SAFEX NEWSLETTER

No. 38 3rd Qtr. 2011

CONTENTS

This is your Captain Speaking

The tone which top management of an organisation sets has a significant bearing on the safety performance of that organisation. In this Feature top executives of Member companies show their commitment to HS&E by outlining philosophies, approaches or interventions they feel are important or have improved the safety performance in their companies.

Paul Clark – Arabian Explosives Company

While working for Tarmac as a trainee, Paul studied Quarrying and Road Surfacing for 3 years at Doncaster in the UK. He then worked in quarry management at various hard rock sites for Tarmac for a further 8 years. At that point he left to focus on explosives. He worked as Area Manager UK and Ireland for Explosives Developments Limited (EDL) for 3 years before joining EPC-UK. After working for 5 years as a drilling and blasting Area Manager for EPC Blasting Services in England and North Wales, he became the Factory Manager at AREX in 2006.

Arabian Explosives Company (AREX) is based in the United Arab Emirates supplying packaged explosives to the UAE and neighbouring GCC countries. AREX was formed in 1978 as joint venture between local partners and the EPC-Groupe. Due to AREX's geographical location within the EPC-Groupe it has always operated under slightly different rules and cultures. HSE therefore has always been viewed slightly differently compared with the rest of the group's operations within Europe.

The philosophy within in AREX is that safety is a priority - not an after-thought or bolt-on addition which restricts efficiency and productivity. The different HSE challenges faced at AREX compared to most of other explosives companies is mainly communication related.

We are operating in the Middle East where the UAE's spoken and written language is officially Arabic; therefore all of our paperwork related to the Police and other authorities is conducted in Arabic. National laws and regulations are published in Arabic without "official" translations into other languages, which can often create confusion and misinterpretation. We operate under strict Police supervision due to the sensitive nature of our business and geographical location. This supervision includes 24 hour armed Police guards at our factory, armed Police escorts for raw material imports as well as explosives deliveries. We have Police Technicians supervising our magazine storage and authorising all of our deliveries. The Police all speak in Arabic, with very few speaking little English and even less in other languages.

None of our workforce is Emirati, or has Arabic as their first language. Like all companies within the UAE and most GCC countries in general, our workforce consists of immigrant workers from India, Pakistan or Bangladesh amongst others. Their own languages vary considerably within their native country. There are also differences in the standards of education which results in some individuals having poorer reading and writing skills compared to their counterparts in Europe and other developed areas. Initially most of these people do not understand HSE; their culture doesn't recognise HSE as a fundamental value. In the local news there are many examples of a lack of an HSE culture in business and everyday life . The countries and their citizens are still developing and HSE is still a luxury to them at times. We try to educate our employees to change their culture regarding HSE and apply best practice and awareness at work and at home.

At AREX we try to adopt and maintain European standards regarding HSE. We follow the EPC-Groupe procedures and implement their policies. We frequently translate site signage, documentation and safety data sheets for all materials into different languages for ease of use. Whenever possible we use pictorial signage so employees, Police, contractors and visitors can understand them more easily. We carry out annual HSE training in both English and various Indian languages with tests to confirm understanding. Since introducing a NEBOSH qualified HSE trainer/translator our employees understanding and implementation has increased beyond recognition. The SAFEX Incident Reports are also extremely useful as a classroom tool. We use the lessons learnt from these in our training programs and they always create discussions. These incident reports are incidents that our employees can relate too, this material is absorbed and often referred to at a later date when creating a permit to work or risk assessment.

We have found that people are willing to learn, if we give them the necessary tools and understanding they will progress and grow as individuals. The company benefits in increased HSE performance and ultimately in the bottom line profitability, the employees are now working safer, staying healthier with better attendance records, as the HSE culture expands and positive actions create further positive reactions, all concerned benefit from the improvements.

Our employees are our greatest investment, but also our greatest asset. Let's look after them and lead our industry forward in a safe and professional manner.

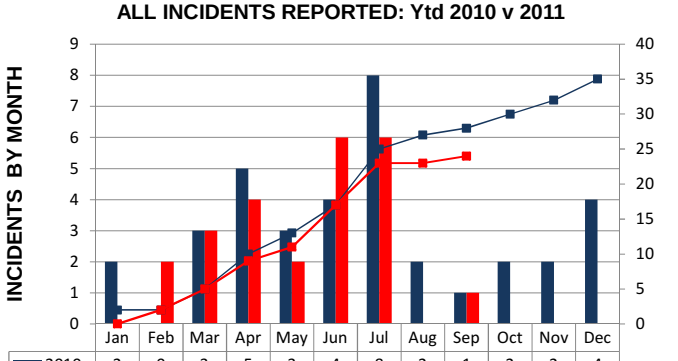
Paul is engaged to Imke from Holland. Together they enjoy desert driving, dune bashing or camping in their desert prepared Land Rover Tombraider. If not in the desert they enjoy sailing, snorkelling or scuba diving in the Arabian Gulf.

Incident Reporting

Monitoring our Reporting Performance

"Every incident that is reported may prevent another from occurring. You can save a life by reporting an incident - including a near-event."

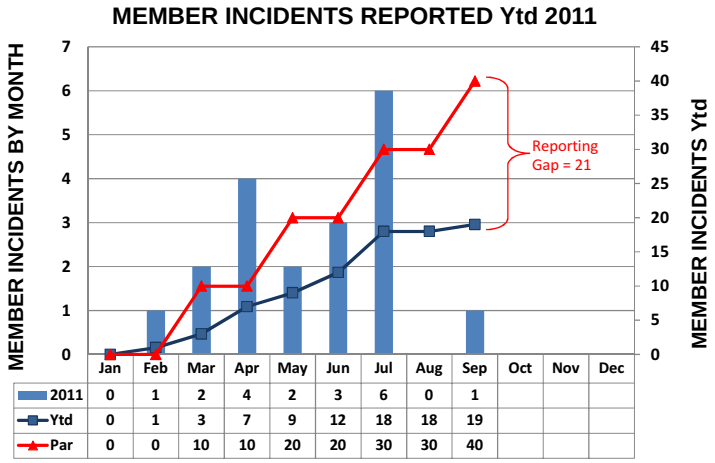
SAFEX members learn from each others' experiences through the incident reports we receive. By applying these lessons we can prevent similar incidents recurring. This is the reason we track our incident reporting performance as follows:

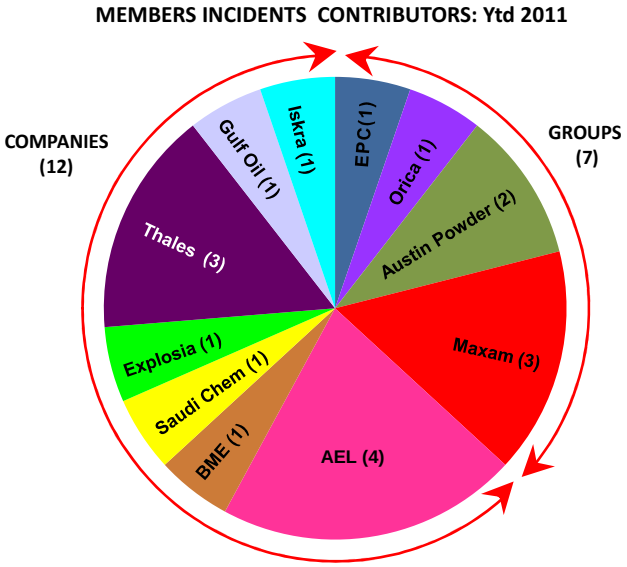


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	2	0	3	5	3	4	8	2	1	2	2	4
2011	0	2	3	4	2	6	6	0	1			
Ytd 10	2	2	5	10	13	17	25	27	28	30	32	35
Ytd 11	0	2	5	9	11	17	23	23	24			

All the incidents reported. This chart compares the sum of non-member and member incidents reported to SAFEX every month this year to the previous year. As you may notice we had no incidents reported in August this year. Furthermore, fewer incidents were reported year-to-date this year than in 2010. Are we having fewer incidents or are we not reporting the incidents we are having? Every incident not reported is a lost learning opportunity. Remember, it's never too late to report an incident.

Member incidents reported. Because they give us the best learning opportunities, we track member incidents (MI's) separately as in the chart on the right. PAR is an estimate of how many MI's are occurring based on the severity of the MI's reported. The gap between the number of MI's reported and PAR is our Reporting Gap. The Reporting Gap suggests that only ½ of our MI's are being reported.





Contributors of member incidents. This chart identifies those members who reported their incidents. It shows the number of incidents each of these members have reported relative to the total number of MI's received. The chart distinguishes between Group Members and Company Members merely to indicate the performance of the two membership categories. There are roughly twice as many operating units in the Groups as in the Companies. In 2010 Groups reported fewer incidents than their counterparts in single Companies and the pattern seems to be the same year-to-date.

Explosives Research Notes

For several years Dr Phil Lightfoot from CERL has been responsible for the regular articles that have appeared in this feature. The articles were appreciated by our readers and resulted in positive feedback. Phil has now assumed another position and is no longer with CERL. CERL wants to continue its contribution to the Newsletter but in Phil's absence will only be able to do so annually and not quarterly. Therefore, we look forward to publishing whatever CERL is able to produce when it can. SAFEX is grateful for all the support CERL has given us and values its on-going association with CERL.

SAFEX Newsletter thanks Phil Lightfoot most sincerely on behalf of all its readers. By providing us with his regular articles, Phil has demonstrated his commitment to explosives safety and SAFEX in particular. He never missed a quarter and to him it was a labour of love notwithstanding the imposition it must have been from time to time. SAFEX Newsletter and its readers appreciate his contributions and wish him well in his new assignment.

Despite our best efforts to approach other institutions engaged in explosives research for similar contributions we have been unable to identify regular contributors to this Feature. We will, nonetheless, continue our efforts in the hope that a number of researchers will offer articles for us to publish on work in progress or which they may have done. In this way our readers will have an appreciation for the research that is taking place to make our industry and its products less hazardous to people and the environment.

Nevertheless, we are confident our Members and collaborators will come forward to share relevant material with us. While the contribution which follows is not new and has been published in ISEE Proceedings, it relates to an issue raised in our previous Newsletter. It is therefore relevant and we trust readers will find it interesting.

In the *Inbox@SAFEX-international.org* feature of the last SAFEX Newsletter (No.37) an incident was discussed in which shock tubing snapped and initiated after becoming entangled in the coiler during manufacture. Lon Santis (IME) suggested that these incidents have three components: the snap, a slap, and then the shoot. It will therefore be more accurate to refer to them as "snap, slap and shoots". SAFEX invited readers to comment on their experiences with "snap, (slap) and shoots" and highlight any research into the mechanism of this phenomenon.

Roger Holmberg (EFEE) kindly made the following Paper available. He and Dick Salomonsson presented it at the 2002 ISEE Conference while working for Dyno Nobel, Gyttorp, Sweden. Roger is now responsible for the Secretariat of the European Federation of Explosives Engineers (EFEE). While this research was published previously, we thought it appropriate to publish it again given its relevance to our previous discussion. We are grateful to Roger and the ISEE for permission to do so.

This paper was presented by the authors at the 28th Annual Conference on Explosives and Blasting Technique in Las Vegas, Nevada USA, February 10 - 13, 2002. The paper was published in the Conference General Proceedings and is being reprinted with the permission of the International Society of Explosives Engineers. The Society notes that the opinions and ideas expressed in the paper are not necessarily those of the International Society of Explosives Engineers.

Snap, Slap & Shoot – A Possible Cause for Premature Ignition of Shock Tube

by

Roger Holmberg and Dick Salomonsson,

(Dyno Nobel, Gyttorp, Sweden).

Background

In the early days there were some accidents that occurred in production of non-electric initiation system shock tubes. It was found that static electricity was involved and this led to the conclusion that the Al content had to be reduced in the HMX/Al mixture. After this corrective action no additional reports on accidents have been released until 1991.

The last decade, however, there have been five officially reported accidents in the field where shock tubes have been unintentionally stretched to breakage. It is believed that in some instances this has caused the tubes to initiate. There have also been reports about a similar type of tube initiation in tube manufacturing facilities. This phenomenon is known in the industry as -Snap & shoot; -Stretch & shoot; -Snap, slap and shoot; or -Whip/Snap and shoot; and has been annoying users of shock tube systems and regulatory bodies.

Accidental initiations of shock tube in the field.

The accident that occurred at Fraser Mine, Falconbridge Ltd. Canada, April 30, 1991.

Quote from the incident report (Ref.1);

"The crew was in the process of loading a corner breast hole using a #17 Nonel cap and a tow reverse priming method with Amex. The worker noticed that he should have primed with a #18 cap. The Amex was blown out of the hole using the AnFo hose. The cap was pulled to remove it from the hole when it got jammed in the hole. The worker pulled hard to break the fuse. As the shock tube broke, the worker noticed a spark at the hole collar and approx. 4 to 5 seconds later the cap exploded in the hole. Since all the explosive had been removed from the hole, the worker fortunately received only minor injury".

The accident at Homestake Mine, February 7, 1992. (Ref. 2, 3)

A worker was pulling at Primadet shock tube, manufactured by the Ensign Bickford Company, Simsbury, CT, coming out of one of two drill holes which had failed to detonate with the others in an underground blast set off the previous day. As the worker was pulling on the tubing, he observed a flash, possibly from inside the tube; a short time after that the charge in that hole detonated, severely injuring the worker, who survived. The exact cause of the explosion was never determined, but it was thought that perhaps pulling at the tubing had caused the Primadet tubing to snap and initiate, or that the detonator, possibly damaged from the previous blast, might have ignited as a result of the pulling. The reported time delay between the flash in the tubing and the detonation of the charge is difficult to reconcile with the theory that ignition occurred inside the detonator - ignition of the pyrotechnic delay element would not be likely to ignite the reactive shock in the shock tube. There is no indication in the accident report, however, that violent efforts were made to pull out the tubing and detonator - but both men present reported hearing a "pop" as one man "reached up and pulled on the tubing hanging out of the hole, and the man pulling at the tube reportedly had time to say of the pop: what was that?", before the explosive in the hole detonated, seriously injuring that man.

The "Pick-up truck accident" at Costaine Coal April 28, 1994 (Ref. 4, 5).

The accident took place at 11: 15 a.m. on April 28, 1994 at Costaine Coal, Fayette County, West Virginia. According to Reference 4, a Ford Explorer 4-wheel drive vehicle was driven between rows of holes in a strip mining round, where non electric EXEL shock tube detonators manufactured by ICI

Explosives USA Inc. and PowerAN ANFO 5000 (wet bags) explosive were loaded into 7 1/2 inch diameter drill holes. The EXEL shock tubes coming out of the holes were not connected together; the tubing was coiled at the mouth of each hole. As the vehicle was backed out of the way to make way for a loading truck, it passed immediately above one loaded drill hole; observers saw the tubing get caught on the exhaust pipe of the vehicle, and as it was stretched, a flash in the tubing was observed. A short time after the flash was observed, the explosive in that hole detonated and threw the vehicle 18 m (60 feet) into the air and up the high-wall, severely injuring the driver, who survived. None of the other loaded holes detonated. It was thought that the EXEL tubing had somehow caught under the vehicle, causing ignition. Because of the extensive blast effect, it could not be clarified if the initiation had occurred by snapping of the tubing caught at the vehicle or as a result of the tubing pulling at the detonator, somehow causing the detonator to activate. Remnants of the EXEL tubing found after the accident on the catalytic converter were inspected and found to be spent (the HMX/aluminium powder had reacted).

The accident at Queensland, Australia 1997.

A miner was charging a blast in an underground operation using shock tube detonators. He was working from a manoeuvrable charging basket. When all blast holes were primed and charged with explosives, tie in started. As the miner moved the basket from the last hole charged to a side hole to commence connecting up with cord clips to detonating cord in the centre of the blast, a flash was seen, shortly followed by a detonation. It was the hole he had just finished to charge that detonated and he received serious injuries. An offsider also received injuries, but less serious. The cause of the detonation has not been determined. (No final report has been issued.)

The accident at New South Wales, Australia 1998.

A blast in an open pit coal mine had been charged and a vehicle was used to put stemming material into the blast holes. A shock tube from a blast hole became entangled with the driver's side wheel, when the vehicle was backed out from between two rows of blast holes. As the vehicle swung out to reverse down to an access ramp, the shock tube was stretched some 3.5 metres (11.5 feet) to breaking point. It appears that the phenomenon of "snap & shoot" then occurred, initiating the booster and main charge of 35 kg (77 lbs) emulsion in the blast hole. Three people were on the blast at the time of the premature initiation. None were seriously injured. Minor damage was caused to the stemming vehicle by fly rock. (No final report has been issued.)

Technical Bulletins issued from manufacturers.

Subsequent to the two accidents in 1991 and 1992, warnings were issued by ICI Explosives USA and ICI Explosives Canada. These warnings describe the "Snap & shoot" initiation as a possible, though rare event. The ICI bulletin further reports that: "Despite extensive laboratory testing, we have not been able to duplicate this initiation process".

In a June 1994 Technical Bulletin from the Ensign Bickford Company, signed by Tom O'Leary (Ref. 6), it is pointed out that it is important to avoid any situation where shock tube can become entangled or entwined in vehicles, machines, or equipment and prematurely initiate

Discussion of the three accidents reported from USA and Canada.

Although accident reports are often inconclusive, because of the extensive damage caused by the explosion of any explosive charge, it is difficult to explain these three accidental explosions as having been generated by any mechanism other than initiation of the shock tube prior to the detonation of the detonator attached to the tubing. All three accident reports speak of a "flash of light" at the mouth of the hole, or from inside the tubing at the mouth of the hole, the flash of light in all three cases being observed some moments prior to the explosion of the detonator (in the Canadian incident) or the detonation of the explosive (in the other two accidents). All three reports mention the tubing being “pulled” or in one case snagged on the exhaust pipe of a moving vehicle” just prior to the appearance of the flash of light.

"Snap & shoot" incidents in shock tube manufacturing.

Most manufacturers of shock tube systems have indicated that they have had "Whip, snap & shoot" incidents from their tube extrusion facilities. The process to produce shock tube varies to some extent between manufacturers, but the basic principle is the same. Plastic granules are fed into an extruder where heat and the pressure from a screw melt them and pass the mixture through the extrusion tool where the tube is formed. Reactive material HMX/Al is dosed into the tube as it is formed. The tube then passes various processing stages to get its specific qualities before it is finally wound up on big spools. Improved extrusion technology and automatic process control have made it possible to increase the line speed, and consequently higher speed on the spools at the uptake end of the line.

With the amount of tube in process from extrusion to uptake in a high-speed line, there are several critical points where the tube may entangle. If that happens, the speed of the line and the strength of the winding equipment can easily stretch and break the tube.

Most of the incidents reported seem to have occurred at the take up spool when the tube is snagged, or when the tube is entangled in any equipment and stretched to breakage. When breakage occur the elastic energy can be quite high forcing the loose end to whip or hit a solid object with relatively high impact velocity.

Investigations and efforts to understand the mechanism for the phenomena.

Dyno Nobel performed a project together with the Research Center for Energetic Materials (RCEM) at the New Mexico Tech, Socorro, USA, where many series of experiments were carried out to simulate conditions under which Whip, Snap & Shoot can happen. It has not been possible to reproduce this phenomenon just by stretching a straight tube until it breaks or by whipping the end of the tube. A wide range of strain rates has been tried. Several series of laboratory experiments were carried out to simulate conditions under which the shock tube in the NONEL® - detonator system could conceivably initiate by fast or slow mechanical stretching, tearing, impact, rapid whipping, or electrostatic discharge.

The results of the RCEM experiments were all negative, i.e. not a single one of the experiments led to initiation.

The report made by Miles Olinger and Per-Anders Persson (Ref. 7) was published April 17, 1997. This report has been communicated and distributed to Explosive Industry at a FEEM meeting at Brussels 1997.

Conclusions from Miles Olinger and P-A Persson, RCEM, NM, USA.

Quote from the RCEM report;

"*In spite of our concerted efforts at initiating NONEL tube by mechanical means, such as pulling, whipping, or tearing the tube, we have been totally unable to obtain even one ignition in the laboratory. Nor have we been able to initiate the NONEL tube by electrostatic discharge in the voltage range 1-10 kV. We conclude that initiation of NONEL tubing will not occur as a result of any such normal handling that would occur at a blasting site or in a storage facility. Normal handling of NONEL tube should not include stretching or pulling the tubing towards fracture.*

NONEL tubing thus appears to be extremely difficult to initiate by even violent mechanical means or by accidental discharge of static electricity. Under normal circumstances, such as we have been able to produce in the laboratory, we do not believe it is humanly possible to tear the tubing by hand in such a manner that initiation will occur. However, the reports of three known accidents, two of them leading to very serious injury, indicate that there may exist rare circumstances under which possibly initiation can occur in the tubing when it is being pulled out of a loaded hole, by hand or by mechanical means, such as when the tubing leading down into a loaded hole is snatched on a truck backing over a loaded hole (in violation of existing regulations).

The accident reports indicate that removal of shock tubing from a charged hole should never be done by pulling at the tubing, but instead by one of the following methods:

a) Initiate the tubing coming out of the hole using a detonator or primacord taped along the tubing. Such initiation must be done from a safe distance, since the charge in that hole will normally then detonate.

b) First remove the explosive by flushing it out with water or compressed air, then initiate the tubing by the methods indicated in a) to explode the detonator, this procedure also being done from a sufficiently long safe distance.

Under no circumstances should tubing attached to a detonator in a drill hole be removed by pulling on the tubing.

We are fully convinced that NONEL tubing can be initiated by mechanical means in some relatively rare instances during manufacturing. Repeated instances of such initiation have been reported from the manufacturing plants of several manufacturers, but in all these instances, the extension and initiation is apparently effectuated by the inertia of a mechanically driven, large heavy reel containing many kilometers of tubing. A simple and effective method of eliminating such accidental initiations from occurring at a blasting site or in a customer storage facility would be to limit the use of these very large reels of tubing to the manufacturing plants."

Ongoing R&D work

Dyno Nobel felt it was important to continue the work to understand the mechanism and the investigations continued at the Dyno Nobel R&D Centre for Initiation Systems at Gyttorp, Sweden.

From all the experience established from the RCEM tests, reported accidents/incidents, discussions with other manufacturers (Ref. 10) and our own efforts to simulate initiations we built a test equipment where we tried to replicate ignitions of the tube. The test equipment was set up to simulate what can happen if a tube is tangled underneath a truck or other equipment and pulled to break

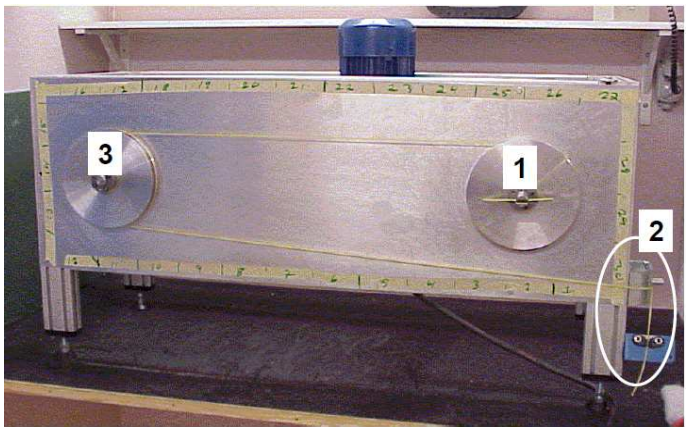


Figure 1: Test equipment comprising (1) pulling wheel; (2) fastening ratchet; and (3) support wheel.

Figure 1 shows the test equipment built. The tube is taken from a standard (3000m (9800 feet)) bobbin and one end of the tube is connected through a hole along the perimeter of the pulling wheel (1), pulled to the left around the support wheel (3) and back to the fastening ratchet (2) underneath the pulling wheel, secured and cut. We used an electric motor (7.7 kW) for driving the pulling wheel. The support wheel to the left in Figure 1 is free running. The diameters of the wheels are 200mm (7.9 inches).

The operator stands clear of the area and starts the electric motor. The pulling wheel starts rotating clockwise at a perimeter speed of 124 m/min (407 feet/min) corresponding to a ground velocity of 7.4 km/h (4.6 mph) (similar velocity as a slow moving truck), until it stops by the operator at tube break.

The tube is pulled and elongated through the yield point and up to the break point. At tube breakage the free ends are, through the released elastic energy, accelerated to a high speed. When the tube end gets clear of the test equipment it whiplash and hits a soft (wood fiber wall) or hard surface (metal plate) often at a supersonic speed.

Figure 2: Side view of the test equipment

The first goal was to get the testing equipment functioning, to achieve an effective consistent and repeatable test method, along the lines of the theory that the tube itself has the capability to ignite without any excessive force igniting it. A small test round (100 pieces. of standard tube) was run and minor adjustments of the distance between the barrier and the test equipment showed that it was possible to find such right conditions that the frequency of initiations was high. The barrier was placed 41 cm from the centre of the free running wheel, parallel to the wheel axis and perpendicular to a line through the two wheel axis.

We noticed often "full ignition" which means that the tube ignites and the propagation proceeds from impact point to the tube end. "Partly ignition" means that the tube ignites but the propagation stops after maximum 40 cm (15.7 inches).

Recording of the test events was first tried with a high-speed 16mm film camera (500 fps) merely to get an overview of the test procedure and a feeling for the tube movement in the test rig. As the speed of the tube action/reaction is very high after the tube break, a more sophisticated unit was needed. The choice fell on using a high-speed video system (Kodak motion analyzer HS4540MX), connected to an online computer, capable of recording maximum 393216 partial frames at 40500 fps. At the tests we used a frame speed of 4500 - 40500 fps.

Experimental results

Based on the first results a sample mix of 30 tube recipes was set-up and 15 of them (T1-T15) was produced in the R&D pilot plant and tested. 100 pieces of tube of each batch was run in the first test series. The results from it gave strong indications on where the critical parameters were. In the next test series some of the tubes in the first test batch were omitted and others added, and the number of tube samples for testing was increased to a total of 3980 for own produced tubes. Another 383 tests were performed for the three competitor produced tubes B1-B3. See Figure 4 and Table 1 on the next page

In the vast majority of the tests, the cause was tube impact with high enough energy to ignite and/or partially melt the tube (Figure 3).

Figure 3: Example of tube tip that was partially melted and ignited

The main cause of unintentional ignition of shock-tube is the active charge mix in combination with the capacity of the tube to store and release enough energy to ignite it. If core load is varied between 10-22 mg/m (0.05-0.1 gr/ft.) the ignition rate varies from 22 to 42% of the tubes tested. A slight decrease was seen close to 7 mg/m (0.033 gr/ft.) (T7). The propagation of the shock wave after ignition almost stopped for core loads below 6 mg/m (0.028 gr/ft). Within the functional range of the shock-tube, an aluminium content of 5-9.5% has no significant impact on the results.

The elastic energy released is a major key to unintentional ignition when pulling the tube past the breaking point. To pull the tube to breakage, a certain force is needed. The amount of energy needed for tube breakage, in combination with tube properties, decides the amount of elastic energy released after breakage.

Example 1. A strong tube with little or no elongation will be able to release 50-80% of the absorbed energy.

Example 2. A standard tube with normal elongation will be able to release 10-30% of the absorbed energy.

It should be noted that the energy needed for pulling the tube to breakage, is lower in Example 1 but that the elastic energy could be more than twice than for the tube described in Example 2. A strong tube with low elongation has a higher ability for being partly or fully ignited.

Figure 4: Results from the test series of 15 Dyno Nobel produced tubes (T1-T15) and 3 competitor produced tubes.

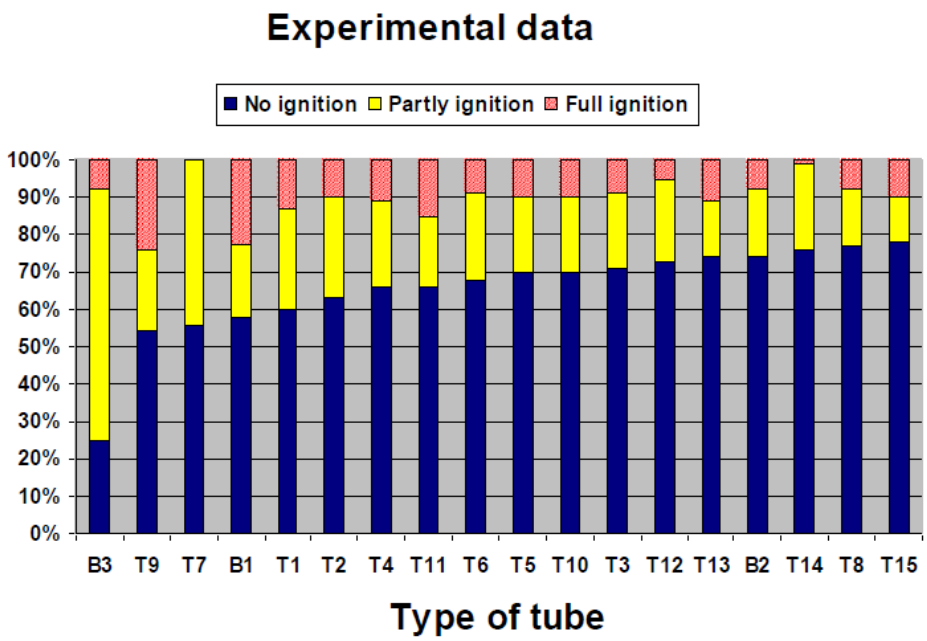


Table 1: Results from the test series of 15 Dyno Nobel produced tubes (T1-T15) and 3 competitor produced tubes.

Type of shock tube	No ignition %	Partly ignition %	Full ignition %	Tested no. pcs.
B3	25,0	66,7	8,3	12
T9	54,0	22,0	24,0	50
T7	56,0	44,0	0,0	50
B1	57,1	19,0	38,1	21
T1	60,0	27,1	12,9	350
T2	63,1	26,9	10,0	550
T4	66,0	23,0	11,0	100
T11	66,0	19,1	14,9	350
T6	68,0	23,1	9,1	350
T5	70,0	20,0	10,0	350
T10	70,0	20,0	10,0	200
T3	71,1	20,0	0,3	350
T12	72,5	22,5	5,0	80
T13	74,0	15,1	10,9	450
B2	74,0	18,0	8,0	350
T14	76,0	23,1	0,9	350
T8	77,0	15,0	8,0	200
T15	78,0	12,0	10,0	200
			Total	***4363***

Issued practices for handling shock tubes

There are many local regulations and recommendations when handling shock tube in the field and it is advised that the user follow these rigorously in order to avoid any accident due to a possible Snap, slap and shoot event.

Below we just remind you what the US and European manufacturing associations IME (Institute of Makers) and FEEM (Federation of European Explosives Manufacturers) have stated.

IME "Always" and "Never" (Ref 8).

The following have been issued for Shock Tube Systems by IME:

ALWAYS lead shock tubes to the hole in a straight line and keep it tight.

NEVER drive any vehicles over shock tube.

NEVER pull, stretch, kink or put tension on a shock tube such that the tube could be caused to break or otherwise malfunction.

FEEM CGP Blasting Practise Publication No. 28 (Ref 9).

10.1.8 No vehicle should ever drive over the lead-wires or shock tube of the initiating system.

10.3 Vehicles must be removed from the area before coupling starts.

11.1.2 The area of the blast should be secured to avoid unauthorized entry.

13.1.6 (Dealing with misfires.) No attempt should be made to retrieve a non-electric detonator by pulling the shock tube.

The CGP is a 35 page recommendation giving recommendations of handling initiation systems in transport, handling, priming, blasting misfires etc.

Summary

All the tests at RCEM where a stretch-to-snap-off with various length of tubing was performed at different strain rates never resulted in any ignition. Nor were RCEM successful in achieving any ignitions by whipping the tube or by tearing the tube.

It is clear that accidents have occurred in field and incidents have occurred at production plants when tube has been stretched. However in these cases there were objects in the neighbourhood, which the tube tip could have hit after breakage.

We could in the tests performed at Gyttorp after carefully positioning of a barrier at a specific (worst) distance replicate ignition extremely well (20-75% of the tests). In field use there is always a risk that an object could be positioned at this "worst" distance causing an accident if a tube breakage occurs due to stretching.

From the documented accidents it shows that the probability for a Snap, slap and shoot event is extremely rare. In this paper five possible (but not confirmed) accidents could have been caused by Snap, slap and shoot. In 30 years time far more than a billion shock tube detonators have been used. Five in a billion is a small number but still to big for our industry to accept.

Dyno Nobel is continuing the efforts to investigate phenomena like Snap, slap and shoot in order to make the products safer for production, handling and transportation.

It must also be emphasised that we must never violate the rules! If you are experiencing a misfire, do not rush. Stop the work, assess the situation and decide upon the course of actions. Be careful to follow the written routines on how the misfires should be handled.

NEVER violate local regulations.

NEVER drive any vehicles over shock tube.

NEVER pull, stretch, kink or put tension on a shock tube such that the tube could be caused to break or otherwise malfunction.

References

1. NN, Incident Report UO-910430-09-02-EN, April 30, 1991, Falconbridge Ltd, Fraser Mine (Canada); from Dick Fisher, MSHA.
2. Iver A. Iverson, "Non-Fatal Blasting Accident I.D. No. 39-00055, Homestake Mine-Lead, Homestake Mining Company of California, Lead, Lawrence County, California, February 7, 1992", Accident Investigation Report (Underground Metal/ Nonmetal Mine), U.S Department of Labor, Mine Safety and Health Administration, Rocky Mountain District, Metal and Nonmetal Mine Safety and Health, P.O. Box 25367 DFC, Denver, CO 802250367.
3. Ken Kinghorn, (compiler), "Blast Accident to Dave Eaves and Dave Tyler", U.S. Department of Labor, Mine Safety and Health Administration, undated compilation of "sequence of events discovered by the investigation team", apparently written upon the site visit by the investigative team, 02-07-92.
4. Marvin A. Nichols, Jr. and Vernon R. Gomez, "Premature Detonation of Explosives at a Surface Mine", Program Information Bulletin No. P94-24, Mine Safety and Health Administration, U.S. Department of Labor, July 27, 1994.
5. Paul E. Hess, Jr. and Jerry E. Sumpter, ""Report of Investigation Surface Coal Mine, Non-Fatal Other (Explosives) Accident, Costain Coal, Inc., Pax Surface Mine (ID No. 4606877), Long Branch, Fayette County, West Virginia, April 28, 1994", U.S. Department of Labor, Mine Safety and Health Administration, District 4, 100 Bluestone Road, Mount Hope, West Virginia 25880.
6. Thomas G. O'Leary, Technical Bulletin - June 1994, The Ensign Bickford Company, Simsbury, CT 06070-0483.
7. Miles Olinger and Per-Anders Persson, "Shock Tube Experiments", Report under contract with Dyno Nobel, 1997, RCEM, Socorro, NM, USA.
8. IME “Always” and “Never”. Institute of Makers of Explosives.
9. FEEM CGP Blasting Practise Publication No. 28., Federation of European Explosives Manufacturers.
10. Peter Rekas, Schaffler & Co. Ges. m.b.H., Vienna, Personal Communication, January 1997.

Meet our New Governors

At the recent Ordinary General Meeting of members held during the XVII SAFEX Congress in Istanbul, the following new Governors were elected

Terry Bridgewater (Chemring Group PLC)
Carlos Orlandi (Enaex Servicios S.A.)
John Rathbun (Austin International)
Thierry Rousse (Groupe EPC)
Mark Thomas (Orica Mining Services)

We will be introducing the new Governors to our readers in forthcoming Newsletters as we did with Terry Bridgewater in the previous issue. It is now our pleasure to introduce Carlos Orlandi to you.

Carlos P. Orlandi

Carlos is currently the Engineering and Development Manager of Enaex Servicios S.A., a recently created subsidiary of Enaex, the largest explosives and ammonium nitrate manufacturer and blasting services contractor in Latin America, with main activities in Chile.

Graduated Chemical-Civil Engineer (Universidad de Chile) and Magister in Business Administration (Universidad Alberto Hurtado), Carlos also has several certificates, among them, Marketing for Executives (U. de Chile), and Technology and Innovation Management (Mendoza School of Business, U. of Notre Dame, USA). He is a part time professor at the Universidad Alberto Hurtado in their joint program with the University of Notre Dame for Innovation and Technology Management.

He has been in the in the explosives industry since 1978, with prior experience in a petrochemical company for one year, and four years in a sugar beet processor. Carlos started his career in Enaex as Process Engineer for the Company's first ammonium nitrate plant, serving afterwards several positions in different areas: Production Superintendent Assistant in the Rio Loa Works, the old du Pont plant in Calama, near the Chuquicamata copper mine, in northern Chile; Blasting Services Supervisor for Chuquicamata (1978-1980); Corporate Purchasing Manager (1980-1983); Assistant Commercial and Tech Service Manager (1983-1987); Research and Development Manager (1987-1992), and Technical Development Manager (1992-2009). When Enaex turned into a holding corporation in 2010, he was appointed as the Engineering and Development Manager of the new company, Enaex Explosivos & Servicios S.A.; in this position is responsible of the areas of R&D, Product Development, Quality Management and Engineering.

Member of the Chilean Society of Engineers; Chilean Institute of Mining Engineers; founder and current President of the Chilean Association of Explosives Engineers ASIEX, the local chapter of the ISEE; member of the ISEE since 1989, having served the Society as a member of the Board of Directors in 2003 – 2006; member of the International Organizing Committee of the Fragblast Group since 1997. He was in charge of organizing the 8th International Symposium on Rock Fragmentation by Blasting – FragBlast 8, held in Santiago de Chile in May 2006, having been the chairman of this world class event of the explosives industry. In the industrial area, Carlos is Director of Minnovex A.G., an association of suppliers to the mining industry of innovative products and services.

Carlos was elected to the SAFEX Board of Governors during the recent Congress in Madrid; his dream for SAFEX is to expand its activities to the mining countries in South America, including the final users, to promote safety considering the whole life cycle of the explosives.

Photography, philately, gardening, biking, "some skiing" and travelling are his hobbies; he enjoys driving off road in southern Chile, collecting native plants and seeds with his wife Isabel, who is also well known in our industry.

Know the Expert Panel

The Expert Panel comprises individuals who were nominated by members and approved by the Board. Such an individual must be associated with the explosives industry and have acquired expertise in specific fields. He must also be willing to make the same available to SAFEX members on a commercial basis which is agreed between the expert and the member. SAFEX merely "connects" the Expert and the Member who has a need and does not get involved in the detail arrangements.

To access the services of a SAFEX Expert, a client Member accurately defines the need it wishes the Expert to address. This requirement is captured in a Brief which is e-mailed or faxed to the Secretary General. The Member will be notified of the details of Experts that could meet this need. It is then up to the Member to select an Expert and enter into an agreement directly with him.

Silvio Giavitto

PERSONAL

Position: President and Owner
Technical advisor to Negotrade Ltd.

Company: High Energy Technologies (HET) s.r.l.

Location: Udine, Italy

Education: Mech Eng

Affiliations: Member of ISEE

Languages: Italian, English, French,

CAREER OUTLINE

With BIAZZI (1970 – 1995):
Chief Erector
Maintenance Manager
Workshop Manager

With Negotrade Ltd (1995 – Present)
Technical Director

HET (2002 – Present)
President

EXPERTISE

- Design, construction, erection and commissioning of facilities for explosives manufacture mainly for nitration processes, dynamites, emulsion explosives, detonating cord, safety fuse, black powder and others.
- Technical knowledge (mechanical, electric, electronic, hydraulic) and practical operational experience of all explosives manufacturing plants

TYPICAL ASSIGNMENTS

Various projects for explosives and accessories including:

- Detonating Cord for perforating charges plant (China)
- NG for Pharma grade plant (India)
- NC plant (Italy)
- Detonating Cord plant (Greece and Poland)
- Emulsion explosives plant (Poland)
- Cartridging units (several customers)
- Shock tube lines (Poland, France, South Africa, Czech Republic, Russia)

Our Explosives Regulatory World

We regret we are unable to bring you an article for this Feature in this edition of the Newsletter. We have been promised some contributions for future Newsletters and hope not to disappoint our readers.

May I appeal to any readers, especially those from a regulatory environment, to contact me if they are able to make a contribution in this Feature. Our readers are interested in the approach regulators from different parts of the world adopt in establishing explosives regulations in their jurisdictions.

Explosives Eco-talk

The impact explosives and explosives manufacture has on the Environment fall squarely in the SAFEX domain. We are as interested in the experiences members of the SAFEX community (Members, Associates and Expert Panel) have in minimising explosives' environmental impact as we are in safety and health. While most of our explosives incidents concern the safety and health impact, we are eager to learn about the environmental side of our activities. By way of this Feature we encourage readers to let us have contributions which create awareness of this facet of our operations as well as assist our industry to behave with environmental sensitivity and responsibility.

The authors have kindly condensed their original Paper to produce this article. Readers who are interested in the original Paper may approach the Secretariat for it.

Dumped Ammunition in Mine Shafts

Hydrogeochemical evaluation in two mine shafts at Dalkarsberg Sweden.

by

Ulf Qvarfort & Birgitta Liljedahl

(Swedish Defence Research Agency, CBRN Defence and Security, SE-901 82 Umeå, Sweden)

1. Introduction

Military forces produce a large quantity of toxic and harmful wastes of which some are similar to the civil organizations and some specific for the Army such as explosives and chemicals for NBC defense. After the Second World War a huge amount of ammunition was destroyed or dumped at different sites. For this purpose the Swedish Army use lakes, the sea or some former mining shafts for dumping. Potential environmental hazards are now posed by the presence of ammunition and explosives in two mineshafts together with municipal sludge and household wastes. Potential migration of e.g. TNT from the ammunition, as well as components from the municipal waste, is of current concern.

The purpose of the study was to evaluate the future hydrogeochemical status of the repository for explosives at the Central and Bäckaskog shafts of the Dalkarsberg mine.

2. Basic Site Description

The investigation focuses on an abandoned iron mine, Dalkarsberg, which is located in the province of Närke, central Sweden. The mine was originally worked as early as 1559. During the period 1819 to 1925 the production was 3 000 000 tons of iron. Mining at Dalkarsberg ceased at the end of the 1930s, when the price for iron dropped.

During the period 1955 – 1968 the mineshafts were used for dumping of military ammunition and explosives together with municipal household wastes and sludge's. The shafts are expected to contains 7 tons of gun ammunition, 143 tons of hand grenades, 35 tons of land and personal mines, chemicals and 1.7 millions of detonators. Together with the household waste and sludge the shafts is today filled up to the surface

3. Field investigations chemical analysis and mathematical modeling

In the summer of 1997 a monitoring programs started were water samples were taken from inside the shafts. The samplings were done after diamond drillings at different angles from the surface and into different depths in the shafts. By this method is possible to get water samples from 125 meters depth below the surface. According to used drilling techniques it was not possible to get any deeper. A vertical boring through the dumped material and into the shafts was not possible according to safety reasons. A mining map can bee seen in the figure 1 below.

The samples were analyzed for metals by using ICP-MS and ICP-AES. Sweden. The organic components were detected using GC-techniques according to the EPA-programs.

Three different groundwater models have also been established. A regional model that represents a large area surrounding the Dalkarsberg mine and two local models that represent smaller areas surrounding the studied mine. For

the regional modeling we used the computer code MODFLOW . This is a three dimensional finite difference model. The regional model extends over a horizontal area of about 50 km^2.

The local modeling was performed by the use of the computer code GEOAN. This is a three dimensional finite difference model, capable of modeling the interaction between the groundwater surface, the ground surface and the groundwater recharge, hence, calculating recharge and discharge areas etc, it is also a model specially designed for use of the stochastic continuum approach. The purpose of Model 1 was to estimate the flow pattern of the groundwater in the rock mass, assuming that no mine exists. The purpose of Model 2 was to estimate the flow pattern of the groundwater in the rock mass as well as estimate the flow pattern of the groundwater and in the connecting tunnels .

4. Discussion and Conclusions

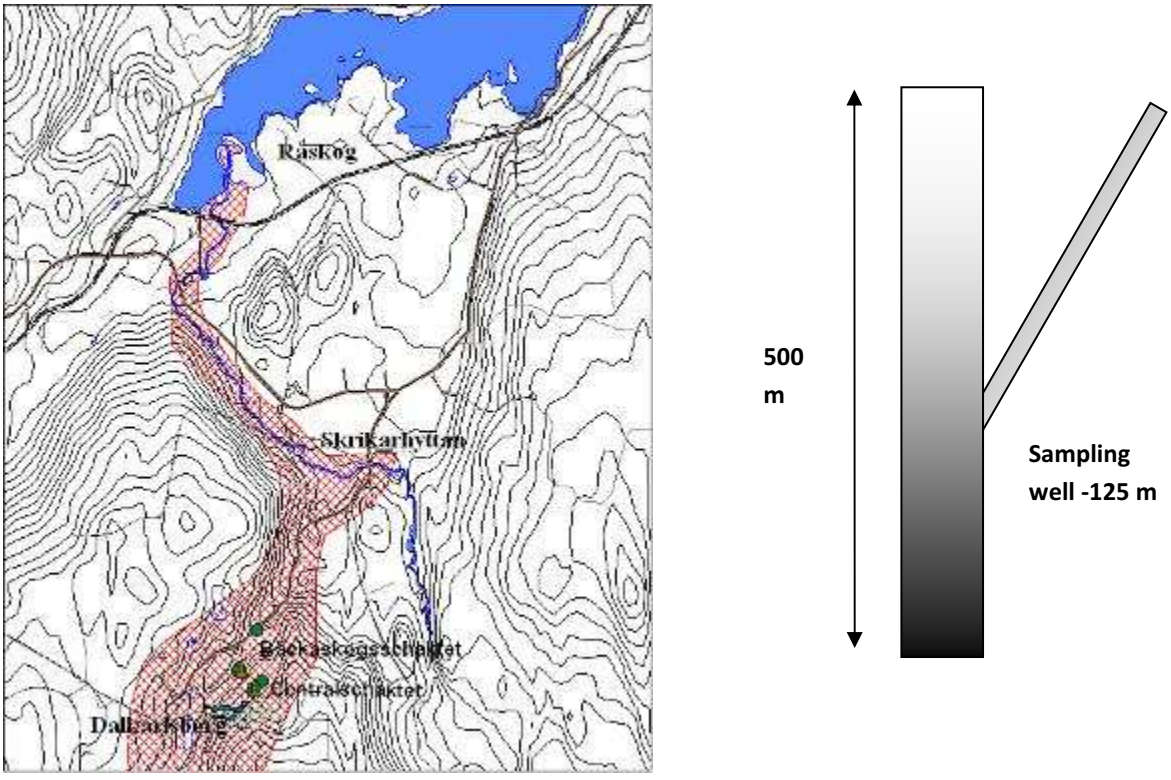
Field investigations and chemical analysis of water from the 125-meter level in the shafts showed that no trace of explosives or its degradation products could be detected in the water. The lack of TNT and lead acid in the water is thus explained by the fact that the ammunition has not started leaching. A complete release due to diffusion has been calculated to 2000 – 20 000 year. However, this did not explain the lack of trace from the extensive amount of picrine acid that was dumped in both shafts. This also applies for e.g. nitrogen and chloride that would be expected from the municipal sludge and household waste in the shafts.

The model predicts however that all water in the mine system will discharge to the surface water in the very near vicinity of the uppermost part of the Bäckaskog shaft. A stream will then drain the discharge area to a lake in the vicinity of the mining area. Due to the local topography in combination with the design of the mine the model predict a somewhat unexpected flow pattern. Unlike a very slow groundwater flow that is commonly found in abandoned, hydrological stabile mine in Sweden, the groundwater flow is relatively fast and concentrated to the tunnels and shafts. No long flow paths of potential polluted water are thus expected to the surrounding bedrock.

The results reveal that the water as mention above in the upper 125-meter level of the shafts is of drinking water quality today. This unexpected high quality of the water might be explained by the high flow indicated by the model. The model predicts a break through time at the Central shaft between 1.5 and 16.5 year. In the Bäckaskog shaft the time varies between less than one year up to 15 years. This means that all the soluble components as picrine acid and nitrogen/chloride has been washed out from the system.

In a long time perspective, over 1000 years, the concentration of TNT in the discharge area at the Bäckaskog shaft might be expected in a magnitude of 0.001 mg/L. The main conclusion for the moment will be a recommendation to seal the shaft to prevent further dumping and to end the monitoring program for the coming five years. The monitoring program is then recommended to be done with a periodicity of 2 to 5 years.

Figure 1: Map of the mining area. The right part of the figure shows the shaft and the sampling well.



Pondering the Profession

The so-called 'Safety Professional' is an important component of the explosive industry's health, safety and environment efforts. If that is the case, we should be devoting a column to our Safety Professionals and create a forum in which we can talk about the Profession. We have referred to it as "so-called" because as we well know the work of the Safety Professional goes further than safety and often includes health, the environment and sometimes security as well. The Board of Certified Safety Professionals (BCSP) puts it this way: "*Today's safety professionals are well-educated, highly-motivated and aim to recognize, evaluate, and control risks to people, property and the environment. They must be able to apply technology and work with top management to minimize risk and ensure that safety, health and environmental performance are fundamental measures of business success.*" Our aim is that this column will be read by all but that the Safety Professionals in our industry will make it their own.

Thoughts on the Safety Function in an Organisation

In the last edition of the SAFEX Newsletter we asked 3 questions about the Safety Function in an organisation:

- Where a Safety Department should be placed in the organisation structure of a company?
- What a good organisation structure for a Safety Department will be?
- How a company should implement a Safety Management System (SMS)?

These questions were prompted by a member company who was in the process of reviewing their Safety Function.

We were fortunate to receive two responses which we are happy to publish in their entirety. It is noteworthy that both responses came from serving Governors. To us this indicates that our Governors are committed to safety issues and active contributors to the SAFEX Newsletter. The first response is from Terry Bridgewater who is the Director of Safety for the Chemring Group and a long-serving safety professional. Steve Dawson who is the President of Dyno Nobel Asia Pacific gives a line managers perspective in his response.

We are very grateful to Terry and Steve for their contributions which we hope will encourage other safety professionals and managers also to contribute to this discussion or any other issues regarding the Safety Function in an organisation.

Terry Bridgewater (Director of Safety, Chemring Group) Responds

1. "Where should a Safety Department be placed in the organisation structure of a company?"

I think I have experienced most reporting structures. I currently report directly to the CEO and this has to be the best way. He sits in the next office to me and is easily accessible – and everyone around the business knows that and it provides me with a reflected authority. However, most companies are not organised this way.

In my last job (a large FTSE100 engineering firm) I reported to the HR Director. He is a lovely man and safety had a softer feel but it was difficult to significantly influence the manufacturing operation because there was no direct authority and the message was easily diluted or ignored. My prior job was working for a US aerospace company where I reported through the legal department – clearly their concern was with legal compliance rather than a broad process of continual improvement. In the 1990s, I worked for another aerospace company where I reported to the VP Operations. This was a successful structure and I was on the same level and had the same boss as the factory general managers. We were in the same team and built our objectives together. At Rolls Royce, I believe that safety comes under the VP Engineering which is interesting because some argue that the root of all product and manufacturing process problems are the result of decisions made by engineers and thus, with safety at the core of engineering, downstream issues should be eased.

2. "What will be a good organisation structure for a Safety Department?"

The first thing is to understand what you want the department to do. I am a big believer in making sure that safety is the responsibility of all in the work place. Safety in a production facility is the responsibility of the production management. They are responsible for hazard assessments, protective systems and equipment as well as ensuring training is up to date. The safety organisation should not 'do' safety.

I believe that the key corporate safety department roles are (a) to set and communicate the overall strategy, goals and aims; (b) to monitor and report to the Board on performance and compliance with the strategy. Additional roles may be to run an audit programme, to promote and share good practice amongst different parts of the organisation and to develop minimum requirements for certain activities. Furthermore, they should be involved in developing and presenting safety training programmes, formulating safety policy and

strategy, participating in incident investigations and anything in which an independent view is required.

Each individual business unit must have competent safety professionals attuned to the risk with a direct reporting line to the local operations management. Again, the local safety professional will facilitate hazard and risk analysis with local teams but Operations must own the responsibility and be accountable.

3. "How should a company implement their safety management system (SMS)?"

This should be the easy bit. Once a clear vision and policy has been established, this can be divided into individual activities and competent people assigned. Making sure that areas of responsibility are clear and that there is local ownership tied in to personal performance and remuneration goals will get the job done.

However, I am unsettled by the wording of the question. It suggests that a SMS has been developed and now they want to implement it. This is the wrong way round. The SMS has to be developed from the bottom up with full and active participation of all levels and areas of the organisation. If not, it will fail.

Steve Dawson (CEO, Dyno Nobel Asia Pacific) Gives His Views

Key issue for me is that HSE remains a line responsibility. Any HSE department created should be there to act as coaches and mentors to line management, effectively an internal consultancy. In addition the HSE team should do the detailed work in terms of understanding regulatory requirements, HSE systems and processes that can deliver improved safety performance across the business, i.e. they have responsibility to identify and operationalize Continuous Improvement opportunities in the HSE field.

It is critical that line management don't see the HSE team as responsible for HSE performance in the business. It is also important not to complicate things unnecessarily as this makes compliance difficult – the Keep It Simple Principle (KISS) applies

Structure, to me, is less important than the principles outlined above. That said, my preference is a small HSE team reporting into a senior manager. This makes it easier for this team to take on the consultancy type role. My experience when HSE professionals report into lower level line management is that there is a tendency for them to become administrators for the manager as well as creating the perception that they are responsible for safety in the team not line management. This is obviously people dependent. Both options can work I just think the first option is easier to manage, control and therefore delivers a better outcome.

Safety Snippets

Accident Investigation – How not to do it

by

Ken Price

(Riskom International Pty Ltd)

Ken Price was an explosives regulator for 30 years and retired as the CIE of Western Australia in 2001. Since then he is consulting as Riskom International. Its activities include working with and for the United Nations Secretariat in Geneva. Riskom consults to governments and industry on explosives safety in transport, storage and manufacture. Ken is the Honorary Secretary of the International Chief Inspectors of Explosives (CIE) Forum. Because of his experience and commitment to SAFEX, Ken was unanimously accepted as an Individual Associate Member of SAFEX at the recent General Meeting in Istanbul

This paper was prompted by numerous observations and personal investigations that were less than perfect in explosives and dangerous goods work. I hope I have managed to cover my tracks sufficiently that it doesn't result in any lawsuits or too many lost friends or associates.

Particular thanks to Martin Braithwaite and Bob Sheridan for supplementary ideas when the article was being developed. Unfortunately I can't blame them for the content of the paper should there be any complaints.

First action – Don't Panic!! (Captain Mainwaring, there's a mine under the pier!)

On several occasions when I was trying to work through the immediate response part of an accident I contemplated that one of the early actions that should be taken would be to deploy a person to run around randomly waving arms about and generally generating the appearance of doing stuff. This appearance of activity is good for Ministers (my experience is with governments, but it probably works for Managing Directors and Senior Board Members) who need to see Immediate Action and be able to Reassure Constituents that everything is under control.

Then, while the mad faffer is faffing around, the first priority of the investigation is to discover whether the regulator is in the clear - after all, the community is relying on the regulator to protect them aren't they? And anyway, once we get the answer to this one, we can then determine how 'serious' the investigation needs to be.

If there is some doubt as to whether the regulator is in the clear then appoint the Inspector who regularly inspects the subject site to be the lead investigator - this will ensure that there will be no serious deficiencies found, at least none that weren't previously raised by the Inspectorate.

Of course if this appears too obvious, appoint an investigator from outside the regulated area, 'to ensure an honest and open investigation'. The fact that the investigator knows nothing about the subject can be spun as a good thing; after all , he is completely independent. And the side effect is that it will also ensure no deficiencies will be found, with the cause being determined as lightning, meteorite or some other Act of God.

Immediately after the panic – get the lawyers involved.

This is ideal protection. Messrs Sue, Grabbitt and Runne seem to have a reputation in this area; they successfully manage to cover everything in spin and fluff and then avoid questions because the matter is before the courts. And of course the lawyers will make sure that no useful report ever sees the light of day. So unfortunately the rest of industry can't learn from the errors of others.

You might however also suggest to the lawyers, that one day, the truth will come out. And when it does, if there are subsequent events that might reasonably have been prevented should the truth have come out earlier, then there could still be law suits – and likely much more onerous.

Secure the site and keep all the experts out.

After all, we should know all about the site so why bother ourselves with other points of view. Then when we are satisfied we have a plausible cause and we won't be held responsible for anything, we can release a report showing how it was all someone else's fault.

Never let the facts get in the way of future potential problems.

Clean up as you go.

Don't record the position of debris, just clean up the site as you go. This can be called "looking forward" or "moving on" or a similar positive sounding phrase, and will ensure that your conclusions can't be challenged.

Don't make any real changes

If you make changes it lets your boss know that you aren't perfect and can't manage within your resource allocation. Or that perhaps your site is vulnerable to the same problem that wasn't identified in the first accident. We wouldn't want any of that!

Worse still, we ignore the elephant in the room. We all know that some of our practices are wrong – pick one that suits:

- we shouldn't park loaded explosives trucks ready for an early departure tomorrow morning (but the convenience and cost savings outweigh the potential risk of theft of explosives, boosters and detonators in one convenient package);
- we shouldn't be mixing ANE in an industrial area. (It will never explode – it's only Class 5 – an oxidizer);
- we shouldn't pump petrol into overhead tanks. (This is an old one from my dangerous goods repertoire. It was too dangerous for the majors but they were happy for their small time agents to do it);
- we shouldn't drive over the speed limit. (Getting personal now. Lets keep safety in the workplace where it belongs. Don't bring it into my personal world);
- we shouldn't test electric detonators at the face – or tolerate out customers doing it. (A really old one. Is it still done?);
- we shouldn't talk on the mobile phone while driving. (Another personal one);
- we shouldn't sell emulsion to miners who don't understand the potential for danger when sensitizing it. (After all, one pump is as good as any other);
- etc.

But "everyone is doing it" and if we change, we will be at a commercial disadvantage. So we'll continue to tell everyone that we are the safest company with the best procedures and they'll continue to believe us.

Forget about the long term – focus on the immediate problem

How often have I observed a major calamity in another jurisdiction and seen related organizations reassure their management that all is well and we have no need to make any changes here.

A real strategic thinker will have one or two contingency plans in his bottom drawer ready for deployment in the right circumstances.

The brown stuff hits the rotating cooler big time, your boss comes to you and says: "what should we do about this?" Out comes the plan that you have wanted to deploy but could never hope to get approval for in normal circumstances.

A good variation on this theme (generally only applicable to government employees) is to get the relevant politician to promise (to the media) that all the recommendations of the inquiry will be implemented. Then you can get those resources that you had long been seeking as one of the high priority recommendations.

Take some immediate action to make sure that accident won't happen again.

A car runs into an explosives truck on a major regional arterial road and traffic gets held up for two days because the local fire brigade is unsure what to do. He cordons off the entire area for two kilometres and evacuates 500 people in the middle of winter. The locals complain, the media is going nuts…

So at the height of the media blitz, the Minister declares all dangerous goods vehicles will no longer use that road in order to safeguard the public. Big cheers all round, until either:

- The mining industry grinds to a halt because no explosives are getting through;
- The local business people (the same ones who complained about the accident) notice that business has dropped by 50% because the truckies who used the old highway no longer stop at their cafes;
- The trucks then use a variety of minor roads that are much more dangerous, closer to people and increase driver fatigue; or
- The minister takes no substantive action, so all the trucks ignore him and carry on as usual.

Meanwhile, the untrained fire brigade commander continues to agitate because the trucks continue to travel through his patch and he still doesn't know how to properly manage an incident.

And all the long term issues continue to be ignored.

Don't apologise or accept that anyone made a mistake.

And don't acknowledge the painfully obvious. So despite parts of magazine doors being removed from residential houses' ceilings, or rocks as big as tables landing in living rooms, the incident was only a minor one, no one was killed (well, not yet anyway) so our safety measures worked well, and it's unlikely that it could ever happen again.

If you do have to admit there was a mistake made, some good options to assign blame to are:

- Human error (particularly effective if all the humans affected are deceased);
- The previous manager;
- The previous site operator;
- Lightning or other Act of God.

Ideally, the previous manager will be deceased or the previous site operator will have gone out of business thereby tying up all the loose ends for you.

Marlie Farm Significant Findings Report Published

Marlie Farm after the explosion
(Photo: Safety & Health Practitioner Magazine)

Two fire fighters died and four people (including two fire fighters and a police officer) were hospitalised following a fire and subsequent explosions at Festival Fireworks UK Ltd, an explosives site at Marlie Farm, Ringmer, East Sussex on 03 December 2006. The site was licensed to store over 20 tonnes of imported fireworks, to prepare fuses and build displays. After the incident Des Prichard, Chief Fire Officer & Chief Executive of the East Sussex Fire & Rescue Service (ESFRS) said: "I can give you my absolute assurance that *I will be open and honest with regards to the accident investigation and the fire investigation. I owe that to the families* (italics added), to be open, but it will undoubtedly be a long and protracted investigation and when the facts have been obtained they will be made available."

On 27th July 2011 Des Prichard made good the promise when the ESFRS published its Significant Findings Report on the explosion at Marlie Farm. The Marlie Farm Accident Investigation Team was led by ESFRS Deputy Chief Fire Officer Gary Walsh who said: "The Significant Findings Report provides information on the background to the incident, a minute-by-minute timeline of exactly what happened on the day and the areas looked into as part of the investigation. First and foremost I must stress *that its purpose is not to apportion blame to any individuals, but to establish if anything could be done to help prevent a similar situation occurring in the future* (italics added). Ultimately, *by sharing the report's findings, it is our objective to try and prevent a similar event ever re-occurring* (italics added).

While this report concerns a fireworks incident, we believe there may be some learning points for our readers as well. In addition Adrian Brown, Director of Response & Resilience, East Sussex Fire & Rescue Service has asked us to bring the report to the attention of Members' local Fire Services. He says: "I would stress this is the Fire Service report into its actions and what happened with regard to its staff. I encourage you all to read the report and if possible make your local Fire Service aware of the report and its contents."

Readers will undoubtedly recognise the similarity between the portions in italics and the SAFEX message. A copy of the full report can be accessed at http://www.esfrs.org/document/pdf/about_us/marlieFarmReport/significantfindingswhole.pdf

Inbox @ SAFEX-International.org

From time to time we receive e-mails from members of the SAFEX community on a variety of issues. It is important we share such experiences and insights and if necessary debate them. Our quarterly Newsletter may just be the forum for doing so.

We therefore invite ALL readers to drop us a line at secretariat@safex-international.org if they want to raise an explosives health, safety or environmental issue or comment on any of the opinions received from our correspondents.

SAFEX members contribute to Safety Performance Indicators (SPIs)

At the end of June Terry Bridgewater (Chemring PLC) asked SAFEX members for examples of leading safety performance indicators (SPI's) that can predict safety performance in the explosives industry and (a) Are not too difficult to collect; (b) Do not require huge amounts of data; (c) Can be used as a basis of comparison between sites; and (d) Offer sufficient clarity to drive change within an organisation.

Terry wants to thank the following members for replying to this Request for Information (RFI): Philippe Aufort (Eurence Sorgues); Frank Barker (Expert Panel); Jeff Benz (Hi-Shear Technology); Richard Bilman (CSBP); Janusz Drzyzga (Nitroerg); Susan Flanagan (IME); Piet Halliday (AELMS); Noel Hsu (Orica USA); Niamh Joyce (Kemek); Ismail Kir (Nitromak DNX); Peter Lenzin (RWM Schweiz); Karen Lowe (BAE Systems); Lisa Molochkova (Iskra); Helen Muller (Dyno Nobel); Ardaman Singh (Visfotak); Takaaki Torikai (Kayaku Japan); Mervyn Traut (Expert Panel); Gerhard Vosloo (Burkan); and Dave White (EPC-UK).

Terry consolidated the feedback he received and prepared the following summary of the SPI's SAFEX Members provided:

Audit

- Overdue actions;
- % Actions from audits, risk assessments and inspections completed on time;
- Workplace inspections: planned v actual;
- Results from a predefined list of audit questions measured for improvement on a year on year basis;
- Incidents/near misses reviewed where causal factor was failure to implement audit recommendations;
- Review of risk assessments and operating instructions (planned v actual, actions closed on time);
- Review of high hazard processes in line with their basis of safety (planned v actual);
- Number of Basis of Safety audits completed;
- Regulatory inspections with citations.

Leadership

- Senior executive tours: planned v actual;
- Incidents/near events reviewed where causal factor was insufficient management leadership and presence;
- Senior management participation in the risk assessment process;
- Leading annual basis of safety workshops, helping with risk assessments or JSA's;
- Face to face audits with local managers on the rigour of their risk assessment process.

Process Safety:

Emergency preparedness

- Emergency safety systems – frequency of testing v testing programme;
- Maintenance of fire prevention/protection systems.

Incident management

- Investigation close-out;
- Early injury reports;
- Recordable injuries or illnesses;
- Security incidents;
- First aid injuries;
- Investigations open > 30 days.

Process control

- % of waste destruction fires inspected by lab staff prior to lighting;
- Incidents/near events reviewed where causal factor was unclear or incorrect operating instructions;
- Safety shutdown system inspections completed/not completed.

Management of Change

- % of actions identified v auctioned;
- Sample check of change process;
- Incidents/near events reviewed where causal factor was failure to control change.

Maintenance programmes

- % completed v schedule: Adherence to PM schedule;
- Breakdowns in a month;
- Incidents/near events reviewed where causal factor was failure to inspect, test or maintain;
- % processes with current FMECAs.

Product

- Incidents/near events reviewed where causal factor was a deficiency in design.

Hazard studies / Risk Assessment etc

- Risk assessments - % reviewed v schedule;
- Risk register actions overdue - actions from hazard studies, risk assessments etc;
- Job Safety Analysis completed on high risk and non-routine tasks;
- % of hazard studies, risk assessments and JSAs completed vs. Requirements.

Culture

- Daily Tool Box Talks / Talk safe discussions planned v ACTUAL, % attendance;
- Evaluation so that employees can express (dis) satisfaction;
- Reporting of near events, unsafe places and unsafe acts : target v reported %;
- Safe act observations completed;
- Safety Meetings held

Housekeeping

- Frequency of inspection of screening systems v foreign object inspection programme;
- Incidents/near misses reviewed where causal factor was poor housekeeping.

Competence

- Operator errors;
- Number of training/retraining hours completed;
- Incidents/near events reviewed where causal factor was not following instructions;
- Incidents/near events reviewed where causal factor was lack of competence;
- Training: planned attendance v actual
- Qualified people:
  a. % employees having xx years' experience in the industry, including x years in the current activity;
  b. % employees qualified in explosives/chemistry etc;
- % completion of hazard study training and new leaders;
- Core skills training;
- Active off-the-job safety training.

We will welcome any comments or further suggestions for leading SPI's from our readers

Further thoughts on fighting tyre fires

Comments about a tyre fire on a truck carrying a container of ANFO explosive, cartridge emulsion and detonating cord on the way to a customer site were published in this feature in the last SAFEX Newsletter (No. 37).

This prompted Ken Price (Individual Associate) to add the following observations: A similar accident occurred in Western Australia about 15 years ago. As a consequence Dyno Nobel did some research into fire extinguishers and concluded that water based fire extinguishers using aqueous film-forming foam (AFFF) were the most effective. Water is needed for the cooling and normal foam tends not to stick to the tyre as well as AFFF.

Another finding was that if the driver is confident he has a tyre fire, the best option is to keep driving as the tyre will shred and dissipate. This is certainly not for the faint hearted. It sounds good if you say it fast, but comes with many subsidiary problems. For example: on a long vehicle, how can one be sure a fire is a tyre fire; what if the molten rubber sticks to other parts of the vehicle and ignites them etc.

Alex Mandl (now with Maxam, Australia) led most of the research and may be able to provide more details.

Are our decontamination procedures up to scratch (and being followed)?

A member reported a near-event recently in which a small quantity of nitrocellulose hidden in a weld ignited during repair work.

This incident reminded Mervyn Traut (Expert Panel) of a similar incident he had encountered: I wonder whether the decontamination in this case was done chemically (typically using an alkaline solution); or by boiling in a hot bath (typically glycerine at an elevated temperature); or in a specifically designed oven (typically barricaded or underground); or by burning on the burning ground)? The latter is normally the most effective way if the contaminated item can withstand the temperature without its mechanical or other properties being affected.

I am aware of two occasions in the past involving similar incidents. In both cases the items has not been decontaminated at all because of a mix up in the identification (tagging) system resulting in the wrong bit of equipment being tagged. The root cause was found to be that contaminated and decontaminated objects had not been physically separated in the decontamination bay and so had the potential to be mixed up. The other problem was that the person who had done the decontamination had gone off shift, passed on a verbal message and the person on the next shift got it wrong. The person who was involved in the one welding incident where PETN was involved was not as lucky and lost two fingers. It could have been worse. In the other incident the mistake "only" resulted in a "pop" and served as a good warning!!

You can understand I have a thing about the correct procedures being followed with respect to decontamination and really do not think we always pay attention to the process. It is again a bit like burning grounds where we often go through the motions without regard for the consequences.

Do not burn empty drums and explosives together

Members recently received an Investigation Report that highlighted the recommendations and learning points from a burning ground explosion which occurred while a Member was destroying emulsion explosives cartridges.

Maurice Bourgeois (GD-OTS) commented as follows: There is a lot to learn from this incident. In addition to the obvious conclusion about avoiding excessive explosive confinement during burning, I think that mixing empty or sometimes not so empty drums with explosives on a burning ground should be prohibited. We have had empty or not so empty black powder kegs on our empty container burning ground travelling near 100 m distances. They usually bulge and hot gases are eject through the pouring hole propelling the keg like a rocket. I can imagine a keg with the hole pointing to the sky creating quite an impact on the hot explosive bed below. **S**o yes, the corrective measure to separate drums from bulk explosives is a good idea.

Value of drop tests emphasised

A near-event occurred in a Member facility earlier this year when a 5.56 mm cartridge initiated during packing.

We received the following observations from Maurice Bourgeois (GD-OTS): This is an interesting case. Primer cap sensitivity can be adjusted by increasing primer cap depth in the cartridge case bore hole. This increases primer cap anvil compression which increases sensitivity. If the drop height of the cartridge is sufficient and primer cap sensitivity is adjusted on the high side, the 5.56mm projectile having sharp nose can impact the primer cap and set off the cartridge just as the striker of the firearm would. Drop tests should be done to determine the critical height. Equipment settings should then be made so that the fall height of cartridges in the process is lower than the critical height. If that can't be achieved some type of speed control mechanism should be put in place to reduce the cartridge speed or an intermediate escapement should be introduced to cut down the fall height.

Safety demands good process and equipment design

Another Investigation Report reported in an open and honest manner the issues leading up to an incident in which an operator lost a hand as result of a detonator crimping incident. Another worker who was passing-by was also injured by shrapnel. The Report highlighted non-compliance with prescribed operating procedures on the part of the operator. One of the issues was that the operator had to watch out for passers-by.

T**his prompted Maurice Bourgeois (GD-OTS) to observe**: I am puzzled that the operator has to watch out for passers-by. I think the work station should be designed or isolated in a way that passers-by are protected against shrapnel. Alternatively, passers-by should not be permitted in the area during production. Also, I don't think the operator should have a hand on the detonator during the crimping operation. Usually, we use twin tie-down switches. This means the operator must push on two switches simultaneously for the equipment to operate which eliminates the risk of having one hand in harm's way.

Takaaki Torikai (Kayaku Japan) also commented on the same Report as follows: Thank you for this Investigation Report. I am impressed by its honesty and the trouble the Member has taken to report the causes in great detail. Well done. .

In his reaction to the Report John Bennett (Orica UK) wrote: I completely agree with the importance of following procedures highlighted in the Report. We have a similar assembly operation at one of our sites. In this case the crimp dogs are activated only when the base of the detonator touches a pressure sensor at the bottom of the unit. In the process layout we have adopted it makes no sense for the operator to have any other detonator in hand other than the one being crimped. However as always we are dependent upon procedures being followed and we audit and monitor to ensure this.

Another area where a similar incident could occur is the test area where I believe there is a bigger risk of the operator having more than one assembly in hand and potentially firing the wrong one.

Tony's Tale-piece

A tailpiece is something that appears at the end of a publication. I guess it is derived from the tail of an animal which is (normally) fixed to "the end" of it. However, we refer to this feature as a "Tale-piece". It is not a spelling mistake but a different tale. This "tale" is about telling stories. While it appears at the end of our Newsletter, it is also meant to tell a story hence the play on words. Let me tell you what "Tony's Tale-piece" is about.

Tony Rowe from AEL Mining Services has kindly agreed to provide a regular feature based on truths he has discovered over many years in his work with explosives. He has a unique style of writing (perhaps "telling stories" may be a better way to describe it) which we hope gets a well-known message across in a new way. This Feature is there to remind readers of some explosive(s) truths in a different way!

So you thought the life of an Explosives Operator was easy

by

Tony Rowe

(AEL Mining Services)

Readers interested in the manufacture of commercial explosives may be intrigued to discover the hidden realities underpinning the production of explosives in the 21st Century. It is not all wine and roses as I discovered when I recently was offered the enlightening experience (for me at least) of working as an operator within an explosives manufacturing plant. I was to learn that despite all the advances in technology, sometimes there is no substitute for sheer hard work.

I was selected from a short list (*the only other candidate suddenly upping stakes and leaving the country*) to work at a facility manufacturing primary explosives.

It was certainly a unique experience, one that in hindsight I might have been far wiser to avoid. As it turned out, four weeks of uncompromisingly hard labour did offer some benefits; for instance I gained some fresh perspectives around the meaning of life and the ethos surrounding the diversification of labour, but also learned more practical stuff such as the topical application of pain relieving embrocations and liniments. I also came away with a whole lot of respect for the personnel who routinely man such production plants.

The exercise cost me 5 kg of useless, ugly fat - my head fell off, but it could just as well have been much lower down, as quite frankly I worked my butt off too.

I broke nails, stubbed my toes and ached in places I had forgotten even existed. Despite consuming around 2,5 litres of liquid per day, I remained constantly thirsty. Urination had all but ceased, I was putting it in, but it wasn't coming out. I didn't eat much either – I didn't get time.

It was dark when I left home and dark when I returned. I became irritable and grumpy. Home after a hard day in the cubicles, I would snarl at the dogs and shout at my long suffering wife. Small grievances became major issues and intense arguments would be sparked by the silliest of things. I would crown it all by wolfing down my supper and going straight off to bed. My wife almost divorced me. She said that I was no fun.

She was right I wasn't fun. I was an operator. I no longer drove a desk; not any more. I didn't even have one, I stood instead and I walked. I walked up stairs and I walked down stairs. I lifted unaccustomedly heavy weights and trudged endless cold kilometers. I treated and transferred liquid effluent.

I hosed out evaporation ponds and carried hundreds of kilograms of primary explosives,

but by far the worst job - and one that I came to dread - was the making up of bulk reagent solutions.

It was simple enough work. It involved pouring a few hundred kilograms of a heavy metal salt into a large mixing tank filled with water, called a dissolver. The reagents themselves came in 25 kilo bags. The trouble was that over time, the once free flowing salts would harden into a solid lump. Such bagged lumps were endowed with the properties and pourability of paving stones. The ancient Egyptians could have built pyramids out of them.

Affected bags (which meant all of them) had thus to be subjected to a pre-softening process. This involved the vigorous application of a heavy metal device, commonly called a club. Bags would be first spoken to harshly, then beaten until they behaved. This demanded significant physical effort on my part, generating lots of unwelcome perspiration. What was soul destroying was that even after such dedicated attention, the stuff still refused to flow through the grid into the dissolver. More physical encouragement was required, once again via the vigorous application of the metal persuader.

At the end of a dozen or so such bags I was a broken man. If someone had told

me to pulverize just one more bag, I would have promised anything, given away all the money in my wallet, the keys to my car or sold my immortal soul to avoid processing it.

The salt itself was also pretty toxic, so no skin contact.

To protect my delicate extremities I was supplied with and routinely wore a pair of black rubber gloves extending to above my elbows. I was thus transformed. I had become a proctologist, but arguably not a very good one, as both my sense of touch and manipulative dexterity where both horribly diminished. The handling of anything smaller than a pipe wrench was fraught with difficulties. With my gloves on, I found that with practice that I could tell the difference between a bar of Toblerone and a sachet of milk, but not by touch. I had to read the labels.

The reagent was also toxic if swallowed or breathed so I wore a mask. I kept a spare one in my pocket. My wife thought it was Halloween. Safety glasses protected my eyes and acid resistant overalls and rubber boots covered the other bits. Underneath it all I wore my "V" necked underpants known as "Long johns" and as a consequence sometimes walked with a bit of a trot. Fully protected by my splendid new outfit I pressed buttons, dispensed acid, sprayed water, stirred and pumped effluent and washed and carried explosives.

Am I a better man for it all?

I am certainly lighter now and much slimmer. I move though with all the grace of a clockwork parrot as both knees have seized-up. My hair, once an attractive mousey colour, has turned white and I have black curly teeth.

I am convinced that my head is on upside-down.

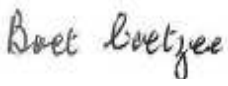
I still have the nightmares. My doctor says not to worry, to keep taking the lithium and they'll probably stop in a few years. In the meantime I should foster warm fuzzy thoughts and drink lots of cocoa.

I was also proud. I was proud of what we had achieved. We never short supplied and the up-line processes were kept at close to full production. No small thing, I suppose, but still I don't want to go back. Please Doctor, please don't make me go. The room with mattresses on the walls. Yes Doctor. Oh! The yellow tablet? Of course……

Happy fuzzy thoughts.

The explosive I was making was a primary explosive known as lead azide. It remains a vital component of the modern detonator. During more than 50 years of continuous use, it has proved itself to be a robust and reliable detonant. Lead azide is thermally stable to >200°C, but because it releases lead upon detonation makes the material somewhat environmentally unfriendly. Lead azide also has a few foibles. It doesn't like copper, brass or silver for instance and can, under certain conditions of manufacture, react with them to form other dangerously sensitive explosive compounds. The presence of grit or other foreign matter is another no-no. If you somehow become unfortunate enough to cause the initiation of lead azide it will proceed to detonate at somewhere in the region of 4500 meters per second. It's a challenging material.

Time to sleep now.



Boet Coetzee
Secretary General, SAFEX International
Tel: + 1 919 342 5848
Tel/Fax: + 27 21 854 4962
E-mail: secretariat@safex-international.org

ACKNOWLEDGMENTS

SAFEX International thanks the following for their contributions to this Newsletter:

- **Paul Clark,** Arabian Exploisves Company
- **Roger Holmberg & Dick Salomonsson,** Formerly Dyno Nobel, Gyttorp
- **Jeff Dean,** ISEE
- **Carlos Orlandi,** Enaex Servicios
- **Silvio Giavitto,** HET
- **Ulf Qvarfort** & **Birgitta Liljedahl,** Swedish Defence Research Agency
- **Terry Bridgewater,** Chemring Group
- **Steve Dawson,** Dyno Nobel Asia Pacific
- **Ken Price,** Individual Associate
- **Mervyn Traut,** SAFEX Expert Panel Member
- **Maurice Bourgeois,** GD-OTS, Canada
- **Takaaki Torikai,** Kayaku Japan
- **John Bennett,** Orica UK
- **Tony Rowe,** AEL Mining Services

BOARD OF GOVERNORS

REGISTERED OFFICE

SAFEX International
c/o Modoux Services Sárl
Route du Village 13
CH – 1807 BLONAY. Switzerland
Web: www.safex-international.org