MSAC FATALITY REVIEW 2013-14

Report for NSW Mine Safety Advisory Council

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October 2014

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Revision Log

Revision date	Ver	Revision description
15 October 2014	0.1	Exposure Draft
21 October 2014	1.0	Final
31 October 2014	1.1	Final 2

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CONTENTS

EXECUTIVE SUMMARY

Noetic Solutions Pty Ltd (Noetic) was contracted by the NSW Department of Trade and Investment (the Department) to examine four fatal incidents which occurred in 2013/2014 in the New South Wales mining industry (including companies, workforce and regulator). Noetic were asked to:

+ consider the current industry circumstances

+ identify contributing factors to the incidents using information available to the Department

+ explore systemic and underlying issues that may influence serious incidents.

Interim observations were presented to the Mine Safety Advisory Council (MSAC) on 4 September 2014, with the current report finalising Noetic's findings.

The four incidents were:

+ a single fatality which occurred on 30 November 2013 at Ravensworth Open Cut Mine when a haul truck collided with a light vehicle

+ a double fatality on 15 April 2014 at the Austar Coal Mine in the Hunter Valley when a rib burst occurred

+ a single fatality on 21 May 2014 involving a mobile elevated work platform, where the deceased was trapped by the head between the platform's safety rail and part of the structure being built

+ a single fatality on 11 June 2014 when a worker entered water in a sump to clear a borehole and disappeared beneath the surface and was found trapped by his leg in the borehole under the water.

Noetic did not find any obvious immediate similarities between the incidents. However, there were a number of possible common factors which it is recommended that the MSAC should consider. From the information provided Noetic concluded that three of the four incidents represented the tragic outcome of well-known risks in the mining industry. Given this finding, Noetic then looked for evidence of the extent to which the controls for these risks are *normally* implemented in the mining industry (i.e. when no incident has occurred). This is important to help determine if these incidents are exceptional and how well risk controls are routinely implemented. Unfortunately, apart from some limited information mainly in relation to specific incidents, this type of information was not readily available. Noetic believes information on the implementation of controls for significant risks should be available to industry in a form which supports their ability to formulate appropriate incident prevention strategies.

Noetic makes three recommendations in the Report:

Recommendation 1: MSAC should consider how information on the implementation of risk controls for significant risks could be routinely collected, analysed and used to support a data led accident prevention strategy.

Recommendation 2: Drawing on the discipline of Human Factors, including human and organisational factors expertise, identify the reasons which make it more likely risk controls will be successfully and reliably implemented.

Recommendation 3: Consider if the regulator should explicitly focus on critical controls for significant risks as part of an incident prevention strategy.

INTRODUCTION

Aim and Scope

The aim of this report is to provide advice to MSAC in accordance with the letter and Terms of Reference sent to Noetic dated 4 August 2014 by NSW Trade and Investment (attached as Annex A). We were advised that the Minister was concerned at the apparent increase in significant incidents at the same time as substantial adjustment and change was taking place in the industry. We were further advised that although the incidents were being thoroughly investigated, the Minister believed there was a role "…for a deeper… examination of current circumstances to ensure…any systematic and underlying issues…are identified and responded to." This Report describes the nature of the information available to us, the approach taken to examine the information including assumptions, an introduction on the concept of incident causation and a discussion of the current incidents from this perspective, and the conclusions drawn.

The Review was conducted over 11 days in August and September and prepared in early October. This period allowed for meetings in Sydney and in the Hunter region, reading time and analysis of the information. At the time of conducting the Review the incidents were still under investigation and any details on the four incidents reflects material made available by the Department in August. As a result it is possible that additional material about the specific incidents will become available. However, the Review is focussed on broader systemic issues and it is unlikely that additional detailed information about the incidents would have altered Noetic's conclusions.

It should be noted that the Terms of Reference require us, amongst other things, to "consider current industry circumstances." We have interpreted this to include current *economic* circumstances. It was put to us by a member of the Panel that in a time of economic trouble, particularly for the coal industry in New South Wales, this would inevitably result in concern amongst the workforce for the future of their jobs. In turn this could result in cost cutting on safety and pressure (real or imagined) by some in the workforce not to report safety concerns because of the economic climate. Equally, it is not unknown for economic turbulence, as was being encountered by coal mining in particular at the time or writing, to result in structural changes through mergers and acquisitions which again can add to uncertainty about employment.

Noetic has carefully considered the potential impact of concerns about employment prospects. We do not doubt that this is a legitimate concern. Not surprisingly, there is no evidence available to Noetic to support or reject the impact that economic circumstances have on the safety 'climate'. This is not to say that the economic climate does not have an effect or that data may become available but just that such information is not available at the time or writing. Given the absence of data that would be susceptible to analysis regarding these issues, Noetic has not further considered the link between the economic climate and these particular incidents.

APPROACH

Information

In approaching this Review, Noetic has worked from the presumption that all fatalities are preventable and this concept is a central idea of our analysis. As such, we must consider if any underlying issues that influence

serious incidents can be identified. This Review explains what we did, our underlying assumptions and reasoning and makes recommendations based on our findings.

The Department provided us with a great deal of information on mine safety including incident and accident statistics (from the COMET database) and data on the activities of the Department (from the *NSW Mine Safety Performance Report 2012-13*). In addition, following the MSAC meeting on 4 September we received, as requested, examples of audit reports and related material from the Director Mine Safety Operations and Chief Inspector of Mines and Coal Mines.

The Department also facilitated a meeting with the staff of the Investigation Unit. They provided a very useful briefing on each of the fatal incidents and fully engaged in discussion about them which Noetic found very helpful. They subsequently provided additional information following a request made by Noetic.

All of the written material reviewed came from the Department.

Process

We started the Review looking at the specific circumstances of the four incidents and other serious incidents in the recent past. We also looked at the broader background to safety in the NSW mining industry and the economic circumstances in the industry. We did this by:

+ Reading the publically available Information Releases on the four fatal incidents prepared by the Investigation Unit

+ Reviewing completed investigation reports on a number of serious incidents from 2013 and 2014

+ Reviewing a large quantity of data on incidents, incidents, other reportable matters contained in NSW Trade and Investment documents and its COMET database.

+ Receiving a detailed briefing from the Investigation Unit and subsequently requesting and receiving additional information from them

+ Collecting information on the current circumstances, including the economic circumstances of the industry using Noetic sources of information.

Early in our review of this material and discussions we came to the conclusion that a threshold question needed to be answered if we were to meet the requirements of the Terms of Reference to “explore systemic and underlying issues that may influence serious incidents”. This question was “were there any systemic issues that may have contributed to these four tragic incidents?” Are they one-off incidents with no wider significance? To answer this question Noetic was required to determine if the risks evident from these fatalities were known in the industry and how well these risks were generally controlled in industry. However, we acknowledged that the absence of incidents does not necessarily mean that all the relevant risk controls are working effectively. This issue is discussed in more detail in the next section.

INCIDENT CAUSATION

Incident Causation Model – How are incidents caused?

In analysing incidents of any type it is important to acknowledge that we all have some experience of incidents. In practice, we have, to a greater or lesser degree developed some assumptions about how incidents occur. Our mental model of incident causation may also be shaped by our personal experience. This experience can range from minor kitchen incidents, other household mishaps and car crashes to industrial incidents or even major disasters. Mental models shape our thinking and analysis of incidents. Consequently we believe it is important to set out the model Noetic has used for this work.

Methods for the assessment of industrial incidents have evolved over the years. Early approaches which focussed primarily on the behaviour of the individual were in time supplemented by techniques which considered the impact of known influences on the individual such as fatigue, distractions, inadequate equipment, poor procedures, undue production pressures and so on. Both approaches had the individual as the focus of the assessment.

By the 1990s the recognition of the importance of broader managerial influences and the success of the quality movement and its systems orientated approach led to the development of formal safety management systems and in time national and international standards for safety management. At around the same time, James Reason's work in a number of articles and in particular his 1997 book, *Managing the Risk of Organizational Accidents*,[1] were influential in improving understanding of human error and bringing to greater notice the discipline of Human Factors, a branch of Psychology.

A key development was a better understanding of human error; that human error is part of the human condition and cannot be eliminated. However, defences (or controls) can be put in place to reduce the frequency and/or consequences of human error. The concept of the 'hierarchy of control' explicitly recognises this and places engineering controls higher up the hierarchy of preference as a means of risk control than those which are inherently more vulnerable to human error such as following a procedure. In practice, managing any one risk is usually much more complex and requires a rich mix of engineering and procedural controls, assuming the risk cannot be eliminated.

Since the late 1990s there has been a greater recognition of so called organisational factors in incident causation. This draws on both organisational psychology and other disciplines and has illuminated how individuals operate within organisational structures, processes and systems, and their contribution to incidents.

Modern incident causation models integrate all of the above. The best known is the so called 'Swiss cheese model' popularised by James Reason and which forms the basis for a number of proprietary incident investigation tools widely used in industry including mining.

[1] James Reason, 1997, "Managing the Risks of Organizational Accidents", Ashgate Publishing.

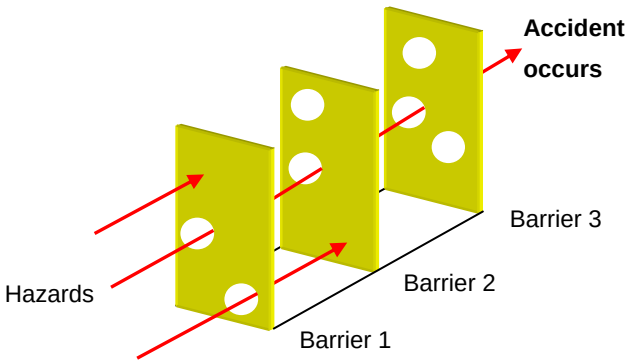

Figure 1. Swiss Cheese Model of Incident Causation

This model assumes that discrete barriers (or risk controls) to prevent incidents from occurring can be identified. These controls are represented graphically as slices of Swiss cheese, as indicated above. The model assumes all risk controls are imperfect and have 'holes' or weaknesses, which represent an opportunity for an incident to occur. Risk controls include engineering controls (roof bolting), systems or processes (management of change procedures), controls intended to ensure individuals can carry out assigned duties safely, training and competence assurance schemes and organisational level controls such as the provision of certain structures to ensure appropriate governance over safety. In practice, a number of different types of barriers are usually needed.

There are some important assumptions which lead from this type of model. These are:

+ **Multiple-causation** – Incidents are seen as not just arising from a single cause, but from a combination of conditions. These may be associated with individual behaviour, characteristics of the task or working environment, or wider organisational issues.

+ **Immediate and underlying cause** – While most incident investigations typically identify the immediate triggers or causes of an incident such as the failure to follow a procedure or the use of the wrong equipment, many investigations fail to address the underlying causes of these conditions. These causes are typically characterised as those organisational and management policies (that is the system factors) that create the preconditions for incidents.

+ **Controls are imperfect** – Few risk controls are perfect. The Swiss cheese model illustrates why it is possible to have imperfect controls but no incident. It is only when the holes 'line up' that an incident occurs.

This last point will become particularly important in this Report. A key underlying assumption is that it *is* possible to identify the relevant risk controls to prevent incidents (and this is an important aspect of the mining safety legislation). Furthermore, controls can be imperfect but this does not necessarily lead to an incident because of the defence in depth idea explained in the Swiss cheese model. An incident only occurs in the presence of other failures. The corollary to this though is that successful incident prevention requires identification and fixing of the defences before an incident occurs. This Report will argue that we have inadequate information about the status of risk controls (with some exceptions) and we have most information

once an incident has occurred. This is an important aspect of this Report and is discussed in subsequent sections of this Report.

THE 2013-14 INCIDENTS

This section of the Report provides a summary of each incident drawn from information provided by the Investigations Unit and a high level comparison of the incidents prepared by Noetic.

Incident Summaries

a. **Ravensworth Open Cut Mine**, **Ravensworth**. Single fatality occurred on 30 November 2013. The incident occurred when a large haul truck collided with a light passenger vehicle on the main haul road at a T-intersection. The incident occurred at night, with ambient light over the intersection. The roads were noted as wet and muddy but it was not raining at the time of the incident. The review of the incident indicates that the light vehicle approached the right side of the haul vehicle when making a right turn onto the main haul road from the ROM stockpile ramp. The right turn intersected with the direction of travel of the haul vehicle along the main haul road. The victim was the driver of the light vehicle.

b. **Austar Coal Mine**, **Hunter Valley**. Double fatality occurred on 15 April 2014. The fatal incident occurred when there was a major burst of coal from the mine rib. At the time of the incident, several workers were operating a bolter miner and shuttle car to develop a gate road for a future longwall panel. The two men that died in the incident were working in an area close to the rib on the left hand side of the bolter miner. When the rib burst, the material caused by the burst engulfed both men killing them at the scene. The other miners were evacuated and escaped injury. Current investigations do not suggest that the rib burst due to gas.

c. **Boggabri Coal Mine**, **Boggabri**. Single fatality occurred on 21 May 2014. At the time of the incident the deceased was operating a mobile elevated work platform (MEWP) and trapped his head between the safety rail protecting the operator's console and a 600 mm steel beam overhead. Prior to the incident, the worker was observed standing alone in the MEWP basked with only a small distance between the worker's safety helmet and the steel bar overhead. It was noted that no movement of the MEWP basket was possible unless the foot control was continuously activated by the operator. The position of the deceased was facing the control panel with his jaw on the safety bar and the back of his head against the steel beam.

d. **CSA Mine**, **Cobar**. Single fatality occurred on 11 June 2014. The fatality occurred when two workers were attempting to clear a blockage in a borehole at the base of a sump. The sump (which drains through the boreholes) contained a considerable volume of water. When attempting to unblock the borehole with a scaling bar, the bar was accidentally dropped into the water. The deceased entered the water in an attempt to retrieve the bar, but disappeared under the surface. Following activation of the emergency procedures and search and rescue attempts, the worker was found below the surface with his leg trapped in a borehole. Due to the pressure of the water, it is likely that he was unable to remove his leg from the hole. The hole had a diameter of 180mm and was 30m deep. A strainer, normally fitted in the borehole, was found nearby and it is not known if it was fitted at the time, or if not, how it was separated. It was also noted that the borehole would not have been visible from the surface.

Incident Additional Lines of Inquiry with the Department included

Noetic examined the incidents using the following lines of inquiry with the department:

+ What activity was underway at the time of the incident? For example was it a construction activity, longwall mining, transport and so on.
+ What were the employment circumstances of the deceased; employee of mine operator, contractor, other?
+ What was the age/experience of the deceased?
+ What time of day did the incident occur and how long was this into the shift for those involved?
+ What was their recent work pattern; hours and shifts worked?
+ What controls were intended to be in place for the activity and how would these be classified in accordance with the 'hierarchy of controls'?
+ To what extent were these controls to be implemented by the deceased and/or the work team involved.
+ Was a supervisor present at the time of the incident?
+ To what extent are incidents of this type or category known in industry in general?

The Incidents Compared

Our first consideration was whether the number of fatalities in 2013-14 constituted a statistically significant 'spike' in fatal incidents. Although this was not explicitly included in the Terms of Reference, we saw value in viewing the frequency of incidents in the context of the historical data. Using a standard statistical method the long-term data was analysed.[2] Within the past 17 years, the only statistically significant 'spike' in fatalities was 1999-2000, where 11 fatalities were recorded. The 2013-14 year, with 5 fatalities, cannot be considered a significant outlier.[3] Despite this finding, the 2013-14 year saw the most fatalities since the spike in 1999-2000.

The four incidents involve quite different activities. Two occurred at open cut coal mines, one at an underground coal mine and the fourth at a metalliferous mine. One involved surface transport, one was a construction activity, another involved underground maintenance and the last involved cutting coal with a continuous miner. The deceased were both employees of mine operators and contractors. The deceased ranged in age and experience from 26 to 50 years of age. The least experienced had ten months experience and the most experienced eight years. In the six days leading up to the incident four of the deceased had worked 42 hours or less. One had worked 65 hours. Incidents related to large truck/light vehicle collisions, rib bursts and mobile elevated work platforms are well known in the mining industry or industry in general. While

[2] The statistical method used was the Grubb Test with a significance value of 0.05. The data provided by MSAC included the previous 17 years until 2014.

[3] The mean number of fatalities per year within the data set was 2.47 with a standard deviation of 2.67. The number of fatalities during 2013-14 was 5 and this falls within 1 standard deviation of the long-term mean, thus cannot be considered significant.

drownings have previously occurred in the mining industry, from the information available to Noetic at the time of writing we do not know if incidents of this *type* have previously occurred.

The Investigation Unit has provided detailed information in response to these questions. Noetic is grateful to the Investigation Unit and its personnel for its detailed and prompt assistance with these issues. Due to the sensitivity of the information, given that Coronial Inquiries have yet to take place and other Court proceedings may take place, Noetic has given careful consideration to the extent to which the detailed information provided by the Investigation Unit is reproduced in this Report. Following consultation with NSW Trade and Investment, Noetic has prepared a summary table (Annex F) which provides a comparison of a number of the lines of inquiry.

Noetic concludes there are no obvious or immediate similarities between the incidents. However, Noetic will consider if there are any underlying issues which may contribute to serious incidents, in accordance with the Terms of Reference. In particular, we will return later in this Report to the implications of the observation three of the four incidents are of a type of incident well known in mining or more widely in industry.

Analysis – Common Themes?

Although we have said "…there are no obvious or immediate similarities between the incidents," based on the above summaries, there are some *possible* common themes. First, three of the four incidents were described to us by the Investigations Unit as "well known" or "known risk". Second, the same three of the four incidents are activities considered routine in the mining industry.[4] If these assumptions are correct; that is that most of the incidents represent known risks from routine activities, then this begs the question of why are well known risks not effectively controlled? There is no easy answer to this question. However, there is a preliminary question which should be easier to answer, namely:

+ How well implemented are the controls for these apparently well-known risks in the normal conduct of work at mine sites?

These issues are discussed in the next sections of the Report. But first we need to recap on the accepted views on incident causation and the implications of this approach.

How Well Are Risk Controls Implemented?

To help us make a judgment as to whether the fatal incidents were one-off incidents or if there are systemic issues, we need to clarify the answer to the question posed earlier, namely: how well implemented are the controls for these apparently well-known risks in the normal conduct of work at mine sites? We will draw on the risk control approach that is guided by the 'Swiss cheese model' outlined above.

We looked for this information in the reports provided by NSW Trade and Investment. Noetic carefully considered the material provided. Most of the data provided consisted of data about the *activities* carried out by the Department or was information about *incidents* which is required to be reported by law. For example, the *Mine Safety Performance Report 2012-13* contains detailed information about the *activities* they have carried out in terms of the number of inspections and enforcement action, but not on the *results* of inspections.

[4] Note: Noetic did not have sufficient information at the time of writing to judge if the fourth incident, the drowning was a routine activity and a known risk, and so for the purposes of this discussion it has been excluded

We assume the inspection outcomes would inform what was found on mine sites and allow a comparison with legislated requirements.

There is also a significant amount of information about the incidents (and other data) required to be reported to NSW Trade and Investment. However, as noted earlier, incidents are relatively rare and it is important to obtain a more complete picture of what is routinely happening by examining how well controls for significant risks are implemented even when no incident has occurred. Note that the Swiss cheese model explains how defective controls do not necessarily lead to an incident.

We regard this as important information which should be available to the industry. Our assumption is that such information is of benefit on a number of levels. It should assist Trade and Investment in directing its resources to decide what the priorities are for its proactive prevention strategies. This should also assist in helping to decide what to inspect or audit and which resources to apply, assist mine operators with their compliance activities, and provide a vehicle for informing the workforce on areas of importance.

When this topic was discussed at the MSAC meeting on 4 September 2014, we were advised that this type of information, namely how risk controls were implemented for significant risks as a matter of routine, *was* available in Mine Safety audit reports. A sample of these was provided to us, for example the *Safety Audit Report for Metalliferous and Extractive Mines* dated February 2011. After reviewing the material, our hypothesis is that if we accept the prevailing view of how incidents are caused and can be prevented (and as is reflected in the relevant legislation), then an important activity for industry is to know how well controls are implemented in practice. However, the Safety Audit Report is actually a "…desktop assessment of documents…"[5] and does not contain this implementation detail. This is not a criticism of the document, which so far as we can tell met the objectives set for it, however it does not contain the risk control implementation detail other than at a high level (in systems and plans) and does not look at the implementation of the controls in practice. To know whether or not a control is robust or not we need to know if it is applied effectively where it is needed. This Safety Audit Report does not do that but nor was it intended to. We have carried out a more detailed analysis of the documents supplied to us after the September MSAC meeting in Annex C.

We concluded the documents provide relatively little information on how well risk controls are applied in practice. We accept that the information does exist to some extent. However, it does not seem to exist in a structured, documented form which can be used to direct industry safety strategies.[6]

As a result, we recommend that MSAC reviews the information available to the industry about how effectively risk controls are implemented in practice for the most significant risks,[7] given the currently accepted incident causation theory and practice and the underpinning assumptions in the legislation. This should also help to answer the related question of "how well known are the controls for these risks to those who have the responsibility to implement the controls?" In practice, leadership of this task usually falls to bodies such as MSAC and government regulators. We have provided an example of how another regulator from the upstream oil and gas sector has presented this sort of information in Annex D.

[5] Safety Audit Report for Metalliferous and Extractive Mines dated February 2011, page 11.

[6] It should be noted that the only documented information made available to Noetic for this "Desk Top Review came from NSW Trade and Industry.

[7] By significant we mean those which have the potential to cause widespread injury or ill-health (even if the consequences are not life threatening), risks which have the potential to cause fatalities and risks which even if very rare have the potential to have catastrophic consequences from one event (such as an underground explosion) or from an occupational health perspective.

Recommendation 1: MSAC should consider how information on the implementation of risk controls for significant risks could be routinely collected, analysed and used to support a data led incident prevention strategy.

Why are Controls Implemented Effectively/Ineffectively?

Answering the question as to how well controls for these apparently well-known risks are implemented in the normal conduct of work at mine sites should also help us to understand *why* controls *are* or *are not* effectively implemented. It does not appear that this information is currently available. We believe it would be beneficial to the industry to know the reasons *why* risk controls for significant risks are or are not effectively implemented.

Making judgments on the reasons why controls are implemented the way they are will require more than the usual engineering and technical skills which predominate in the industry. To give one narrow example, in a number of key industrial sectors, Noetic routinely sees poorly drafted and presented safety critical documents, such as operating procedures which have not drawn on the extensive body of knowledge on effective communications. However, we emphasise this is but one narrow example. We believe answering the question as to why controls are implemented as they are will require expertise in human and organisational factors as applied to industrial safety.

This leads to our next recommendation. Assuming Recommendation 1 is accepted and decision is made to observe how controls are implemented in day to day operations (at least for the more significant risks) then this could provide an opportunity to assess why the controls were implemented as they are. If they are found to be effectively implemented, then what are the reasons for this, and if not, why not?

Recommendation 2: Drawing on the discipline of Human Factors, including human and organisational factors expertise, identify the reasons which make it more likely risk controls will be successfully and reliably implemented.

What is a Risk Control?

To answer the questions posed above about the implementation of risk controls begs the question of what we mean by a 'risk control' including how two different but related concepts interact. One is the idea of a *hierarchy* of control which assumes that some *types* of controls are inherently more reliable than others. The second is the idea of *critical* controls. In essence, the concept of critical controls suggests that some controls are more important than others. This is not to say that management systems and plans are not important but to use an over familiar phrase, critical controls could be said to be 'where the rubber hits the road'. These two concepts are discussed next.

The Hierarchy of Control and Critical Controls

It is assumed interlocking the guard of a dangerous part of machine with the power source so that the machine cannot operate whilst the guard is open, is more reliable than relying on procedures which require a person to isolate the power. Interlocking is regarded as being higher up the hierarchy than a procedure. In practice it is normal to find that a number of different types of control are needed to provide defence in depth as illustrated by the Swiss cheese model. In this case the procedures for maintaining the interlock in good

working order would also be important. The concept of the hierarchy of control is well understood and often embraced by modern safety legislation and is not discussed further here.

The second concept and one which is important to this Review is the idea that some controls are more important than others or are *critical* to preventing incidents. When assessing the risks and identifying controls it is not unusual to identify a relatively large number of controls which may impact on the probability of an event occurring or on its consequence if it does. For example, Noetic has seen a bowtie prepared for the mining industry which has over 100 controls identified, though it should be noted that controls are repeated in different parts of the bowtie. However, only three controls were categorised as *critical*.

For controls to be reliable and if they are really needed it is essential to effectively monitor their implementation. It does not make sense and is not practicable to have the same degree of monitoring and governance over a large number of controls in circumstances where some controls can be identified as more important than others or in other words are regarded as 'critical'.

There are a number of definitions of what constitutes a critical control. Noetic is aware of further work being done on this topic by individual companies and industry peak bodies.

One example of a definition of a critical control (in the context of major hazard facilities) is that provided by Victorian WorkCover, which defines a critical control as:

> *Control measures that significantly reduce or eliminate the likelihood or hazards or reduce the severity of consequences*:[8]

Noetic's experience in this area provides an insight of a range of other definitions known to be used (or proposed for use) in the mining industry. These include:

+ *"Critical Controls are measures which can have a significant role in preventing, reducing or mitigating the risks…"*

+ *"A critical control is a control that will have the greatest impact on preventing the risk(s) relating to the Fatal Hazard from occurring, or if the risk was to occur the critical control would provide the greatest mitigation of the potential consequences."*

+ *"A barrier, whose integrity is so important that if it is compromised, then there is a good chance that the hazard/aspect will cause harm."*

Unfortunately there does not seem to be much discussion of this topic in the academic literature. One statement (in a respected peer reviewed journal) of the problem is given below. For obvious reasons Noetic has to declare an interest in this area.

> ***4.3.2 Increased Reporting burden***
>
> *Another challenge with additional effective barriers is the increased burden of monitoring and reporting on the status of the greater number of barriers and correctly understanding the implications of the information in these reports. The increased volume of communication has*

[8] http://www.worksafe.vic.gov.au/__data/assets/pdf_file/0003/12387/50712_WS_10_Control_measures_4HR.pdf

> *aspects of detail complexity in the additional number of pieces of information that need be analysed and evaluated to see what action, if any, is required. But extra dynamic complexity has also been added to the system since the various effective barriers can interact with each other and the organization's risk culture.*
>
> *The complexity added to the system by more barriers can adversely affect the organization's ability to monitor the barriers and comprehend the implications of changes to the states of the barriers. So, more can be less.*[9]

Whether or not there is significant academic study of this topic, this concept is increasingly used by companies and regulators in some industries, including mining and oil and gas, and Noetic expects that this concept of 'critical controls' will continue to become more widely used. Most if not all mining companies have companywide specific rules typically aimed at preventing fatal incidents. Many members of MSAC will have had first-hand experience of developing and/or implementing these 'golden rules', from a company or workforce perspective, often aimed at preventing fatal incidents. Noetic suggests that as the concept is in widespread use in industry this is an approach that MSAC and/or the regulator could use to focus inspection and audit activities as part of a wider incident prevention strategy and report on the findings as suggested in Recommendation 1.

The purpose of classifying some controls as 'critical' is to help identify which of the controls are most important and warrant additional monitoring and reporting to encourage their maintenance at a high level and to identify failure. Although this concept is predominantly used by companies, Noetic recommends that MSAC considers this concept form part of the approach used by the regulator to support industry in preventing incidents.

A focus by industry on the controls and in particular critical controls is increasingly being recognised as an important aspect of risk management. Noetic's experience of investigating a wide range of incidents internationally strongly suggests that most incidents are associated with a failure to *implement* what should be well-known controls for well-known risks. This is mirrored by respected international organisations working in this field. For example, Det Norske Veritas (DnV), the Norwegian Classification Society and risk consulting organisation, has commented on upstream oil and gas incidents:

> *Investigations into major accidents conclude in most cases that the events which occurred were known risks for which a number of safety measures had been planned and implemented. However, the accidents occurred as a result of multiple barrier failures, often in combination with a lack of or inadequate barriers in certain areas. Effective risk management requires a thorough understanding of the relevant risks and that applicable and reliable safety barriers are at all times in place to prevent and mitigate the different risks. The safety barriers' performances must be defined and their status must be continuously monitored, and action must be taken if they deviate from the set targets.*[10]

Noetic's view is that the move to a more risk based approach in industrial safety legislation which has occurred over the last 40 years or so is appropriate. However, within this approach careful consideration must be given to the balance between the elements of a risk based approach from hazard identification, risk

[9] Ian Hoffman and Peter Wilkinson, 2011, "The barrier-based system for major accident prevention: a system dynamics analysis", p. 10.

[10] Enhancing offshore safety and environmental performance, Position Paper, Offshore Safety

assessment to risk control. Noetic has seen some indications that the balance between risk assessment and risk control implementation is not always appropriate and that a greater emphasis may have been placed on the process of risk assessment at the expense of implementing risk controls.

Recommendation 3: Consider if the regulator should explicitly focus on critical controls for significant risks as part of an incident prevention strategy.

SUMMARY

Conclusion

Noetic's main conclusion from the Review is that it is not clear if the industry has all the information necessary to support a data led incident prevention strategy which focuses on risk *control* for known significant risks such as fatal incident risks.

Initially, we looked to see if there were obvious similarities between the incidents. However, the immediate circumstances of the four fatal incidents are all different involving widely varying activities including mining, construction, surface transport and ancillary underground activities. The deceased were employed by both contractors and mine operators. Their experience levels varied as did their age and other factors.

In the absence of obvious similarities we then tried to judge, with help from NSW Trade and Investment, if the incidents involved activities known to have significant risks. We believe they do, at least in three of the four incidents. Where the activities involved in the fatal incidents are known risks which have previously resulted in fatal incidents we sought to determine if these particular incidents were exceptional events or one-off failures to control these known risks. To do this we needed to know how effectively the controls for these risks were usually implemented in the normal course of work on mine sites. This is important because it is not possible to obtain a clear picture of how well individual controls are working just from examining incidents which have occurred. This is because, as is explained by the Swiss cheese model, risk controls can have gaps but this does not mean an incident will occur, unless the 'holes' in each risk control 'barrier' line up. However, the information which we sought on the implementation of controls was not readily available.

Allied to the need for information on the implementation of controls, we also believe information on what has proved successful in the implementation of controls, including what has worked (or not worked) and why, is also important. Finally, drawing on our experience as a safety regulator, working with major companies and consulting widely on incident prevention, we also question whether amongst the undoubtedly substantial efforts being made on incident prevention, sufficient focus is applied to the implementation of risk controls as part of the risk management process compared to the risk assessment process. Clearly, there needs to be assurance that the risk management process will be supported so that its impact is maximised, however we question whether the risk assessment process has received a greater, and perhaps unequal, emphasis.

We cannot conclusively determine the answers to these questions from a Desk Top Review of this type, but we believe they warrant further consideration and Noetic has made recommendations that will provide a greater insight for MSAC moving forward.

Recommendations

Recommendations made throughout the report are as follows:

Recommendation 1: MSAC should consider how information on the implementation of risk controls for significant risks could be routinely collected, analysed and used to support a data led incident prevention strategy.

Recommendation 2: Drawing on the discipline of Human Factors, including human and organisational factors expertise, identify the reasons which make it more likely risk controls will be successfully and reliably implemented.

Recommendation 3: Consider if the regulator should explicitly focus on critical controls for significant risks as part of an incident prevention strategy.

List of Annexes

A. Terms of Reference

B. List of Stakeholders Engaged

C. Analysis of Audit Documents

D. KP3 ‘Best Practice’ Example

E. Documents Supplied by NSW Government

F. High Level Comparison of Incidents

ANNEX A

Terms of Reference

2014 Fatalities Review

CONTEXT

The Minister is concerned at the apparent increase of significant incidents at the same time as significant adjustment and change in the industry. Although the recent fatalities are being thoroughly investigated by NSW Trade and Investment, the Minister believes there is a role for a deeper, holistic examination of current circumstances to ensure that any systematic and underlying issues contributing to serious incidents are identified and responded to. The Minister is seeking advice from the Mine Safety Advisory Council and for it to review the situation in a collaborative and tripartite approach.

Step 1- Desk Top Review

TERMS OF REFERENCE

The Lead Reviewer with assistance from the NSW Trade and Investment will:

1. Examine the four fatal incidents and:
    a. Consider current industry circumstances;
    b. Conduct an assessment of information available to the department and identify contributing factors.
    c. Explore systemic and underlying issues that may influence serious incidents.
2. Follow discussion with an expert panel draw conclusions for MSAC consideration regarding underlying or systemic issues within the industry that may contribute to serious incidents.
3. Present to MSAC interim observations at its 4 September 2014 meeting and agree with MSAC a timeframe for a final report.

ANNEX B

List of Stakeholders Engaged

During the course of the Review Noetic met with a variety of stakeholders and attended the following meetings:

+ **Investigation Unit**, Thornton, 11 August
+ **Assessors**, Sydney (Keith Shaw, Andrew MacMahon with John Flint), 19 August
+ **Keith Shaw,** Wyong, 10 September
+ **Andrew McMahon**, Sydney, 19 September
+ **MSAC** Meeting 4 September.

ANNEX C

Analysis of Audit Documents

Noetic was provided with four reports from NSW Trade and Investment that detail safety regulation. Noetic has approached the analysis of these documents within the context from which they were provided, i.e. as evidence that regulators were assessing the level of implementation of risk controls for significant risks.

Mine Safety Performance Report 2012-13

Section 6 of the NSW Mine Safety Performance Report 2012-13 (MSPR) describes "formal and informal mining, electrical and mechanical inspections, audits, assessments and reviews conducted by NSW Trade & Investment Inspectors and Mine Safety Officers." However, it appears to report on the number of these inspections, audits, assessments and reviews. As such, the MSPR cannot be considered an *outcome*-focused report, as it does not detail any outcomes, but rather an *activity*-focused report as it's purpose appears to be a statement of activity.

Safety Audit Report - Metalliferous and Extractive Mines, February 2011

The Safety Audit Report – Metalliferous and Extractive Mines was developed as part of the Mine Safety Audit program through NSW Industry and Investment's Mine Safety Operations. The Mine Safety Audit program was established following recommendations from the Wran Mine Safety Review in 2005 under provisions provided in the *Mine Health and Safety Act 2004* (MHS). The legislation mandated mines to develop Mine Safety Management Plans (MSMPs), which cover certain matters, one being the use of contractors on the mine site which requires a Contractor Management Plan (CMP) be developed and enforced. Coal mines are legislated under the *Coal Mine Health and Safety Act 2002* (CMHS Act) and *Coal Mine Health and Safety Regulation 2006* (CMHS Regulation). The current report focuses specifically on metalliferous and extractive mines.

The audit program under MHS assessed the compliance of MSMPs and CMPs in mines throughout the state. The audit objectives include, amongst others, the provision to "assess whether the systems for managing health and safety at NSW metalliferous, extractive and "other" mining operations (excluding coal) include all matters, plans and procedures required under the MHS Act and MHS Regulation."[11] However, upon further reading, the report identifies the method of assessment of the audit "consisted of a desktop assessment of documents that looked at the extent to which the required legislative elements were addressed and integrated into the documented MSMP and CMP used at the mine."[12] As such, the audits themselves take the form of a desktop review of existing procedures.

Emergency Management System Audit

An Emergency Management System Audit was conducted by the NSW Department of Trade and Investment on the West Cliff Coal Mine during April 2014. It was provided to Noetic as an example of the broader program of Emergency Management System Audits. The audit assesses the mine's system compliance with the *Coal*

[11] NSW Government, 2011, "Safety Audit Report – Metalliferous and Extractive Mines", p. iii.

[12] NSW Government, "Safety Audit Report", p. 11.

Mine Health and Safety Act 2002, *Coal Mine Health and Safety Regulation 2006*, *Work Health and Safety Act 2011*, and the *Work Health and Safety Regulation 2011*.

Compared to other audits review, the audit appears to utilise a more robust methodology as it includes a site visit. This visit allowed the inspectors to review not just the documentation (as was done in the 'desktop review' style of the Safety Audit above) but also examine the practical considerations, such as whether a control room has the most up-to-date manuals or whether mine workers are following established procedures. This allows the audit to make recommendations such as "Risk assessments not completed and signed off and personnel not notified to carry out actions in the assessments exposes the mine to the risk of not tackling the hazard."[13]

The audit is both activities and outcomes based, as it reports on what the audit team reviewed and makes conclusions based on an assessment. However caution should be applied, as noted above, to the self-reporting nature of some aspects of the audit.

NSW Underground Metalliferous Mines – Fires on Mechanical Plant – Incident Analysis 2008-2012

The NSW Underground Metalliferous Mines Incident Analysis was undertaken by NSW Trade and Investment – Mine Safety in November 2013. The analysis looks at the circumstances surrounding fires on mine sites, and was prompted by an increase in this type of incident being reported. The report analyses all notifications of incidents reported of mechanical fire at underground metalliferous mines over five years from January 2008 until December 2012.

The report draws its data from the COMET database. The data collection method for these incidents is self-reported from the mines through either a Mine Notification of Incident Form of an incident investigation report. The report notes that "in some cases, the data available from COMET was not sufficient to be able to draw reliable conclusions about fires."[14]

[13] NSW Government, 2014, "Emergency Management System Assessmen – West Cliff Mine, p. 3.

[14] NSW Government, 2013, "NSW Underground Metalliferous Mine – Fires on Mechanical Plant – Incident Analysis", p. 3.

ANNEX D

KP3 'Best Practice' Example

Noetic's experience with regulation both within the mining industry and related industries (such as offshore oil and gas) provides context around international standards on safety regulation. Noetic believes that the UK Health and Safety Executive's (HSE) *Key Programme 3 (KP3) – Asset Integrity Programme* provides an example of how planned regulatory activities can look at how risk controls are routinely implemented, in the absence of an incident. KP3 assesses the integrity of safety-critical elements (SCEs), i.e. risk controls, whose purpose is to prevent, control or mitigate major accident hazards (MAHs). Specifically, this involves an on-site visit which assesses 17 elements of each asset, with a particular focus on maintenance management.

The methodology to KP3 assessments are reporting across the 17 elements, which includes a range of aspects from regulatory compliance to physical asset integrity. Assessments are conducted through targeted inspections, and the programme assesses around 40% of the total installations within the HSE's mandate in the offshore oil and gas industry. Reporting within KP3 is robust and detailed, as the HSE reports on both the activities and the outcomes of their assessments in detail.

ANNEX E

Documents Reviewed

Legislation and Compliance Documents

+ *Mine Health and Safety Act 2004*
+ *Mine Health and Safety Act 2002*
+ *Coal Mine Health and Safety Regulation 2006*

Documents Provided by NSW Department of Trade and Investment

+ MSAC Analysis of 2012-14 Incidents
+ Mine Safety Investigation Unit Information Releases and Investigation Reports
    - Compilation of investigations into 17 incidents that occurred in NSW Mines between May 2011 and November 2013
+ Coal Mine Safety Audit Report, February 2010
+ NSW Mine Safety Performance Report, 2012–2013
+ Emergency Management System Assessment – West Cliff Mine, April 2014
+ Safety Audit Report: Metalliferous and Extractive Mines, February 2011
+ NSW Underground Metalliferous Mines: Fires on Mechanical Plant Incident Analysis, 2008–2012

Incident Summaries (compiled from COMET database)

+ Incident Summary Coal Notification 2013-14
+ Incident Summary Non-Coal Notification 2013-14
+ Incident Summary Ravensworth Operations Notification 2013-14
+ Incident Summary Austar Operations Notification 2013-14
+ Incident Summary Boggabri Coal Operations Notification 2013-14
+ Incident Summary CSA Mine Operations Notification 2013-14
+ Incident Summary Mine Operations Notification 2013-14

Mine Safety Investigation Unit Information Releases

+ Fatality – Ravensworth 30 November 2013
+ Double Fatality – Austar 15 April 2014

+ Fatality – Boggabri 21 May 2014

+ Fatality – CSA 11 June 2014

Other Documents

+ Health and Safety Executive, Key Programme 3: Asset Integrity Program

+ Health and Safety Executive, Key Programme 3: Asset Integrity – A review of industry's progress, July 2009

ANNEX F.

High Level Comparison of Incidents

	Mine A	Mine B	Mine C	Mine D
Activity undertaken	Transport activity on surface haul road (out of pit), interaction between light vehicle and heavy vehicle.	Longwall development underground, cutting coal with continuous miner, strata failure – pressure burst of rib coal	Associated preparation plant construction	Ancillary services, construction crew, clearing underground deep water sump
Employment status	Employee of contractor	Both casualties were employees of the mine operator	Employee of contractor	Employee of mine operator
Age and mine experience	Age: 38 Experience: 10 months	Victim A Age: 49 Experience: 8 years 1 month Victim B Age: 35 Experience: 7 years 6 months	Age: 50 Experience: 1 year at mine, 1 year 6 months conducting similar tasks, 2 years 6 months construction.	Age: 26 Experience: 2 years 4 months.
Time of day and time in shift	Incident: 2350 hours Shift: Six hours into 12 hour weekend shift.	Incident: 2105 hours Shift: six hours into 10 hour afternoon shift	Incident: 0845 hours Shift: Three hours into day shift	Incident: 2305 hours Shift: four hours into 12 hour night shift
Recent work pattern (7 days up to and including day of incident)	Day 1: 0 Day 2: 12 Day 3: 12 Day 4: 7 Day 5: 0 Day 6: 12 Day 7: 6 (incident occurred)	1. Victim 1 Day 1: 10 Day 2: 0 Day 3: 0 Day 4: 0 Day 5: 10 Day 6: 10 Day 7: 6 2. Victim 2 Day 1: 10 Day 2: 0 Day 3: 0 Day 4: 0 Day 5: 10 Day 6: 10 Day 7: 6 (incident)	Day 1: 10.5 Day 2: 11 Day 3: 11 Day 4: 11 Day 5: 10.5 Day 6: 11 Day 7: 3 (incident)	Day 1: 0 Day 2: 0 Day 3: 0 Day 4: 0 Day 5: 12 Day 6: 12 Day 7: 4 (incident)

	Mine A	Mine B	Mine C	Mine D
Visibility of this type of incident within the industry	Motor vehicle accidents and large truck/light vehicle interactions are well-known	This was a known risk with deep underground coal mines. Gas outburst issues have occurred in NSW south coast mines	This is a well-known risk and incidents in mining and construction industries	Issues with deep water are well known. There have been several drowning incidents at Australian mines