holes not drilled to release water. Although not mandatory a high reliability organisation would likely initiate this process as it offers higher levels of risk control within the hierarchy of control. (P. 29)</p> <p>Use of a lower-order hierarchy of control (manned bogger) option in lieu of available remote-controlled bogger (substitution/isolation) to remove cuttings. (P.39)</p> <p>Supervisor did not include the option of the remote-controlled bogger in the final risk assessment/Job Safety Environmental Analysis (JSEA) document. (P. 39)</p> <p>Pathway 2 Failure to heed clear warning signals</p> <p>Successive supervisors failed to respond to the increased evidence of water and the impact on the potential for inrush.</p> <p>The area where the shaft was excavated was known to be a wet area. When the pilot hole was completed, water was seen flowing from the hole. It appears no specific arrangements were made to accommodate the reaming of a wet shaft. (P. 35)</p> <p>Failure to recognise and respond to bogging delays (P. 39) – “The slurry material from the reaming process was causing blockages in radiator, and the bogger to be used on 21 February had broken fan belts.”</p> <p>On this occasion three staff members (including a Supervisor) indicated that the shaft was blocked/choked on 3 occasions in the 24 hours prior to the incident.</p> <p>Supervisor/consultant failed to reconcile cuttings bogged with amount reamed which would have identified risks. (P. 35)</p> <p>There were also pre-warning signs from previous work undertaken which should have alerted supervisors to the non-contextual method of calculating the amount reamed. Method had been calculated using dry cuttings not wet cuttings. (P. 37)</p> <p>Pathway 3 Flaws in risk assessment</p> <p>A documented risk assessment was developed for Cadia East RB1 raise bore hole. The document was not updated for the raise boring activities taking place at the time of the incident. It did identify the risk of potential inrush from a blocked hole but the residual risk was classified as insignificant and rare.” (P.34)</p> <p>...”risk assessment document did not address the risk from wet reamed material.”</p>
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	<p>No assessment of catastrophic failure of the material pile and subsequent inrush potential and consequently, a failure to identify the build-up of water in the shaft once it was blocked.” (P. 34)</p> <p>JSEA had not been reviewed since 2006 which suggests failure to review its integrity and, where possible, continuously improve risk management systems and control outcomes indicating a normalisation of an inrush hazard.</p> <p>Pathway 4 Flaws in WHS management systems</p> <p>Failure to follow standard or safe work procedure (SWP) (P. 38)</p> <p>The Inspector noted that communication regarding high risk activities may be relevant to the continued safe operation of the mine or the safety of people working at the mine. (P. 24)</p> <p>The JSEA did not identify safer systems of work other than using the bogger on the lower side of the material pile when the material was known to be wet. (P. 40)</p> <p>A number of supervisors confirmed during interviews that the JSEA was not completed. (P. 40)</p> <p>Pathway 5 Flaws in system auditing</p> <p>The JSEA had not been reviewed since 2006.</p> <p>No inspection of the bottom of the VR5A shaft had been completed by a qualified engineer. Instead inspections were conducted by Supervisors with no formal qualifications in geotechnical matters. (P. 34)</p> <p>A reconciliation document provided by Cadia East mine failed to identify that there were less cuttings taken away than were created during the raise boring process. (P. 35)</p> <p>Supervisor signed off poor quality JSEA having immediate knowledge that the risk controls in that document were not satisfactory in the circumstances that led to the incident (P. 20)</p> <p>Line supervisors failed to have the JSEA signed off by higher management (OHS Consultant and superintendent) which was contrary to internal policies. (P. 41)</p> <p>Pathway 6 Economic/reward pressures compromising safety</p>
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	<p>A decision was made by mine management about a week before the incident to permit the raise bore to cut as quickly as possible in order to complete the VR5A shaft. (P. 28)</p>
References	<p>Published Investigation Report prepared for the Director-General of the Department of Trade and Investment, Regional Infrastructure and Services by the Mine Safety Investigation Unit, Thornton. NSW</p> <p>https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0006/418416/Cadia-east-inrush-report-for-publication.pdf</p>

Case study – Northparkes Mine, Parkes NSW

Date	24 November 1999
Location	Northparkes Mining, Parkes NSW
Principal Hazard NSW Mining Legislation	(i) Ground or strata failure
Incident details	<p>The incident occurred during a period of maintenance shut down in Northparkes E26 Mine. At the time there were approximately 65 persons working underground.</p> <p>At about 2.50 pm the ore body above the cave back collapsed into the void, creating an air blast which travelled through underground workings of the mine, in particular through the exploration drive at One Level.</p>
Human and organisational factors	<p>The risk assessment process failed to effectively identify the scope of risks associated with the activity which was uncommon in the industry at the time.</p> <p>The organisation did not have a comprehensive system in place for managing change in mining methods or process changes.</p> <p>The organisation failed to take action to correct engineered safety controls when they were compromised by the mining method adopted.</p> <p>Hazard management procedures required more specific definition (e.g., zones within the mine and muckpile heights).</p>
Critical controls	<ul style="list-style-type: none"> ○ Mine Risk Management system ○ Mine inspection and monitoring arrangements ○ Change Management and approvals to mine process
Patterns of failure	<p>Pathway 1 Design, engineering and maintenance flaws</p> <p>The usefulness of the bulkhead as a safeguard against air blast on One Level was negativised by allowing the bulkhead to come into the zone of influence of subsidence of the cave and allowing the dog-leg cuddy to also come into the zone of influence of subsidence in the cave. Finding 7(b)</p> <p>Pathway 2 – Flaws in risk assessment</p> <p>Any mining operator intending to employ the process of block cave mining is to identify and analyse the elements of all the risks associated with its block cave</p>

	<p>operations and develop and maintain hazard management procedures for the management of the void of the muck pile, height of the muck pile above the extraction level and, air blast hazard and shall include all the appropriate controls for the air blast all opening and potential openings into the cave zone.</p> <p>Recommendation 3</p> <p>Pathway 3 – Flaws in management systems</p> <p>Failure of the company to assure the safety system including risk management and critical controls were in place and functioning.</p> <p>That North Parkes Mine should have been aware that the position of the bulkhead as a safety guard against air blast on One Level had been compromised and no longer served that purpose before the 24.11.1999. (Finding 7c)</p> <p>Pathway 4 Economic/reward pressures compromising safety</p> <p>For production to continue, the extraction rate of the ore was in volumes greater than those which were falling from the cave back. This in turn created a void between the cave back and the top of the muck pile on the extraction level – this void increased with time and eventually the air void was some 180 m in height. (P i)</p> <p>“I find the only reason that the air gap void was allowed to become as large as it was....was that North Parkes Mines maintained a production rate far greater than the rate at which the ore was falling from the cave back. It is quite clear that the production rate took precedence over factors which concerned the safety of those within the mine.” (Finding 4)</p>
References	<p>Findings and Recommendations – John Bailey, Coroner (2003)</p> <p><i>Re: Inquest into the deaths of R Bodkin, M House, S Osman and C Lloyd-Jones on the 24th November 1999 at the E26 Lift 1 Mine North Parkes Mines, Parkes NSW.</i></p> <p>http://eagcg.org/common/pdf/NorthParkesCoronial.pdf</p>

Case study – Ravensworth Mine, Hunter Valley, NSW

Date	30 November 2013
Location	Ravensworth Mine, Liddell, NSW
Principal Hazard NSW Mining Legislation	(vii) roads or other vehicle operating areas
Incident details	<p>A mine worker suffered fatal injuries when the Toyota Landcruiser they were driving collided with, and was run over by, the front right-hand side wheel of a haul dump truck (Caterpillar 793D), weighing approximately 351tonnes (including 186 tonnes of coal).</p> <p>The driver was the only occupant of the Landcruiser vehicle and approached a T-intersection with the stockpile ramp and proceeded to turn into the path of the truck. The truck operator saw the Landcruiser enter the haul road on their right but then lost sight of it.</p> <p>Approximately 10 months later 4 people died in a similar fatal accident on the Freeport Copper Mine, Papua Province, Indonesia when a Caterpillar 785 haul truck also accidentally collided with a shift change light vehicle with nine occupants.</p>
Human and organisational factors	<p>The driver may have recognised the presence of the intersection but was not able to detect the truck and/or observed the truck, but misinterpreted the road environment presented and what was required. (P. 2)</p> <p>Traffic management systems and the interaction between light and heavy vehicles on haul roads may have created the opportunity for collision.</p> <p>Design and construction of road bunding failed to consider possibility for obscuring visibility for light vehicles.</p> <p>Due to the height of the truck and its close proximity to the intersection, the lack of light coming from the bumper lights would have made it difficult for the Landcruiser driver to see the truck.</p> <p>Neither vehicles had proximity alert or collision avoidance systems installed. This is not currently legislated but is emerging best practice.</p>

<p>Critical controls</p>	<ul style="list-style-type: none"> ○ Mine engineering and design standard for haul roads and intersections ○ Traffic management system regarding light and heavy vehicle interaction ○ Training and Competency System for operating light vehicles ○ Mine processes for lighting ○ Light vehicle specification and maintenance system
<p>Patterns of failure</p>	<p>Pathway 1 Design, engineering and maintenance flaws</p> <p>Inv Report - Contributory factor #2</p> <p>Some aspects of the intersection design and signage did not meet Ravensworth mine’s guidelines and/or ARRB best practice.</p> <p>Inv Report - Contributory factor #4</p> <p>The background lighting near the intersection had the potential to disorientate or confuse drivers approaching the intersection on the 8th ramp.</p> <p>Inv Report – Contributory Factor #6</p> <p>The poor visibility of the truck due to the obscured front bumper lights and recessed right side low beam may have contributed to the incident by limiting the visibility of the truck that night.</p> <p>Inv Report - Contributory factor #7, #9</p> <p>Absence of other illumination devices on the truck to enhance visibility.</p> <p>No proximity or collision avoidance systems installed on the truck or Landcruiser to warn operators of the presence of another vehicle.</p> <p>Inv Report - Contributory factor #10</p> <p>An over-reliance on administrative controls to manage heavy and light vehicle interactions at Ravensworth mine.</p>
<p>References</p>	<p>Investigation report</p> <p>Investigation into a fatal collision between a Caterpillar 793D haul dump truck and a Toyota Landcruiser at Ravensworth open cut mine on 30 November 2013.</p> <p>Report prepared by the NSW Mine Safety Investigation Unit for the Secretary of NSW Trade & Investment</p> <p>March 2015</p>

	<p>https://www.resourcesandenergy.nsw.gov.au/_data/assets/pdf_file/0005/553523/Ravensworth-Investigation-Report.pdf</p> <p>https://www.sbs.com.au/news/deaths-at-us-mine-in-indonesia</p>
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Case study – Cudal Limestone Quarry, Cudal NSW

Date	27 August 2014
Location	Cudal Limestone Quarry, Cudal, NSW
Principal Hazard NSW Mining Legislation	Under WHS Act
Incident details	<p>A resident of a neighbouring property to the Cudal Limestone Quarry was found deceased. The house was supplied with electricity from the quarry’s electrical supply. The deceased woman appeared to have suffered a fatal electric shock.</p> <p>The house was approx. 250m from the crushing plant which was supplied by a three-phase overhead line.</p> <p>Electrical testing identified that when the electrical supply was on and the crushing plant was operating, excessive voltage appeared at the house earth stake and water pipes. A phase-to-earth fault was identified on a motor supply cable.</p>
Human and organisational factors	<p>The organisation allowed a non-compliant electrical installation to operate on the site.</p> <p>Electrical work at the site was not completed to a sufficient standard to meet legislative and Australian Standard requirements.</p>
Critical controls	<ul style="list-style-type: none"> ○ Site standard and statutory compliance program for electrical installations ○ Site electrical maintenance program ○ Site electrical inspection program ○ Site program for training and competency for electrical work
Patterns of failure	<p>Pathway 1 Design, engineering and maintenance flaws</p> <p>Lack of safety devices “The absence of the earth to neutral link at the quarry switchboard does not meet the requirements of the wiring rules for a MEN earthing system” (P.4)</p> <p>Insufficiently engineered and maintained electrical system.</p> <p>Pathway 5 Flaws in system auditing</p>

	<p>Non-compliant electrical work. At the main switchboard, it was observed that no earth to neutral link (E-N link) was fitted. The absence of the E-N link at the main switchboard resulted in an increase in the earth fault loop impedance from the motor of the crushing plant to the supply transformer. This increased fault loop impedance resulted in a voltage rise on the neutral conductors throughout the quarry supply system during and electrical fault condition. The earth leakage relay did not activate during the fault event.” (P.3)</p>
References	<p>Information release – NSW Mine Safety Investigation Unit 3 February 2015 https://www.resourcesandgeoscience.nsw.gov.au/data/assets/pdf_file/0009/542475/IIR15-01-Fatality-at-house-near-quarry.pdf</p>

Case study – Moolarben Coal Operations, Ulan, NSW

Date	6 June 2015
Location	Moolarben Coal Operations, Ulan, NSW
Principal Hazard NSW Mining Legislation	(i) Ground or strata failure
Incident details	<p>Regular open cut mining operations were being undertaken on the morning of 6 June 2015 when a section of the highwall adjacent to a public road failed. There was nobody in the immediate area at the time of the slump.</p> <p>The failure was about 160 m wide and approximately 55 m high. The highwall edge before the failure was 40 m from a public road and 12 m after the failure.</p> <p><i>Contributing factors</i></p> <p>A palaeochannel infill sequence of materials had been exposed during recent mining operations. It included materials that had not been identified in geological modelling. A palaeochannel is a remnant of an inactive river or stream that has been filled or buried by younger sediment. This palaeochannel was locally deeper than previously exposed and comprised of differing lower level sediments. The increased thickness of the channel consisted of relatively loose silty sands and weaker clays which were at the base of the palaeochannel infill at the top of the coal seam.</p> <p>The upper 25 m of materials were stiffer and stronger and it is believed these have caused overstressing of the clays and infill sands. Undrained pore pressure is believed to have triggered localised liquefaction and lubricated the fissures within the clays.</p>
Human and organisational factors	<p>Inspections and geo-technical data failed to identify the paleochannel.</p> <p>The organisation and management team believed that that the additional monitoring and the implementation of the buttress wall would be sufficient to prevent slippage.</p>
Critical controls	<ul style="list-style-type: none"> ○ Mine monitoring and inspection system ○ Authority to mine process ○ Mine planning process
Patterns of failure	Pathway 1 Design, engineering and maintenance flaws

	<p>The mine had previously recognised potential for instability in the northern highwall. The wall design reflected this. Further, the mine had implemented routine measurements of the sidewall crest and periodic face scanning. Groundwater monitoring was being undertaken as well as increased inspections by the mine’s geotechnical consultant.</p> <p>Pathway 2 Failure to heed clear warning signals</p> <p>The failure to detect the localised change in the palaeochannel at exploration meant that no adjustment to the wall design, or change to the mining sequence, was possible and the failure of the highwall was unable to be prevented during the mining process.</p> <p>Pathway 3 Flaws in risk assessment</p> <p>The change in the area of the last strip was identified during excavation and the mine organised an inspection by their geotechnical consultant. He identified an additional control of a 25 m coal buttress to be left in situ in front of the deepest areas of paleo channel material. This was put in place on 29 May 2015. This additional control provided for increased separation for mining equipment, however it was not sufficient to prevent the failure of the highwall.</p> <p>Pathway 4 Flaws in management systems</p> <p>Improved monitoring of the area from 29 May 2015 would not have prevented the failure but may have assisted in ensuring that no people could have been put at risk, by isolating the area and controlling the adjacent public road. It is unlikely that monitoring would have provided for adequate warning to allow for backfilling in the area in a safe and timely manner.</p>
References	<p>High potential incident – Open cut highwall failure adjacent to a public road. Moolarben Coal Operations adjacent to Ulan-Wollar Road, Mudgee</p> <p>https://www.resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/585836/IIR15-04-Moolarben-highwall-failure.pdf</p>

PowerPoint slides for case studies

NB: Due to the one hour duration of this program, it is recommended that only one case study is reviewed and discussed in detail. However, it is recommended that the facilitator covers off on the remaining seven case studies briefly to create awareness of other types of mine disasters included in this training package. The PowerPoint slides for the remaining case studies could be interspersed throughout the day as determined by the facilitator.

Aberfan, United Kingdom

Please see accompanying PowerPoint presentation. Some slides contain embedded video clips. The slides are designed to highlight the key findings of each incident review.



Case study: Aberfan, UK

21 October 1966

Principal Hazard – (i) Ground or strata collapse

Pattern of failure:

1. Design engineering and maintenance flaws

Failure to recognise debris pits as structures requiring maintenance.

2. Failure to heed clear warning signals

Previous debris slides occurred at Aberfan in 1944 and 1965.

Rainfall in 3 weeks prior resembled 1944 experience.

Slippage occurred day prior and day of the incident which should have triggered early warning system.

3. Flaws in risk assessment

Little or no risk management around debris tip management.



Fatalities: 144 (116 children)



9

Case study: Aberfan, UK

Pattern of failure:

4. Flaws in work health and safety management system

Lack of training and no accountability or responsibility of management to develop and maintain a safety system.

5. Flaws in system auditing

Failure to audit and inspect.

6. Economic/reward pressures compromising safety

It was argued that the costs involved in removing debris tips may have undermined worker positions.



Fatalities: 144 (116 children)



10

Case study: Aberfan, UK

Pattern of failure:

7. Failures in regulatory oversight

Role of the Inspectorate was only focused on safety of the miners. Lack of legislative imperatives to inspect or manage debris pits.

8. Worker, consultant and supervisor concerns prior to incident

Failure by the engineers to communicate with staff or around attendances or concerns raised.



Fatalities: 144 (116 children)



11

Case study: Aberfan, UK

Pattern of failure:

9. Poor management, worker communication and trust

Evidence of failure to share information on concerns or relevant incidents from local borough and workers.

10. Flaws in emergency procedures and resources

Poor communication systems on site negated possibility of last minute warning being given to Aberfan village.



Fatalities: 144 (116 children)



12

Gretley Colliery, Hunter Valley, NSW

Case study: Gretley, Hunter Valley, NSW

14 November 1996

Principal Hazard – (ii) inundation or inrush

Pattern of failure:

1. Design engineering and maintenance flaws

Flawed maps of working.

2. Failure to heed clear warning signals

Evidence of abnormal water prior to incident.

3. Flaws in risk assessment

Failure to assess risk of inrush.

7. Failures in regulatory oversight

Inadequate and poorly targeted enforcement activity.



Fatalities: 4 miners



20

Pike River Mine, New Zealand



Case study: Pike River, New Zealand



Fatalities: 29 miners

Time 13:20



15

Case study: Pike River, New Zealand

19 November 2010 - Principal Hazard – (ix) Fire/explosion

Pattern of failure:

1. Design, engineering and maintenance flaws

Decision to use hydro mining and the positioning of the main mine ventilation fan.

2. Failure to heed clear warning signals

Failure to respond to trends in atmospheric pressure and methane levels.

3. Flaws in risk assessment

Failure to risk assess hydro mining or UG main mine ventilation fan.

4. Flaws in management systems

Failure to maintain safety critical systems – stone dusting, ventilation, equipment.



Fatalities: 29 miners



16

Case study: Pike River, New Zealand

Pattern of failure:

5. Flaws in system auditing

No proper OHS audits conducted.

6. Economic/reward pressures compromising safety

Production pressure/cost cutting compromising safe work practices and incentive pay systems encouraging unsafe work practices.

7. Failures in regulatory oversight

Insufficient/inadequately trained or supervised inspectors.

Inadequate/poorly targeted enforcement.

Flaws in legislation – standards, reporting requirements, sanctions, workers rights.



Fatalities: 29 miners



17

Case study: Pike River, New Zealand

Pattern of failure:

8. Worker, consultant and supervisor concerns prior to incident

Failure to respond to supervisor, consultant and worker concerns about safety.

9. Poor management, worker communication and trust

Poor management response to worker, supervisor and union concerns leading to non-productive relationships.

10. Flaws in emergency procedures/resources

No second egress.

Unsatisfactory emergency response procedures post incident.



Fatalities: 29 miners



18

Cadia East Mine, Orange NSW

Case study: Cadia East Mine, Orange, NSW

21 February 2010 Principal Hazard – (I) Inrush

Pattern of failure:

1. Design, engineering and maintenance flaws

Drilling of tell-tale holes (not mandatory but best practice) – offered higher level of risk control.

2. Failure to heed clear warning signs

Increased evidence of water.
Failure to respond to a shaft blocked with slurry.

3. Flaws in risk assessment

Failure to address risk from wet reamed material.
Job Safety Environment Analysis (JSEA) had not been reviewed since 2006.
Lower order hierarchy of control employed (manned v remote bogger).



Photo depicting height of water during inrush

Fatalities: 0
7 miners at direct risk



21

Case study: Cadia East Mine, Orange, NSW

Pattern of failure:

4. Flaws in management systems

Failure to follow Safe Work Procedure (SWP).
JSEA not completed correctly but signed off by supervisor.

5. Flaws in system auditing

Failure to reviews JSEA's since 2006.
No inspection of bottom of VR5A by qualified engineer.
Failure to audit and reconcile the quantity of cuttings.

6. Economic/reward pressures compromising safety

Decision made to permit the raisebore to cut as quickly as possible in order to complete the VR5A shaft.



Photo depicting water during inrush

Fatalities: 0
7 miners at direct risk



22

Northparkes Mine, Parkes NSW



Case study: Northparkes Mine, Parkes, NSW



Rob Cunningham Mining Operations Manager
Northparkes Mine

Time 4:30



23



Case study: Northparkes Mine, Parkes, NSW



Block cave mining at Northparkes Mines

Time 3:10



24

Case study: Northparkes Mine, Parkes, NSW

24 November 1999

Principal Hazard – (i) inundation or inrush of any substance

Pattern of failure:

1. Design engineering and maintenance flaws

Allowing the bulkhead which was acting as a safeguard to come into the zone of influence of subsidence in the cave.

3. Flaws in risk assessment

Failure to appreciate the risks associated with the muck pile.

4. Flaws in management systems

Failure to recognise that the positioning of the bulkhead as a safety guard had been compromised.

6. Economic/reward pressures compromising safety

'Production rate took precedence over factors which concerned the safety of those within the mine' – Coroner Bailey.



Fatalities: 4 miners
Impact of explosion



25

Ravensthorpe Mine, Hunter Valley, NSW

Case study: Ravensworth Mine, Hunter Valley, NSW

30 November 2013

Principal Hazard – (vii) roads or other vehicle operating areas

Pattern of failure:

1. Design engineering and maintenance flaws

Intersection design and signage.

Background lighting.

Poor visibility around the truck at night.

Absence of illumination devices to enhance visibility.

Lack of collision avoidance systems.

Over reliance on administrative controls.



Fatalities: 1 miner



26

Cudal Limestone Quarry, Cudal NSW

Case study: Cudal Limestone Quarry, Cudal, NSW

27 August 2014

Principal Hazard – (x) a hazard identified under clause 34

Pattern of failure:

1. Design engineering and maintenance flaws

Failure to meet wiring requirements

Inadequate engineering to include multiple barriers to electric shock

5. Flaws in system auditing

No Earth to Neutral (E-N) link at main switchboard

Non compliant electrical work



Fatalities: 1 neighbouring resident



27

Moolarben Coal Operations, Ulan, NSW

Case study: Moolarben Coal Operations, Ulan, NSW

6 June 2015

Principal Hazard – (1) ground or strata failure

Pattern of failure:

1. Design engineering and maintenance flaws

Potential for instability had been identified but the impact on the roadway not considered

3. Flaws in risk assessment

Measures implemented to manage the risk were insufficient if preventing the failure of the highwall

4. Flaws in management systems

Improved monitoring may have assisted in isolating the area and controlling the adjacent public road.



Fatalities: 0
Public road adjacent



5. Participant resources

Case study templates with content removed for participants

Case study – Aberfan, United Kingdom

Date	21 October 1966
Location	Merthyr Vale Colliery, Glamorgan, South Wales (UK)
Principal Hazard NSW Mining Legislation	(i) ground or strata failure (ii) inundation or inrush of any substance
Incident details	<p>The Aberfan disaster was a catastrophic collapse of a colliery spoil tip in the Welsh village of Aberfan, near Merthyr Tydfil, on 21 October 1966, killing 116 children and 28 adults.</p> <p>It was caused by a build-up of water in the accumulated rock and shale, which suddenly started to slide downhill in the form of slurry.</p> <p>Over 40,000 cubic metres of debris covered the village in minutes, and the classrooms at Pantglas Junior School were immediately inundated, with young children and their teachers dying from impact or suffocation.</p> <p>Many noted the poignancy of the situation: if the disaster had struck a few minutes earlier, the children would not have been in their classrooms, and if it had struck a few hours later, the school would have broken up for half-term.</p> <p>Great rescue efforts were made, but the large numbers who crowded into the village hampered the work of the trained rescue teams and delayed the arrival of mineworkers from the Merthyr Vale Colliery. Only a few lives could be saved.</p> <p>The official inquiry blamed the National Coal Board (NCB) for extreme negligence. Parliament soon passed new legislation about public safety in relation to mines and quarries.</p>
Human and organisational factors	With few exceptions, regulators, government, the mine workers and the public had built a perception that the tip did not represent a risk to the community and efforts to manage risk were directed elsewhere.

	<p>Some members of the public had made complaints about the tip but the major concern had focused around the dumping of very fine material into the tip rather than the size of the dump. These protests were largely withdrawn when it was agreed not to dump any further fine waste on the tip.</p> <p>Men were given tasks and accountability for which they were not competent to undertake..</p> <p>A culture of poor communication and accountability existed within both the council and the NCB.</p> <p>The NCB was aware of the existence of a spring underneath Aberfan mine tip, yet failed to take action.</p>
<p>Critical controls</p>	<ul style="list-style-type: none"> ■ System to engineer and design debris pits ■ System to ensure monitoring and maintenance of debris pits ■ Systems to communicate information within organisation ■ Effective oversight by the regulator (NCB) – there was no policy related to mine tips, and they had failed to take action in regard to previous debris slides and minor slips leading up to the incident. ■ System of training and competency
<p>Patterns of failure</p>	
<p>References</p>	<p>http://aberfan.walesonline.co.uk/ http://www.mineaccidents.com.au/mine-accident/119/aberfan-disaster-1966 Source: Aberfan Tribunal Report Additional material: “Drift into Failure” Sidney Dekker (2011)</p>

Case study – Gretley Colliery, Hunter Valley, NSW

Date	14 November 1996
Location	Gretley Colliery, Hunter Valley, NSW
Principal Hazard NSW Mining Legislation	(ii) inundation or inrush of any substance
Incident details	<p>At about 5.30 am employees of The Newcastle Wallsend Coal Company Pty Limited were engaged in work on the night shift.</p> <p>Four men from a team of eight were in the process of developing a roadway (known as C heading) in an area of the mine called 50/51 panel, operating a continuous mining machine. The remaining four members of the team were in a crib room a little distance away.</p> <p>Suddenly, with tremendous force, water rushed into the heading from a hole in the face made by the continuous miner. That machine, weighing between 35 and 50 tonnes, was swept some 17.5 metres back down the heading where it jammed against the sides. The four men were engulfed by the water, swept away and drowned.</p> <p>The remaining team members survived the disaster by reason of being in the crib room, which itself was flooded.</p>
Human and organisational factors	<p>Individuals and the organisation failed to recognise subtle warning signs.</p> <p>The mine surveyor was new to the role and did not sufficiently question the accuracy of plans of adjacent workings provided by the NSW Government and Mine Subsidence Board.</p> <p>The undermanager failed to respond to concerns raised by the deputy or to investigate further when reports of water ingress were noted on inspection reports.</p> <p>The regulator failed to question the absence of any risk assessment.</p> <p>Cost pressures were involved around dewatering the adjacent workings and the perception existed that approval for implementation of dewatering methods would not be granted.</p> <p>Additional risk controls were due to be implemented but were not initiated in time to prevent the inrush (drilling ahead process).</p>

<p>Critical controls</p>	<ul style="list-style-type: none"> ○ Geo-technical data and systems of analysis ○ Inspection and monitoring arrangements ○ Training and competency of statutory processes for statutory roles ○ Systems of communication of information between shifts ○ Regulator over sight in relation to approvals for extraction
<p>Patterns of failure</p>	
<p>References</p>	<p>Report of a formal investigation under Section 98 of the Coal Mines Regulation Act 1982 by His honour Acting Judge J.H. Staunton (July 1998) https://trove.nla.gov.au/work/8874656?q&versionId=46593902 “Ten Pathways to Death and Disaster”, Michael Quinlan (2014) “Lessons from Gretley: Mindful Leadership and the Law”, Andrew Hopkins (2007)</p>

Case study – Pike River Mine, New Zealand

Date	19 November 2010
Location	Pike River Mine, Greymouth, South Island, New Zealand
Principal Hazard NSW Mining Legislation	(ix) Fire or explosion
Incident details	At 3.45pm there was an underground explosion at the Pike River coal mine resulting in 29 fatalities.
Human and organisational factors	<p>The cost of the mine development had exceeded its budget.</p> <p>Mine production had failed to meet the anticipated targets, and the commitments given to stakeholders, resulting in production pressure to complete unsafe work.</p> <p>The company ignored advice regarding risks associated with placing a main mine ventilation fan underground.</p> <p>High rates of staff turnover and inability to attract and retain skilled staff compromised safety systems.</p> <p>Lack of appropriate resources related to WHS systems and auditing.</p>
Critical controls	<ul style="list-style-type: none"> ○ Introduction to site process ○ Regulatory and legislative over-sight regarding 2nd egress ○ Regulatory and legislative over-sight regarding main ventilation fan location ○ Risk management controls for hydro mining technique ○ Mine systems to prevent prohibited items/contraband underground

Patterns of failure	
References	Final Report Pike River Royal Commission (30 October 2012) http://pikeriver.royalcommission.govt.nz/Final-Report “Ten Pathways to Death and Disaster”, Michael Quinlan (2014)

Case study – Cadia East Mine, Orange NSW

Date	21 February 2010
Location	Cadia East Mine, Orange NSW
Principal Hazard NSW Mining Legislation	(ii) inundation or inrush of any substance
Incident details	<p>An inrush of mud and water from an almost completed ventilation shaft partially flooded the underground workings. The ventilation shaft was being formed by raise boring.</p> <p>The inrush material travelled 814m along a roadway to the top of a second ventilation shaft where it continued to fall 375m down a shaft to a second level in the mine.</p> <p>The inrush pushed a 57 tonne manned bogger (front end loader) for 30 – 40m along a roadway and pushed a 5.7m tonne unmanned mini excavator an unknown distance along a roadway.</p> <p>Although no one died seven people were directly exposed to the risk of serious injury or death.</p> <p>“The dried mud left on the walls by the inrush was, in places, higher than a person. The height of the flow and the force would have had serious consequences for anyone caught in its path.” (P. 20)</p> <p>“The inrush was the result of an excessive build-up of reamed cuttings choking the raise bore shaft at its base and the subsequent build up of water and cuttings in the shaft bursting out from the bottom of the shaft.” (P. 33)</p>
Human and organisational factors	<p>Supervisors failed to recognise or respond to the increased evidence of water in the hours leading up to the incident.</p> <p>The organisation made the decision not to drill telltale holes.</p> <p>The risk assessment process failed to effectively identify the scope of risks associated with the activity.</p>
Critical controls	<ul style="list-style-type: none"> ○ Training and competency management system for supervisors ○ Inspection and monitoring arrangements ○ Safety management system monitoring and review process

Patterns of failure	
References	<p>Published Investigation Report prepared for the Director-General of the Department of Trade and Investment, Regional Infrastructure and Services by the Mine Safety Investigation Unit, Thornton. NSW</p> <p>https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0006/418416/Cadia-east-inrush-report-for-publication.pdf</p>

Case study – Northparkes Mine, Parkes NSW

Date	24 November 1999
Location	Northparkes Mining, Parkes NSW
Principal Hazard NSW Mining Legislation	(i) Ground or strata failure
Incident details	<p>The incident occurred during a period of maintenance shut down in Northparkes E26 Mine. At the time there were approximately 65 people working underground.</p> <p>The ore body above the cave back collapsed into the void, creating an air blast which travelled through underground workings of the mine, in particular through the exploration drive at One Level.</p>
Human and organisational factors	<p>The risk assessment process failed to effectively identify the scope of risks associated with the activity, which was uncommon in the industry at the time.</p> <p>The organisation did not have a comprehensive system in place for managing change in mining methods or process changes.</p> <p>The organisation failed to take action to correct engineered safety controls when they were compromised by the mining method adopted.</p> <p>Hazard management procedures required more specific definition (e.g., zones within the mine and muckpile heights).</p>
Critical controls	<ul style="list-style-type: none"> ○ Mine risk management system ○ Mine inspection and monitoring arrangements ○ Change management and approvals to mine process

Patterns of failure	
References	Findings and Recommendations – John Bailey, Coroner (2003) <i>Re: Inquest into the deaths of R Bodkin, M House, S Osman and C Lloyd-Jones on the 24th November 1999 at the E26 Lift 1 Mine North Parkes Mines, Parkes NSW.</i> http://eagcg.org/common/pdf/NorthParkesCoronial.pdf

Case study – Ravensworth Mine, Hunter Valley, NSW

Date	30 November 2013
Location	Ravensworth Mine, Liddell, NSW
Principal Hazard NSW Mining Legislation	(vii) roads or other vehicle operating areas
Incident details	<p>A mine worker suffered fatal injuries when the Toyota Landcruiser they were driving collided with, and was run over by, the front right-hand side wheel of a haul dump truck (Caterpillar 793D), weighing approximately 351 tonnes (including 186 tonnes of coal).</p> <p>The driver was the only occupant of the Landcruiser vehicle and approached a T-intersection with the stockpile ramp and proceeded to turn into the path of the truck. The truck operator saw the Landcruiser enter the haul road on their right but then lost sight of it.</p> <p>Approximately 10 months later, 4 people died in a similar fatal accident at the Freeport Copper Mine, Papua Province, Indonesia when a Caterpillar 785 haul truck accidentally collided with a shift change light vehicle with nine occupants.</p>
Human and organisational factors	<p>The driver may have recognised the presence of the intersection but was not able to detect the truck and/or observed the truck, but misinterpreted the road environment presented and what was required. (P. 2)</p> <p>Traffic management systems and the interaction between light and heavy vehicles on haul roads may have created the opportunity for collision.</p> <p>Design and construction of road bunding failed to consider possibility for obscuring visibility for light vehicles.</p> <p>Due to the height of the truck and its close proximity to the intersection, the lack of light coming from the bumper lights would have made it difficult for the Landcruiser driver to see the truck.</p> <p>Neither vehicles had proximity alert or collision avoidance systems installed. This is not currently legislated but is emerging best practice.</p>

<p>Critical controls</p>	<ul style="list-style-type: none"> ○ Mine engineering and design standard for haul roads and intersections ○ Traffic management system regarding light and heavy vehicle interaction ○ Training and competency system for operating light vehicles ○ Mine processes for lighting ○ Light vehicle specification and maintenance system
<p>Patterns of failure</p>	
<p>References</p>	<p>Investigation report</p> <p>Investigation into a fatal collision between a Caterpillar 793D haul dump truck and a Toyota Landcruiser at Ravensworth open cut mine on 30 November 2013.</p> <p>Report prepared by the NSW Mine Safety Investigation Unit for the Secretary of NSW Trade & Investment</p> <p>March 2015</p> <p>https://www.resourcesandenergy.nsw.gov.au/_data/assets/pdf_file/0005/553523/Ravensworth-Investigation-Report.pdf</p> <p>https://www.sbs.com.au/news/deaths-at-us-mine-in-indonesia</p>

Case study – Cudal Limestone Quarry, Cudal NSW

Date	27 August 2014
Location	Cudal Limestone Quarry, Cudal, NSW
Principal Hazard NSW Mining Legislation	Under WHS Act
Incident details	<p>A resident of a neighbouring property to the Cudal Limestone Quarry was found deceased. The house was supplied with electricity from the quarry's electrical supply. The deceased woman appeared to have suffered a fatal electric shock.</p> <p>The house was approximately 250 metres from the crushing plant, which was supplied by a three-phase overhead line.</p> <p>Electrical testing identified that when the electrical supply was on and the crushing plant was operating, excessive voltage appeared at the house earth stake and water pipes. A phase-to-earth fault was identified on a motor supply cable.</p>
Human and organisational factors	<p>The organisation allowed a non-compliant electrical installation to operate on the site.</p> <p>Electrical work at the site was not completed to a sufficient standard to meet legislative and Australian Standard requirements.</p>
Critical controls	<ul style="list-style-type: none"> ○ Site standard and statutory compliance program for electrical installations ○ Site electrical maintenance program ○ Site electrical inspection program ○ Site program for training and competency for electrical work

Patterns of failure	
References	Information release – NSW Mine Safety Investigation Unit 3 February 2015 https://www.resourcesandgeoscience.nsw.gov.au/_data/assets/pdf_file/0009/54247/5/IIR15-01-Fatality-at-house-near-quarry.pdf

Case study – Moolarben Coal Operations, Ulan, NSW

Date	6 June 2015
Location	Moolarben Coal Operations, Ulan, NSW
Principal Hazard NSW Mining Legislation	(i) Ground or strata failure
Incident details	<p>Regular open cut mining operations were being undertaken on the morning of 6 June 2015 when a section of the highwall adjacent to a public road failed. There was nobody in the immediate area at the time of the slump.</p> <p>The failure was about 160 metres wide and approximately 55 metres high. The highwall edge before the failure was 40 metres from a public road and 12 metres after the failure.</p> <p><i>Contributing factors</i></p> <p>A palaeochannel infill sequence of materials had been exposed during recent mining operations. It included materials that had not been identified in geological modelling. A palaeochannel is a remnant of an inactive river or stream that has been filled or buried by younger sediment. This palaeochannel was locally deeper than previously exposed and comprised of differing lower level sediments. The increased thickness of the channel consisted of relatively loose silty sands and weaker clays which were at the base of the palaeochannel infill at the top of the coal seam.</p> <p>The upper 25 m of materials were stiffer and stronger and it is believed these have caused overstressing of the clays and infill sands. Undrained pore pressure is believed to have triggered localised liquefaction and lubricated the fissures within the clays.</p>
Human and organisational factors	<p>Inspections and geo-technical data failed to identify the palaeochannel.</p> <p>The organisation and management team believed that that the additional monitoring and the implementation of the buttress wall would be sufficient to prevent slippage.</p>
Critical controls	<ul style="list-style-type: none"> ○ Mine monitoring and inspection system ○ Authority to mine process ○ Mine planning process

Patterns of failure	
References	High potential incident – Open cut highwall failure adjacent to a public road. Moolarben Coal Operations adjacent to Ulan-Wollar Road, Mudgee https://www.resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/585836/IIR15-04-Moolarben-highwall-failure.pdf

Discussion activity templates

Instructions: These activities are designed to be conducted in conjunction with the PowerPoint presentation and workshop, *Learning from Disasters – program 1*.

Activity 1 – Identifying principal hazards in mining environments

In pairs/groups work through the list and confirm which principal hazards are present in your workplace. Reflect on why some of the hazards are particularly challenging to manage in your operating environment.

References:

WHS Regulation 2017 Part 3.1 34 and WHS(MPS) Regulation 2014 – Part 1 (5)

LEGISLATION REFERENCE	TYPE OF HAZARD	TICK IF PRESENT IN YOUR MINING ENVIRONMENT
(i)	ground or strata failure	
(ii)	inundation or inrush of any substance	
(iii)	mine shafts and winding systems	
(iv)	gas outbursts	
(v)	spontaneous combustion	
(vi)	subsidence	
(vii)	roads or other vehicle operating areas	
(viii)	air quality or dust or other airborne contaminants	
(ix)	fire or explosion	

Are there any additional hazards that are not listed?

(x)	a hazard identified by the mine operator under clause 34 of the WHS Regulations Clause 34 - Duty to identify hazards “A duty holder, in managing risks to health and safety, must identify reasonably foreseeable hazards that could give rise to risks to health and safety ”
	List any additional hazards here:

Activity 2 – Learning the lessons

Step 1:

Discuss each of Quinlan’s Pathways by reading the description provided.

Step 2:

In groups/pairs reflect on the case studies contained in the workshop and Quinlan’s 10 Pathways.

Discuss and identify two of Quinlan’s pathways that you believe **present the greatest possibility of a safety failure in your workplace?**

Use the sample questions to prompt your discussions. After considering the factors in your workplace, circle the two pathway numbers you have selected as highest priorities.

Consider the evidence you have to support your position. Each group will be asked to present their views for group discussion.

PATHWAY	PATHWAY DESCRIPTION	SAMPLE PROMPT QUESTION	SUPPORTING EVIDENCE
Pathway 1	<p>Design, engineering and maintenance flaws.</p> <p>Latent flaws originating from decision making by the mine operator and in some cases expert consultants, with technologies that were not overly complex or deficient. In most cases the flaws were known or should have been detected before the incident.</p>	<p>Do you have pro-active systems, policies or procedures that ensure design, engineering or maintenance flaws are identified in your planning stages?</p> <p>Is there evidence of design or engineering flaws in your operations?</p> <p>How well is plant and equipment maintained to avoid health and safety incidents?</p> <p>Have you allocated sufficient budgets to ensure required maintenance cycles are maintained?</p>	<p><i>Example only: Poorly designed process which is routinely bypassed by staff</i></p>

PATHWAY	PATHWAY DESCRIPTION	SAMPLE PROMPT QUESTION	SUPPORTING EVIDENCE
<p>Pathway 2</p>	<p>Failure to heed clear warning signals</p> <p>In some cases prior warnings or causes for alarm were ignored. Problems with regard to well-known hazards were ignored, overlooked or withheld. Prior incidents were not fully investigated nor had they triggered a risk assessment. Warning signs had been ignored or had not been recognised.</p>	<p>Is there evidence that warning signals relating to safety incidents are not being responded to?</p> <p>For example, how well are near miss incidents recorded? How consistent and effectively are investigations conducted after incidents occur?</p> <p>Do these investigations include a range of stakeholders including technical and worker representation?</p>	
<p>Pathway 3</p>	<p>Flaws in risk assessment</p> <p>Failures in risk assessments or even the failure to conduct risk assessments in a meaningful way. Risk assessments should not be generic and need to be informed by knowledge of the hazard being addressed, suitable control measures, monitoring and revision.</p>	<p>How confident are you that the risk assessments and processes you use are current and valid?</p> <p>When was the last time you completed a full review of your safety management system and in particular the risk management framework, tools, policies and procedures?</p> <p>How do you determine whether your risk management approach is succeeding?</p>	

PATHWAY	PATHWAY DESCRIPTION	SAMPLE PROMPT QUESTION	SUPPORTING EVIDENCE
Pathway 4	<p>Flaws in management systems</p> <p>Management systems failed to deliver effective control of well-known hazards. Safety management systems were full of gaps, biases and a preoccupation with key performance indicators (KPIs) or changes in work organisations.</p>	<p>What evidence do you have that your health and safety management system is effective in controlling known hazards?</p> <p>Do you understand and ethically apply the hierarchy of control when considering the most effective risk control/s to introduce?</p> <p>What lead (positive) indicators do you use to measure the success of your safety management systems?</p> <p>Do these measures include both quality and quantity expectations?</p>	
Pathway 5	<p>Flaws in system auditing</p> <p>Failure in auditing or monitoring to verify that controls and safe work practices were in place. This failure to audit meant unsafe conditions and bad decisions were overlooked or uncorrected.</p>	<p>What evidence do you have of an effective auditing and monitoring program? How well are outcomes and recommendations managed?</p> <p>Do you ensure effective system auditing occurs through strategies such as three lines of defence?</p> <p>Are the outcomes of your internal and external audits shared</p>	

PATHWAY	PATHWAY DESCRIPTION	SAMPLE PROMPT QUESTION	SUPPORTING EVIDENCE
		widely amongst the management and supervisor group?	
Pathway 6	<p>Economic/reward pressures compromising safety</p> <p>Pressure due to financially troubled operations. Production overly focused on operations through substantial bonuses and incentives. These may have contributed to a number of disasters.</p>	<p>Is there evidence that a focus on production has contributed to poor health and safety outcomes?</p> <p>Do your managers and supervisors have the authority to stop production where a serious health and safety breach or issue is identified?</p> <p>Would they be supported by senior management if they did decide to stop production?</p>	
Pathway 7	<p>Failures in regulatory oversight</p> <p>Serious non-compliance with existing regulations, gaps in regulatory frameworks and lack of regulatory oversight and inspection have all been identified as causes.</p>	<p>How effective do you believe the regulatory approach and practices are in identifying and managing health and safety risks effectively?</p> <p>What additional strategies of assistance would you like to see offered by the Resources Regulator to improve WHS outcomes in the quarry sector?</p> <p>What has been your experience when dealing with regulatory</p>	

PATHWAY	PATHWAY DESCRIPTION	SAMPLE PROMPT QUESTION	SUPPORTING EVIDENCE
		workers such as WHS inspectors? Do you believe they have contributed to WHS improvements in your workplace?	
Pathway 8	<p>Worker, consultant and supervisor concerns prior to incident</p> <p>The concerns of workers and others were not considered or ignored. Workers did not appear to have been meaningfully consulted.</p>	<p>Is there evidence of a failure to adequately address concerns of safety?</p> <p>How do you ensure reports of hazards, risks or process safety matters are appropriately addressed and reported back to the person initiating the concern?</p> <p>What systems do you have in place?</p> <p>Who has oversight and responsibility for ensuring your system works?</p>	
Pathway 9	<p>Poor management/worker communication/trust</p> <p>Effective communication and the trust (not to be confused with harmony) that flows from it was missing. This would have enabled dialogue on critical safety issues.</p>	<p>Is there evidence of positive and constructive communication processes between management and workers around health and safety issues?</p> <p>Do you believe the consultation mechanisms under the <i>WHS Act 2011 and</i></p>	

PATHWAY	PATHWAY DESCRIPTION	SAMPLE PROMPT QUESTION	SUPPORTING EVIDENCE
	Poor relationships between managers and workers feature in many investigations as there were no constructive communication processes in place.	<p><i>WHS (MPS) Act 2013</i> (i.e.: health and safety representatives) are working effectively?</p> <p>Are these mechanisms supported and nurtured by your mine management team?</p> <p>Do you believe workers at your site get the opportunity to influence the outcome in relation to WHS matters such as the selection of risk controls?</p>	

Pathway 10 **Flaws in emergency procedures/resource**

Emergency and rescue play a role in mitigating escalation, enabling withdrawal or rapid evacuation. In many inquiries this was found to be deficient.

Is there evidence of effective emergency management and rescue procedures in place?

Is there evidence of regular communication around the procedures and testing?

How often do you review your emergency management systems apart from undertaking regular drills

Facilitator feedback

Please provide your feedback on this course at the following link:

www.surveymonkey.com/r/facilitatorLFDP1

Participant feedback

Note: Approved Training Providers must email the following Survey Monkey link to each participant and request participants complete the survey within 10 days of undertaking the course:

www.surveymonkey.com/r/LFDProgram1