EXPLOSIVES – HAZARD MANAGEMENT

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INTRODUCTION

Explosives are substances or mixtures of substances which will react rapidly to produce large quantities of gas and heat. That such products of reaction are produced in such a rapid fashion, milliseconds or less, provides opportunity for much useful work and makes them essential tools for mining, quarrying or construction industries.

However these same characteristics present risks to organisations employing explosives as they become exposed to the chance that the necessary initiating stimuli will be applied at an unintended time at an unexpected location and in an unplanned manner. The useful work sought from such explosives now becomes a devastating potential for tragic loss.

Where industries employ explosives in their operations, and it is recognised they remain an essential tool for the mining industry, the associated risks posed by these materials need to be carefully managed to provide a safe workplace for employees and a safe environment for the general community.

The term "Explosives" represents a broad class of inherently dangerous materials, including blasting explosives, fireworks, propellants, ammunition and other explosive devices. Consideration here will be restricted to those blasting explosives typically used within the mining and construction industries.

BACKGROUND

Prescriptive legislation covering explosives has been around for considerable time. The existing Explosives Act 1952 in Queensland superseded the Explosives Act 1906, which itself was a reflection of the U.K. Explosives Act of 1875. Despite the fact that legislation aimed at ensuring safety has been around here in Queensland, all other States and Territories in Australia and, indeed, all around the world for a long time, accidents continue to happen with explosives with tragically high consequence.

Where such accidents are investigated and where it is possible to draw conclusions as to probable causes, it is less frequently the case that a breach of legislation caused the event. Rather, it is typically the result of a lack of appreciation of the hazard or the lack of appropriate measures to effectively manage that hazard.

It is not surprising therefore that regulators and industry alike are moving towards the employment of safety management systems as a tool for minimising risk in a workplace. Safety management should not be considered a separate entity but rather be incorporated into an organisation's good management practice.

THE PROCESS

One of the important and integral parts of a good safety management system/plan involves consideration of the following process:

1. Hazard Identification
2. Risk Analysis
3. Risk Assessment
4. Risk Control

While it is ideal that such a process should occur early in the design phase of planned operations/activities, it is also applicable to established operations for review and safety improvement.

The implementation of this Risk Management process on mine sites, or indeed any sites, would involve the study of products, equipment and processes to determine areas where safety may be compromised and to institute methods of managing those areas of risk.

There will of course be areas of grey in any such study – areas where the measure of risk may be difficult or complex and where the extent to which control measures should be applied is not easy to assess.

However we are specifically addressing explosives and the risk management process that follows will apply to all sites employing explosives to produce useful work. Because of the nature of the materials in question the process becomes a relatively simple one and can be portrayed in the following manner.

Hazard Identification

EXPLOSIVES ≡ HAZARD

Explosives are by definition, by international classification, by experience and by any measure of assessment, inherently hazardous.

Risk Analysis

A risk analysis normally requires estimates of both the frequency or probability of an undesired event and the associated consequences or severity of the outcome of such event.

Risk = function (Consequence, Probability).

With respect to the analysis of risk from blasting explosives there is little need to progress beyond a qualitative risk analysis.

(a) Probability

With existing control measures in place it could reasonably be expected that the probability of an explosives event may be considered as low.

The following example of qualitative measures of probability could be applied:

Level	Descriptor	Description
A	Almost certain	Expected to occur in most circumstances
B	Likely	Probably occur in most circumstances
C	Moderate	Should occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstance

A study of explosives accident/incident history and an expectation of existing control measures would reasonably lead to a level D probability. However insufficient or ineffective control measures would drive this measure towards a level C.

(b) Consequence

With blasting explosives the consequences of any reasonable event will inevitably be rated as high. The products concerned are designed for a specific purpose and it should come as no surprise to all involved that an unplanned initiation event is likely to produce maximum output.

The following example of qualitative measures of consequence can be employed:

Level	Descriptor	Description
1	Insignificant	No injuries, low financial loss
2	Minor	First-aid treatment, medium financial loss
3	Moderate	Medical treatment, high financial loss
4	Major	Extensive injuries, loss of production, major financial loss
5	Catastrophic	Death, huge financial loss

In our explosives scenario, the likely consequence of unplanned initiation events is at level 4 to 5.

(c) A simple risk analysis may now be carried out by creating a matrix of the two measures, probabilities and consequences outlined above.

Probability	Consequence				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
A (almost certain)	S	S	H	H	H
B (likely)	M	S	S	H	H
C (moderate)	L	M	S	H	H
D (unlikely)	L	L	M	S	H
E (rare)	L	L	M	S	S

H ≡ high risks; detailed research and management planning required at senior level.
S ≡ significant risk; senior management attention needed.
M ≡ moderate risk; management responsibility must be specified.
L ≡ low risk; manage by routine procedures.

Any simple qualitative analysis of the risks posed by blasting explosives will come to the conclusion that explosives present a high risk to any organisation and such risk needs to be effectively controlled.

Risk Assessment

Risk assessment takes the risk analysis one step further by determining the tolerability of the risk. In such an evaluation many factors are taken into consideration including:

- The objectives of the project
- The extent of opportunities provided
- The socio economic aspects, and
- The ability to effectively control the determined risks.

There is no reason to believe that the hazards associated with explosives cannot be effectively controlled and hence continued use in mining projects which produce enormous benefits to the community can be justified. However the measure of risk posed by explosives demands the application of risk control measures.

Risk Control

There are a number of measures which can be employed to control risks and these can be listed in order of preference as follows:

(a) Elimination

While it may be argued that in certain instances this is an option, eg underground coal mining, secondary blasting, there is currently no practical alternative to the efficiency of work produced by explosives in the majority of mines and quarries.

Hence elimination of the hazard, explosives, is not a practical control measure that can reasonably be employed.

(b) Substitution

Replacing the hazard with one of lesser risk has, to some extent, occurred over the past twenty years with the move away from the more sensitive explosives to the slightly more forgiving emulsion and watergel types.

In so doing, the risk from the explosives could be seen as lower since the probability of a less sensitive explosive initiating is lower while the consequence remains almost the same. However such an assessment must be viewed with caution as advancing technology has not only given us less sensitive explosives but also a rougher environment in which they are employed. For example, most would accept that emulsion explosives are less sensitive than nitroglycerine based explosives. But who would entertain manufacturing NG based explosives in the back of a cement truck and pumping or auguring them down deep blast holes. As explosives have moved to lower sensitivities, restrictions imposed by legislation or safety guidelines have reduced also.

It has been argued that the move to less sensitive explosives has not therefore been accompanied by a reduction in the probability of initiation, and those that offer this argument point to the number of incidents occurring around the world as supporting evidence.

It must be stressed here that the move to less sensitive explosives is one control measure aimed at lessening risk. However, the end result is a low probability high consequence event, ie a high risk, that continues to demand risk control measures.

(c) Engineering Controls

These controls are employed to a limited extent in lessening the high risk posed by explosives by either reducing the probability of an event or by reducing the consequences.

Examples include:

- the design specifications for explosives transport and manufacturing vehicles aimed at reducing the probability of an initiation;
- the design specification for a barrier on explosives transport vehicles between detonators and high explosives aimed at minimising the consequences of an initiation;
- the design of explosives magazines aimed at reducing the probability of your explosives presenting a high risk to the general public; and
- the designed location of explosives magazines at recognised safe distances to minimise the consequences of an event.

However, guards or barriers which can and are employed to protect persons from the hazards of certain explosives, eg fireworks, detonators, are less than effective, and may even provide higher risk, in control of blasting explosives on mine and quarry sites.

(d) Administrative (procedural) Controls

In the use and handling of blasting explosives on mine and quarry sites, it is, in the main, this measure which is called upon to effectively control the high risk posed by the explosives.

As it is far from the preferred method for controlling any risk, it is essential that this method be employed in the most comprehensive and competent manner to achieve the desired controls on these high risk materials.

The extent of these controls will be addressed later in this paper.

(e) Personal Protective Equipment (PPE)

This type of control measure can be effective with certain explosives eg flame retardant clothing for people working with firework compositions, safety glasses for people manufacturing or packaging detonators. With respect to blasting explosives however, it would seem the only practical benefit of personal protective equipment in the event of an incident might be to determine in which particular direction certain body parts may have been propelled – hardly the purpose or the designed function of the PPE.

In summary therefore the main measure employed to control risks in this scenario is the administrative (procedural) controls.

SCOPE OF ADMINISTRATIVE CONTROLS

From the moment explosives arrive at a particular site there exists a high risk requiring effective controls and there exists a responsibility or obligation, presumably on the mine or quarry manager, but also on those both above and below these people to varying extents, to ensure those effective controls are in place to protect both the employees and the general public from the hazards associated with those explosives.

It is acknowledged that while ever blasting explosives are being employed to perform practical work on mines and quarries, risk cannot be eliminated, however that risk needs to be controlled to an acceptable level. In the area of administrative controls it is considered that large reductions in the level of risk can be obtained with relatively low expenditure.

Just as it is less than effective to build a good protective fence on only some sides of a swimming pool, so is it less than effective to address only some of the explosives activities on a mine or quarry site.
It is necessary to track the explosives on site from point of receipt to point of use or disposal (including decontamination of explosives handling equipment eg vehicles), and to determine where it would be appropriate to institute procedures to control or minimise the high risk.

While these will vary from site to site, the following are some areas of concern which would need to be considered:

(a) Receipt of explosives
- Who receives (explosives competency)
- Where temporarily located
- Stock check (records management)
- Time taken/exposure of personnel
- Explosives competency of driver
- Suitability of vehicle
- Material safety data sheets (MSDS)

(b) Transport of explosives
- What modes
- Suitability of vehicles
- Explosives competency of driver
- Routes
- Temporary/unmanned stoppages
- Emergency response

(c) Storage of Explosives
- Design of magazine
- Location of magazine
- Nominated magazine keeper
- Explosives competence of keeper
- Receipt into magazine
- Issue from magazine
- Authorised access
- Maintenance (+ Repairs)
- Inspections
- Stock records
- Emergency response
- Legislative requirements

(d) Manufacture of explosives
- Types of explosives
- Location
- Approved methods
- Explosives competence of operators
- Equipment
- Maintenance (+ repairs)
- Inspections
- Keeping of manufactured product
- Legislative requirements
- Records

(e) Use of explosives
- Blast design (Who?)
- Explosives competence of operators

- Exposure (numbers)
- Technical data available
- Legislative requirements
- Misfires
- Environmental factors
- Methods employed
- Initiating types
- Site control
- Records
- Hot areas/high temperatures
- Reactive ground

(f) Disposal of explosives
- Who (Explosives Competence)
- How
- Where
- Records
- Legislative requirements
- Control of site

(g) Decontamination of explosives equipment
- Who (Explosives Competence)
- Hot work system
- Where
- How

(h) Assessing Explosives Suppliers
- Explosives types
- Legislative requirements
- Quality
- Material safety data sheets (MSDS)
- Technical data sheets

(i) Blasting Contractors
- Safety systems
- Competence (explosives)
- Equipment

As a significant high risk, explosives should be controlled at all stages of their life on a mine or quarry site. Administrative (procedural) measures should reflect this accordingly.

ADMINISTRATIVE CONTROLS

Documented procedures and work instructions, otherwise known as safe systems of work, standard operating procedures or standard work procedures for explosives should:

- be relatively simple and easy to read;
- be written for any activities to be carried out in an efficient manner;
- be integrated with other requirements of quality, environment and more general workplace health and safety;
- be developed with assistance from explosives competent people (external) together with those responsible for, and those required to perform, the tasks;
- be developed with the objectives of reducing the probability of an event and the consequences of an event (Hazard and Operability studies, Fault Modes and Effects Analysis or other relevant analysis techniques should be employed);
- be explained to persons required to use such procedures (including why they need to be used);
- be readily accessible;
- be reviewed regularly and when prompted by changes to equipment, materials or processes or as a result of information on accidents/ incidents/near misses, etc;
- be complied with (internal inspections/audits).

CURRENT POSITION – EXPLOSIVES SAFETY

Queensland is a major user of explosives and in the past ten years has experienced four fatalities (3 suicides) and over thirty serious injuries resulting from explosives. Of these one fatality and five injuries are mine or quarry related.

For such a high risk area this could be seen by some as a good result. However such an assessment is not supported to any reasonable extent by:

- the numbers of incidents (near misses?) occurring;
- the attitudes and practices employed with explosives on some sites;
- the competencies of persons involved with explosives;
- the commitment (or lack of it) by some in responsible positions to treat explosives as a high risk; and,
- the experience in equivalent areas of explosives use.

SUMMARY

The risks posed by explosives are high and need to be managed.

Effective risk control measures are few and heavy emphasis is placed on the administrative/procedural controls. It is essential therefore that these are comprehensive in coverage, competent in content, implemented with commitment and enforced.

The resultant good safety record with explosives use and handling can then be seen to be based on good management rather than good luck.

ATTACHMENT 1

EXPLOSIVES INSPECTORATE CONTACT LISTING

	TITLE	NAME	OFFICE	MOBILE
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	Principal Inspector Coordination (Acting)	W R (Ron) Carlyon	07 3237 1389	041 7764791
SOUTHERN REGION (Area: As far north as Hervey Bay)				
Helidon Explosives Reserve Airforce Road HELIDON QLD 4344 Facsimile: 07 4697 6668	Inspector of Explosives	J (Jim) Fowler	07 4697 6161	041 7764794
CENTRAL REGION (Area: From Hervey Bay to Proserpine)				
Qld Govt Bldg Ground Floor 209-214 Bolsover Street PO Box 257 ROCKHAMPTON 4700 Facsimile: 07 4938 4310	Inspector of Explosives	B R (Brad) Bauer	07 4938 4683	041 7764793
NORTHERN REGION (Area: From Proserpine North to the Cape)				
Nathan Business Centre 340 Ross River Road PO Box 840 AITKENVALE QLD 4814 Facsimile: 07 4760 7400	Inspector of Explosives	I (Ian) Tutt	07 4778 1213	041 7764792