The Introduction of a Risk-Based Safety System to Three Quarries
A Case Study

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BACKGROUND

The Rail Infrastructure Corporation (RIC) is a NSW statutory State-owned corporation formed under the NSW Transport Administration Amendment (Rail Management) Act 2000. RIC's core business is the construction, maintenance and upgrading of rail infrastructure and the overhaul and maintenance of rolling stock within the rail industry. Within RIC the Track Products division operates three hard rock quarries that produce materials for rail ballast and other commercial products. Martin's Creek and Ardglen quarries are located in the NSW Hunter Valley; Bombo quarry is on the coast approximately 90km south of Sydney.

Basic quarry operations include blasting, shovel/loader and truck haulage, crushing, screening and stockpiling. Product is dispatched by road trucks and via train loadout systems and occasionally private individuals purchase small amounts of material. Workforces at the quarries are small by typical mine standards, the smallest being seven persons including a production supervisor and administration assistant, the largest being twenty, and they have been stable for many years. Routine operations and servicing are handled in-house although some activities, for example blasting and some maintenance functions, are managed via contractors.

RIC has comprehensive corporate safety systems and strongly emphasizes the high priority of safety in all of its activities. Also the quarries have enjoyed a good safety record. So what prompted the need to embark on a safety improvement programme? The basic reason, put forward in early 1999, was that the overall safety systems were strongly focussed on rail and track activities and it was felt that there was a need for greater focus on quarrying operations and needs. The managers felt that a focus on their site-specific issues would engender more "ownership" and provide the opportunity to go "beyond compliance". Compliance not only with their moral and corporate duties, but also with the obligations under the mines legislation which are unique to the quarry operations within RIC. The Mines Inspection General Rule 2000 (the General Rule) was due to commence in September 2000 and being similar to the Queensland mining legislation, it contains requirements for, and strongly emphasizes, a risk-based systems approach to safety management.

THE INITIAL STEPS

In mid 1999 Jim Knowles was approached and then commissioned to conduct a hazard awareness and risk assessment course at all quarries. This introduced the fundamental risk-basic principles and exposed the workforce to their practical application. Jim also recommended that "broad-brush" risk assessments be conducted in order to provide a risk-based priority of site operations, and these were undertaken shortly after. Having presented the outcomes of these exercises, the author was posed the "where to from here?" question.

SETTING THE DEVELOPMENT FRAMEWORK

The quarry people are extremely practical and speak plainly. They had also been doing their jobs, without injury, for many years, decades in some cases. To introduce the concept of risk into their daily routines, bringing with it the (incorrect) associations of "you're doing it wrong", "it's your fault" and so on, was somewhat daunting. Another concept that did not sit easily with the general workforce was "paperwork". A significant advantage of their small numbers and long-term relationships was their excellent local knowledge and informal communication networks. Most people knew what was happening at the quarry, when and where, and they would not be persuaded, cajoled, or otherwise made to deal with any paperwork that was not seen to be of any value to them.

This was a fact of life, irrespective of any internal or external system requirements or the manager's desires, and represented a significant complicating factor for the future of timely, accurate, comprehensive, traceable, etc, etc, documentation and records. You could argue that the JDI (just do it) approach should have been taken however we felt that these realities had to be faced if any system was to stand a chance of being "owned" by the workforce – and therefore be effective and sustainable.

Another complicating factor was that there was to be no "Grand Plan". The managers were keen to involve their people but needed to see benefit from any investment they would make. They recognized that change would take time but were not prepared to commit to a return that would only be realized in the distant future. They knew that they wanted a more site-specific system and that it needed to be risk-based but were not sure of the form it would take. There was no need to re-invent elements of the overall RIC system they considered acceptable but it was clear that what was called "the kilo approach" was totally unacceptable. ("The kilo approach" was the production of impressively large volumes of text that although technically correct would be of little practical value to their workforce.) In fact the managers had already evaluated their risk and defined a general strategy: – Get someone in to help, but don't over-commit and expect some short-term results. Only continue on the basis of previous efforts and further justification.

The initial objective was defined to be the generation of site-specific operating procedures. Although written procedures had been produced earlier the managers were concerned that they had been prepared in isolation and that the format was too "wordy". The challenge was therefore to address the immediate objective within a framework that was scaled to the quarries' needs and circumstances and that provided opportunities for further development. Bearing in mind all these factors and considering the nature of the business, the following framework was agreed:

1. The system had to be targeted at the workforce. We had to recognize for whom we were doing this. We agreed that it was not for the quarry management nor the Inspectorate, at least not directly. It was for the workers at the quarry. The argument was that if the workforce could effectively apply the outcomes we would succeed with the requirements of the others. Experience, capabilities and other strengths of a small organization had to be recognized whilst also providing the means and motivation to improve on any weaknesses. It was essential to have a sound basis in the principles of risk management but an enormous emphasis was placed on the need to keep it practical and simple.

2. The process had to be one of involvement and participation. This applied not only to the workforce but to all the stakeholders. Visible involvement would reinforce the priority of safety, demonstrate commitment and engender ownership. Obviously, with so few people employed at the quarries the involvement in the development phases had to be scaled to levels that permitted production to continue. This was not going to be easy but everyone was to be involved at some stage. Also, involvement with the Inspectorate was considered to be very important and so communication lines had to be kept open at all times.

3. Development must be modular. Each step had to be self-contained and generate a benefit while providing "hooks" for future options. This would provide break points for reviews by the workforce and assessments by the managers. It was understood that this may require some iteration or revisiting of previous outcomes, but the degree of re-work was to be minimized.

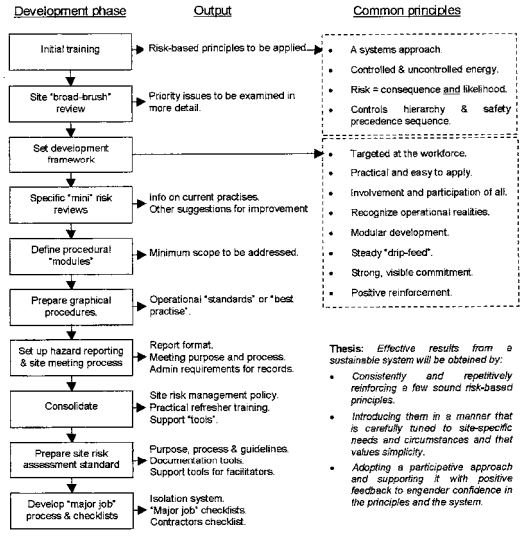
4. This is not a quick fix. While recognizing point 3 above there were no expectations of sudden major changes. The idea of a risk-based approach was new and it would take time for it to be fully understood and appreciated. A process of steady, continuous "drip-feed" reinforced by positive outcomes was considered to offer the best chance for sustainable outcomes.

5. There must be solid and visible commitment. This fell mainly to the quarry managers who had to provide the people, time and financial resources. The need for commitment from the top may be a cliché but it is still an absolutely critical requirement for success.

At this early stage it was clear that a collaborative effort was needed. No single party would be capable of delivering the outcomes and all stakeholders had a role to play. The quarry managers, the workforce, the Inspectorate and the consultant were all stakeholders and so all needed to contribute. Also development had to occur from the bottom up in a step-wise manner while being directed by the general principles of risk management and the requirements of the General Rule. (I called this approach "directed evolution".) Finally, and most importantly, the outcomes had to be simple but not simplistic. This is not easy to achieve and requires considerable thought and discussion throughout the process. A three-pronged approach was adopted.

1. Minimize the number of new ideas to be introduced by demonstrating the logic and common sense of a few risk-based principles and repeat them at every possible opportunity.
2. Provide basic tools to assist in applying the principles to specific circumstances, thereby eliminating the need for a complex set of rules that could not possibly address every circumstance nor be remembered.
3. Provide document formats that the workforce could easily relate to, that could be used in practical circumstances and that minimized the need for written input.

Figure 1 – *A simplified model of the system development.*



"Mini" risk reviews

The initial "broad-brush" risk assessment provided a basis for more detailed examination of the quarry operations. The intent was to undertake a series of facilitated "mini" risk assessment exercises with the multiple objects of increasing familiarity with the risk principles, obtaining information about the priority hazards and controls, and opening up the potential for change. Table 1 illustrates the initial scope of these exercises.

***Table 1** - Initial scope of "mini" risk assessment exercises.*

- Drilling.
- Blasting.
- Shovel/loader operations in the quarry.
- Vehicle movements.
- Dumping of loads.
- Plant operations and access.
- Inspections and servicing of conveyors.
- Clearing blockages.
- Use of loaders on stockpiles.
- Train loadout operations.

This phase was planned as a staggered series of exercises so that no one spent more than half a day "at school" at a time. In some cases this required two sessions. Typically two quarry people participated, sometimes more, having been selected for their particular expertise with the topic, and most people were involved in a few exercises.

Levels of expectation for the implementation of suggested changes had to be dealt with very carefully as it was too soon to expect that major changes would be made. We were looking for simple ideas that could be implemented quickly in order to demonstrate that the risk principles did make sense, that the management was committed, and that the workforce could have influence in the way their workplace is managed if they tackled it in a systematic manner. The results provided us with useful information for the next phase in terms of the currently accepted best practice as well as highlighting other issues that needed to be addressed. I believe that benefit was gained just by discussing what could or should be done for the "higher" risk issues. Often these discussions just reinforced the importance of existing measures that had been taken for granted or emphasized that people had really been too accepting of some hazards.

Development of procedures

The next step was to develop a list of procedures and there was now plenty of source material to call on. The "broad-brush" review, the managers' written information and the "mini" operational risk reviews provided a comprehensive set of site-specific information, but each source was structured differently and included different overlapping details of the overall picture. This information had to be synthesized into a minimum set of simple, non-repetitive, modular procedures. Three basic classes were identified: operating procedures, maintenance tasks and general awareness issues. A sorting exercise extracted the details relevant to the items identified in each class and Table 2 illustrates operating examples.

***Table 2** – Examples of operating procedures*

- Site access.
- Product access.
- Shot preparation.
- Drilling.
- Blasting.
- Loading trucks.
- Haulage.
- Dumping.
- Working around the quarry face.
- Plant operations.
- Train loadout.

Priority was given to developing the operating procedures for which two constraints were applied. Firstly, the procedure had to be limited to a single A4 piece of paper (subsequently relaxed to permit a double-sided page), and secondly the amount of text had to be minimized. These requirements led to the obvious conclusions that the procedures had to be highly pictorial and graphical, and that if the issue could not be clearly presented on one sheet of paper it was too big and had to be sub-divided. (Refer to the presentation for examples.)

Each draft was reviewed by suitable representation from the workforce before being finalized, the same people involved in the respective "mini" risk review being used whenever possible. It was also emphasized that these procedures were not intended to teach people how to do their jobs – it was their information that was being used after all and a separate initiative was in progress for formal assessments of specific competencies such as loader and truck operation. The procedures assumed these competencies but represented the current best practice at the quarry and so defined the minimum expected standard. For example, the haulage procedure defined the site-specific issues to be addressed assuming the operators were competent to drive trucks. It was also emphasized that these procedures (or minimum

standards) could not cover every possible circumstance that might be encountered and so there was still a continuous need to be aware of actual and potential safety hazards and other unwanted situations.

Hazard reporting and site meetings

Now that the workforce had been given an understanding of risk principles and some operating standards by which to work, and on the basis that nothing is perfect, we should expect to be told of hazards, difficulties, or non-compliances with the procedures. If this was not happening we had not done our jobs. A hazard reporting system was needed. But we could not stop there – we needed some means to decide what should be done about the hazards. This logic was presented to the entire workforce at each quarry and a common system of hazard reporting and regular site meetings was discussed and set up. A hazard report form was agreed (minimum written input and checkboxes) and a "crib-card" of basic risk principles issued to all employees.

One side of the Crib-Card of basic risk principles – shown full size.

The ABC of risk control

A – Identify Hazards

Are **ENERGIES** under control?

GRAVITY?	People or things falling.
MECHANICAL?	Things moving.
ELECTRICAL?	Sparks, arcs, or exposure to live equipment.
PRESSURE?	Too much or too little.
HEAT?	Hot surfaces or radiant.
CHEMICAL?	Gasses, fuels, etc.
NOISE?	Level & duration.
BIOMECHANICAL?	Sprains & strains.

Is the **System of Work** OK?

Is there a difference from site standards or what you would expect?

Although this system was adopted with some enthusiasm there were aspects which presented some initial difficulties A fundamental issue was trust. Not that there was a general culture of mistrust, but this was something new and unproven. The workforce were concerned that reporting a hazard would somehow imply individual fault or deficiency and so be subject to the manager's ire. Also that if they took the trouble to report a hazard that nothing would happen about it. The managers' concern was that issues would be raised that were so wide-ranging that they had no realistic chance of being addressed within a reasonable budget or timeframe. Nevertheless, everyone felt that the process provided the best opportunity to improve matters and so had some investment in its success. The trust issue was tackled by appealing to good common sense, the practical realities of the operation, and the positives to be gained by all parties. On this basis, and with the managers' insistence that hazard reports would be encouraged, there was a common understanding that improvements would come but that they needed to start in a small way and proceed on the basis of results obtained.

Another key issue was the effectiveness of the site meetings. The intent was to provide the opportunity to review hazard reports in a small group and to recommend actions to be taken. The meetings were to be facilitated by an assistant manager or production supervisor but there was to be no permanent appointees from the workforce. Participation was considered to be a responsibility of all employees and required that attendees were familiar with the latest hazard reports and actions. Unfortunately there was a tendency for the meetings to develop into lengthy discussions about the details of *how* particular solutions were to be implemented rather than decide *what* should be done. Also meeting preparation, records and feedback was clearly going to be at risk of the "paperwork" aversion once the initial novelty had worn off.

***Table 3** – Site Meeting Manager functions*

- Accept and log hazard reports.
- Prepare meeting agendas.
- Structure meetings into main phases of reviewing progress of outstanding actions, reviewing new hazard reports and assign actions, and planning the next meeting.
- Prepare progress reports and individual action plans.
- Provide a traceable history of all hazard reports, meetings held and actions arising.

The solution was to provide a computer program that forced a consistent structure on the meetings and minimized the administration overhead. For example, record keeping was automated and agendas, progress reports and action plans were available via "single-click" operations. It was designed to be used with the absolute minimum of computer expertise and training – basically a "point and click"

operation – and as far as possible to be "idiot proof". Technically the system is still a prototype under evaluation but has been in use for about six months. Its main functions are shown in Table 3. An important feature is the ability to enter not only hazard reports but also any other topic as an agenda item. For example, an update of the latest notices from the Inspectorate, or some other internal matter can be included. This feature also can neatly close the loop with the initial "mini" risk reviews in that the suggestions made at that time can be fed into the meeting process for resolution.

Numerous actions were implemented as a result of the hazard reporting and site meeting process and trust was developing. The workforce could see their hazard reports being actioned and the managers could see that the workforce was being positive about the system. Also the loop of hazard reports – meetings – actions and feedback – more hazard reports, was being sustained. The combination of logic and common sense, the appreciation of a few basic risk-based principles, and simple and practical support tools was working.

Consolidation

We were now at a stage where the various elements could be consolidated. A quarry risk management policy was prepared, and all employees were issued with a package containing the policy, a simplified set of risk principles and the "crib-card", the hazard reporting and site meeting processes and all operational procedures. This was backed up with practical refresher exercises in hazard identification and risk ranking, competency assessments of the system elements and a "user guide" for the site meeting program. But there was still some way to go.

A standard for risk assessment

Risk assessment was a missing element of a quarry safety management system. Although they had experienced a number of risk assessment exercises the process had been set up and managed by me - not a sustainable situation. Support materials for hazard identification, risk ranking, the controls hierarchy, and action planning were now developed and being applied but the focus was on the overall *principles*, not on the details of managing the *process* of a risk assessment exercise. Since formal assessments would most likely be run by the quarry managers or supervisors, a set of process guidelines and supporting tools was prepared for this level, and training exercises were conducted. The materials included sections on identifying needs, the appropriate level of response, roles, resources, planning, documentation, interpretation and feedback, and the objectives were to develop the competency to manage the process in-house and to provide a site standard against which to judge risk assessments undertaken by others.

"Major jobs" and contractors

We now returned to maintenance tasks but it was obvious that to prepare a procedure for every job was clearly a huge task with the risk of falling into the "kilo approach" trap. Also the spectre of paperwork was present since the need for sign-offs was specified. To simplify this aspect we concentrated on a minimum set of generic tasks that may be required as part of any job.

Firstly a lockout system was devised and implemented and, although the principles and need for isolation were non-negotiable, the workforce was involved in the details of implementation. For example,

Q: Should locks be issued to individuals or should they be available as a common set?
A: A common set.

Q: How many sets do we need and where should they be located?
A: Different numbers and places were specified for each quarry.

Q: Do we need colour-coded locks to distinguish between types of users?
A: Not necessary – the system is the same for everyone.

Q: What happens if someone loses their lock, key, or fails to remove their lock?
A: Everyone is responsible for applying and removing their own isolation – but we need a contingency procedure if this happens otherwise there is the risk that the system will fail.

A general isolation procedure was then prepared in the single-page, graphical/pictorial format used for the operating procedures, and practical training conducted.

***Table 4** - Scope of generic maintenance tasks to be included.*

- Isolation.
- Working at height.
- Hotwork.
- Working on large vehicles.
- Lifting and slinging.
- Towing/de-bogging.
- Working on pressurised systems.
- Working in confined spaces.
- Excavation.

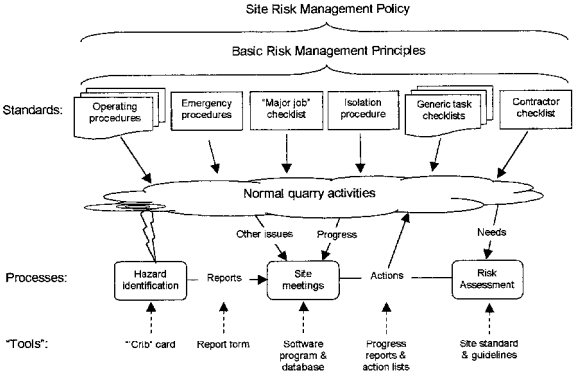
By referring back to the "broad-brush" and "mini" risk assessments and in discussion with the tradesmen, a series of headings were developed for generic tasks. Table 4 shows the scope. Checklists were then prepared covering essential pre-start conditions and other do's and don'ts. Also a single-page "major job" checklist was prepared to define the nature of the work to be undertaken and fulfill the essential documentation requirements. The full set of checklists, plus the isolation and site emergency procedures and, once again, the basic risk principles, was then collated into a laminated, credit-card size pack and issued to all employees.

Having completed this work it was obvious that it also could, and should, be applied to contractors. (Also, with little modification it could be developed into a permit system.) The final step was to prepare a "contractors' management" checklist, based on the requirements of the General Rule. This was neatly able to refer to the site standards previously developed for access, "major jobs" and risk assessment.

RESULTS

The system, as developed and implemented so far, is shown schematically in Figure 2. In itself it does not address all the requirements for a Safety Management Plan however this was not the purpose. It does provide a sound basis for the site-specific issues related to risk management and, in conjunction with the wider RIC system, will provide an appropriate framework of standards and processes.

***Figure 2** – Scope of the overall system.*



In terms of the approach taken, I have summarized the results arising as follows:

Acceptance. Active participation, though not always easy, eliciated positive responses from the workforce and the Inspectorate. It also brought with it a greater understanding, amongst all parties, of what was being done and why. Greater understanding led to "ownership" and acceptance of both the system and the need for actions that arose.

Improved confidence in safety management. Having a structured system of standards and processes in place that is accepted, that is based on a few key risk-based principles that are understood, and that is applied in a pro-active manner, has contributed to effective safety management.

More time to manage. Day-to-day decisions can be taken at the appropriate level of the organizational structure, allowing the manager more time to manage the quarry.

Recognition brings responsibility. The approach taken was presented to the Institute of Quarrying in August 2000 and to a session of the NSW DMR Small Mines Campaign in February 2001 where positive responses were received. This was encouraging since there was the implication, at least, that others recognized it had some merit. This positive feedback and congratulations were communicated to the employees at all three quarries who quite naturally received it well. I believe that this recognition reinforced, and brought with it, the responsibility to maintain the system to a high standard.

CONCLUSIONS, LESSONS TO BE DRAWN, AND PERSONAL OBSERVATIONS.

Since the system was specifically developed for the RIC quarries the particular process and outcomes may not be appropriate for all organizations, however more generally:

Be clear about your requirements. Take the time to carefully define what is needed. In doing so consider not just the need for legislative compliance but the site-specific circumstances that form the context within which you are working. Set some general principles for the approach to be taken, set priorities and incorporate checkpoints along the way. Most importantly, be very clear about for whom the requirements are being defined.

Set limits to expectations. Be realistic and don't expect that the world will change overnight. Be very clear about the degree of freedom available to all parties so there will be no disillusionment or disappointments down the track. Initially set small goals that you are confident can be achieved then reinforce success with positive feedback.

Listen to the workforce and give them credit for their knowledge and experience. Those who are doing the job know best what is happening. This may not be what is thought is happening or even what should be happening but it is vital to understand the realities. Their knowledge and experience is a major asset and should be respected.

Show commitment. This is probably the most important requirement. Commitment needs to be shown continuously and visibly by example and by perseverance.

Simplicity is a virtue but it can be hard to achieve. Simplicity is in the eye of the beholder and it has to be valued and designed for. In the context of the quarries it meant that the workforce should be able to effectively apply the risk principles with the least amount of physical, cognitive and administrative effort. Simplicity of results does not therefore equate to a simplistic design and development process, but this in turn doesn't imply that development must be complex. It must however be thorough and will require some thought.

Involve the Inspectorate. The Inspectorate can offer helpful advice, not only in terms of specific technical issues and legislative requirements, but they can also provide a wider perspective and act as a check on the appropriateness of what is being done. Don't leave it too late though!

Be accepting of change. Things can always be improved and circumstances are bound to change sooner or later. For example, during the course of this process people have been promoted and transferred, equipment has been upgraded and new facilities installed. The entire process has been a significant change to the way safety is managed at the quarries. Accepting change does not imply surrender to it, but rather that there is a need for continuous vigilance. Understanding that change is inevitable somehow makes it easier to deal with.

Pros and cons of the participative approach. A participative approach is heavily dependent on the management style and, as with all things, there are risks and benefits. In full recognition of their duties and responsibilities and despite a strong commitment to the process, both managers had initial difficulties, and still have some reservations, with the need for some degree to "let go" of the direct control of some day-to-day decisions. On the other hand, the benefits can be a greater understanding of the workplace by all concerned, not only in terms of health and safety, but also in terms of the operational issues and effective management generally. The approach doesn't imply total democracy, nor that everyone will like the decisions since there will always be imperatives to be met by all sides, however a better understanding of why decisions are made must contribute to their smooth implementation.

The principles can be transported to other areas. Sometimes risk management is seen as synonymous with safety and although this system was focussed on safety management the same basic ideas and approach can be applied to any area. Just one potential area for small mines and quarries could be maintenance management. Of course safety must always be of the highest priority but I suggest that only when the basic risk principles are seen to apply to the broader context can we truly say that we are adopting a risk-based approach to the industry.

THE BOTTOM LINE

At the end of the day the management of risk is what everyone must do, irrespective of their position or role, and it is fundamental to the concept of "Duty of Care". By establishing priorities and making decisions on sound, risk-based principles a common framework can be established, but it will be the appropriateness of that framework to each organization combined with the efforts and vigilance of everyone involved that will determine the degree of success we can achieve.

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