INCREASING SAFETY THROUGH THE INTRODUCTION OF AN ELECTRONICALLY-BASED CENTRALIZED BLASTING SYSTEM

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1. Introduction:

The mining industry is continually under pressure to prevent injuries and lower the exposure of employees to hazardous conditions. Blasting is one area where personnel will certainly be exposed to serious risk; hence the focus of this paper on how an electronically-based centralized blasting system or blast network for controlling the initiation of multiple blasts throughout an underground narrow reef mine can mitigate some of the risks that underground personnel is exposed to.

2. Historical development:

With the discovery of Gunpowder, the Mining Industry was revolutionized in that the fragmentation of the ore could now be done with blasting operations and not just digging with anymore.

This meant that mining operations could go faster; rock could be fragmented to a manageable size that can be transported and processed. It also meant that the mining could be taken to a new level of magnitude and depth underground.

However this revolution introduced a whole new dimension of dangers and drastically increased the mortality rate.

Initially a burning stick was used to ignite crude fuses in the holes containing the explosives on the rock face. In the South African Narrow Reef Mining this device was known as a “Chesa Stick”.

This meant that the person doing the lighting was exposed to the blast and at the mercy of the unreliable burning rate of fuses.

With the need to time and control the sequence of the holes initiating, igniter cord was invented. This was essentially a slow burning cord that transmitted the flame from one end of the blast front to the other and lighting the Capped Fuses in sequence.

To initiate the Igniter cord an open flame was required exposing the blast personnel to dangers associated with open flames in a possible flammable gas environment and at the
mercy of his own judgment at which rate the flame will progress to the initiator and whether sufficient time will be available to evacuate the danger zone.

As technology advanced, the most widely used method of initiating narrow-reef stope blasts and to mitigate the dangers associated with initiating blasts in various areas, involved a slow-burning delay starter.

This was a high density roll of cotton treated to burn at a pre determined rate under controlled conditions. Different lengths constituted different delay times i.e. 30 minutes, 60 minutes or 90 minutes. This system however has certain disadvantages in that burning times can be significantly affected by the flow of ventilation making it difficult to control the exact time of blast.

The person lighting up the delay starter uses an open flame which increases the risk of igniting flammable gasses, explosive dust compounds or setting fire to flammable material found in the workings.

The exact timing of ‘lighting up’ is entirely at the discretion of the Miners sense of time and access control to the blasting area relies largely on the person controlling the workings.

In all the above-mentioned cases not knowing that a panel has misfired increases the risk for the cleaning shift.

These factors highlighted the need for an introduction of a method to centrally control blasting, where blasts can be initiated remotely once the mine has been cleared and at predetermined times.

The first such systems were electrically-based, where a high volt spike was sent to all the workings through a cable infrastructure with step-up transformers strategically placed to ensure that the minimum voltage to initiate the electric starter interface is delivered to each blasting point. The cable infrastructure is expensive and had the disadvantage of not being able to receive information back from the firing points and was not able to monitor the status of the entire blasting process.

The electrical initiators are susceptible to the negative effect of electrical stray currents e.g. static electricity and the effect of lightning strikes. They also could be intentionally initiated by a power source other than the installed control equipment.

Independent studies have indicated that such systems produce in excess of 4% misfired panels on all panels blasted with the system.

There was a requirement from the Mining Industry to better manage production by reducing the number of lost blasts and time spend to identify the basic cause of these lost
blasts, through getting information from blasting systems on its status from surface to the rock face.
Coupled to this and the fact that electronic initiators were developed; a requirement was identified to remove initiation systems that can be set off by an open flame or improvised ignition sources; which will assist in the reduction in usage of these initiators in robbery related incidents.

Thirdly the susceptibility of electrical initiators to lightning, stray currents and illegal power sources which resulted in a number of fatalities necessitated the development of safer and more suitable solution.

The development of Electronic Delay Detonators necessitated the development of Control equipment to communicate with the initiators. This fact that data is used as a communication method lends itself to the system supplying constant feedback communication between the various components of the system, which naturally evolved into an electronic centralized blasting system.
These electronic systems uses very low communication voltages thus eradicated the requirement of high voltage cables and at the same time reduced the size of the copper conductors resulting in a significant cost reduction

3. What is an Electronic Centralized Blasting System:

An electronic centralized blasting system consists of a communication backbone connecting a central safe monitoring and firing point to the mine’s entire blast locations whereby 2-way communication can take place in real time with an electronic device initiating each blast (electronic starter).

The system comprises of a Blast Controller on surface that monitors and reports all activities on a real-time basis on the entire system. The second component is a communication network down the Shaft to each Control Boxes that is placed in a safe area away from the affects of the blast but sufficiently close enough to the workings to place the initiation of the blast under direct control of the accountable person. These Control Boxes initiate the blast by supplying the correct voltage and coded signal to the initiators via a copper blast cable or network.
4. Safety enhanced:

This system can therefore supply sufficient information to the user and management to enable the blasting process to be managed safely and effectively from a central point.

With in-hole Electronic Delay Detonators the blasting of the workings happened within split seconds of each other triggering a significant energy release in a small window of time (diagram 2 and 3). From available data recorded by various Seismic centers it appears that there are a significant improvement in the seismic footprint of various deep level underground mines. It appears that if the system is being used effectively and all the blasting points are initiated from the system; that a period of high seismicity is experienced directly after the blast was initiated.
This period usually fall within the three-hour re-entry period, thus when nobody is on the working face and it is envisaged that this will have a definite influence on seismic related accidents. However it is also acknowledged that blasting is one of numerous factors influencing seismic events, and all benefits cannot be claimed to the effect of centralized blasting.

The expected knock on effect of this is that the next shift will enter in a relatively de-stressed area. With time this should also impact positively on the severity and frequency of FOG and Seismic accidents related to strain bursts.

Diagram 2: Before installing in-hole Electronic Delay Detonator system.
Diagram 3: After installing in-hole Electronic Delay Detonators Centralised Blasting system

The effect of causing a significant energy release during blasting time is not only limited to in-hole Electronics, but can also be achieved in mines using Pyrotechnic systems that fires and entire working place in a time span similar to electronic systems.

A study at a deep level gold mine over a 15 month period produced the following:

- During the use of stay-alight coupled with Capfuse and Ignitercord systems random and often high energy events were detected. (diagram 4)
- The blast window was anything from 11H00 to 20H00 caused mainly by individuals lighting up at various times.
- With the introduction of an electronic centralized blasting system the events flattened out with a spike at the time when the multi blast development initiated and a large spike when the centralized blast takes place. (Diagram 5.
- Because the system allows the user to address specific units (apposed to a global command) using id’s, the blaster can blast one unit, on one level, a portion of the mine or the whole mine depending on the requirement.

Because all the control boxes get the command at the same time, blasting takes place with all the units simultaneously.
With the introduction of the electronic centralized blasting system the blast window changed to between 16h00 to 19H00. This window is determined over a 4 month monitoring period and is governed by when the shaft was clear for blasting.

Diagram 4: No Electronic Centralized Blasting

Diagram 5: With Electronic centralized blasting
Diagram 6: Indicating Fog and Seismic Related LTI rate.

This graph is overlapping the seismic graph in Diagram 3 and 4 indicating the effect that centralized blasting have on FOG and seismic related LTI’s. As previously mentioned centralized is only one factor and further detailed studies is required.

5. Conclusion:

The introduction of an electronic centralized blasting network on a mine and the responsible management there off will produce the following results:

- An improved seismic footprint.
- A reduction in FOG related incidents connected to strain bursts.
- A reduction in the severity of FOG related accidents.
- Reduction of exposure to dust and fumes incidents related to re entry times.
- Reduction or elimination of blasting related accidents.
- Reduction in misfired panels. Graph
- Improved management and actions against misfired panels.
- Enhanced environmental monitoring capabilities.
- Removing people from exposure to dust, managing re-entry period.
The Author

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