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Making Effective Audits Truly Effective

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MAKING EFFECTIVENESS AUDITS TRULY EFFECTIVE

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ABSTRACT: The *Queensland Coal Mining Safety and Health Act 1999* and the *Mining and Quarrying Safety and Health Act 1999* require a mine to have a Safety and Health Management System (SHMS) in place to manage the risk to safety and health of persons at the mine. The legislation assigns the obligation to the site senior executive to develop and implement the mine's SHMS. It assigns a further obligation to the mine operator to audit the effectiveness of the system put in place by the site senior executive.

What is exactly meant in the legislation by the term *effectiveness*, and how to go about assessing effectiveness has been the topic of much debate since the legislation was enacted. In 2008, the Queensland Mines Inspectorate provided some clarification on the issue, when it published *Queensland Guidance Note QGN09 Reviewing the Effectiveness of Safety and Health Management Systems*. However, QGN09 is not an exhaustive treatment of reviewing the effectiveness of an SHMS.

In this paper, former Queensland Commissioner for Mine Safety and Health, Paul Harrison, and former Queensland Chief Inspector of Mines, Phil Goode, discuss effectiveness audits from the perspective of the authors' experience and propose a tool for quantitative measurement of SHMS effectiveness.

INTRODUCTION

The mining industry in Queensland today enjoys one of the most enviable safety records of anywhere in the world, but this was not always the case. Prior to 1994, the record was nothing to boast about. In the 20 years prior to 1994, there was an average of 5.3 fatalities per year in Queensland mines. In the late 80s/early 90s, one large hard rock mine in Queensland recorded 9 separate fatalities in a period of just over 2 years. By the early 1990s the rate of reduction, since 1950, in the Lost Time Injury Frequency Rates (LTIFR) had also started to slow.

These trends were causing concern to industry and the Queensland Mines Inspectorate. In 1992 a legislative review group was established to update the legislation. Progress with the legislative review was initially slow, however, the underground explosion at Moura No. 2 coalmine in Central Queensland in 1994 was the watershed moment in mining history that changed all that.

Following this disaster, the management of mining safety and health in Queensland was completely overhauled. In 2001 new legislation was introduced using a risk based approach to cope with the hazards at a mine and required the development of mine site Safety and Health Management Systems (SHMS). This approach soon gained momentum across the Australian mining industry as a whole.

Prior to 2001 there were no published standards available for SHMS, but in 1997 the Queensland Mines Inspectorate developed their own approach based on the international quality management systems standard ISO 9001:1994 (International Organization for Standardization 1994). They called it SafeGuard, and it was designed to help mines establish and assess their SHMS, to measure its performance and to help ensure continual improvement of the system. Of course, today there are Australian and international standards that specifically address SHMS, namely Australian Standard AS/NZS 4801:2001 (Standards Australia 2001), OHSAS 18001:2007 (BSI 2007) and Draft International Standard ISO/DIS 45001:2016 (International Organization for Standardization 2016).

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The new approach to managing hazards at mine sites has proved effective, as evidenced by the marked improvement in incident statistics (refer to Figure 1 and Figure 2 for examples – data provided courtesy of the Queensland Department of Natural Resources and Mines).

The Queensland legislation requires the senior manager at a mine site to establish the mine's Safety and Health Management System and requires the mine operator to periodically audit the system to ensure it is, and remains, effective. Colloquially, these have come to be called *operator effectiveness audits*.

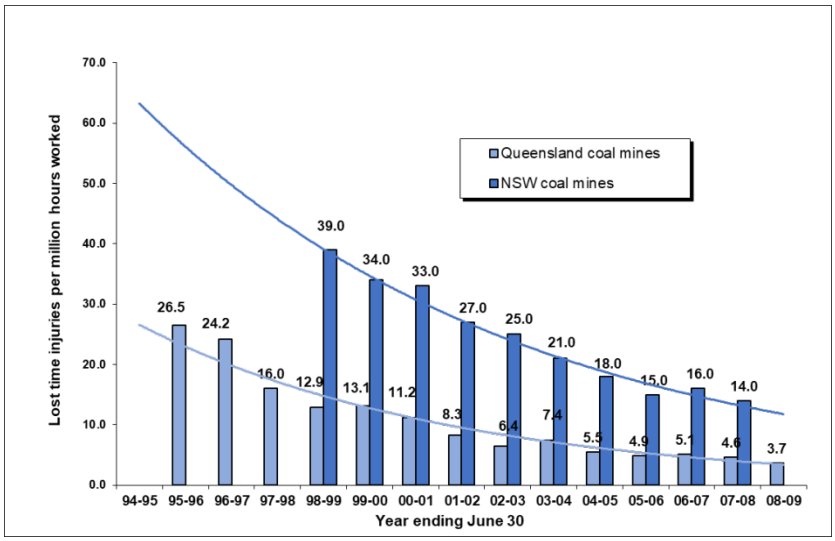

Figure 1: Lost time injury rate comparison for Queensland and NSW coal mines post Moura No. 2 disaster

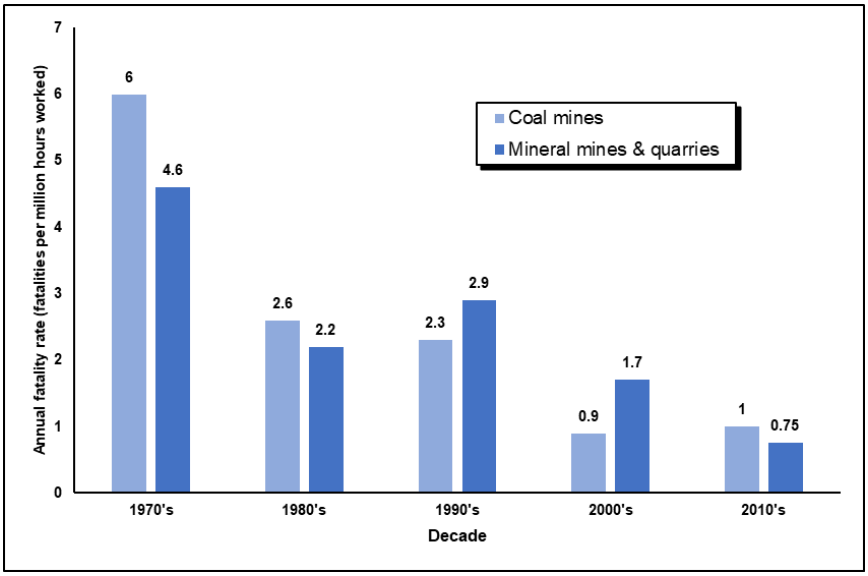

Figure 2: Annual fatality rate for Queensland mines and quarries

MANAGEMENT SYSTEM EFFECTIVENESS
Queensland Guidance Note QGN09

What is exactly meant in the legislation by the term *effectiveness*, and how to go about assessing effectiveness has been the topic of much debate since the legislation was enacted. The legislation merely states that the mine operator has an obligation to '*audit and review the effectiveness and implementation of the safety and health management system to ensure the*

risk to persons from coal mining operations[1] / operations[2] is at an acceptable level' (Section 41(1)(f) *Coal Mining Safety and Health Act 1999* and Section 38(1)(e) *Mining and Quarrying Safety and Health Act 1999*). It provides no further direction on, or clarification of, the requirement.

In 2008, the Queensland Mines Inspectorate provided a degree of clarification when it published *Queensland Guidance Note QGN09 Reviewing the Effectiveness of Safety and Health Management Systems (*Department of Mines and Energy 2008). While providing additional guidance, QGN09 is not an exhaustive treatment of reviewing the effectiveness of an SHMS *(*Department of Mines and Energy 2008, p.6). It identifies some of the key subsystems that should be included in an effectiveness audit. There are other SHMS elements such as planning, objectives and targets, emergency response and document and record control that it does not call direct attention to.

Management system standards' perspective

AS 4801:2001 (Standards Australia 2001, p.12) states that, '*the organization shall establish, implement and maintain an audit program and procedures for periodic OHSMS audits to be carried out by a competent person, in order to determine whether the OHSMS is effective in meeting the organization's policy as well as objectives and targets for continual OHS improvement.*

ISO/DIS 45001:2016 (International Organization for Standardization 2016, p.22) states that an organisation must establish an audit program that, amongst several other requirements, provides, '*conclusions on the continuing suitability, adequacy and effectiveness of the OHandS [occupational health and safety] management system'*.

The word *effective* or variations of it appears 28 times in AS 4801:2001 and 39 times in ISO/DIS 450001:2016. Thus, it is clear that routine ongoing assessment of management system effectiveness is a key requirement for an SHMS. The requirement in the Queensland mining safety and health legislation does not add any new dimensions to the audit process. Any management system audit must be structured to provide for an assessment of effectiveness.

What is management system effectiveness?

In the context of QGN09, effective means that the SHMS reduces the level of risk to safety and health of persons affected by the operation of a mine to within acceptable limits and as low as reasonably achievable. It is considered that achieving this goal will result in continual improvement of safety and health standards and performance.

According to International Standard ISO/DIS 45001:2016 (International Organization for Standardization 2016), the effectiveness of a management system is the extent to which it delivers on planned activities and planned organisational objectives. In the case of an SHMS, these activities and objectives relate to the mitigation of safety and health risks as per QGN09.

An audit of the effectiveness of an SHMS, in its simplest terms, is an assessment of:
The adequacy and suitability of the measures used to set and monitor organisational safety and health objectives.

The extent to which planned activities have been implemented and organisational objectives have been realised. This accounts for how well the system is designed for mitigating safety and health risks and how well it is performing in that respect.

[1] *coal mining operations - defined in the Coal Mining Safety and Health Act 1999 Schedule 3 Dictionary coal mining operations*
[2] *operations – defined in the Mining and Quarrying Safety and Health Act 1999 Section 10 Meaning of operations*

THE EXPERIENCE

The Queensland mine safety and health regulator have been engaged in a debate about what constituted management system effectiveness and how to undertake an objective assessment of it.

One criticism of operator's effectiveness audits was that they tended to be more desktop system audits or compliance audits rather than audits assessing how well the systems are implemented at worker level. An SHMS can only be effective if it is fully implemented. Another criticism that arose was the frequency at which the audits were done (i.e. not frequent enough). Consequently, the standard of operator effectiveness audits was variable. Some other issues observed included:

- Failures to gather sufficient representative evidence to make a reliable and objective assessment
- Insufficient time and resources allocated to the audit to carry out an adequate assessment of what are large and complex systems, especially in relation to assessing implementation of the system at the worker level (e.g. audits conducted in two or three days by a one-person audit team – consider the 13 element management system given as an example in Figure 3, a three day, one person audit, deducting time for entry meeting, exit meeting and initial draft report, would only allow an hour and a quarter to gather and assess data for each management system element)
- Lack of a quantitative measure of system effectiveness to gauge and compare the SHMS performance.

Figure 3: Illustration of how elements of an SHMS fit into the PDCA framework

KEY CONSIDERATIONS FOR ASSESSING EFFECTIVENESS

Continual improvement

Management system standards are built on a management model referred to as the Deming Cycle. The Deming Cycle is a model for the control and continual improvement of processes, products and services. The model has four steps – Plan, Do, Check, Act (PDCA). PDCA requires an organisation to think about:

- What it wants to achieve
- Planning realistically to do it
- Allocating appropriate resources and ownership
- Putting the necessary tools in place and training people to use them

- Measuring and auditing what happens
- Reviewing and improving the system and starting over.

PDCA describes a model for continual improvement of the effectiveness of a management system. It is achieved through the use of policy, system objectives, system implementation, system monitoring, audit and review, followed by corrective and preventive/improvement action. Any SHMS must be structured to fit within the PDCA framework. Figure 3 illustrates the PDCA framework as it applies to an SHMS with 13 main elements.

AS 4801:2001, ISO/DIS 45001:2016 and QGN09 all place a lot of emphasis on continual improvement as it is the cornerstone of any management system. Hence, a critical factor in the assessment of management system effectiveness is the extent to which continual improvement is embedded in the organisation. The tools used for SHMS effectiveness audits described in this paper have been developed using this model as the basis.

Trigger events

There are many events that may trigger the requirement for changes to the SHMS which form part of the process of continual improvement. Some examples include:

- Incident investigations and hazard reports
- Non-conformance reports and corrective action requests
- Audits, inspections and observations
- Toolbox meetings, safety and health committee meetings
- Management review
- Significant changes in operations
- Regulatory action (e.g. mine record entries, directives, prosecutions, improvement notices)
- Safety bulletins and alerts (internal and external)
- Other external factors (e.g. legislative changes, Level 1 exercises, Coronial Inquiries).

When auditing the effectiveness of an SHMS it is important to assess how changes resulting from such trigger events are managed to provide continual and sustainable improvement (i.e. an effective change management process is in place). Figure 4 illustrates a continual improvement cycle arising from trigger events and the management of change process.

Figure 4: The continual improvement cycle initiated by trigger events

Since management of change is a critical element of the continual improvement cycle, an audit of management system effectiveness must include an assessment of how trigger events that could potentially require changes to the SHMS are handled.

Management review

AS 4801:2001 (Standards Australia 2001, p.12) states that, '*the organization's top management shall, at intervals that it determines, review the OHSMS [occupational health and safety management system], to ensure its continuing suitability, adequacy and effectiveness. The management review process shall ensure that the necessary information is collected to allow management to carry out this evaluation*.'

ISO/DIS 45001:2016 (International Organization for Standardization 2016, p.47) states that, '*management reviews are a critical part of the continual improvement of the management system. The purpose of these reviews is for top management to undertake a strategic and critical evaluation of the performance of the management system, and to recommend improvements.*' This is often an area that is not well implemented and, hence, deserves particular attention during an audit of management system effectiveness.

Management reviews should consider:

- *'Suitability: the extent to which the management system fits and is right for the organisation's purpose, operations, culture and business systems*
- *Adequacy: the extent to which the management system is sufficient in meeting the applicable requirements (includes the training and competency of workers)*
- *Effectiveness: the extent to which planned activities are realised and planned results achieved.'*

The purpose of management reviews is to assess system performance and identify opportunities for continual improvement. They should include an evaluation of how well the SHMS is integrated with other business processes and the strategic direction of the organisation.

Representative sampling

Like any other activity, audits are constrained by cost, time and resources. An SHMS can be very large and complex, and associated records extensive. Thus, it is not possible to evaluate every system document or record, or interview every worker. It is only possible to evaluate a sample, but that sample should be representative of the whole system. This must include sampling of evidence about how the SHMS is managing the risk of hazards, particularly principal or critical hazards. An audit should verify how each element of the SHMS contributes to the management of a particular hazard.

Collecting objective evidence to support findings of conformance and non-conformance using accepted sampling methods helps to minimise auditor bias. Findings are based on objective evidence not the subjective judgement of an auditor.

To ensure the sample selected for an audit is representative of the whole system, representative sampling methods must be used by the auditor when gathering data to test the effectiveness of the implemented system. Representative sampling using a probabilistic sampling approach will ensure that evaluations are objective, unbiased and consistent between auditors within the current audit team and with past and future audit teams.

Probabilistic sampling is broken into four types:

- *Random sampling.* The application of random sampling ensures that each member of the population being sampled has an equal chance of being selected. It selects samples purely by chance, allowing the sample sub-population to represent the entire population without bias. For this approach to sampling, random sample numbers are generated using random number tables or a random number generator. The latter can be achieved using an Excel spreadsheet.

- *Block sampling.* Block sampling is used when the population is very large and selecting a random sample would result in a sample set too large to manage. Block sampling examines a block(s) of contiguous items from within the population. A random number table or generator should be used to select the first sample in a block to avoid potential bias.
- *Stratification sampling.* Stratification sampling treats a population by dividing it into discrete sub-populations which have an identifying characteristic, for example:
- Roster A vs Roster B
- Day shift vs night shift
- Permanent employees vs contractors.

The sub-populations are treated as separate populations. Sampling of the sub-populations allows the auditor to categorise the total population by sub-population, providing for an accurate comparison of one group against another as well as an accurate assessment of the total population.

Stratification sampling is useful when there are wide variations in the size or characteristics of a population. It reduces the variability of items within each sub-population and allows sample size to be reduced without increasing sampling risk.

Interval sampling: The purpose of interval sampling (also referred to as systemic selection) is to pick samples at various intervals. The number of sampling units in the population is divided by the sample size to give a sampling interval. For example, if the sample size is 30, a starting point within the first 30 items is selected at random, and then each 30th sampling unit thereafter is selected.

When using interval sampling, the auditor must take care that sampling units within the population are not structured in such a way that the sampling interval corresponds with a pattern in the population.

Sample size

Sample sizes can be determined either statistically or based on the exercise of professional judgement. The level of sampling risk that the auditor is willing to accept affects the sample size required. The lower the risk the auditor is willing to accept, the greater the sample size will need to be.

When circumstances are similar, the effect on sample size of factors such as an increase in the expected rate of deviation of the population to be tested will be similar regardless of whether a statistical or non-statistical approach to sampling is chosen.

A QUANTITATIVE MEASUREMENT OF EFFECTIVENESS

Quantitative measurement of system effectiveness can be achieved by evaluating the individual elements which make up the SHMS (examples of system elements are shown in Figure 3).

An audit tool specific to the organisation/site is developed prior to conducting the onsite component of the management systems audit, based on the documented management system structure. The purpose of the tool is to assess the level of conformance and/or non-conformance with performance standards for each of the management system elements.
Representative sampling is undertaken during the onsite audit to obtain representative, unbiased and objective evidence of the degree of that conformance or non-conformance.
Following the collection of evidence of conformance and/or non-conformance, each management system element is scored between 1 and 5 according to predetermined criteria. For example:

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- *If no performance standard requirements have been considered, then the system element will score a 1*

- *If the performance standard requirements are demonstrated to be fully effective, then the system element will score a 5*
- *If implementation of the performance standard requirements is found to be somewhere in between (the most likely scenario), then the system element will score somewhere between 1 and 5, depending on the level of that implementation.*
- *These scores can be categorised by traffic lights which give an indication of the extent to which system elements and processes satisfy the management system performance standards. Table 1 illustrates scoring against each element of the SHMS for example Mine X1 (these elements were introduced earlier in 3). Figure 5 demonstrate how the assessment can be represented visually as a gap analysis. This provides a quantitative measure of management system effectiveness which can* be used to benchmark performance over time and between sites/organisations.

Table 1: Example of measured effectiveness of Mine X's SHMS

Mine X SHMS element	Score	Percent (%)
1. Leadership and accountability	3.0	60
2. Legal and other requirements	3.0	60
3. Hazards and risk	3.0	60
4. Planning, goals and targets	3.5	70
5. Awareness, competence and behaviour	3.0	60
6. Communication and consultation	2.5	50
7. Design, construction and commissioning	3.0	60
8. Operations and maintenance	2.5	50
9. Documents and records	4.0	80
10. Suppliers, contractors and partners	2.5	50
11. Incidents and emergencies	3.0	60
12. Monitoring, audit and review	2.0	40
13. Management of change	2.5	50

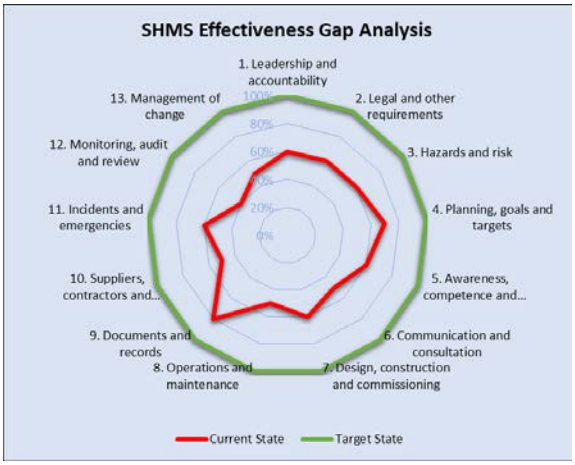

Figure 5: Radar plot of SHMS effectiveness analysis for Mine X showing gap between measured state and target state

CONCLUSIONS

There is nothing special about an effectiveness audit. Australian and International Standards for SHMS, stipulate that all audits of the management system or its component parts must assess effectiveness. According to QGN09, effective means that the SHMS reduces the level of risk to safety and health of persons affected by the operation of a mine to within acceptable limits and as low as reasonably achievable. ISO 45001:2016 (International Organization for Standardization 2016, p.47) defines the effectiveness of a management system as, '*…the*

[1] *These are the results of an actual audit of a mineral mine.*

extent to which it delivers on planned activities and planned organisational objectives'. Thus, an audit of the effectiveness of an SHMS, in simple terms, is an assessment of:

- The adequacy and suitability of the measures used to set and monitor organisational safety and health objectives
- The extent to which planned activities and organisational objectives have been realised.
- The cornerstone of the management systems approach is continual improvement, so for any system to be deemed fully effective, demonstrated evidence that continual improvement is fully embedded in business processes is required.
- A quantitative measurement of SHMS effectiveness is possible through the systematic use of representative, objective and unbiased statistical sampling of data about system performance, and the application of scoring criteria to the data gathered. This quantitative measure can be used to assess the current state of management system effectiveness against the target state, benchmark system performance over time and to compare sites/organisations.

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