ELECTRONIC DELAY DETONATORS – A UNIQUE SOLUTION TO PERTINENT MINING PROBLEMS

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1 Initiating Systems – a definition

An initiation system is a combination of explosive devices and component accessories specifically designed to convey a signal and initiate an explosive charge from a safe distance.

In the use of explosives, the initiating system performs the functions of transmission and control of the firing signal to each explosive charge. As functional groups, initiating systems may be considered as:

Starters *Those which provide the initial signal to start the blasting process.*

Surface systems *Products which provide transmission of the starter signal and delay timing (if any) across the surface of the blast outside the blast hole.*

In-hole systems *Products which provide the signal transmission, delay timing (if any) and the initial explosives energy in the blast hole.*[1]

2 Different types of Initiating Systems

The initiation systems commonly used in Sub Saharan Africa are:

- Detonating cord and detonating relay systems
- Capped fuse and igniter cord systems
- Shock tube non electric systems
- Electric systems
- Electronic detonators

3 Overview of Electronic Delay Detonator Technology

Conventional detonators use pyrotechnic delay elements and the variation of the actual delay periods is at best approximately 1% the nominal delay. The lack of guaranteed precision common to all pyrotechnic systems enhances the likelihood of negative environmental blasting effects.[3]

For example, take a 500 ms in hole delay. In conventional detonators this means that 95 % of shots fire within 10 ms of the mean. i.e. a window of 20 ms. Taking a fixed interval between shots of 25 ms, with a range of $\pm$ 3 ms, a very ragged firing pattern could be expected which in practice would result in non uniform fragmentation.

On the contrary, the negligible variation in the electronic delays mean that the firing pattern will consistently be the same for each blast resulting in uniform blast results.[2]

Electronic detonators are therefore a key tool in establishing control of the blasting process due to their precision delay and consequent ability to ensure sequential firing.

4 The Mufulira mine challenge – the mining problems

For close to 18 months prior to the implementation of this project, Mufulira mine, owned by Mopani Copper Mines Plc, had struggled both to meet its production targets and to lower it's mining costs. Employing a modified mechanised longhole open stoping method as its primary mining method, major problems were caused by large boulders in the stopes and consequently excessive secondary blasting. Secondary blasting in the orepasses on the tramming levels was also taking its toll on the production boxes which were being damaged at an alarming rate.

In seeking to address all these problems, the mine management was seriously looking at modifying its ring design by reducing the ring and toe burdens. But this would have meant increasing the powder factors as well as increasing the drilling and explosives costs.

5 The bold decision – unit cost versus cost per tonne

The decision to convert from shock tube to electronic "Smartdets" was not an easy one for the mine to make. Firstly, it meant swimming in new waters as the product was new on the Zambian market. Secondly, Smartdets carrying a higher unit cost than Shock tube, and this meant that the mine's expenditure on its stoping initiating systems would increase by 362%!

However, the mine management recognised the potential benefits to be gleaned from using Smartdets and the go ahead was given to trial the Smartdets in one section of the mine commencing in May 2003.

6 Project Objectives

- To resolve the fragmentation problem and by so doing improve production
- To reduce the frequency and cost of secondary blasting
- To improve loader productivity
- To reduce the amount of blast damage on production boxes
- Consequently to improve the mine's unit cost of mining.

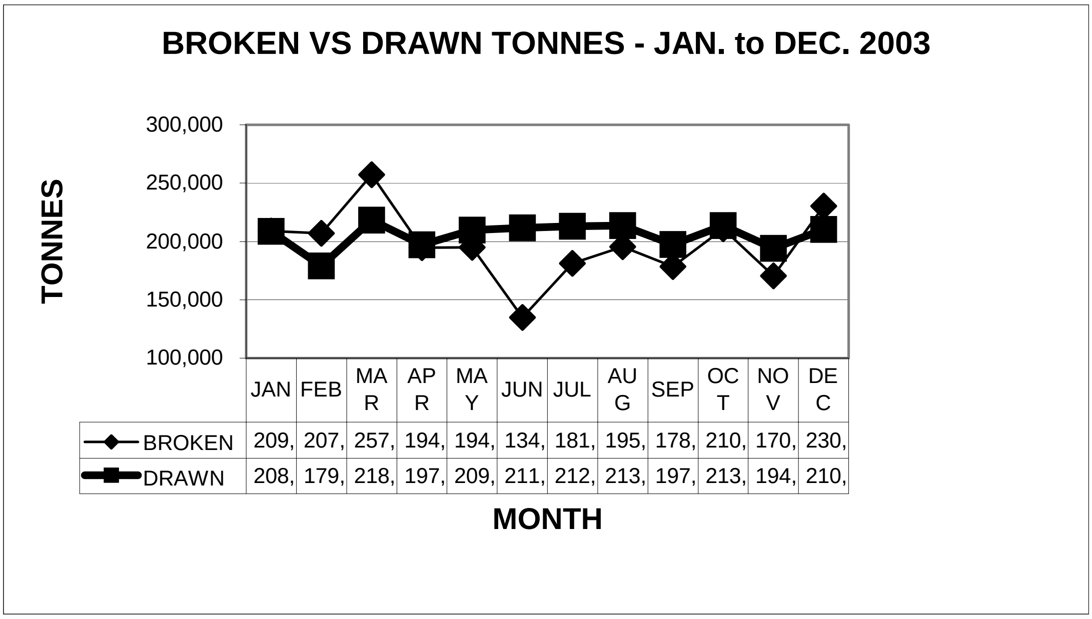
7 Benchmarking and Project Results

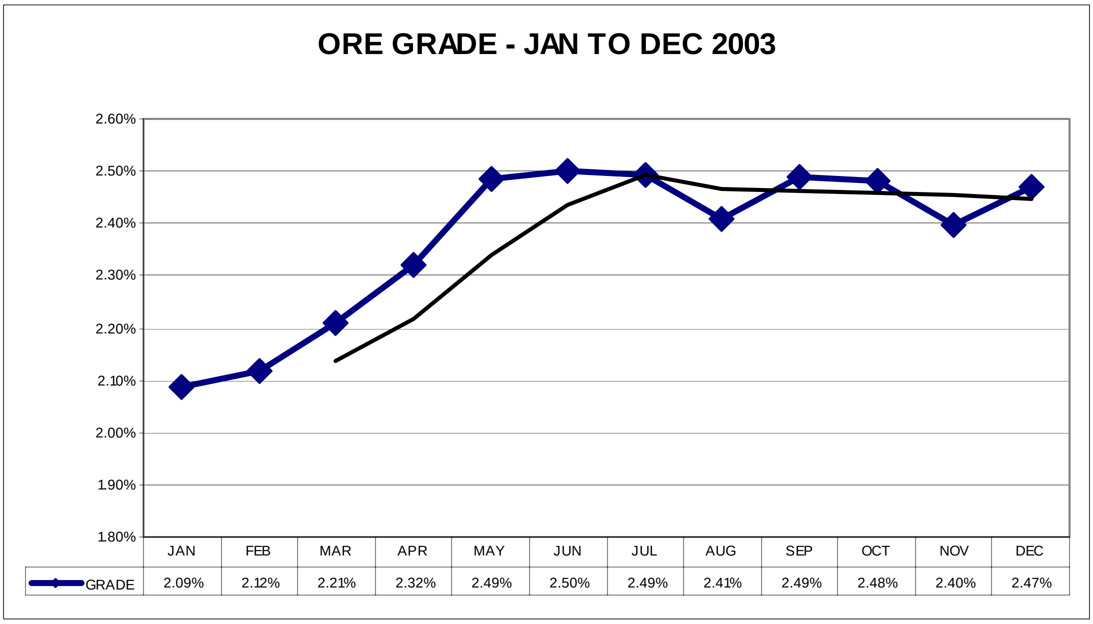
7.1 The Benchmark

The project benchmark consisted of observing and recording chosen parameters obtained whilst the mine was still using the Shock tube initiating system. The same parameters were again monitored after the introduction of Smartdets. The before and after were compared and are shown in the graphs below.

7.2 Graphs of various parameters

7.2.1 Broken versus Drawn tonnes

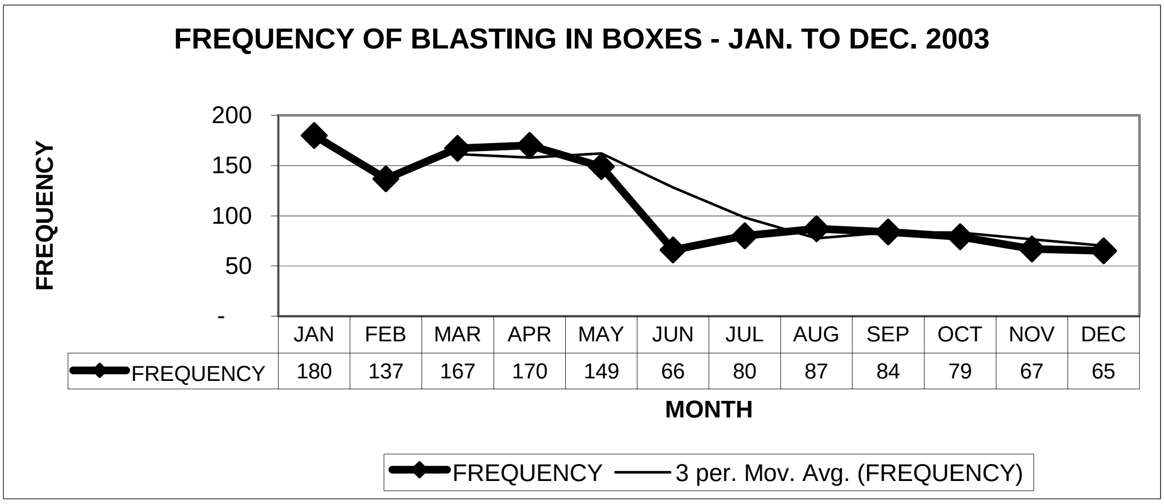




The mine had almost always drawn less tonnes than they would break prior to the introduction of Smartdets. The change in this trend can be attributed to two related factors namely:

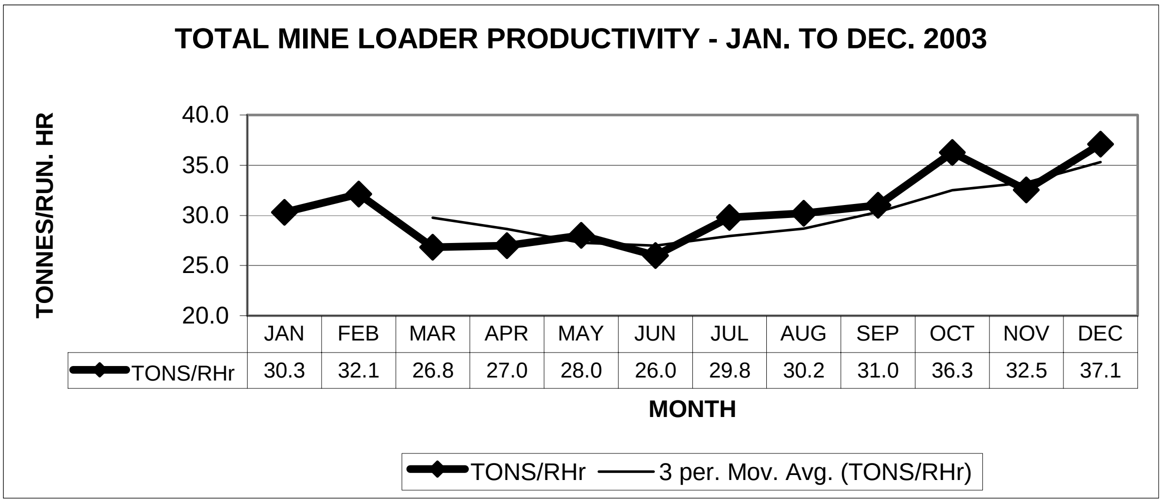
- Firstly, improved fragmentation after the introduction of Smartdets meant that no ground was being left in the stopes as large boulders. The fragmentation improved so much so that the ore that was being left behind in the form of large boulders was now easily being mucked out. Initial calculations show that the large boulders that were previously left behind in the completed stopes resulted in a loss of copper ore to the value of U$ 1.5 million per month. There was no compromise on the grade as can be seen from the ore grade graph above.
- Secondly, the mine introduced remote loaders that were able to muck out the better fragmented ground left in the stopes.

7.2.2 Frequency of secondary blasting in production boxes



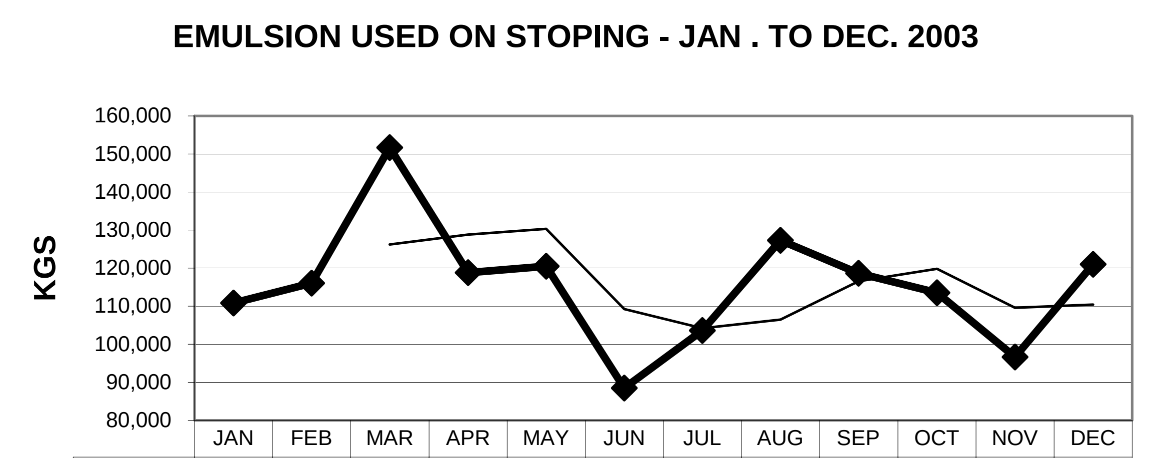
There was a marked drop in the frequency of secondary blasting in the production boxes. This was as a direct result of the improvement to the fragmentation coming from the primary blasts.

7.2.3 Loader Productivity



The steady improvement in loader productivity after May is attributed to the loaders being able to handle more ground as a result of the improved fragmentation.

7.2.4 Reduced frequency of primary blasting



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
KGS	110,84	116,03	151,69	118,79	120,53	88,483	103,62	127,30	118,66	113,50	96,650	121,00

The improved quality of the primary blasting meant fewer rings had to be blasted in a given month. This has significantly reduced the mine's consumption of primary explosives.

8 Downstream benefits

In addition to the more direct benefits are other downstream benefits that are accruing to the mine as a consequence of the introduction of Smartdets, for example;

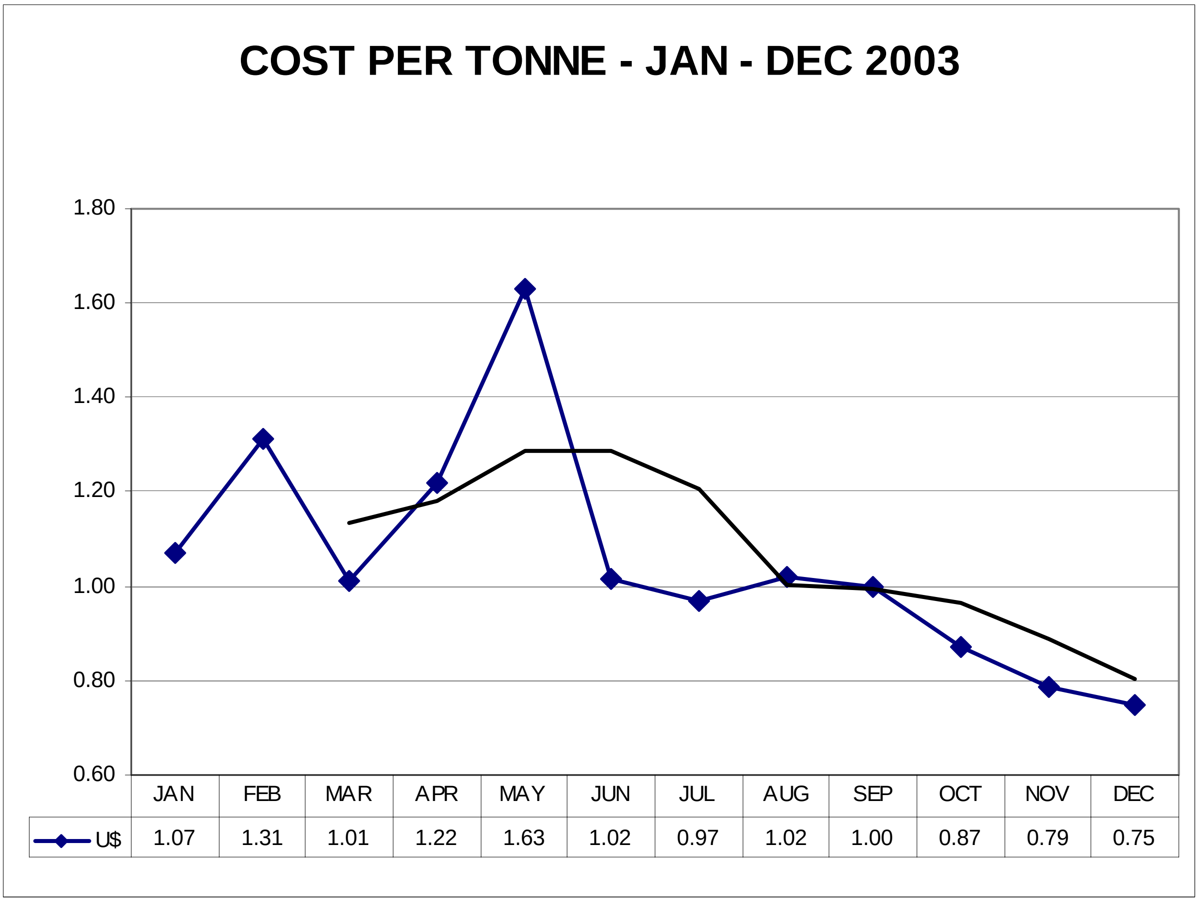
- Reduced maintenance and replacement costs on production boxes
- Extended lifespan of loaders
- Reduced maintenance and replacement costs on crushers.

9 Potential or future benefits

Improved fragmentation should introduce potential for a change of ring design parameters i.e. the ability to increase the hole spacing and the ring burden. This would reduce the amount of drilling required in a stope and consequently drilling costs would be reduced, this over and above the obvious potential reduction in explosives consumed.

10 The bottom line – Reduced Cost per tonne

All the improvements highlighted above have had the net effect of enabling the mine to lower its cost per tonne of mining as shown in the graph below.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
U$	1.07	1.31	1.01	1.22	1.63	1.02	0.97	1.02	1.00	0.87	0.79	0.75

11 A culture of continuous monitoring and improvement to maximize Smartdet benefits

The mine has continued to monitor all the relevant parameters to ensure that the benefits arising from the introduction of Smartdets are sustained.

12 Conclusion

Mufulira mine has since become the first mine in Zambia, to convert 100% of its stoping operations to Smartdets from the traditional non-electric Shock tube. This was because the mine's management was prepared to look beyond the unit cost of a product and were ready to look at the broader picture of cost effectiveness and increased productivity.

References

1. Massive Mining – Explosives Engineers' Course Manual – AEL
2. Paper for Fragblast – Finsch: By Simon St J Tose and Cor Baltus
3. DetNet Solutions – Product Launch Sheets.