The Consistent and Systematic Management of Hazards - Development of Management Plans.

M. L. Ogilvie.

Principal Mining Engineer
GeoGAS Systems Pty Ltd.
139 Kenmbla Street,
Wollongong 2500.

Abstract: Until relatively recently in Australian underground coal mines, hazards, almost universally, and operational matters to a large degree, were generally managed in an ad hoc manner and with significant reliance on externally prescribed and enforced legislation.

A number of events over the past 15 years, varying from purely procedural to catastrophic in nature, commencing with the introduction in NSW in 1984 of a more enabling Coal Mines Regulations Act and culminating in the Queensland Department of Mines and Energy response to the Moura disaster, have led to the recent proliferation of Management Plans as a means of essentially self determination of a variety of aspects of underground coal mining operations.

A Management Plan, whether safety or operationally related, and no matter how comprehensively written, will not, by itself, cure the ills of an organisation nor effectively govern its key operations. Underscoring the words which make up the Plan must be the acceptance, within the entire organisation, commencing at the highest corporate level, that the discipline imposed by the Plan is “the way we do business”. Only then will the potential benefits of any Management Plan, and the system which it formalises, be realised.

Key Words: Management Plan, hazard control, consistent, systematic, quality document.
Introduction.

Until relatively recently in Australian underground coal mines, hazards, almost universally, and operational matters to a large degree, were generally managed in an ad hoc manner and with significant reliance on externally prescribed and enforced legislation. This tended to promote a mindset where the minimum safety standard prescribed by legislation was considered to be the benchmark and operational standards altered with the incumbent Mine Manager and his In Charge Undermanager and Engineers. Legislation tended to focus on the ‘big picture’, potentially catastrophic hazards. It was based on the hard learned lessons of history, imposed industry wide standards, neglecting the essential differences inherent in individual mines (allowing only provision for individual exemptions) and was relatively deficient in areas relating to base safety and occupational health. Consequently, the industry, whilst suffering relatively few disasters, had a poor record of accidents, incidents and personnel injury.

The advent of the less prescriptive and more enabling legislation of the rewritten Coal Mines Regulations Act in 1984, the gradual acceptance of its augmentation within the Coal Industry with the provisions of the Occupational Health and Safety Act, incidents such as outbursts and spontaneous heatings in NSW and the Moura disaster in Queensland which prompted Mines Inspectorate intervention and the recognition by a growing number of CEO’s that, to remain competitive, their organisation needed to manage its operations in a consistent and systematic manner, has led to the recent proliferation of Management Plans to govern a variety of aspects of underground coal mining operations.

A Management Plan represents the formalisation of the Management System implemented to control a particular risk or operation at an individual mine. As such it should consist of the collection of measures determined by mine management as being necessary to be undertaken to assess and control that risk or manage that process. In the control of a risk, the system of management must be based on the assessment (preferably formally) of that particular risk (in terms of consequence and probability) as it exists at that particular operation. Consequently each system of management and the Management Plan which describes that system should be unique (perhaps only subtly) to the individual operation. The collection of measures described above, in each case, represents the operational elements of the Plan, appropriately complemented by individual procedures. Because of the nature of underground coal mining, risks and operations at a mine generally tend to alter with time and location. An unchanging approach to the management of any risk or operation is, therefore, inappropriate. To ensure that Management Plans remain ‘living’ documents and to institutionalise the degree of discipline essential for effective control of the risk or process, quality elements are necessary to augment the operational elements. These quality elements are represented by the AS3900 (ISO9000) series of quality assurance standards and include such managerial control measures as training, regular auditing to check the degree of implementation of Plan procedures and compliance with Plan documentation and regular review of the Plan to ensure its continued applicability and effectiveness.
A Management Plan, whether safety or operationally related, and no matter how comprehensively written, will not, by itself, cure the ills of an organisation nor effectively govern its key operations. Underscoring the words which constitute the Plan documentation must be the acceptance, at all levels within the organisation, that the discipline imposed by the Plan is "the way we do business".

Whilst Management Plans can be developed as a means to control any key process associated with the mining operation, this paper will concentrate on the development of those Management Plans which formalise the systems designed to address the hazards identified within an operation. Whether such a hazard is legislated as a result of bitter experience as was the case with the outburst phenomenon of the NSW Southern coalfields, intrinsic to all operations (to varying degrees) such as those associated with Ventilation and Gas Management or identified by an individual mine as requiring control at that site (eg the KCC Gas Drainage Borehole Management Standards), the process remains the same. This process is the Risk Management Process.


In broad terms the Risk Management Process (Figure 1) involves four steps:

- Identification of the hazards associated with a particular process and analysis of the risks associated with each hazard,

- development of controls (existing and new),

- formalisation of controls augmented by quality assurance standards and their implementation as an integral part of the process and

- ongoing monitoring of the controls and the effectiveness of the Plan itself.

The development of the Management Plan is, thus one step in a total Risk Management process undertaken with the fundamental objective being to establish safe and efficient production through an operating environment which is controlled in relation to that particular hazard. The essential elements in any controlled operating environment and which must be adequately addressed by the Management Plan relate to:

- Staffing with competent personnel, achieved through effective selection and comprehensive training of the personnel who will participate in the process.

- Operating with equipment which is fit for the purpose, achieved by identification of all items of plant, equipment and materials likely to be involved in the process, specification of the standards to apply to every such item and establishment of effective goods and services acquisition procedures.

- The development of Safe Work Practices by which the competent personnel can use the fit for purpose equipment to implement the process in a safe and efficient manner.
FIGURE 1 - THE RISK MANAGEMENT PROCESS

HAZARD IDENTIFICATION

RISK ANALYSIS

RISK PRIORITISATION

MONITOR CHANGES IN HAZARDS & ENVIRONMENT (RISK REVIEW)

IDENTIFY CONTROLS

NEW CONTROLS

EXISTING CONTROLS

MONITOR EFFECTIVENESS OF CONTROLS

DEVELOP & IMPLEMENT CONTROL DETAILS

FORMALISE CONTROLS

MANAGEMENT PLANS

STANDARDS & PROCEDURES

TRAINING

WORK INSTRUCTIONS
For an operating environment to be truly controlled and yield safe and efficient production, ALL three of these fundamental elements must be in place and interact. In identifying hazards and potential hazards in each step of a process, it is necessary to focus on the negatives associated with each of these three elements, namely incompetent personnel, incorrect, substandard or poorly maintained equipment and lack of standards of operation or Safe Work Practices. Conversely, in considering controls to be implemented to manage each identified hazard, consideration should be directed towards the requirements to achieve positive outcomes associated with these three elements in each case.

The relationship between these three elements to create safe and efficient production from a controlled operating environment is shown in Figure 2.

![Diagram](image)

**FIGURE 2 - AN INTEGRATED SYSTEM TO ACHIEVE SAFETY IN THE WORKPLACE.**

The Risk Management Process can be examined as three separate phases. These are:

- The conduct of the formal Risk Analysis,
• The formation and implementation of the Management Plan and

• The ongoing monitoring of both the Plan and the effectiveness of the controls which it formalises.

The Risk Analysis.

Most people working in underground coal mines are familiar with the conduct of an accident or incident investigation. Few have participated in a Risk Analysis. The intent of each is the same, aiming to prevent an unwanted accident or incident from occurring. However, an accident or incident investigation is a reactive process, conducted after the event in order to determine the root cause of an existing accident or incident with a view to preventing re-occurrence. A Risk Analysis is the proactive equivalent, where a particular process in, or aspect of, the operation is examined in detail so as to identify potential hazards and threats, which, if not addressed, could precipitate an accident or incident. It is worth noting that, whilst an analysis such as this tends to focus on issues relating to personnel safety, it is perfectly valid (and in the interests of the organisation) to identify threats which have the potential to disrupt operations as well. Controls or a combination of controls are then identified which, if implemented, ensure that the potential for such an accident or incident is never realised.

For a Risk Analysis to be efficiently conducted and effective in its outcome, a number of essential elements need to be in place:

• A manageable group of participants consisting of those with the relevant technical expertise along with supervisors and operators involved in the process or aspect of the operation being examined. This principal should also be applied to the development of the Standards, Procedures and Work Instructions which will emanate from the Risk Analysis process. By doing this every tier within the organisation develops ‘ownership’ of the total process and the resulting plans and procedures have less chance of ending up as a ‘paper exercise’. The right mix of participants will provide the necessary experience and knowledge to adequately identify existing and potential hazards and threats and to put effective and realistic controls in place.

• An experienced facilitator who understands sufficient about the process or aspect of the operation under consideration to keep the ‘debate’ amongst the participants focussed, but without imposing his own views or dominating the discussion. The questions asked or lines of investigation opened up by a competent facilitator who has limited actual experience of the process under consideration can sometimes stimulate lateral thought amongst the participants who, themselves, may be ‘too close to the action’ and too focussed in their deliberations.
• Adequate time and resources provided by the organisation to allow the task to be completed properly and without participants feeling that they are being pressed to finish and not allowed to adequately explore every consideration.

The steps involved in a Risk Analysis are:

• Identify the individual tasks or job steps involved in the process under consideration.

• Identify all of the hazards or threats associated with each task or step ie “what can go wrong?”.

• Assess the level of risk associated with each of these hazards or threats using Risk Ranking Criteria Tables. This part of the process is described in Figure 3. The tables describing Consequence and Probability should be developed by the Risk Analysis team with criteria descriptors appropriate to the size and type of organisation to which they belong.

• Prioritise the hazards according to their risk ranking. The risk ranking process allows the hazards and threats to be prioritised for the purpose of considering controls with most emphasis placed on those hazards with the greatest risk of occurrence and/or consequence. High risks are those ranked from 1 to 6 and are judged to require substantial action to reduce the risk to an acceptable level for everyday operation. At least two hard barriers or the equivalent are necessary to ensure this. Risks ranked from 7 to 15 are judged to be medium risks and generally need one hard barrier or the equivalent to lower their risk ranking to an acceptable level for everyday operation.

The concept of “Acceptable Risk” is open to debate. Some organisations consider that wherever ANY risk is identified at least one control is required to manage that hazard or threat. In reality, by addressing the high and medium risks, controls will generally be in place that will manage the low level risks as well.

• Identify existing controls and develop new controls where it is considered that existing controls are inadequate. Controls can be thought of in terms of barriers which prevent the energy associated with a hazard or threat being able to inflict detrimental effects on people, equipment, production or the environment. There are hard barriers, generally physical controls and engineered safety systems which attempt to eliminate of the hazard itself (not always possible or practical) or minimise the energy released which is generally the cause of injury or loss associated with the hazard. On the other hand there are soft barriers which rely on the human element, at least to some degree. These include training and skills acquisition, signs and warnings, and procedures and standards. They are almost always less effective than a hard barrier. Hard barriers must always be the first consideration in the control of a hazard or threat but soft barriers are often the only controls practically available or even possible at all.

Management Plan Development and Implementation.

The product of the Risk Analysis process is a series of existing and new controls aimed at managing the hazards and threats identified as existing in a particular process or
FIGURE 3 - RISK RANKING CRITERIA.

Each hazard or threat identified needs to be ranked in terms of its PROBABILITY and its CONSEQUENCE.

In assessing CONSEQUENCE it is possible to imagine scenarios for every threat where its consequence is extreme. In practice this is not the case and to avoid this happening it should be considered in terms of THE MAXIMUM REASONABLE CONSEQUENCE.

<table>
<thead>
<tr>
<th>CONSEQUENCES (SEVERITY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSONNEL SAFETY (S)</td>
</tr>
<tr>
<td>1 FATALITY</td>
</tr>
<tr>
<td>2 SERIOUS INJURY</td>
</tr>
<tr>
<td>3 LOST TIME INJURY</td>
</tr>
<tr>
<td>4 MINOR INJURY</td>
</tr>
<tr>
<td>5 MEDICAL TREATMENT</td>
</tr>
</tbody>
</table>

PROBABILITY (LIKELIHOOD).

A COMMON
B HAS OR IS LIKELY TO HAPPEN
C COULD HAPPEN
D NOT LIKELY TO HAPPEN
E PRACTICALLY IMPOSSIBLE

The scales of Probability and Consequence combine to produce a Risk Ranking by reference to the Matrix below.

RISK RANKING MATRIX.

<table>
<thead>
<tr>
<th>PROBABILITY</th>
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<tr>
<td>A</td>
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<td>4</td>
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<td>5</td>
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Note that a Risk Ranking of 1 represents the highest risk or the worst case.
aspect of an operation and having the potential to cause loss or injury. The formalisation of these, so that they can be effectively incorporated as an integral part of the operation of the mine, is a Management Plan.

A Management Plan should not represent an additional layer of pseudo regulation. The codes, standards, regulations and guidelines already in place at a mine (whether part of existing statutory regulation or developed internally in response to historical problems) will be incorporated into the Management plan along with any additional controls, identified in the Risk Analysis, considered necessary to adequately manage the hazards and threats associated with the particular aspect of the operation which is to be the subject of the Management Plan. By this means, rather than control of a process by ad hoc or informal means, the Management Plan provides a framework within which the process can be systematically and efficiently managed, independent of changes in personnel at the mine. It sets out formally the actions, controls and procedures which have been instituted to demonstrate that the hazards associated with a particular operation have been identified and controlled. Moreover, every person who has a role in that process or aspect of the operation has his role clearly defined and has a single reference detailing every requirement associated with the management and control of the total process. Most importantly, the Management Plan should reflect the way by which the organisation wishes to conduct its business, having been considered and deemed to be the safest and most efficient methods.

Management Plans will vary from concise to extremely comprehensive documents depending on the degree of risk associated with the hazard or nature of the aspect of the operation to be controlled and the complexity and size of the mining operation. A properly constructed Management Plan for any process or aspect of the operation, though, should consist of up to four levels of documentation. These are:

- The Plan document itself which sets out the corporate policy and principles by which the company (as represented by the CEO) expects operations to be conducted, the means by which performance standards are set and met, the organisation associated with that particular process or aspect and a summary of the duties and responsibilities of individuals under the Plan.

- Any generic Standard Procedures which would represent major components of the process and provide the broad management framework by which the hazard is controlled. Such is dependent on the complexity of the process or aspect of the operation under consideration eg for a mine subject to outbursting, the Outburst Management Plan may have separate generic standard procedures associated with In-scan Drilling, Geological Structure Identification and Interpretation, In Situ Gas Content Testing, Outburst Operation, Normal Mining Procedures etc. Within each of these there will be individual procedures associated with aspects of each Generic Procedure. As well if some of the Quality elements (as represented by the AS3900 (ISO9000) series of quality assurance standards) have in-depth procedures defined such as for Auditing, Plan Review, Training, Appointment of and Delegations to Officials, Document Control etc, these may be the subject of separate generic Standard Procedures. Alternatively, the organisation may have the Standards for these elements defined in a set of Corporate Procedures which are then merely referred to in
individual Management Plans. The conceptual relationships between operational and quality elements, within a quality system are shown by Figure 4.

**FIGURE 4 - RELATIONSHIP BETWEEN OPERATIONAL AND QUALITY ELEMENTS IN A QUALITY SYSTEM.**

- Individual standard operating procedures, safe work practices or work instructions governing the tasks associated with the process or any generic Standard Procedure eg in the case of the In Seam Drilling Standard Procedure referred to previously, there may be individual procedures associated with the operation, inspection and maintenance of each type of drill rig employed at the mine, for clearing a blocked borehole, for installing a standpipe and relating to drill rig site housekeeping standards.

- Training modules for each procedure, safe work practice or work instruction, as well as for the principles of the overall Management Plan and each generic Standard Procedure as well. Training modules must be competency based defining the standard to be achieved in order to be accredited with that particular skill.

The formulation of an individual Management Plan is a substantial undertaking if done correctly. Whilst it is absolutely essential that the major components of a Plan are determined and developed by the organisation's own employees, it is equally essential that direction and perspective are maintained by a co-ordinator, preferably with experience in the development of Management Plans, whose role is to assemble the multitude of procedures and controls into a concise, coherent, practical and complete document.

Having completed the documentation of the Management Plan, or perhaps even during the process of its assembly, Management at the mine must be responsible for requiring that operations be conducted strictly according to the Plan documentation and that the various procedures and other components are implemented into the 'fabric' of the business. Often employees will resent the disciplined and systematic approach inherent in
the Plan, will outwardly accept the Plan but revert to previous practices at the first opportunity or will require considerable training in the new procedures and controls. Without unwavering commitment by Management at the implementation stage, the effort expended in developing the Plan and all its procedures and standards will have been wasted on a 'paper exercise'.

Ongoing Monitoring.

It is unlikely that, at the first attempt, the ultimate Management Plan to control a process or aspect of an operation will be developed. Moreover, the nature of mining and the fact that the work environment constantly changes as the work progresses means that conditions on which a procedure is based today will be different in the future. A single, unchanging approach to the management of any hazard is, therefore inappropriate. Any Management Plan must recognise this and incorporate mechanisms which require the Plan, the controls which it formalises and the circumstances which gave rise to those controls to be regularly reviewed and amended. It also must provide for the discipline required to detect and interpret the, often, subtle changes in a mine’s operating environment which can signify the emergence of a hazard or the altered level of risk associated with a hazard.

A review protocol is an essential Quality element which defines both time and event based ‘triggers’ for reviewing the continued applicability of the Plan and the controls which it formalises. Corrective Action procedures, by which any person may highlight perceived deficiencies and non compliances and Auditing procedures whereby internal and external checks are made of ongoing compliance and applicability are two further essential Quality elements, as are procedures for Maintenance and Amendment of the Plan and Document Control so that suggested changes can be assessed and enacted without undue delay, but by a standard process.

Conclusions.

To operate according to Management Plans for many, if not most, processes or aspects of an organisation's mode of operation is a task requiring unwavering commitment and an underlying philosophy which recognises and values the ultimate benefits to be achieved. The process by which a Management Plan is developed requires a significant investment of time and resources. The implementation of the Plan into the ‘fabric’ of the organisation such that it becomes “the way we do business” requires equally as much commitment. Even if the ultimate objective is achieved over several years and a number of iterative revisions of a hastily assembled ‘first attempt’, the commitment must still be there to reach that ultimate conclusion. To do otherwise pays only ‘lip service’ to the process resulting in time and resources being wasted on whatever is produced and the ultimate benefits of a systematically and efficiently managed operation producing predictable and consistently good results are never realised.

Besides anticipated improvements in output, external administrators and stakeholders within the organisation (unions, shareholders, suppliers) gain a sense of confidence in management and a workforce which is demonstrating a proactive, consistent and disciplined approach to solving problems and addressing hazards.