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Risk Assessment System

Utilised at the George Fisher Mine

For

Lateral and Vertical Development

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1.0 <u>Introduction</u>

Risk management is the foundation of the Queensland *Mining and Quarrying Safety and Health Regulation 2001* as highlighted by the title of Chapter 2 – **Ways of Achieving an Acceptable Level of Risk**. Further, Part 2 of the Regulation entitled **Safety and Health Risk Management** outlines the government's expectations for the management of safety and health risk in the mining industry.

Managing safety and health risks via a risk management system allows the mining industry to take a proactive approach to safety and heath issues rather than utilising continual reactive measures, meaning that accidents / incidents (especially high potential) can be prevented rather than allowed to happen and then having to institute preventative measures.

The first step in managing safety and health risks in the mining workplace is to identify the hazards in the workplace, which is done with the participation of both management and worker representatives via the company's risk management system. Once all the known hazards associated with a task / procedure have been identified, the risk of an incident occurring has to be analysed taking into account the likelihood of an incident occurring due to the hazard being present in conjunction with the severity / consequences of the potential outcome. Providing a risk rating based upon the likelihood and consequence / severity allows for the analysis of the risk (see Table #1). If the rating of the risk associated with a known hazard is not considered **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA) or acceptable, additional controls to augment any current ones to reduce the risk of a hazard causing an unwanted outcome have to be applied, with the following being the order of application of the required controls:

1. Eliminate the hazard
2. Substitute with a hazard having a lesser associated risk
3. Separate the hazard from personnel potentially affected by it
4. Implement engineering controls
5. Implement administrative controls
6. Require the use of personal protective equipment (PPE)

In general, controls which affect the likelihood of the hazard causing an incident are the most effective controls to implement (i.e. elimination of the hazard), while controls which affect the consequence / severity of the outcome only are the least effective (i.e. PPE).

Consequence

Likelihood		1	2	3	4	5
Almost Certain	A	11	16	20	23	25
Likely	B	7	12	17	21	24
Occasional	C	4	8	13	18	22
Unlikely	D	2	5	9	14	19
Rare	E	1	3	6	10	15
	Injury	Minor	Medical	LTI	Permanent Dissability	Fatality
	Business Impact	<$10K	$10-$100K	$100K-$1M	$1M-$10M	>$10M

Legend
Extreme 18 to 25
High 10 to 17
Moderate 6 to 9
Low 1 to 5

<u>Table #1: Risk Assessment Matrix Utilised at George Fisher Mine</u>

If there is any residual risk remaining after the implementation of the controls it is to be monitored via at least one of the following to ensure that the residual risk is indeed ALARA / acceptable:

1. personal monitoring
2. self-monitoring
3. biological monitoring
4. health surveillance

The remainder of this paper highlights the sequence of events required to take a design proposal from the conceptual stage to having the work completed by competent personnel at all levels through the work.

2.0 George Fisher Mine Operation

George Fisher Mine, situated approximately 20 km north of Mount Isa, is currently ramping up annual lead / zinc ore production to the +3 million tonne range due to the current economic situation in regard to zinc (see Figure #1 and Table #2).

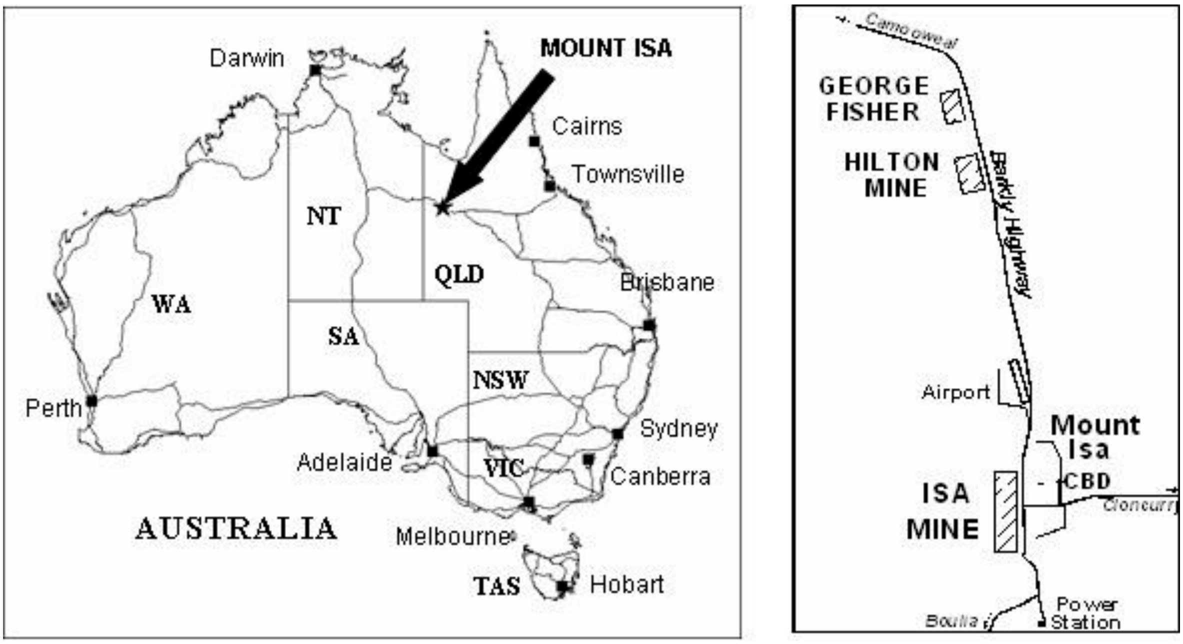


Figure #1: Location of George Fisher Mine

The mining operation is split into two distinct areas: George Fisher North (GFN) and George Fisher South (GFS), formerly known as the Hilton Mine. The two areas are connected via an internal decline as well as an internal truck haulage system that transports the ore from GFN to GFS for processing through the ore handling system at the P49 Shaft that services GFS (see Figure #2).

The main mining method utilised in GFN is transverse long-hole open stoping augmented by longitudinal benching where required as the orebodies associated with GFN are larger. The main mining method employed in GFS is benching due to the vein-like nature of the orebodies in this area of the operation.

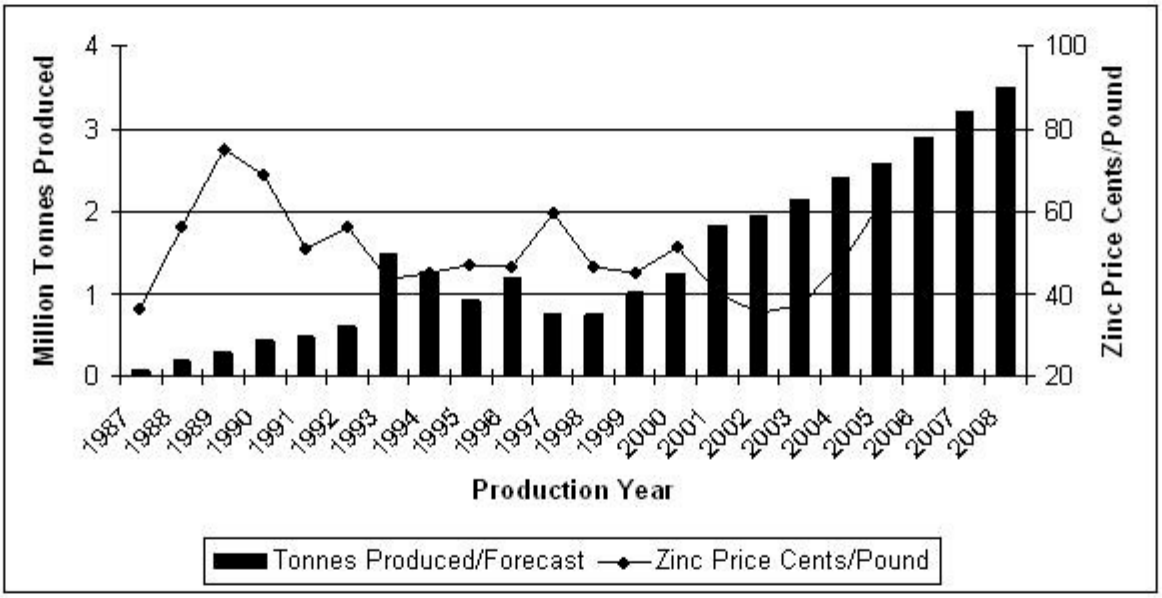


Table #2: George Fisher / Hilton Historical Production and Zinc Prices

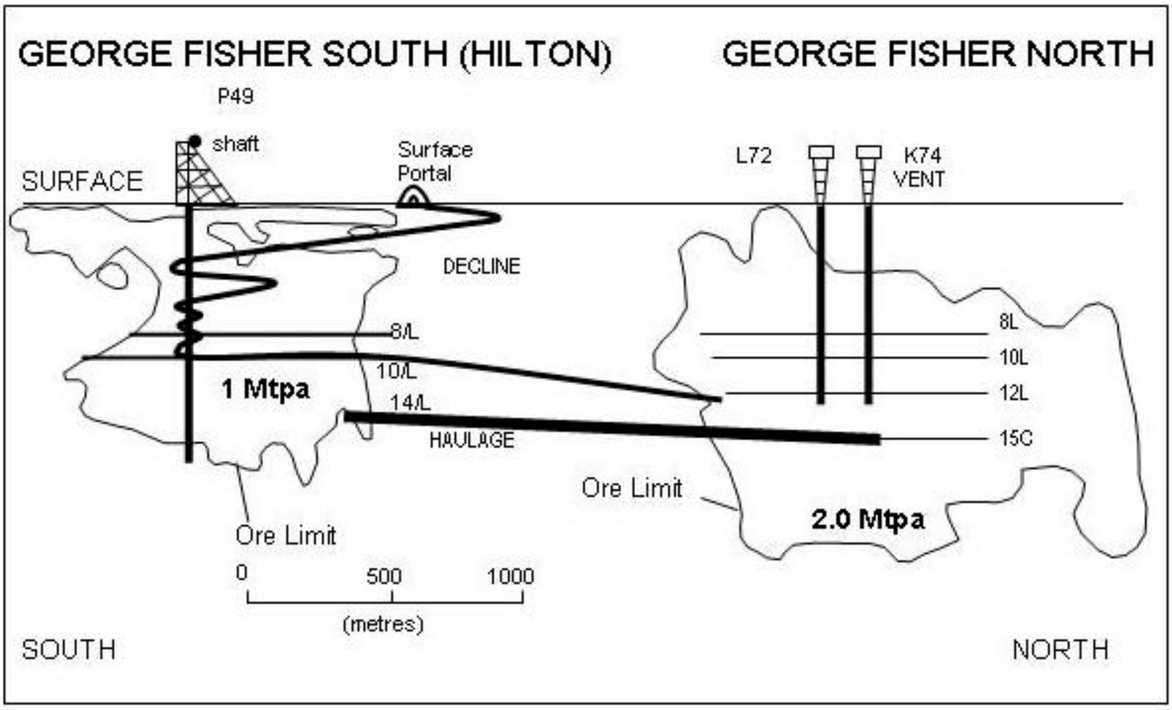


Figure #2: Longitudinal Schematic of George Fisher Mine

Annual lateral development for the combined operations is in the range of 10km, indicating that the levels where lateral development is occurring can be very interactive and dynamic.

Annual vertical development is in the range of 1.5-2.0km utilising a combination of winze drilling / firing and raiseboring, with the vast majority of the vertical development being completed via the winze method. Again, the vertical development of infrastructure entails dynamic interaction with the lateral development as well with production.

3.0 Design and Planning of Vertical and Lateral Development

One of the challenges facing the Mine Planning Department is the dynamics of development interfacing with production. That is, ensuring that the expansion of the required lateral and vertical development to sustain and increase production to expected levels is carried out in a safe, effective and efficient means in conjunction with maintaining current production requirements.

To ensure the safety of all stakeholders, a risk assessment system has been developed, which allows these stakeholders an opportunity to express concerns ***and*** propose solutions in regard to planned work (i.e. lateral / vertical development, stoping), or any work considered unusual, or associated with a unique hazard potential.

Another challenge facing the Mine Planning Department is the continual inflow of new personnel not only into the Planning Department, but also into the workforce comprising the Operations Department. Again, the instituting of a consistent risk assessment system allows management to cope with the changes and growth within the workforce by ensuring that hazards and risks (including likelihood and severity / consequences) as well as controls are recorded and highlighted in a consistent manner for review and use by relevant stakeholders.

The steps for designing both lateral and vertical development are the following (in general terms):

i. Long term development conceptual design (3 years to life-of mine)
ii. Medium term development budget design (1 – 3 years)
iii. Short term actual design (immediate use – 1 year)

The long and medium term development designs have an “informal” risk assessment completed, but this is usually done within the confines of the Technical Services Department at the minesite, which has the responsibility of completing the required designs within the stipulated timeframes.

However, when the development designs are incorporated into the Mine Planning Department, the risk assessment outlined in the remainder of this paper is utilised as this is the design that will be implemented by the Operations Department.

The mine planning software utilised at George Fisher Mine is Minesight. It is quite similar to any other mine planning design software available on the market. The theme of this paper is not to discuss the exact software used, but rather the methodology used to ensure that a design is accepted as safe and then followed accordingly. The software that is utilised for design purposes is only mentioned to highlight the fact that electronic data is the basis for design work / checking / storage.

4.0 Risk Assessment Procedure

When completing the design work for both vertical and lateral underground development, the following is taken into account and verified by the engineer planning the specific development:

- Relevant geological and geotechnical data (location of faults, orebodies, etc)
- Existing access and travelways (location in 3D space in relation to the planned development)
- Fixed emergency facilities (nearest location / what will be required)
- Ground control (appropriate ground control system as dictated by the geological / geotechnical data)
- Contaminants in the ventilation system (interaction with current ventilation system)
- Stockpiling (where mullock / ore is to be transported / stored)
- Underground water treatment (current drainage / pumping system and future requirements)
- Vehicular interaction

To ensure consistency with the design, checklists are utilised where the person completing the design, the person checking the design and the persons approving the design are able to verify that specific items have been included in the design work. This ensures that the appropriate members of the following stakeholders have an opportunity to review the proposed design relative to their field of expertise:

- Geology

- Rock Mechanics
- Ventilation
- Operations

Once the design has been completed, the actual risk assessment is conducted.

As there already exists Standard Operating Procedures for completing the task of lateral development (boring / charging / firing / mucking / ground support) and vertical development (drilling / firing), the risk assessments for these tasks have already been completed. Rather, the risk assessment for the proposed lateral / vertical development seeks to identify any hazards and subsequent risks that are associated with this specific proposed development. These identified risks are usually linked to technical issues and thus the personnel included in the risk assessment are from the technical / supervisory aspect of the operation (i.e. Rock Mechanics / Planning / Geology / Operations Staff). However, if there are foreseen hazards that are associated with the actual accomplishment of the tasks, then worker representatives are also requested to attend the risk assessment.

For example, if it is identified that there is an opening in close proximity to the proposed development that in the opinion of a technically knowledgeable person could promote a hazard of sloughage, the risk (both from a personnel and financial perspective) would be quantified, (using Table #1) and the influence of current controls gauged to ascertain the level of risk. If the level of risk was deemed unacceptable, or not ALARA, then additional controls would be discussed and agreed upon to mitigate the risk. Further, if there was a foreseen hazard associated with the actual work around the opening, then a worker representative would be asked to attend the risk assessment to ensure that any required controls under the realm of operations would be highlighted and pursued for implementation.

Risk that is deemed unacceptable for personnel is any risk level above a 5 rating. If any hazard associated with the proposed lateral / vertical development is identified as having a risk above 5 for personnel involved, especially after discussing additional controls, the design is not accepted until the risk level is reduced to a maximum of 5 via design change / further additional controls / etc.

Financial risk is considered on a case-by-case basis with the lowest attainable risk being the goal with no compromise allowed to personnel safety.

5.0 <u>Issuing of Survey Memos</u>

The results of the risk assessment are recorded on the sheet entitled "*Primary Development Risk Assessment*" with this risk assessment being filed with the original plans for the proposed development. A copy of this sheet can be found at the end of this paper.

The risk assessment record consists of 4 sections. The first section identifies the development being assessed as well as the date of the risk assessment and the participants.

The second part provides the risk matrix for the participants to utilise as a refresher tool.

The third part is the actual risk assessment where the existing hazards are identified, existing controls listed, and the subsequent levels of consequence and likelihood established to quantify the relevant risk. If the level of risk is deemed unacceptable, additional required controls are identified and the risk (i.e. change in consequence and/or likelihood) re-quantified. At this point, the risk must be within the acceptable range, or the development will not proceed in its current form.

The final part of the risk assessment identifies the action required for the identified controls to be implemented, who is responsible for the completion of the action, the due date and the completion date of the action to ensure that the level of risk is established as outlined in the risk assessment.

The next step is to provide this information to the personnel actually working on the proposed development.

For lateral development, the procedure is for the surveyors to issue a Survey Memo to provide the development miners with the information required to maintain the appropriate grade and azimuth as well as ground support. On the reverse side, the Primary Development Design (PDD) memo is issued, which highlights the hazards identified in the risk assessment, the actions required and the person(s) responsible for these actions. This is the main tool to convey this valuable safety information to the workers in regard to technical hazards identified for this particular lateral development and the remedial actions required to ensure that the risk associated with the identified hazards have been reduced to acceptable levels. An example of this PDD memo can be found at the end of this paper.

For vertical development, the actual risk assessment sheet is attached to the drilling and firing plans respectively.

6.0 Follow-Up on Development

Follow-up during the excavating of the actual lateral / vertical development to ensure that existing controls as well as additional controls identified during the risk assessment consists of the following:

- site inspections by the workers' supervisors
- site inspections by Operations staff
- site inspections by Planning staff
- site inspections by Rock Mechanics staff
- site inspections by Geology staff
- site inspections by surveyors
- notification from workers that controls are not in place

If at any time it is noted that the listed existing and/or additional controls are NOT in place, the work is to be stopped until the required controls have been (re)instituted.

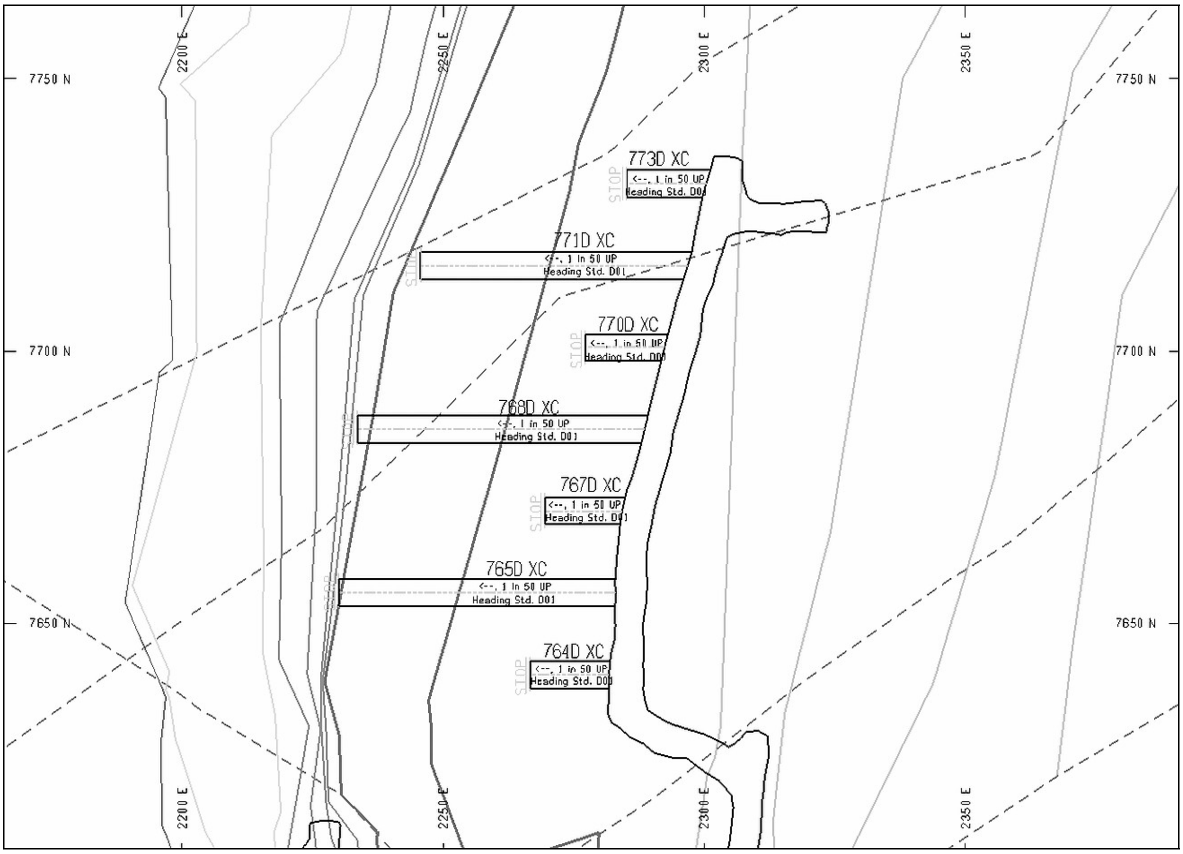
Further, if an unforeseen hazard does present itself at any time during the actual development, a Job Safety Analysis (JSA) is to be done by the workers with their supervisor(s) acting as the facilitator(s). This allows immediate action on implementing any required additional controls to reduce the risk associated with the hazard, unless the identified required controls cannot be implemented through the front-line supervisor. If this is the case, the request for assistance to implement the identified required controls is forwarded upwards through management while the work is put on hold. A copy of JSA form can be found at the end of this paper.

7.0 Summary

In summary, the challenge of lateral and vertical development interacting with the day-to-day production at George Fisher Mine, coupled with the ever changing personnel in all departments, is handled by the risk management system in place that allows the information regarding hazards / associated risks / required controls to be delivered to the hands of the personnel carrying out the actual work. The visual tools utilised for this are the Primary Development Risk Assessment sheet and the PPD memo. An additional safeguard is the use of JSA when unforeseen hazards become apparent, allowing rapid reassessment of required controls to mitigate the risk.

REMEMBER
NO JOB IS SO IMPORTANT THAT WE CANNOT TAKE THE TIME TO DO IT SAFELY.

To:	GFN Shift Supervisors
From:	
Copy:	
Date:	
Re:	



Hazards Identified	**Actions Required**	**Responsibility**
Ground Conditions at the intersections	- Cable bolt all the intersections unless otherwise advised by Rock Mech	Shift Supervisor
Ungrouted DDH	- Note ungrouted DDH on the survey memo for 773D XC	Surveyor
Pyrite	- Std pyrite precautions	Operators
Ground conditions around the pillar	- Mesh down to grade around the pillars	Shift Supervisor

GFN Mine Planning Engineer